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INFLUENCE OF PROCESS PARAMETERS ON CELLULASE PRODUCTION BY *Trichoderma viride* (MTCC 800) EMPLOYING SOLID STATE FERMENTATION

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ABSTRACT

In this study, the effect of physico-chemical parameters on the production of cellulase from *Trichoderma viride* (MTCC 800) were examined using five different agricultural residues namely banana peel, groundnut shell, corn cob, sugarcane bagasse, and pigeonpea stalk. The process parameters examined were pretreatment method, supplementation media, initial media pH, incubation period, temperature, and leaching agent. Among the parameters studied, maximum cellulase production was obtained on all the substrates treated with 1 N H_2SO_4 supplemented with Mandel's medium of pH 5.5-6 after 6-8 days of incubation at 30-36°C and 0.05 M phosphate buffer (pH 7.0) as a leaching agent.

Keywords: Agricultural biomass, Biofuel, CMCase, FPase, Optimization.

INTRODUCTION

Fossil energy, the chief source of energy used by human beings needs to be replaced with sustainable energy due to the drawbacks of fossil fuels such as limited resources and negative impact on the environment (Ge and Li, 2018). As a result, renewable energy in the form of biofuel has gained enormous interest in recent years (Sindhu *et al*., 2019). Cellulases are the enzymes that completely hydrolyze cellulose present in lignocellulosic biomass into smaller monomeric sugars, such as glucose that has several biotechnological applications including the production of biofuels (Guerriero *et al.,* 2016).

Solid-state fermentation (SSF) is a cost-effective approach for cellulase production, however, in developing a successful SSF process it is essential to investigate the effect of significant fermentation process parameters. Therefore, in the study, we examined the effects of process parameters, viz. pretreatment methods, concentrations of acid for pretreatment, incubation period, temperature, moistening agent, initial pH, and various

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leaching agents for cellulase production employing the SSF technique by *Trichoderma viride* (MTCC 800) using agricultural biomass. Substrates were finalized after proximate and compositional analysis of several agricultural residues collected from the farms nearby the Parbhani district of Maharashtra (India) in our earlier studies (Kakde and Aithal, 2021).

MATERIALS AND METHODS

Microorganism and Culture Conditions

Pure culture of *T. viride* (MTCC 800) selected for cellulase production was procured from Microbial Type Culture Collection and Gene Bank (MTCC), CSIR-Institute of Microbial Technology, Chandigarh, India.

Substrates and SSF for cellulase production

Agricultural substrates used included banana peel (BP), groundnut shell (GS), corn cob (CC), sugarcane bagasse (SB), and pigeon pea stalk (PPS). Each selected substrate (5 g) was taken in a sterile petri dish and inoculated with 0.1 mL spore suspensions (10^8 spores/mL-suspension) of *T. viride*. A sterile Mandel's medium of pH 5.0 was used as a supplementation medium to adjust the moisture content to around 70% (wet basis) for all the substrates. Inoculated plates were incubated at 30°C for six days under stationary conditions (Kakde and Aithal, 2021).

Enzyme extraction and assay

Cellulase enzyme was extracted and assayed as per the methodology mentioned in our earlier study (Kakde and Aithal, 2021). The Carboxymethyl cellulase (CMCase) and filter-paperase (FPase) activities were expressed as Units per mL (U/mL) where 1 unit (U) of CMCase and FPase was the amount of enzyme that releases 1 μmole of glucose from Carboxymethyl Cellulose (CMC) and Whatman filter paper (FP) respectively for every minute under standard assay conditions.

Upstream and downstream process optimization

The effect of various pretreatment methods such as steam, hydrochloric acid (HCl), sulfuric acid (H_2SO_4), and sodium hydroxide (NaOH), various concentrations of sulfuric acid were evaluated for cellulase production. Pretreatment of lignocellulosic agricultural residues was done as described in our earlier reports (Kakde and Aithal, 2020). For the thermochemical pretreatment, the powdered agro-residues were autoclaved at 121°C, 15 psi for 60 min. Similarly, chemical pretreatment was carried out by soaking the substrates in 1 N HCl, H_2SO_4, and NaOH solution, and substrates not subjected to any pretreatment method were termed as 'untreated'. After pretreatment, the samples were thoroughly washed up to neutrality and allowed to dry.

Furthermore, the influence of upstream process parameters such as incubation time (2-10 days), temperature (24-42°C), moisture (distilled water, mineral water, minimal medium, Mandel's medium, and nutrient solution), pH (4.5-6.5), and downstream process parameter like leaching agents (distilled water; 50 mM citrate buffer, pH 4.0; 50 mM citrate buffer, pH 5.0; 50 mM sodium citrate buffer, pH 6.0; and 50 mM phosphate buffer, pH 7.0) were observed.

RESULTS AND DISCUSSION

Influence of pretreatment and various concentrations of sulfuric acid

Results of pretreatment method and various concentrations on the production of cellulase by *T. viride* are as depicted in Figure 1. Cellulase activities were determined using Carboxymethyl-cellulase (CMCase) and filter-paperase (FPase) assay. CMCase activity represents the amount of endoglucanase whereas filter-paperase (FPase) activity is the measure of total cellulase activity i.e. endoglucanases, exoglucanases, and β-D-glucosidases. As mentioned by Batool *et al*. (2015), among the various assays used to estimate total cellulase activity, filter paper assay is the most common assay recommended by the International Union of Pure and Applied Chemistry (IUPAC).

The maximum cellulase activity was observed with H_2SO_4 treated substrates with exception of SB where maximum production was achieved in the steam-treated substrate that produced 0.97 U/mL CMCase and 0.23 U/mL FPase activities in contrast to the H_2SO_4 treated SB where cellulase activity of 0.91 U/mL and 0.12 U/mL in terms of CMCase and FPase respectively were obtained.

Comparing all the employed pretreatment methods in the present study, substrates treated with NaOH showed the lowest enzyme activity. In the case of H_2SO_4 treated substrates, the highest CMCase (1.49 U/mL) and FPase (0.37 U/mL) activity was reported in PPS followed by GS, CC, and BP. Findings in the present study are in agreement with the findings of our earlier work where increased production of cellulolytic enzyme was noted in sulfuric acid-treated agro-residues by

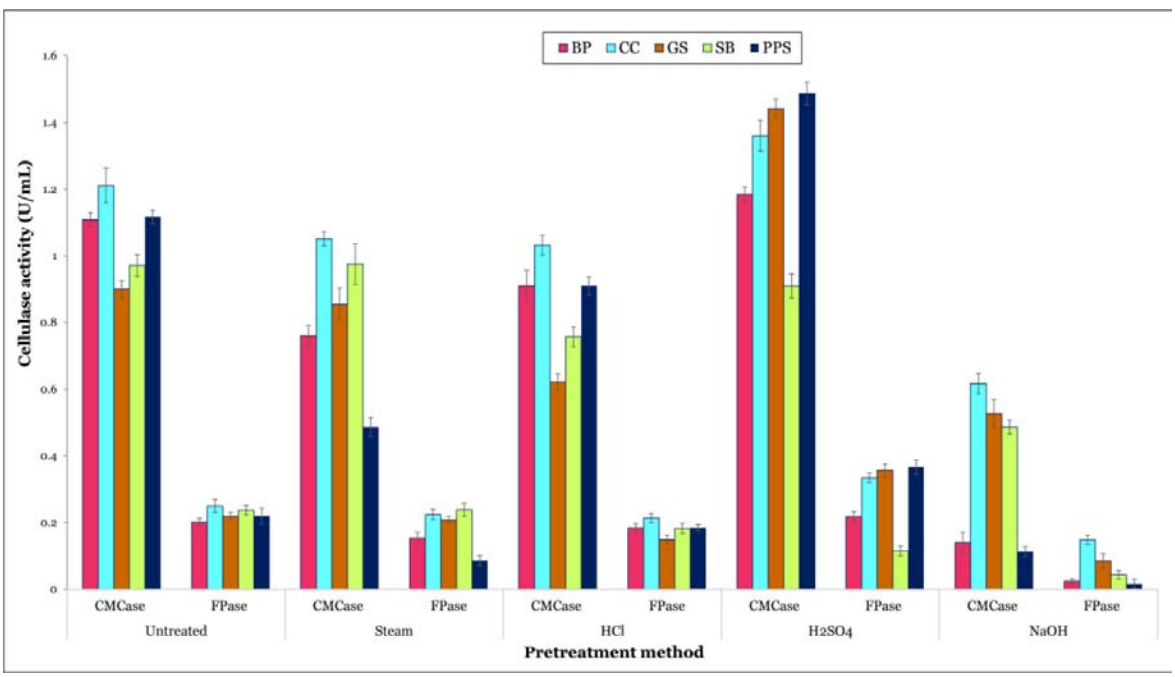

Fig. 1. Influence of pretreatment method on cellulase production by *T. viride*

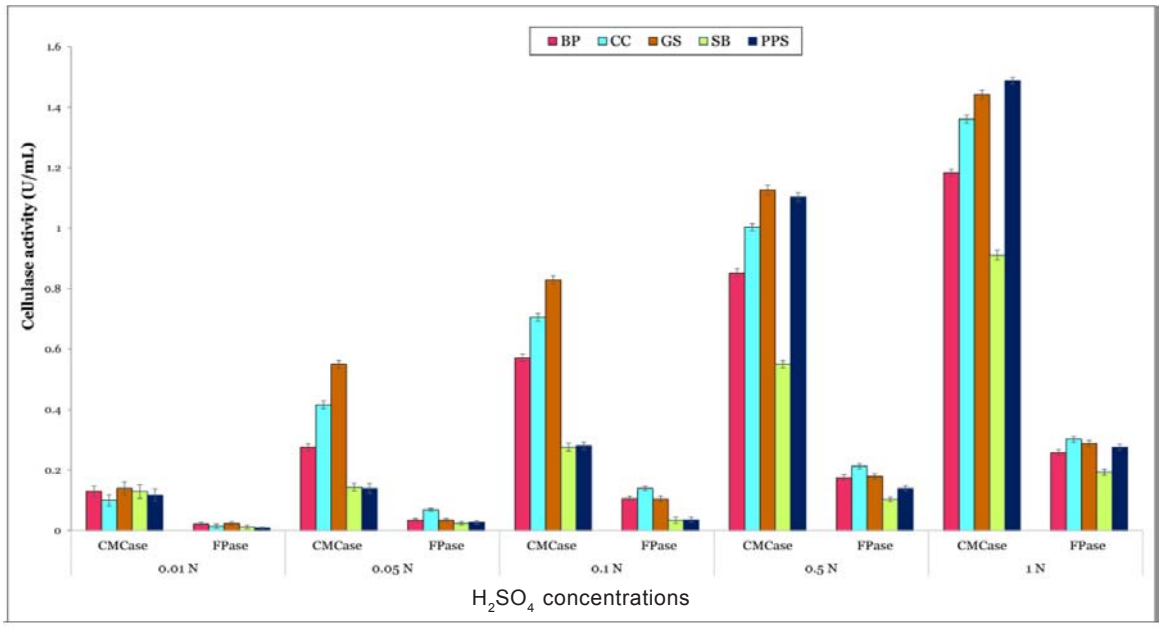

Fig. 2. Influence of H_2SO_4 concentrations on cellulase production by *T. viride*

T. viride and *T. longibrachiatum* (Kakde and Aithal, 2020).

Once the effective pretreatment method for enhanced cellulase production was found, the next step of the investigation was to determine the effect of various concentrations of sulfuric acid on enzyme production. From the Fig. 2, it can be stated that the lower concentrations of acid were inefficient in increasing the susceptibility of the substrates to enzymatic hydrolysis as higher concentrations yielded more enzyme activity. Among all the substrates, the maximum CMCase activity of 1.49 U/mL and FPase activity of 0.28 U/mL was noted in 1 N H_2SO_4 treated PPS followed by GS, CC, BP, and SB. These results are in agreement with the reports of the maximum production of total cellulase from *B. subtilis* K-18 in 1% H_2SO_4 treated *Sacharum spontaneum* by Ghazanfar *et al.* (2018).

Influence of supplementation media and initial pH

Supplementation media used in the SSF process of cellulase production is an important parameter determining the success of any SSF technique since it maintains adequate moisture along with providing all the essential nutrients for enzyme production. Among the five supplementation media used, Mandel's medium produced maximum cellulase in all the substrates. The highest cellulase production was reported in PPS (CMCase 1.59 U/mL; FPase 0.34 U/mL), followed by SB (CMCase 1.52 U/mL; FPase 0.33 U/mL), GS (CMCase 1.39 U/mL; FPase 0.31 U/mL), CC (CMCase 1.26 U/mL; FPase 0.25 U/mL), and BP (CMCase 1.03 U/mL; FPase 0.22 U/mL) as depicted in Fig. 3. Distilled water also supported microbial growth and enzyme production. The lowest enzyme production was noted in substrates supplemented with nutrient solution. Results are in accordance with the

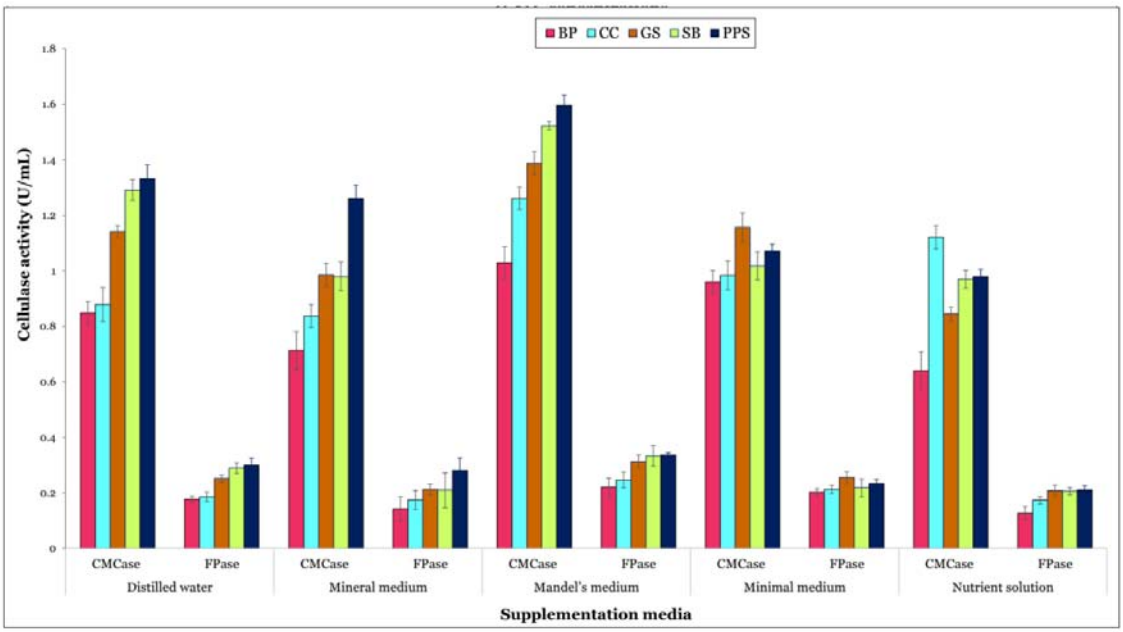

Fig. 3. Influence of supplementation media on cellulase production by *T. viride*

work of Saini *et al.* (2017) and Darabzadeh *et al.* (2019) who used Mandel's medium for supplementation during cellulase production.

pH is one of the crucial physical parameters affecting microbial growth and metabolism (Abatenh *et al.,* 2017). Thus, the effect of various pH of supplementation media on the production of cellulase by *T. viride* was studied between the range of 4.5 to 6.5 (Fig. 4).

The highest CMCase and FPase production on BP (0.41 U/mL and 0.25 U/mL), CC (0.70 U/mL and 0.15 U/mL), and SB (1.47

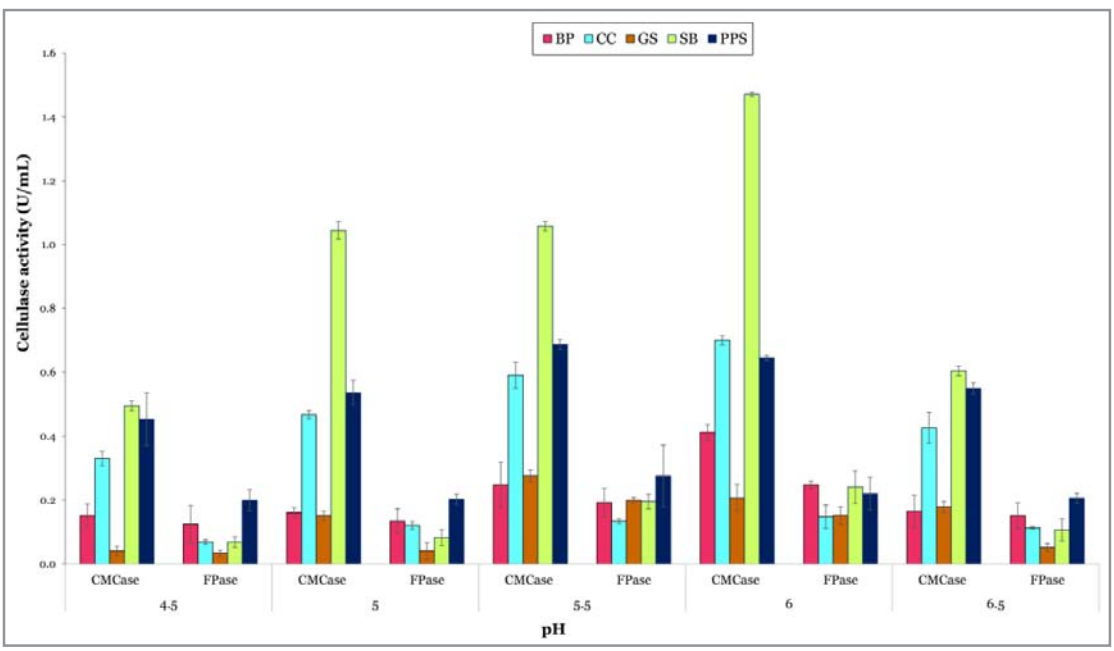

Fig. 4. Influence of initial pH on cellulase production by *T. viride*

U/mL and 0.24 U/mL) was found at pH 6 whereas on GS (0.28 U/mL and 0.20 U/mL) and PPS (0.69 U/mL and 0.27 U/mL) it was reported at pH 5.5. These results of maximum cellulase production at the acidic pH are in agreement with the fact that fungi are mostly acidophilic (Dey and Roy, 2018).

Influence of incubation period

Cellulase production was analyzed by incubating the inoculated petri plates at various time intervals (2 to 10 days) and it was detected that enzyme production progressively increased with an increase in incubation period with maximum production after eight days as shown in Fig. 5. The subsequent decline in enzyme production was observed beyond the peak incubation period. The results revealed that on BP and CC as substrates, the highest enzyme production was reported on the 8th day followed by the 6th, 4th, 10th, and 2nd, whereas, on GS, SB, and PPS, the peak enzyme production was reported on the 6th day. Among all the five substrates, maximum cellulase production CMCase 0.74 U/mL and FPase 0.13 U/mL was noted on BP. Nehad *et al*. (2019) reported the maximum cellulase production by fungus *Penicillium decumbens* after incubation for six days.

Influence of incubation temperature

Every enzyme-mediated metabolic process possess an optimal temperature and thus, temperature is one of the important physical parameter contributing to the proper microbial growth and their survival (Abatenh *et al.,* 2017). The optimal temperature for the cellulolytic enzyme production by *T. viride* MTCC 800 in the present study was determined by studying the enzyme production between the ranges of 24°C, 30, 36, and 42ºC**.** As depicted in Figure 6, on BP, GS and PPS as substrates, maximum production CMCase 0.63 U/mL; FPase 0.13 U/mL, CMCase 0.21 U/mL;

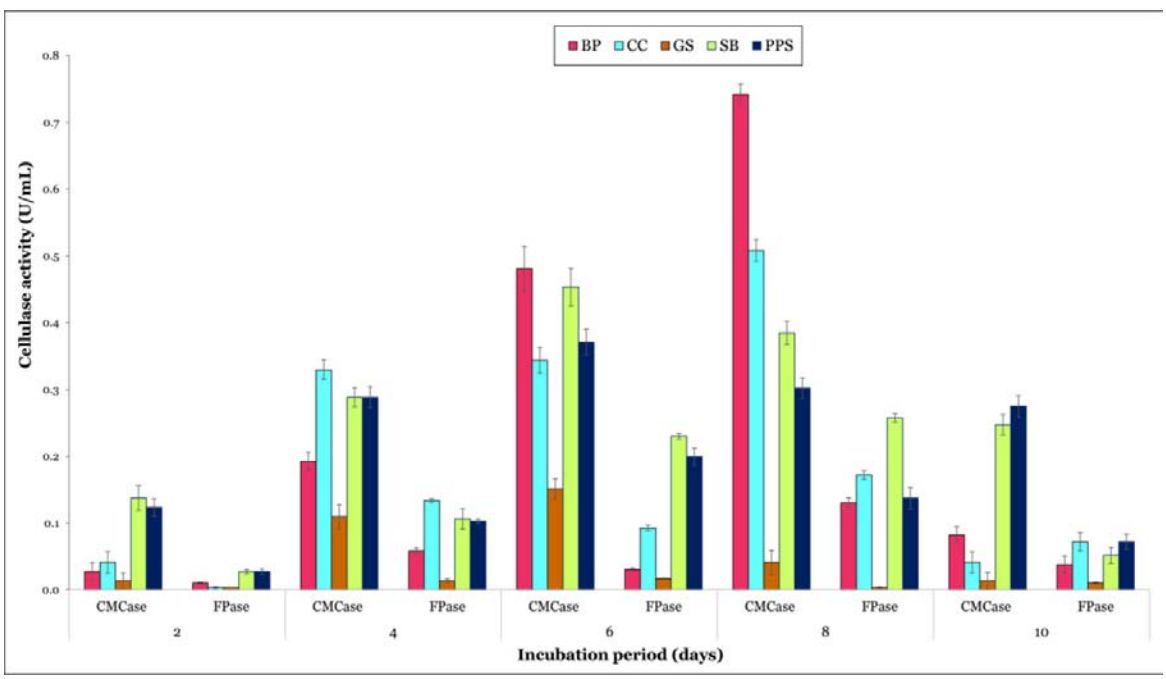

Fig. 5. Influence of incubation period on cellulase production by *T. viride*

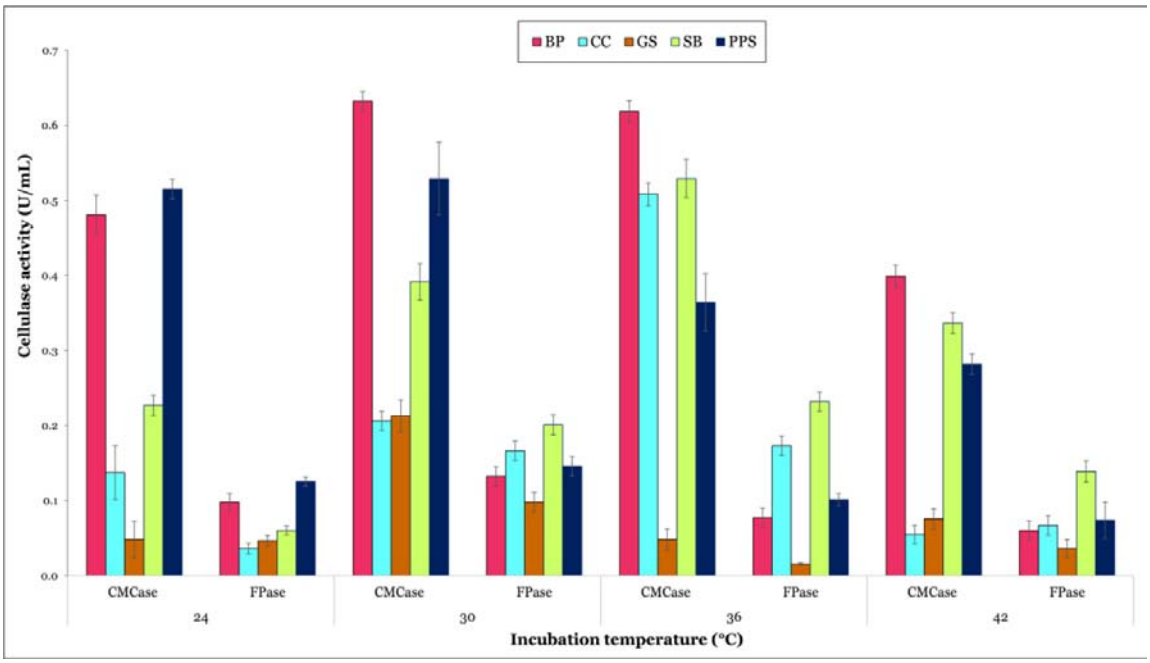

Fig. 6. Influence of incubation temperature on cellulase production by *T. viride*

FPase 0.10 U/mL, and CMCase 0.53 U/mL; FPase 0.15 respectively was reported at 30°C whereas on the substrates CC and SB, maximum production of CMCase 0.51 U/mL; FPase 0.17 U/mL and CMCase 0.53 U/mL; FPase 0.23 U/mL respectively was obtained at 36°C.

Different experiments were performed on varying incubation temperatures ranging from 20 to 50°C. The obtained results in the current study were in accordance with the findings of

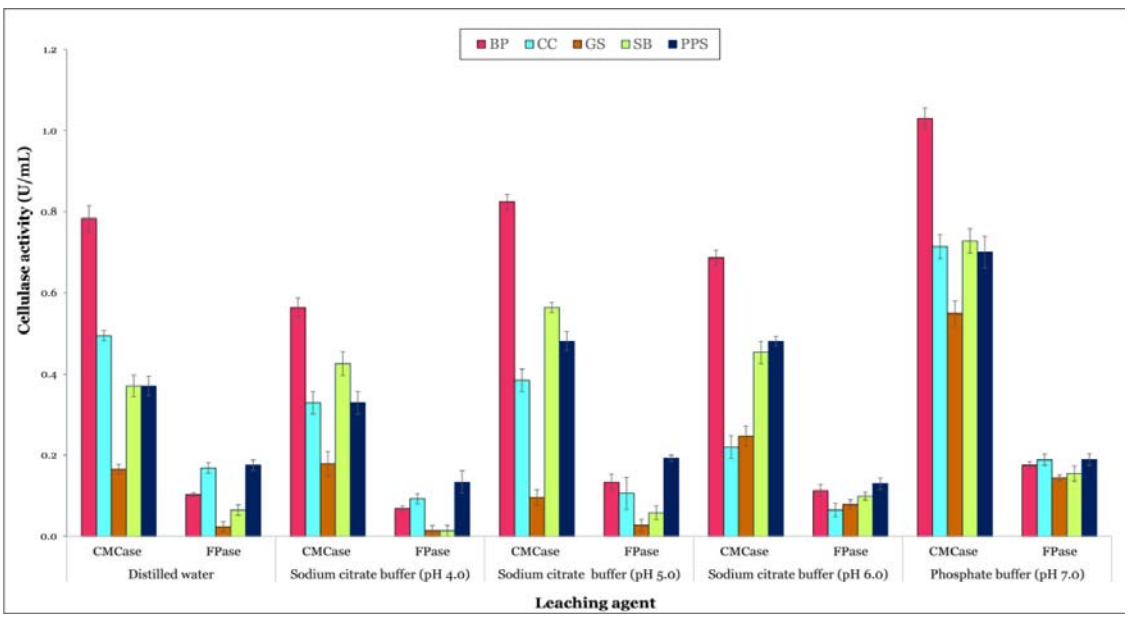

Fig. 7. Influence of leaching agent on cellulase production by *T. viride*

Nehad *et al.* (2019) who reported the maximum cellulase production at 30°C.

Influence of leaching agents

The solvent screening experiments in the present study were conducted using leaching agents such as distilled water, sodium citrate buffer (pH 4.0), sodium citrate buffer (pH 5.0), sodium citrate buffer (pH 6.0), phosphate buffer (pH 7.0). As depicted in Fig. 7, the highest cellulase activity was reported with phosphate buffer of pH 7 as an extraction solvent on BP (CMCase 1.03 U/mL and FPase 0.17 U/mL) followed by SB (CMCase 0.73 U/mL and FPase 0.15 U/mL), CC (CMCase 0.71 U/mL and FPase 0.19 U/mL), PPS (CMCase 0.70 U/mL and FPase 0.19 U/mL), and GS (CMCase 0.55 U/mL and FPase 0.14 U/mL). Earlier, Nathan *et al*. (2014) have used phosphate buffer (pH 6.8) for eluting cellulase enzyme from *T. viride* VKF3.

CONCLUSIONS

The study investigated the effect of physico-chemical parameters on cellulase production by *T. viride* (MTCC 800) under the SSF technique. From this study, it can be concluded that all the five agricultural residues used as substrates were capable of supporting cellulolytic enzyme production and can be utilized for industrial purpose. Sugarcane bagasse produced higher cellulase with 1 N H_2SO_4 treated substrate supplemented with Mandel's medium (pH 6) after 6 days of incubation at 36°C leached using 0.05 M phosphate buffer (pH 7.0). The study is important since estimating the influence of physico-chemical parameters is crucial for enhanced cellulase production. The effect of the process parameters was positively confined to pretreatment method, incubation temperature, incubation period, pH, moisture, and leaching agent indicating the enhanced cellulase activity achieved at their optimal level. The results obtained in this study confirmed the potential of *T. viride* to utilize lignocellulosic agro-residues that can be significant for large-scale production of cellulase.

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CHARACTER ASSOCIATION AND PATH COEFFICIENT ANALYSIS IN MUNGBEAN

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ABSTRACT

One hundred and sixty germplasms of mungbean (*Vigna radiata* (*L.)* Wilzeck.) were evaluated during *rabi* 2020-21 for yield and its eight contributing traits to study the nature of correlation along with path analysis studies. The seed yield contributing traits *viz.,* number of pods per plant, number of seeds per pod, plant height, number of branches per plant, number of clusters per plant, test weight and days to 50 percent flowering showed significant positive correlation with seed yield; pod length was the only trait which showed non-significant positive association with seed yield in the study. Partitioning of the correlation coefficients of various components upon seed yield into direct and indirect effects revealed that number of pods per plant had high direct effect followed by number of seeds per pod. Highly significant correlation coefficients of all the characters were mainly due to the indirect effects of number of pods per plant followed by number of seeds per pod. This study revealed the importance of the traits such as number of pods per plant, number of seeds per pod, plant height, number of branches and clusters per plant in the crop improvement of mungbean crop.

Keywords: Correlation, Mungbean, Path analysis, Seed yield

INTRODUCTION

Mungbean (*Vigna radiata (L.)* Wilczek) believed to be native crop of India broadly cultivated throughout Asia, including India, Pakistan, Bangladesh, Sri Lanka, Thailand, Laos, Cambodia, Vietnam, Indonesia, Malaysia, South China and Republic of Formosa (Mohan Naik *et al.*, 2020). This short duration legume crop can be grown in varying seasonal conditions, later expanded its cultivation to the USA, Australia and Africa. Mungbean contains high-quality protein which can be used for consumption as whole grains, dhal, or sprouted form and is an excellent combination to rice in respect to balanced human nutrition. In addition to being the prime source of human food and animal feed, it plays an important role in maintaining the soil fertility by improving the soil physical properties and fixing atmospheric nitrogen. In the human diet, particularly for most of the vegetarian population, mungbean a legume, is a cost-effective and environment

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friendly source of protein (20.97–31.32%) and it provides a major amount of proteins (240 g kg^{-1}) and carbohydrates (630 g kg^{-1}) and a range of micronutrients in human diets. (Rane *et al.*, 2021). The total cropped area of mungbean is about 7 million ha, with a total production of 5 million tons worldwide (Nair *et al.*, 2019). Rajasthan, Maharashtra, Madhya Pradesh, Karnataka, Orissa and Bihar are the majorly mungbean growing states of India; and the area has increased from 4.25 to 4.58 million hectares and in the same way production has also increased from 2.41 to 2.51 million tonnes during 2019-20 as compared to the previous year. The production has increased from 0.53 million tonnes in 1965-66 to 2.51 million tonnes in 2019-'20. (IIPR, 2021).

Seed yield is a complex character and is dependent on number of component characters. Correlation coefficient analysis measures the mutual relationship between plant characters and determines the component characters on which selection can be based for improvement in yield. If the association between two characters is considerably positive, it will increase the rate of genetic advancement, while the negative correlation will decrease the genetic improvement progress after selection for the character. Path coefficient analysis gives an idea about the contribution of each independent character to the dependent character, *i.e.* seed yield in this study. Since, the mutual relationship of component characters might vary both in the magnitude and direction, it may tend to vitiate the association of dependent character with the component characters. It is, therefore, necessary to partition the correlation coefficients of the component characters into their direct and indirect effects on the dependent character. In the present investigation, association of various plant, pod and seed characters with economic yield was determined by studying the correlation and direct / indirect effects of these characters on seed yield.

MATERIALS AND METHODS

The investigation was conducted at Regional Agricultural Research Station, Lam, Guntur with 160 genotypes of mungbean (genotypes of Andhra Pradesh (103), Tamilnadu (13), Maharastra (10), Uttar Pradesh (7), New Delhi (7), Telangana (4), Odisha (4), Uttarakhand (3), Chattishgarh (2), Haryana (2), Rajasthan (2), Gujarat (2) and Punjab (1)) during *rabi* season, 2020-'21. The experiment was laid out in augmented design. Each genotype was grown in a single row of 4m length with inter-row spacing of 30 cm x 10 cm. All recommended management practices were followed during the crop period. Observations were recorded on days to 50 percent flowering, plant height, number of branches per plant, number of clusters per plant, number of pods per plant, pod length, number of seeds per pod, test weight, and seed yield per plant. Correlation coefficients and Path analysis were calculated as per standard procedures.

RESULTS AND DISCUSSION

Crop improvement programmes depends to a large extent on availability of sufficient variability and association among different characters which are the pre-requisite for executing an effective selection programme. Seed yield, being a complex quantitative trait, is dependent on a number of component characters. Therefore, knowledge of association

of different components together with their relative contributions has immense value in selection.

The estimation of correlation coefficients among different characters were presented in Table 1. The traits *viz.*, number of pods per plant (0.966), number of seeds per pod (0.564), plant height (0.562), number of branches per plant (0.555), number of clusters per plant (0.531), test weight (0.330) and days to 50% flowering (0.199) had shown significant positive association with seed yield (Fig. 1). In this study, pod length is the only trait which showed non-significant positive association with seed yield. These results corroborated with the findings of Garje *et al.* (2014), Eswaran and Senthil (2015), Anand *et al.* (2016), Kate *et al.* (2017), Jadhav *et al.* (2019), Ahmad and Belvel (2020), Dhunde *et al.* (2021), Sineka *et al.* (2021) and Thirumalai and Murugan (2021).

The trait number of pods per plant also showed significant positive association with days to 50 percent flowering (0.161), plant height (0.574), number of branches per plant (0.570), number of clusters per plant (0.583), number of seeds per pod (0.353) and test weight (0.317). Similarly, the character, number of seeds per pod also recorded significant positive correlation with days to 50% flowering (0.232), plant height (0.286), number of branches per plant (0.218), number of pods per plant (0.353), pod length (0.216) and test weight (0.196). Likewise, plant height also depicted significant positive association with days to 50% flowering (0.379), number of branches per plant (0.168), number of clusters per plant (0.415), number of pods per plant (0.574), number of seeds per pod (0.286) and test weight (0.180).

The trait number of branches per plant equally showed significant positive association with plant height (0.168), number of clusters per plant (0.568), number of pods per plant (0.570), pod length (0.286), number of seeds per pod (0.218) and test weight (0.156). Similarly, the character, number of clusters per plant also recorded significant positive correlation with plant height (0.415), number of branches per plant (0.568), number of pods per plant (0.583) and pod length (0.317). Likewise, test weight also depicted significant positive association with plant height (0.180), number of branches per plant (0.156), number of pods per plant (0.317) and number of seeds per pod (0.196). Pod length which showed non-significant positive correlation with seed yield, however, recorded significant positive association with number of branches per plant (0.286), number of clusters per plant (0.317) and number of seeds per pod (0.216).

Path coefficient analysis (Table 2 and Fig. 2) revealed that the trait, number of pods per plant (0.8901) had high positive direct effect on seed yield followed by number of seeds per plant (0.2560). These two traits had also recorded strong significant positive correlation with seed yield per plant than other characters. The high positive correlations for most of the characters in this study were due to the high indirect effects through number of pods per plant. These results are in confirmation with the findings of Lukman Hakim (2008), Garje *et al.* (2014), Eswaran and Senthil (2015), Anand *et al.* (2016), Ahmad and Belvel (2020), Dhunde *et al.* (2021), Sineka *et al.* (2021) and Thirumalai and Murugan (2021). High positive indirect effects of number of pods per plant on days to 50% flowering (0.1434), plant height (0.5110), number of

Table 1. Correlation coefficients between seed yield and its component characters in mungbean

S. No.	Character	Days to 50% flowering	Plant height (cm)	No. of Branches per plant	No. of Clusters per plant	No. of Pods per plant	Pod length	No. of seeds per pod	Test weight (g)	Seed yield (g)
1	Days to 50% flowering	1.000	0.379**	0.113	0.118	0.161*	0.042	0.232**	-0.078	0.199*
2	Plant height (cm)		1.000	0.168*	0.415**	0.574**	0.034	0.286**	0.180*	0.562**
3	No. of Branches per plant			1.000	0.568**	0.570**	0.286**	0.218**	0.156*	0.555**
4	No. of Clusters per plant				1.000	0.583**	0.317**	0.113	0.095	0.531**
5	No. of Pods per plant					1.000	0.081	0.353**	0.317**	0.966**
6	Pod length						1.000	0.216**	0.054	0.119
7	No. of Seeds per pod							1.000	0.196*	0.564**
8	Test weight (g)								1.000	0.330**
9	Seed yield (g)									1.000

Note: *Significant at 5% level; **Significant at 1% level

Table 2. Direct and indirect contributions of component characters for seed yield in mungbean

S. No.	Character	Days to 50% flowering	Plant height (cm)	No. of Branches per plant	No. of Clusters per plant	No. of Pods per plant	Pod length	No. of seeds per pod	Test weight (g)	Correlation with seed yield
1	Days to 50% flowering	**0.0057**	-0.0083	-0.0001	-0.0007	0.1434	-0.0003	0.0594	-0.0002	0.199*
2	Plant height (cm)	0.0022	**-0.0218**	-0.0001	-0.0025	0.5110	-0.0002	0.0731	0.0005	0.562**
3	No. of Branches per plant	0.0007	-0.0037	**-0.0002**	-0.0034	0.5069	-0.0019	0.0557	-0.0005	0.555**
4	No. of Clusters per plant	0.0007	-0.0091	-0.0001	**-0.0060**	0.5185	-0.0021	0.0289	0.0003	0.531**
5	No. of Pods per plant	0.0009	-0.0125	-0.0001	-0.0035	**0.8901**	-0.0005	0.0905	-0.0009	0.966**
6	Pod length	0.0002	-0.0007	-0.0001	-0.0019	0.0723	**-0.0067**	0.0554	0.0002	0.119
7	No. of Seeds per pod	0.0013	-0.0062	-0.0001	-0.0007	0.3146	-0.0014	**0.2560**	0.0006	0.564**
8	Test weight (g)	-0.0005	-0.0039	-0.0001	0.0006	0.2819	-0.0004	0.0503	**0.0030**	0.330**

Bold: Direct effects; Residual effect: **0.101**

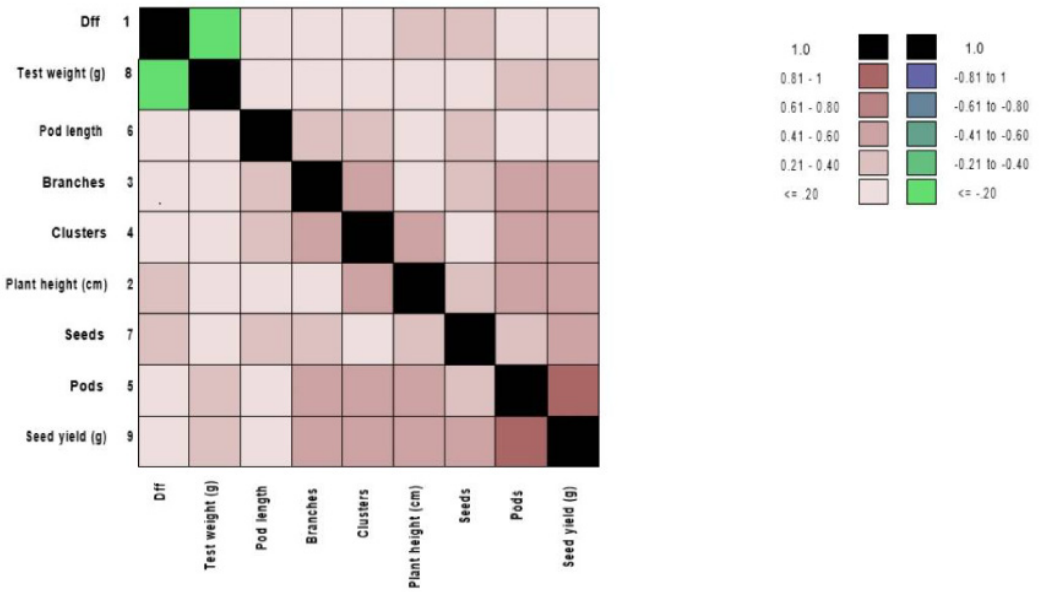

Fig. 1. Correlation matrix between seed yield and yield components in mungbean

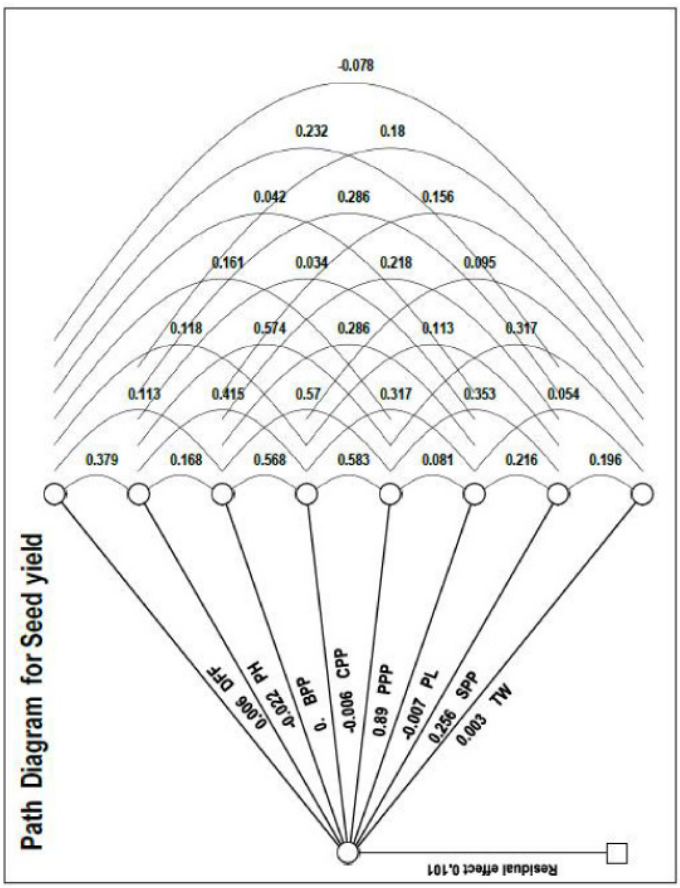

Fig. 2. Path diagram showing direct and indirect effects of yield components on seed yield in mungbean

branches (0.5069), number of clusters (0.5185), number of seeds per pod (0.3146) and test weight (0.2819) was the main cause for positive association of these traits with seed yield per plant revealing the effect of number of pods per plant on all these traits. Likewise, number of seeds per pod also showed positive indirect effects on all the traits under study when compared to rest of the other characters. The residual effect is low (0.101) indicating appropriateness of characters chosen.

CONCLUSIONS

This study has elucidated the importance of number of pods per plant and number of seeds per pod which showed highly significant positive correlation combined with high positive direct effects on seed yield and positive indirect effects on all other traits for seed yield. Concentrating on these traits in selection process along with plant height, number of branches per plant, number of pods per plant will help in mungbean crop improvement program to evolve high yielding varieties which will benefit the mungbean growing farmers.

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ESTIMATION OF YIELD LOSSES IN COTTON DUE TO MAJOR FUNGAL FOLIAR DISEASES

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ABSTRACT

The experiment was conducted at Regional Agricultural Research Station, Lam, Guntur during *kharif* 2019-20 to estimate the losses due to major fungal foliar diseases including Alternaria leaf spot, Corynespora leaf spot and grey mildew in two BG II hybrids and one straight variety of cotton. Two sprays of propiconazole @ 0.1% were applied at 60 DAS and 75 DAS; third spray with metiram + pyraclostrobin @ 0.1% at 90 DAS and final spray of carbendazim @ 0.1% were applied at 105 DAS. Disease observations were recorded to assess the severity of fungal foliar diseases of cotton in protected and unprotected plots. Percent increase in unprotected plots varied from 64.65 to 84.95, 85.77 to 87.12 and 70.59 to 78.40 when compared to plots protected for Alternaria leaf spot, Corynespora leaf spot and grey mildew, respectively. Yield data in protected and unprotected plots revealed that percent seed cotton yield loss of 16.14 in Jaadoo BG II, 20.34 in RCH 2 BG II and 26.28 in L 1060. The highest ICBR was obtained for Jaadoo BG II (26.61) when compared to RCH 2 BG II (19.95) and L 1060 (19.46).

Key Words: Alternaria leaf spot, Cotton, Corynespora leaf spot, Grey mildew, Yield losses

INTRODUCTION

Cotton is an important commercial crop in India with a production of 371 lakh bales of 170 kg lint from an area of 129.57 lakh ha and a productivity of 487 kg ha^{-1} in 2020-2021, which is far behind the leading countries. Andhra Pradesh stood 8th in area (5.24 lakh ha) and production (18.0 lakh bales) but 3rd in productivity (584 kg ha^{-1}) (ICAR-AICRP on Cotton, 2021). Cotton crop is affected by a number of foliar diseases throughout the season. Among the fungal diseases, Alternaria leaf spot/blight, grey mildew and rust cause economic losses in the range of 26.59% - 34.05% under congenial conditions (Monga *et al*., 2013). Foliar sprays with carbendazim (0.1%) at 15 days interval prevented yield losses of 38.38% due to grey mildew (Bhattiprolu, 2012). Propineb (0.21-0.28%) was superior in managing Alternaria leaf spot

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and increasing cotton yields by 31.56% (Bhatttiprolu and Prasada Rao, 2014). Both kresoxim methyl at 500 ml ha^{-1} and propiconazole (0.1%) were effective against important foliar diseases and protected the crop against Alternaria leaf spot, bacterial blight and rust (Bhattiprolu, 2015). Corynespora leaf spot has dominated Alternaria leaf spot in recent years and emerged as major leaf spot in cotton. Estimated yield losses due to target spot in selected cultivars (Deltapine 1050 and Phytogen 499) exceeded 336 $kgha^{-1}$ seed cotton (Conner et al. 2013). Lint yield loss due to target spot on apparently susceptible cotton cultivar had been estimated to be as high as 484 kg lint/ha (Hagan *et al*., 2015).Cultural and morphological variability of *Corynesporacas siicola*(Berk. and Curt.) Wei. causing target spot of cotton was studied (Mohan Venkata Siva Prasad *et al*., 2021). In view of the economic importance,the field trial was conducted to estimate yield losses due to these diseases.

MATERIALS AND METHODS

A field experiment was conducted during *kharif* 2019-20 at Regional Agricultural Research Station, Lam, Guntur, Andhra Pradesh. BG II hybrids *viz*., Jaadoo and RCH 2 along with straight variety, L 1060 were sown in two bulk plots of each by adopting a spacing of 105cm x 60cm, on 26.07.2019. In protected plots, both insecticides and fungicides were applied, whereas, in unprotected plots only insecticides were applied. In protected plots, four sprays of fungicides were imposed to reduce the disease severity. Based on the *in vitro* studies, fungicides were selected for field application. Two sprays of propiconazole @ 0.1% were applied at 60 DAS and 75 DAS; third spray with metiram + pyraclostrobin @ 0.1% at 90 DAS and final spray of carbendazim @ 0.1% were applied at 105 DAS. Isolation

Scale	Per cent of leaf area infected
0	No infection
1	Few spots of less than 2 mm size, leaf area covering less than 5%
2	Spots of 3 mm size, covering 6-20% of leaf area
3	Spots of 3-5 mm size, irregular in shape, coalesce and covering 21-40% of leaf area.
4	Spots covering more than 40% of leaf area

Per cent disease reduction over control was calculated by using the following formula.

$$PDC = \frac{\text{PDI in unprotected plot} - \text{PDI in protected plot}}{\text{PDI in unprotected plot}} \times 100$$

The per cent yield loss in seed cotton yield was calculated by using following formula.

$$\text{Yield loss} = \frac{\text{Yield in protected plot} - \text{Yield in unprotected plot}}{\text{Yield in protected plot}} \times 100$$

distance was maintained between the plots to avoid chemical drift. Observations were recorded to assess the severity of fungal foliar diseases in protected and unprotected plots of these entries.Data on disease severity was recorded from 10 randomly tagged plants, from each plot at weekly intervals. Per cent Disease Index (PDI) of each fungal foliar disease was calculated by using the following formula:

$$PDI = \frac{\text{Sum of individual disease ratings}}{\text{Number of leaves scored} \times \text{Maximum disease rating}} \times 100$$

Diseases severity was assessed using standard disease rating scale (Sheo Raj, 1988).

Data on PDI of Alternaria leaf spot, Corynespora leaf spot and grey mildew and seed cotton yield was subjected to t-test analysis to compare protected and unprotected plots.

RESULTS AND DISCUSSION

Alternaria leaf spot

The disease was observed from vegetative to boll maturity stage in all the three entries. Corynespora leaf spot progressed from flower initiation to harvesting stage whereas grey mildew and rust developed during boll bursting and picking stage. Data on severity of Alternaria leaf spot was collected starting from the first appearance of disease in both protected and unprotected plots. The severity of Alternaria leaf spot, after each spray in protected plot was compared with that of unprotected plot. The incidence of Alternaria leaf spot declined after frequent rainfall in August and September (*i.e.,* after second spray).

Occurrence of Alternaria leaf spot in Jaadoo BG II was noticed at 43 DAS with 1.50 PDI in unprotected and 2.25 PDI in protected plot. At 60 DAS, when the disease reached to 5.23 PDI in unprotected and 6.12 PDI in protected plot, fungicide spray was initiated in protected plot. In protected plot 6.95 PDI was recorded after first spray, whereas in unprotected plot it was 9.28 PDI. After second spray PDI was 5.03 in protected while it was 11.85 in unprotected plots. Disease severity (PDI) decreased to 3.65 in protected plot after the third spray, as against 10.33 in unprotected plot (Table 1).

In RCH 2 BG II Alternaria leaf spot was first observed at 47 DAS with 1.25 PDI in unprotected and 1.75 PDI in protected plots. Fungicide spray was initiated at 60 DAS after the disease attained 7.00 PDI in unprotected and 6.50 PDI in protected plots. In protected plot 6.53 PDI was observed after the first spray; whereas, in unprotected plot it was 8.25. After second spray PDI was 4.08 in protected and 9.50 in unprotected plot. In protected plot 2.13 PDI was recorded after third spray, whereas, 8.08 PDI was observed in unprotected plot (Table 1).

Alternaria leaf spot in L 1060 was observed at 51 DAS with 1.00 PDI and 1.25 PDI in unprotected and protected plots, respectively. At 60 DAS, when the disease was 6.50 PDI in unprotected and 7.25 PDI in protected, fungicide spray was initiated. Protected plot recorded 5.98 PDI after first spray; whereas, unprotected plot showed 7.78 PDI. After second spray, disease severity was

3.95 PDI in protected as against 8.05 PDI in unprotected plot. Disease severity decreased to 1.05 PDI in protected plot after third spray, whereas in unprotected plot 6.98 PDI was recorded (Table 1).

Per cent excess in ALS in unprotected plot over protected plot ranged from 64.67 to 84.96 (Fig. 1); t- test analysis data for Jaadoo BG II, RCH 2 BG II and L 1060 indicated a significant difference in PDI of Alternaria leaf spot between protected plot and unprotected plot in all sprays.

Corynespora leaf spot

In Jaadoo BG II, Corynespora leaf spot was observed at 55 DAS with 2.5 PDI in unprotected plot. At the time of first spray (60 DAS) protected plot recorded 10.25 PDI and unprotected plot showed 10.00 PDI. Disease decreased to 9.50 PDI, after first spray, in protected plot and to 10.58 PDI in unprotected plot. After second, third and fourth spray PDI in protected plot was 8.08, 6.50 and 5.00 whereas in unprotected plot PDI was 15.08, 27.05 and 35.1, respectively (Table 2 and Fig. 2).

At 55 DAS, in RCH 2 BG II, Corynespora leaf spot was 3.50 PDI in protected plot while 4.00 PDI in unprotected plot. In protected plot, 7.25 PDI was observed at the time of first spray (60 DAS) whereas 8.00 PDI in unprotected plot. Protected plot recorded 7.93 PDI after first spray and in unprotected plot showed 9.08 PDI. Disease of 7.50, 6.28 and 5.50 PDI was recorded in protected plot after the second, third and fourth spray while 17.10, 26.30 and 40.70 PDI in unprotected plot (Table 2 and Fig. 2).

Corynespora leaf spot in L 1060, at 55 DAS was 4.00 in protected while 4.25 PDI in unprotected plots. In protected plot, 6.75 PDI was recorded at the time of first spray (60 DAS) whereas 7.25 PDI in unprotected plot. After first spray PDI was 8.35 in protected and 10.50 in unprotected plot. Disease after second, third and fourth spray was 7.30, 6.10 and 5.45 PDI in protected while in unprotected plots, 17.58, 32.18 and 42.30 PDI, respectively (Table 2 and Fig. 2).

Per cent excess in Corynespora leaf spot in unprotected plot over protected plot among three cultivars was 85.77 to 87.12 (Table 2 and Fig. 1). In all the three cultivars, t- test analysis indicated significant difference in the PDI of Corynespora leaf spot between protected plot and unprotected plot in all sprays.

Grey mildew

As Grey mildew appeared at boll maturity stage only one spray was applied in protected plot. Grey mildew appeared at 99 DAS in Jaadoo BG II with 2.75 PDI in protected while 3.25 PDI in unprotected plots. At the time of spray, *i.e.,* at 105 DAS, PDI was 4.25 and 9.75 in protected and unprotected plots, respectively. After the spray, PDI in protected reduced to 2.98 as against 13.78 in unprotected plot. At 111 DAS, grey mildew appeared in RCH 2 BG II with 1.00 PDI in protected and 2.50 PDI in unprotected plot. 1.75 PDI was recorded in protected plot at the time of fungicide spray while 2.75 PDI in unprotected plot. In protected 1.00 PDI was recorded after fungicide spray, whereas, in unprotected it was 3.40 PDI. In L 1060, grey mildew appeared at 115 DAS with 1.00 PDI in

protected, whereas, 2.25 PDI in unprotected plot. After fungicide spray, protected plot recorded 0.48 PDI and unprotected showed 1.63 PDI (Table 3 and Fig. 1). Per cent excess in grey mildew in unprotected plot over protected plot among cultivars was 70.55 to 78.37 (Table 2 and Fig. 1) in all the three cultivars. The t- test analysis indicated significant difference in the PDI of grey mildew between protected plot and unprotected plot (Table 3 and Fig. 1).

Propiconazole inhibits the formation of critical fungal cell membrane ergosterols, primarily by blocking the action of 14-á-sterol demethylase, thus reduced fungal infections in protected fields. Similarly carbendezim inhibits sterol biosynthsispathway in fungi (Nene and Thapliyal 1973). Arunkumar (2008) reported that propiconazole and hexaconozole were highly effective in inhibition of mycelial growth against *A. alternata* whereas Mesta *et al.* (2009) reported that hexaconazole and propiconazole were significantly effective over all other fungicides with respect to inhibition of spore germination of *A. helianthi*. Metiram 70% + Pyraclostrobin 20% WG (0.35 % concentration) was found most effective in inhibiting mycelial growth of *A. alternata in vitro* (Poonam Kumari *et al*., 2020). Pyraclostrobin blocks the mitochondrial electron transport and thus inhibits the fungus energy supply and results in the death of the target fungus. Metiram has contact and protective fungicide preventing the germination of spores and interferes with the development of the germ tubes.Triazoles and Pyraclostrobin combination products were found effective in reducing losses due to Ramularia leaf spot (grey mildew) in Brazil (Juliano Cesar da Silva *et al*., 2019).

Seed cotton yield in protected and unprotected plots

Protected plots of all the three entries recorded significantly higher mean yield when compared to the unprotected plots of the same (Table 4). In protected plot of Jaadoo BG II, significantly higher mean yield was recorded (43.93q ha^{-1}) as against unprotected plot (36.84 q ha^{-1}), whereas, protected plots of RCH 2 BG II and L 1060 yielded 37.22 q ha^{-1} and 36.72 q ha^{-1} in comparison to unprotected plots (29.35 q ha^{-1} and 27.87 q ha^{-1}, respectively). Per cent seed cotton yield loss was to the tune of 16.14 in Jaadoo BG II, 20.34 in RCH 2 BG II and 26.28 in L 1060 (Table 4). Higher B:C ratio was obtained for the protected plots of all the three cultivars of cotton. The highest ICBR was recorded with Jaadoo BG II (26.61) as against 19.95 in RCH 2 BG II and19.46 with L 1060 (Table 5).

Fungicide applications, beginning when lesions were first seen have also been shown to reduce Alternaria - incited premature defoliation of cotton and to improve seed yield by as much at 22% (Bashi *et al*., 1983). Avoidable yield loss of 32.38% due to Alternaria leaf spot was reported with five sprays of propiconazole 0.1% with highest B:C ratio of 1.72 (Hosagoudar *et al*., 2014). Both kresoxim methyl (0.1%) and propiconazole (0.1%), sprayed thrice at 15 days interval starting from the first appearance were effective against foliar diseases in cotton and significantly increased the yield to the tune of 59.66 and 56.99 percent, respectively (Bhattiprolu, 2015).Seed cotton yield gain with

Table 1. Alternaria leaf spot severity (PDI) in protected and unprotected plots of cotton cultivars

Hybrids/ variety	Percent Disease Index (PDI)							
	Before spraying (60 DAS)		After first spray (75 DAS)		After second spray (90 DAS)		After third spray (105 DAS)	
	Protected	Unprotected	Protected	Unprotected	Protected	Unprotected	Protected	Unprotected
Jaadoo BG II	6.12	5.23	6.95	9.28	5.03	11.85	3.65	10.33
RCH 2 BG II	6.50	7.00	6.53	8.25	4.08	9.50	2.13	8.08
L 1060	7.25	6.50	5.98	7.78	3.95	8.05	1.05	6.98
Averages	6.62	6.24	6.48	8.43	4.35	9.80	2.28	8.46
t- test	0.61 NS	3.71**	4.71**	4.98**				
p- value	0.29	0.01	<0.01	<0.01				

** indicates significance of values at p = 0.01; NS indicates non-significance

Table 2. Corynespora leaf spot severity (PDI) in protected and unprotected plots of cotton cultivars

Hybrids/ variety	Percent Disease Index (PDI)									
	Before spraying (60 DAS)		After first spray (75 DAS)		After second spray (90 DAS)		After third spray (105 DAS)		After fourth spray (120 DAS)	
	Protected	Unprotected	Protected	Unprotected	Protected	Unprotected	Protected	Unprotected	Protected	Unprotected
Jaadoo BG II	10.25	10.00	9.50	10.58	8.08	15.08	6.50	27.05	5.00	35.13
RCH 2 BG II	7.25	8.00	7.93	9.08	7.50	17.10	6.28	26.30	5.50	40.70
L 1060	6.75	7.25	8.35	10.50	7.30	17.58	6.10	32.18	5.45	42.30
Averages	8.08	8.42	8.59	10.05	7.63	16.58	6.29	28.51	5.32	39.38
t- test	0.24 NS	2.16*	11.18**	12.01**	15.62**					
p- value	0.41	0.04	<0.01	<0.01	<0.01					

* and ** indicate significance of values at p = 0.05 and 0.01, respectively; NS indicates non-significance

Table 3. Grey mildew severity (PDI) in Protected and Unprotected plots of cotton

Hybrids/ variety	Percent Disease Index (PDI)			
	Before spraying(105 DAS)		After spraying(120 DAS)	
	Protected	Unprotected	Protected	Unprotected
Jaadoo BG II	4.25	9.75	2.98	13.78
RCH 2 BG II	1.75	2.75	1.00	3.40
L 1060	1.00	2.25	0.48	1.63
Averages	2.33	4.92	1.49	6.27
t- test	0.99 NS		2.20*	
p- value	0.19		0.04	

* indicates significance of values at p = 0.05; NS indicates non-significance

Table 4. Seed cotton yield (q ha-1) in protected and unprotected plots of cotton

Treatment	Seed cotton yield (qha^{-1})		
	Jaadoo BG II	RCH 2 BG II	L 1060
Protected (T1)	43.93	37.22	36.72
Unprotected (T2)	36.84	29.35	27.87
t- test	3.00**	4.80**	6.39**
p- value	<0.01	<0.01	<0.01
Per cent yield loss	16.14	20.34	26.28

** indicates significance of values at p = 0.01

two fungicide applications compared with no fungicide was 3.2% and 7.2% in DP cultivars and Phytogen 499, respectively (Bowen *et al*., 2018). Four sprays ofcarbendazim (0.1%) at 15 days interval realized 534 kg / ha^{-1} additional yield in Bunny Bt (Bhattiprolu, 2012).Need based sprays under Integrated disease management in cotton resulted in significant increase in the yield (20.34% - 34.75 %) with maximum IBCR of 1.35 (Bhattiprolu and Monga, 2017). Grey mildew caused losses from 14.8% to 31.7% and pyraclostrobin + fluxapyroxad, pyraclostrobin + epoxiconazole + fluxapyroxad and fentin hydroxide were found effective (Tormen and Blum, 2019).

CONCLUSIONS

It is suggested that cotton farmers should grow tolerant varieties and protect with recommended fungicides starting from the appearance to avoid yield losses due to major diseases in cotton.

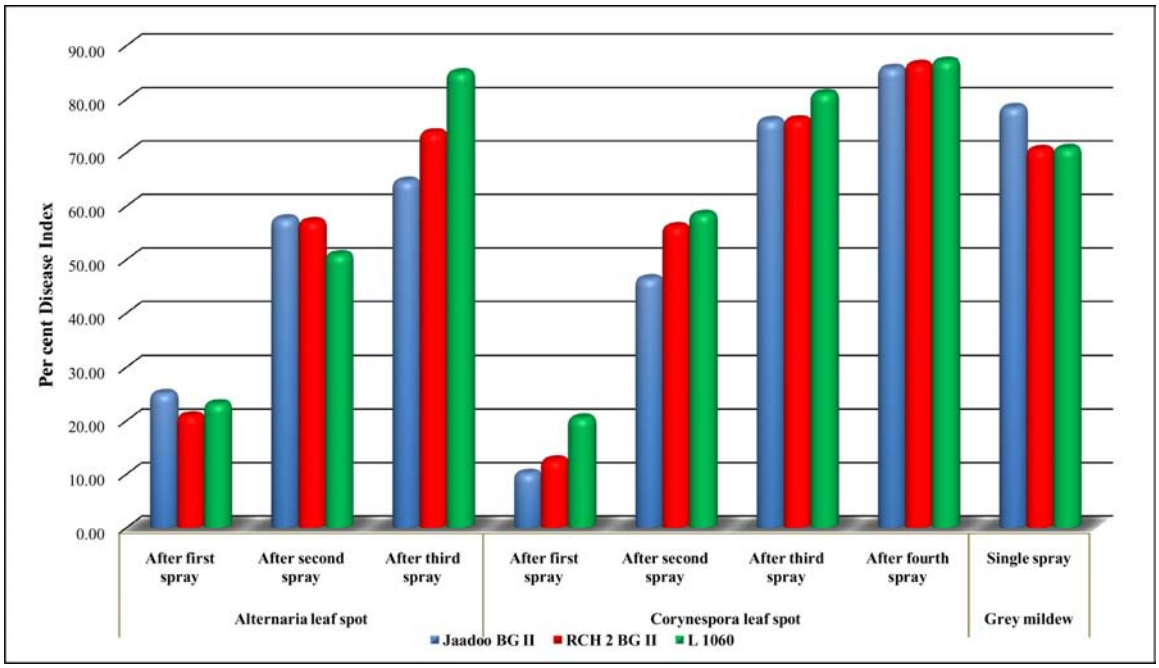

Fig. 1. Per cent excess in disease in unprotected plot over protected plot in cotton cultivars

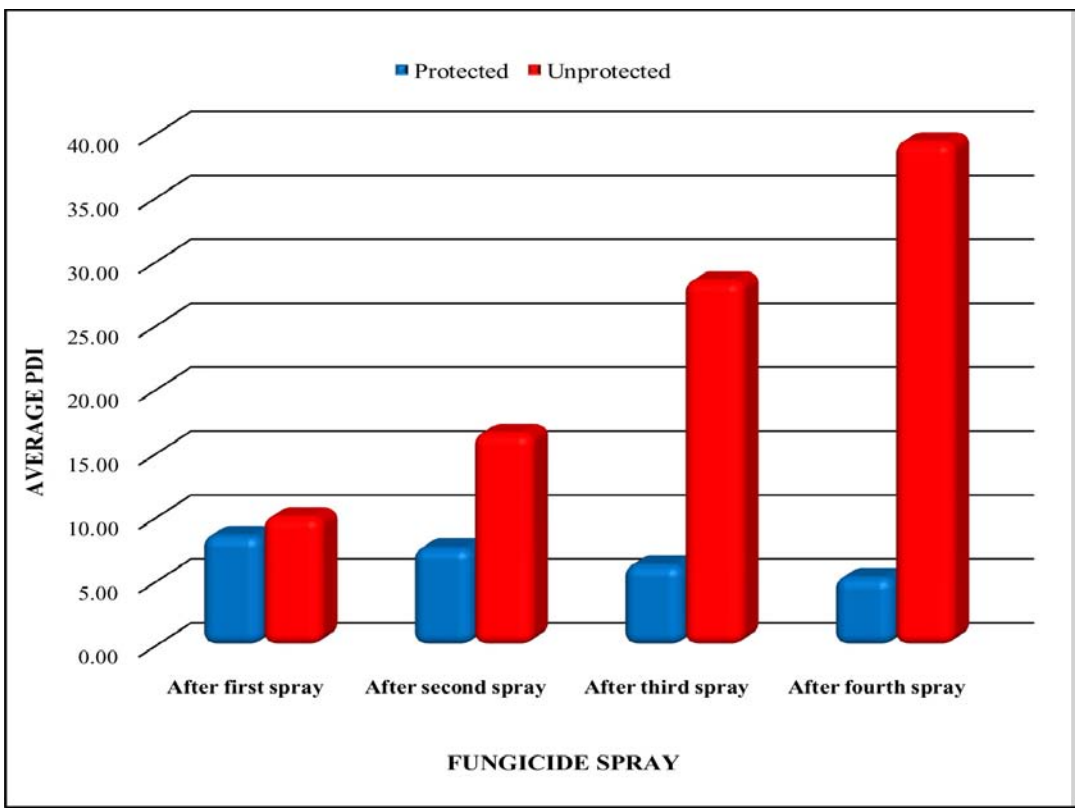

Fig. 2. Comparison of Corynespora leaf spot severity in protected and unprotected plots of cotton

Table 5. Economics of protection from fungal foliar diseases in cotton cultivars

Hybrids/ variety	Treatments	Yield (kg ha^{-1})*	Gross expenditure (Rs.)	Gross returns (Rs.)	Net returns (Rs.)	Benefit cost Ratio	ICBR
Jaadoo BG II	Protected (T1)	4393	77008.50	204967	127958.5	2.66	26.61
	Unprotected (T2)	3684	74500.00	173148	98648.00	2.32	-
RCH 2 BG II	Protected (T1)	3722	77008.50	174934	97925.50	2.27	19.95
	Unprotected (T2)	2935	74500.00	137945	63445.00	1.85	-
L 1060	Protected (T1)	3672	77008.50	172584	95503.50	2.24	19.46
	Unprotected (T2)	2787	74500.00	130989	56489.00	1.76	

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EFFECT OF BIO-MOLECULES AND MULCHING PRACTICES ON FRUIT QUALITY PARAMETERS OF TOMATO HYBRIDS

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ABSTRACT

Quality of tomato fruits is extremely important from the consumer point of view. The pigments responsible for tomato fruit colour offer several health benefits, the firmness of the fruit ensures long distance transportation and reduce food wastage. Though there are several possibilities of enhancing these quality traits in tomato fruits, few agronomic approaches seem to be cost effective and provides easy wins for growers and consumers. In this study, we have evaluated the influence of mulching, humic acid, Lipo-chito-oligosaccharides and their interactive effects with different genetics in improving the fruit colour and firmness in tomato fruits. Better hue and Chroma values observed in hybrid, Ashoka *viz*., 38.79% and 29.99%, respectively and highest transportability (10.2 days) was recorded in TO 1057. Effect of polythene mulch on transportability (10.5 days) showed significantly over crop mulch and no mulch treatments. Application of Ratchet @ 240 ml/ acre showed better hue value (39.8%), Chroma value (28.42%) and transportability (9.22 days). It is concluded that genetics coupled with mulching and bio molecules provide significant benefits on improved quality of tomato fruits.

Key Words: Chroma, Colour, Fruit Quality, Hue, Humic Acid, LCO, Tomato, Transportability

INTRODUCTION

Tomato (*Solanum lycopersicon* Mill) is one of the most important vegetable crops cultivated all over the world. It belongs to family Solanaceae. The demand for tomato both as fresh fruit and in processed form is increasing day by day in India due to its high nutritional qualities especially lycopene, phenolics and Vitamin C, which has opened up marketing opportunities. Among the fruit quality parameters, fruit colour and firmness are extremely important from commercial point of view. The tomato fruits are consumed when they are at higher organoleptic quality i.e., when they become fully red and before excessive softening. Colour of tomato is one of the very important exterior factors to know the ripeness and post-harvest life of the fruits which helps in deciding consumers' preference. The red colour of tomatoes is due to

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chlorophyll degradation and increased biosynthesis of lycopene, a carotenoid. During this process, chloroplasts are transformed into chromoplasts. Deep red colour of ripened tomatoes is principally present due to a pigment called lycopene. It has biological and physiochemical properties hence act as a natural antioxidant. The presence of various carotenoid pigments which are conditioned by different concentrations of pigment types contributes to the complexity of tomatoes colour. Tomato requires high amount of water and lack of water reduce the total production in arid and semi-arid areas (Nangare *et al.,* 2016). Advanced agronomic practices are crucial factors that enhance fruit yield and qualities in tomato cultivation. Practising mulching increases water and nutrient use efficiency, weed control, helps in managing pest and disease spread, improves root growth and maintain optimum soil temperature (Tuzen *et al.,* 2021; Tesfaye *et al.,* 2016). Meter Bi film mulches improves fruit firmness, TSS, colour, carotenoids and Vitamin C (Morra *et al.,* 2016).

Firmness of tomato fruits is decided by several parameters which include turgor, cuticle properties and cell wall structure. Nutrients play one of the most important roles in increasing the fruit firmness. Higher level of nutrients (Ca, Mg, P and K) in fruits make the fruits firmer as these nutrients help in cell wall thickening in turn increase the fruit firmness, delays ripening and increases shelf life of tomato fruits. Transportability of tomatoes is one of the key commercial traits for round and square round (oval) segments in India. Fruit skin colour, fruit shape and size uniformity, fruit maturity, weight, scars on fruits and firmness are important quality parameters that decides consumer preference during buying of tomatoes (Kyriacou and Rouphael, 2018).

Application of humic acid helps in increasing the quality of fruits especially colour of the fruits. Lycopene content is increased with the application of humic acid as it improves the concentration of chloroplasts which are the sites of lycopene synthesis at the time of fruit ripening (Suganya, 2019). Higher supply of nitrogen to the plants induces the higher growth rate, produce big sized fruits, higher concentration of leaf and fruit nitrogen gives poor colour to the fruits skin and reduces the fruit firmness. Excessive nitrogen also reduces the calcium accumulation in the fruits and there by reduces the compactness of pulp. Seaweed extract increases nutrient uptake of soil and makes them resistant to environmental stress and increases overall plant shoot and root development, act as stimulants or hormones which encourages quick seed germination and plant growth. Application of mulching influences release of nitrogen to the plants which attributes to colour and firmness of the fruits. Chito / chitin oligosaccharides application on plants induces plant disease resistance, growth, escapes from abiotic stresses, enhances fruit and flower shelf life (Zhao *et al.,* 2019). Lipo-chito oligosaccharide showed better plant growth especially when plants are growing under stressful environment (Zipfel and Oldroyd, 2017).

To the best of our knowledge, we have limited studies on the interaction of agronomic practices such as mulching, biomolecules and their influence on different genetics of tomato in improving the fruit qualities. Hence, we have

conducted a detailed study for 2 consecutive years to understand interaction of genetics and agronomic parameters in influencing the fruit quality traits of tomato.

MATERIALS AND METHODS

Lab experimentation was conducted to study the effect of biomolecules and mulching practices on fruit quality parameters of tomato hybrids over a period of two years during the summer seasons of 2016 and 2017 at Monsanto Mega Breeding station, Bangalore and the experiment crop was raised in Settihalli, Kolar. The experiment was conducted with 30 plants per replication and 12 pickings were harvested throughout the experiments.

Bio molecules product composition and application in the field

Ratchet (lipo-chito oligosaccharide) and Proventus [humic acid, 39%; cold water kelp extracts, 25% and essential amino acids and vitamins, 36%] were used as bio molecules in the experiment. Ratchet was applied in two different doses *i.e.,* Ratchet @ 120 ml/acre (B1), Ratchet @ 240 ml/acre (B2) and Proventus @ 1000 g/acre (B3) done 20 and 40 days after transplanting on four hybrids as main treatments *viz.,* TO-1057 (H1), Garv (H2), Ashoka (H3) and ArkaRakshak (H4) with three mulching as sub treatments *viz.,* Polythene Mulch (M1), Crop Mulch (M2) and No Mulch (M3). Treatment details and their influence on quality of tomato fruit are presented in Table 2, whereas, interaction effects are presented in Table 1.

Selection of the fruits and sample size

Uniform matured colour breaker staged 15 fruits were randomly picked from each of the treatments for firmness and colour experiments.

Sampling and sub sampling procedure

The harvested and randomly selected fruits were kept in plastic trays, which were cleaned with liquid soap before experiment, and gloves were used while handling the fruits. Samples were initially checked for unmarketable fruits (damaged, shrunken, diseased and uneven ripening/nutritional deficiency) by visual means and such fruits were removed. All the fruits were used in firmness and colour measurement. Experiment was conducted at room temperature.

Measurement of quality traits

The fruits from 5th harvest were considered for experimentation. From the day of harvest, observations on firmness and colour were taken at 5 time points (1, 3, 6, 9, 12 and 15 days after harvest). All the experiments were conducted on the same fruits at every time points, and hence, the experiment was considered as “non-destructive”.

Firmness and transportability measurement

Firmness was measured using Durameter (Agrosta-100) by taking three readings per fruit per time point and average of the 3 readings was considered at every time point. From our past experience, we knew that the fruits can be considered as soft if the durafel reading is less than 65%. Hence, transportability was measured in terms of days required for fruits reach 65% of durafel reading.

Colour

Colour was measured quantitatively by using chroma meter (CR-400, Konica Minolta). Before analysing the samples, we performed the white calibration as per the manufacturer guidance and material. One reading per fruit per time point was taken. Hue and chroma was calculated based on L, a and b values. Colour was measured at 1, 3, 6, 9, 12 and 15 days after harvest. In tomato fruits, at the initial stage fruit colour values will be 90-100 hue, while at fully ripened stage or deep red colour, the hue will be 35-40. Hence, lesser the hue value, better the red colour and hue value of 35-45 is considered as threshold in Tomato. hue steadily decreased as the fruit ripens. chroma represents fruit shining. Better the chroma value, better the fruit shining.

Unmarketable fruits

At every time point, entries were evaluated for fruit rotting and shrinkage. Such fruits were considered as unmarketable and discarded.

Statistical Analysis

Data was statistically analysed and the treatment means were compared by Duncun's Multiple Range Test (DMRT). The software used for the analysis was Tukey HSD (SPSS version 19).

RESULTS AND DISCUSSION

Hue (%)

Hue values measured at 9th day of harvest have been considered for analysis and discussion of results. Among the hybrids, pooled data of Ashoka (H3) recorded significantly lower hue value (38.79) of tomato (Lower the hue, better the colour) as compared to Garv (H2) and ArkaRakshak (H4) 41.46 and 40.75, respectively which were on par with each other but TO-1057 (H1) observed significantly higher hue value of tomato (43.08) than H2, H3 and H4 (Table 2).

It was observed that all the three mulching treatments did not differ from each other (Table 1). However, low hue value (40.83) in Polythene Mulch (M1) was obtained as compared to No Mulch (M3) and Crop Mulch (M2) *i.e*., 40.87 and 41.36, respectively. Similar findings were reported by Tuzen *et al.* (2021) but Karaer *et al.* (2020) who observed positive results on mulched treatments which were significantly higher colour (a and b) values compared to un-mulched plots.

Application of Ratchet @ 240 ml/acre (B2) showed significantly lower hue value, 39.8 than Proventus @ 1000 g/acre (B3), Control (B4) and Ratchet @ 120 ml/acre (B1) *i.e.,* 41.9, 41.55 and 41.66 respectively (Lower the hue, better the colour) and B3, B4 and B1 did not differ from each other (Table 2).

Among the application of Lipo-chito-oligosaccharides (Ratchet @ 240 ml/acre, Ratchet @ 120 ml/acre), Humic acid (Proventus 100 ml/acre), application of Lipo-chito-oligosaccharide recorded lower hue (39.8), higher chroma value (28.42) and higher transportability (9.22 days). Souleimanov *et al.* (2002) indicated that application of Lipo-chito-oligosaccharides improved the stomatal aperture. There was higher carbon dioxide uptake by chloroplasts in the leaves, this helped in increasing the opening of stomata. As there was higher stomatal aperture by this the photosynthesis got stimulated, thus the

quality of the produce improved under stressed conditions. Similarly, foliar application of lipo-chito-oligosaccharide in the range of 10-50 nano gram per plant showed an improved result on the fruit yield and fruit quality when applied at early flowering and fruiting stage as observed by Chen *et al.* (2007). Interaction between the treatments, pooled data of hybrid and bio molecules showed significantly lower hue values compared to other interactions *viz.,* Hybrid and Mulching, Mulching and Bio Molecules and all the three-way interactions and they have showed non significantly each other (Table 1).

Chroma (%)

Two seasons pooled chroma values were presented and higher chroma values indicates better colour intensity (Table 2). Ashoka (H3) showed significantly higher chroma value of 29.99 than rest of the hybrids. TO-1057 (H1) and Arka Rakshak (H4) noted significantly lower chroma value (25.79 and 26.39 respectively) whereas Garv (H2) recorded chroma value of 28.45 which was significantly higher than H4 and H1 and lower than H3 (Table 2). Polythene Mulch (M1) and No Mulch (M3) observed higher pooled chroma value (27.7 and 28.2, respectively) and were on par with each other. During 2017, application of polythene mulch (M1) and Crop Mulch (M2) showed significantly higher Chroma values (28.66 and 28.50) and whereas in 2016, No mulch (M3) showed better chroma values 28.9 followed by polythene mulch (M1) 26.75 (Table 2), some positive results were found on tomato fruits harvested from mulching (MB N8 and LDPE) fields achieved the maximum points of colour components “L” and “b”, respectively (Sekara *et al.,* 2019).

Bio-molecules treatment showed positive impact on fruit colour intensity. Pooled values of Ratchet @ 240 ml/acre (B2) observed significantly more chroma value 28.42 as compared to Ratchet @ 120 ml/acre (B1) and Control (B4) (27.13 and 27.17, respectively) but on par with Proventus @ 1000 g/acre (B3) recorded 27.90 and which was significantly higher than B1 and B4. Both B2 and B3 were showed consistently on par with each other during 2016 and 2017 (Table 2). Highly significant results in the interaction effects between hybrids and mulching treatments could be found but could not observe similar effects in other interactions between hybrids and bio molecules; mulching and bio molecules; hybrid, mulching and biomolecules on chroma values in both the seasons and pooled as revealed in Table 1. Results are in conformity with the findings of Cozzonlino *et al.* (2020), wherein mulching treatment had positive effect on the quality of tomato.

Transportability (Days)

From the firmness data, it is noticed that if fruits reach a Durafel firmness of <65 %, it can be considered as soft/unmarketable fruits. The time taken for fruits to reach 65% durafel readings, firmness was considered as transportable days.

TO-1057 (H1) hybrid showed highest transportability days (10.2) against other three hybrids but Ashoka (H3) and Garv (H2) transportability values were on par (9.66 and 9.04 days, respectively) with H1, but better than H4. Arka Rakshak (H4) which recorded

significantly lower transportability 4.37 days as compared to H1, H2 and H3 (Table 2). Mulching practices influenced the transportability of the fruits significantly. Pooled values of Polyethylene mulch (M1) recorded significantly higher transportability; 10.50 days as compared to rest of the mulching treatments. Significantly lower transportability was observed in other two treatments i.e., 6.84 days in Crop mulch (M2) and 7.62 days in No Mulch (M3) as shown in the Table 2. Improvement in the quality of tomato expressed as transportability days observed in the present study are in line with findings of Dubey *et al.* (2019) and similarly Sekara *et al.* (2019) and Morra *et al.* (2021) who reported highest fruit firmness under mulched treatments compared to non-mulching.

Highest transportability days (9.22) observed in Ratchet application @240 ml/acre (B2) in comparison to rest of the biomolecule treatments. However, B2 has showed higher values but Proventus @ 1000 g/acre (B3) noted 8.20 days and Ratchet @ 120 ml/acre (B1) observed 8.10 days that were showed on par with each other, and significantly lower transportability days (7.75) was recorded in control (B4) (Table 2). Some results were showed on impact of humic acid application increased the concentration of K and Ca on tomato plant leaves that probably helped in nutrient uptake and supported in enhancing fruit firmness (Asri *et al.,* 2015); similarly, Husein *et al.* (2015) observed higher concentration of N, P, K and Ca in tomato plants from the application humic acid + fulvic acid + calcium treated plants. Although, we have observed significant interaction effect on transportability between hybrid and mulching during 2016 but no significant influence between the factors in the pooled years (Table 1).

In this study, application of humic acid (proventus @ 100ml/acre) also showed lower hue % (41.09), higher chroma value (27.9) and transportability (8.2 days) which were on par with the application of ratchet @ 240 ml/acre. This might be due to the application of humic acid helps in increasing the quality of fruits especially colour of the fruits. Similarly, Sure *et al.* (2012) also studied that application of all humic acid on plants showed significant increase of chemical characteristics. Spraying of humic acid 30 ml^{-1} can be suitable treatment for enhanced the quality of the fruits like total soluble sugar (TSS), fruit firmness, fruit skin total chlorophyll, fruit skin chlorophyll a and fruit skin chlorophyll b. Correspondingly lycopene content is increased with the application of humic acid as it improves the concentration of chloroplasts which are the sites of lycopene synthesis at the time of fruit ripening (Suganya, 2019). Similar results were observed with Yildirim (2007) who observed that the application of humic acid to both foliage and soil treatments resulted in higher fruits diameter, fruits height, fruit firmness, mean fruits weight and number of fruits per plant.

CONCLUSIONS

The quality of the tomato fruit is mainly judged on the basis of the skin colour, texture of the skin and the firmness of the fruits which in total increases the marketable value of the produce. In this study, the hybrid Ashoka (H3), Polythene Mulch (M1) and Ratchet @ 240 ml/

Table 1. Effect of hybrid, mulching, bio molecules and their interaction on quality of tomato

S. No.	Source	Year-2016			Year-2017			Pooled		
		Hue (%)	Chro-ma (%)	Trans-porta-bility (Days)	Hue (%)	Chro-ma (%)	Trans-porta-bility (Days)	Hue (%)	Chro-ma (%)	porta-bility (Days)
1	Hybrid (H)	101.86	91.29**	321.59**	62.17**	103.55**	81.32**	152.13**	178.83**	343.41**
2	Mulching (M)	20.29	88.97**	228.13**	15.91**	12.65**	45.66**	5.66	20.99*	237.27**
3	Bio Molecules (B)	13.22	17.70**	8.16*	29.89**	5.23	12.48*	34.99**	18.62*	19.37
4	Hybrid X Mulching	2.82	16.20**	10.43**	7.73*	20.88**	4.59	5.58	20.41**	12.70
5	Hybrid X Biomolecules	8.55	5.07	3.43	3.39	3.21	2.31	9.07*	5.00	3.27
6	Mulching X Biomolecules	4.81	2.20	2.18	0.89	1.78	4.25	3.88	1.06	3.41
7	Hybrid X Mulching X Biomolecules	2.96	2.42	3.02	3.01	2.17	2.70	3.84	2.089	3.49
8	Error	4.17	2.86	2.34	2.45	1.90	3.13	4.49	4.89	4.85

Note: *Significant @ 5% and ** significant @ 1% level of significances, respectively.

Table 2. Influence of hybrid, mulching, bio molecules and their interaction on hue, chroma and transportability parameters of tomato

S. No.	Treatment	Hue (%)			Chroma (%)			Transportability (Days)		
		Year-2016	Year-2017	Pooled	Year-2016	Year-2017	Pooled	Year-2016	Year-2017	Pooled
1	TO-1057 (H1)	43.04 a	43.13 a	43.08 a	25.87 c	25.70 c	25.79 c	12.33 a	8.08 a	10.20 a
2	Garv (H2)	40.29 b	42.64 ab	41.46 b	27.33 b	29.57 a	28.45 b	9.54 b	8.54 a	9.04 a
3	Ashoka (H3)	38.08 c	39.50 c	38.79 c	29.75 a	30.24 a	29.99 a	10.29 b	9.04 a	9.66 a
4	ArkaRakshak (H4)	39.75 b	41.76 b	40.75 b	25.41 c	27.37 b	26.39 c	3.79 c	4.95 b	4.37 b
5	Polythene Mulch(M1)	40.68 a	40.98 b	40.83a	26.75 b	28.66 a	27.70 ab	11.96 a	9.03 a	10.50 a
6	Crop Mulch (M2)	40.81 a	41.92 ab	41.36a	25.62 c	28.50 a	27.06 b	6.81 c	6.87 b	6.84 b
7	No Mulch (M3)	39.37 b	42.36 a	40.87a	28.90 a	27.50 b	28.20 a	8.18 b	7.06 b	7.62 b
8	Ratchet @120ml/acre (B1)	40.62 ab	42.69 a	41.66a	26.37bc	27.89a	27.13 b	9.00 ab	7.20 b	8.10 ab
9	Ratchet @240ml/acre (B2)	39.20 b	40.39 b	39.80b	28.29 a	28.56a	28.42 a	9.75 a	8.70 a	9.22 a
10	Proventus @1000g/acre (B3)	40.87 a	41.30 b	41.09a	27.12 ab	28.58a	27.90 ab	8.87 ab	7.54 ab	8.20 ab
11	Control (B4)	40.45 ab	42.64 a	41.55a	26.58bc	27.75a	27.17 b	8.33 c	7.16 b	7.75 b

Note: Same letters indicate non-significant at 0.95 level of significance

acre (B2) showed lower hue, higher chroma value and higher transportability as compared to other treatments.

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EVALUATION OF WATERSHED PROJECTS USING REMOTE SENSING AND GIS TECHNOLOGIES IN Y.S.R. KADAPA DISTRICT OF ANDHRA PRADESH

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ABSTRACT

The current study was undertaken to investigate the utility of Remote sensing and Geographic information system (GIS) tools for evaluation of seven watershed projects implemented under Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) project during 2009-'16 in YSR Kadapa District of Andhra Pradesh. The study was carried out using high resolution Resourcesat-2, Linear Imaging Self-scanning Sensor (LISS)-IV data of 2011 (pre-treatment) and 2016 (post-treatment) to assess the changes in land use/land cover and biomass over a period of five years (2011-'16). Due to implementation of the watershed developmental activities, an additional area of 3618 ha has been brought under cultivation. The vegetation maps indicated that the areas under dense and open vegetation categories were increased from 2224 to 4915 ha and 5864 to 10670 ha during the project period due to adoption of soil and water conservation practices. An additional area of 191 ha (8.99%) increased under water bodies and 518 ha waste land was converted to cultivable land due to construction of farm ponds, percolation tanks and check dams. This area is attributed to cropland and plantations in the year 2016.

Keywords: Remote sensing and Geographic information system (GIS), PMKSY project, Resourcesat-2, LISS-IV data, Watershed project

INTRODUCTION

Watershed is an area that supplies water by surface or subsurface flow to a given drainage system or body of water such as a stream, river, wetland, lake or ocean. Remote Sensing (RS) and Geographical Information System (GIS) have been proved as effective tools to monitor, and manage the natural resources, and assess the impact on watersheds during the pre and post development. In order to reduce the cost and time satellite remote sensing has been used as an evaluation tool (Liu and Negron, 2001, Schmidt and Skidmore, 2001). Unfortunately monitoring and evaluation has not got its share of attention and therefore it is very difficult to quantify and assess the changes which have taken place not

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only in natural resources but also in livelihoods of people due to these programmes and in the long run to justify the need for these schemes (Shanwad *et al.,* 2008, Srinivasa Vittala *et al.,* 2008, Martin and Saha, 2009, Gopa Kumar *et al.,* 2014, Meenakshi Bai *et al.,* 2018). There is often not enough room for midterm adjustments in ongoing programmes due to lack of a proper monitoring system. The need therefore arises to identify a quick and cost-effective technique for monitoring the impact of such schemes on a 'before project – after project' temporal scale as well as during project implementation stage (Shanwad *et al.,* 2008, Srinivasa Vittala *et al.,* 2008, Martin and Saha , 2009, Gopa Kumar *et al.,* 2014 and Meenakshi Bai *et al.,* 2018).

YSR Kadapa district is one of the districts of Rayalaseema regions of Andhra Pradesh and the district lies in between north latitudes of 13° 43' - 15° 10' and East longitudes of 77° 55' - 79° 29' and spreads over an area of 15,379 sq. km. In the study, seven watersheds have been implemented under Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) project (Batch-1) during 2009-'10 (Table 1).

MATERIALS AND METHODS

The Remote Sensing based methodology is adopted through temporal satellite data for monitoring the watersheds. The study is carried out using Resourcesat-2 LISS-IV data of 2009-11 for the watershed before the implementation of program. 2015-'16 satellite data sets are used after the treatment of each watershed. Similar studies were reported by Shanwad *et al.,* (2008), Srinivasa Vittala *et al.,* (2008), Martin and Saha, (2009), Gopa Kumar *et al.,* (2014) and Meenakshi Bai *et al.,* (2018).

The comprehensive methodology is presented in Figure 2. The images were classified into different land use / land cover categories using supervised classification by maximum likelihood algorithm with minimum mapping unit of 2.5 ha.They were also classified into different vegetation levels using Normalized Difference Vegetation Index (NDVI) approach. The classified outputs of land use / land cover and vegetation cover form NDVI of the two time periods were compared to derive information on changes which occurred over a period of time for each watershed. In order to understand the effect of soil moisture and rainfall over the watershed area, daily soil moisture and rainfall data have been analyzed from 2009 to 2016.

Land use / Land cover changes

Supervised classification was performed using maximum likelihood algorithm for both pre and post treatment and the satellite data have been clustered with the pixel similar spectral characteristics into homogenous classes. This algorithm assumes Gaussian distribution and each pixel is considered a separate entity independent of neighbours. The classified images have different land use / land cover categories pertaining to pre and post treatment periods. The classified outputs have been compared in order to evaluate the changes which have taken place over a period of time.

Vegetation vigour changes

The NDVI is highly correlated with vegetative parameters such as green leaf biomass, leaf area and is an indicator of photosynthetic activity. Hence, it is of considerable value for vegetation discrimination and seasonal growing conditions for making

primary productivity analysis. NDVI is computed using the infrared and red reflectance bands. These values for NDVI range from -1 to 1. Vegetative areas show generally high values of NDVI because of their relatively high NIR reflectance and low visible reflectance. Water, snow and clouds have negative IR radiation. Rocks and bare soil have NDVI values around zero. Only green vegetation has positive NDVI values and high values being associated with higher vegetation vigour. The difference of NDVI images generated for both the dates has been carried out to derive information on changes with reference to vegetation vigour. Based on these NDVI values, vegetation vigour was classified into dense, open and degraded vegetation. The fallow was classified as no vegetation.

Soil moisture and Rainfall analysis

In order to understand the effect of soil moisture and rainfall over the watershed area, daily soil moisture and rainfall data have been analysed for the years from 2009 to 2016. For soil moisture mapping, the level-3 daily soil moisture products from Aqua Advanced Microwave Scanning Radiometer - Earth Observation System (AMSR-E) and AMSR-2 have been utilized. In order to justify the variation in moisture content, the daily rainfall data from Automatic Weather Station (AWS) have also been compared over the periods. These daily rainfall and soil moisture data have been converted in to weekly data. The rainfall mostly occurs from June to December in SW monsoon period. Hence, the same period is considered to plot the variation of rainfall and soil moisture. The relationship between the rainfall and soil moisture content for each of the watershed areas was analysed by plotting the graph between these two parameters. The x-axis (bar graph) represents the rainfall and y-axis (line plot) represents the soil moisture. The similarities in the dynamics in soil moisture and rainfall were observed over the given time period.

Data used

The temporal satellite data is used for monitoring the watersheds. The study is carried out using the following data sets:

- LISS IV satellite data (Pre and Post treatment)
- Fusion (LISS IV + Cartosat-2) data
- SOI topo sheets for reference
- PMKSY monitoring reports from the department
- Soil moisture data from AMSRE-2 data
- Rainfall data

Indicators considered for Evaluations of Watershed

In order to analyze the changes taken place during the project period, the following indicators are adopted:

- Vegetation cover
- Water body area
- Shift from annual crops to perennial crops
- Additional area brought under cropped area
- Soil moisture availability through wetness indicators
- Reclamation of wastelands

Major developmental activities of the Watersheds

The development activities taken-up in the watershed are as follows:

1. The structures are constructed like Loose Boulder Structure, Rock fill dams and check dams for soil water conservation.
2. Farm ponds and percolation tanks are constructed.
3. Plantations in individual farmer's land are another major activity.

Other works such as drainage line treatment, nalla bank stabilization, filter strips *etc.,* have also been implemented.

RESULTS AND DISCUSSION

Changes in Vegetation Cover

For analysing the changes in vegetation cover, Normalized Difference Vegetation Index (NDVI) has been generated for watershed area during 2011 and 2016 and classified into different vegetation vigour classes like dense, open, degraded and fallow. The spatial and statistical distribution of vegetation cover maps are represented in Figures 3 and 4 and statistics are presented in Table 2. The vegetation maps indicated that the areas under dense and open vegetation categories were increased from 2224 to 4915 ha and 5864 to 10670 ha during the period from 2011 to 2016, respectively. This increase may be due to adoption of soil and water conservation practices. The reduction in the area under fallow (10002 ha) are found. In the Table 2, dense vegetation has the highest positive value, indicating high increase of 121% from its initial 2224 ha. On the contrary, fallow land has the highest negative value, indicating a high level of conversion to vegetation categories which reduced its size by 33% from its initial 30321 ha. Figure 5 shows the vegetation index during the project period of the watershed area. It clearly states that there is a progressive change of increase in vegetation cover. Similar results were noticed by Shanwad *et al.* (2008). Figure 4 showed the vegetation index during the project period of the watershed area. It clearly states that there is a positive change of increase in vegetation cover.

Changes in Land use / Land cover during 2011 and 2016

The satellite images of both periods (pre and post) were classified into different land use / land cover categories. Spatial distributions of different land use / land cover categories during 2012 and 2016 are presented in Figure 6 and land use changes shown in Figure 7. It is observed that the area under cropland has been increased considerably and reductions in the area under current fallow are also noticed, due to adoption of water conservation measures and implementation of watershed activities, which is similar to the study conducted by Shanwad *et al.* (2008).

Table 3 shows the statistics of the area under different land use / land cover categories for both periods. Significant increases in the area under cropland and plantations are observed and the increases are from 4242 to 7343 ha and from 938 to 1526 ha, respectively during 2011 and 2016. The current fallows are accounted for 14633 ha (27.22%) in 2011 and it has been decreased to 11273 ha (20.97%) in 2016 due to implementation of drought proofing works, which is accounted in crop land and plantations in 2016.

Changes in water body area

Water spread area is extracted from LISS-IV satellite data for the years 2011 and 2016. A gradual temporal change in the water body area has been noticed. The water body area contributed to 2125 ha in 2011 and increased to 2316 ha in 2016 which is about 8.99% from its initial 2125 ha of the pre year. The constructed farm ponds are shown in Figure 8.

Shift from annual crops to perennial crops

The plantation cover occupied 938 ha (1.75%) in 2011 and it has increased slightly to 1526 ha (2.84%) in 2016. It is found that 588 ha of croplands are converted into perennial crops during the project period which is attributed to plantations in 2016. This may helps in soil erosion control, improve soil structure, increase ecosystem nutrient retention, carbon sequestration, water infiltration, and it can contribute to climate change adaptation and mitigation.

Additional area brought under cropped area

Due to the proper adoption of soil and water conservation measures, it is observed that 3618 ha have been brought under cropped area. This is accounted in cropland and plantations in the year 2016. The changes in cropland have been shown in Figure 9. Similar results noticed by Shanwad *et al.* (2012).

Reclamation of wastelands

Under the watershed development activities, reclamation of wastelands is one of the major activities and it includes contour ploughing, strip farming, terracing, leaching and changing agriculture practices. The wasteland reclamation measures are implemented in project area and resulted in brining 518 ha into cultivable land. Similar results of decreased wastelands were observed by Shanwad *et al.* (2008).The major land use changes are shown in Table 4.

Soil moisture availability through wetness indicators

Maximum rainfall occurring between April and November has been taken into reckoning. Thus, the variation between rainfall and soil moisture have been analysed during the project period. The similarities in the dynamics of soil moisture and rainfall observed over the years are

Table 1. List of watersheds in the Kadapa District

S. No.	Project Code	Project Name	Mandal Name	Project area in ha.
1	YSR-Kadapa-IWMP-1/2009-10	Mallela	Thondur	5000
2	YSR-Kadapa-IWMP-2/2009-10	Chinnachappalli	Kamalapuram	4000
3	YSR-Kadapa-IWMP-3/2009-10	Gopavaram	Gopavaram	5000
4	YSR-Kadapa-IWMP-4/2009-10	Dhodium	Mylavaram	4500
5	YSR-Kadapa-IWMP-5/2009-10	K Yerragudi	Chakrayapet	4000
6	YSR-Kadapa-IWMP-6/2009-10	Verrabelli	Veeraballi	4000
7	YSR-Kadapa-IWMP-7/2009-10	Uppalur	Muddanur	1500

Table 2. Changes of Vegetation cover in watershed area (hectares)

S. No.	Vegetation Vigour Type	Pre-Treatment		Post-Treatment		Change ±	
		Area	%	Area	%	Area	% Increase/ Decrease
1	Dense Vegetation	2224	4	4915	9	2691	121
2	Open Vegetation	5864	11	10670	20	4806	82
3	Degraded Vegetation	12638	24	14934	28	2296	18
4	Fallow	30321	56	20319	38	-10002	-33
5	Built-Up	580	1	598	1	18	3
6	Water bodies	2125	4	2316	4	191	9
	Total	53752	100	53752	100		

Table 3. Land use / Land cover distribution and its changes in watershed area (hectares)

S. No.	Vegetation Vigour Type	Pre-Treatment		Post-Treatment		Change ±	
		Area	%	Area	%	Area	% Increase/ Decrease
1	Built-up	580	1.08	598	1.11	18	3.10
2	Crop land	4242	7.89	7343	13.66	3101	73.10
3	Plantation	938	1.75	1526	2.84	588	62.69
4	Current Fallow	14633	27.22	11273	20.97	-3360	-22.96
5	Forest	9685	18.02	9690	18.03	5	0.05
6	Wasteland/Scrubland	21350	39.72	20796	38.69	-554	-2.59
7	Water bodies	2125	3.95	2316	4.31	191	8.99
8	Quarry area	199	0.37	210	0.39	11	5.53
	Total Area	**53752**	**100**	**53752**	**100**		

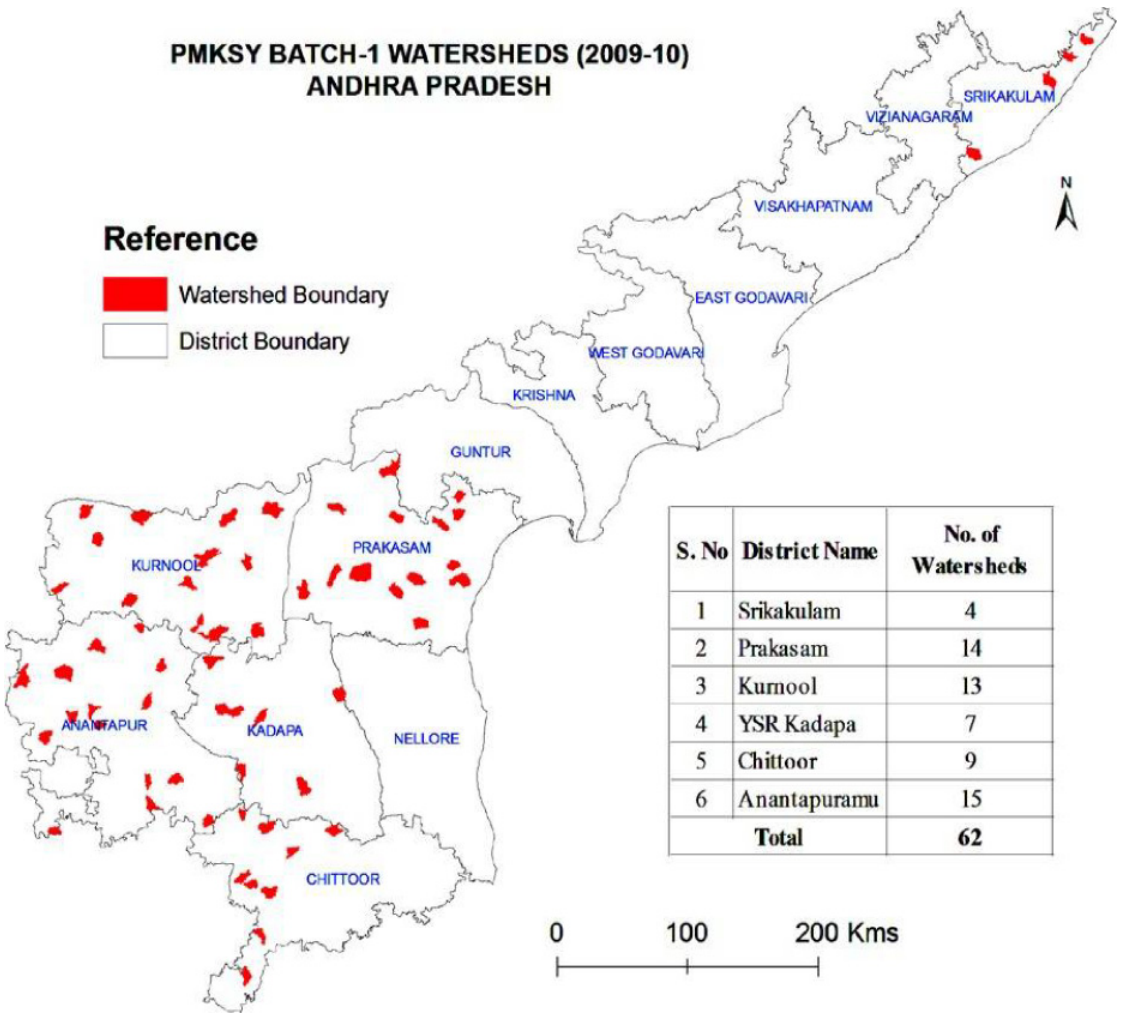
shown in Figure 10. The X-axis represents meteorological weeks, Y_1 axis is Rainfall (bar graph) and Y_2 axis (line plot) represents the soil moisture. The year-wise analyses are used to understand the impact assessment within the watershed.

CONCLUSIONS

Change detection studies have been carried out for the evaluation of seven watersheds in the district and it has been observed that there is a slight increase in

Table 4. Major Land use/ Land cover changes (Units in hectares)

S. No.	Changes		
	From (Pre)	To (Post)	Area in ha.
1	Annual Crops	Perennial Crops	669
2	Wastelands	Built up	06
3	Wastelands	Cropland	165
4	Wastelands	Plantations	04
5	Wastelands	Current Fallow	349
		Additional Cropped Area	**3618**



S. No	District Name	No. of Watersheds
1	Srikakulam	4
2	Prakasam	14
3	Kurnool	13
4	YSR Kadapa	7
5	Chittoor	9
6	Anantapuramu	15
	Total	**62**

Fig. 1. Location map of watersheds

Note: A.P. is divided into 23 districts in the year 2022

Table 5. Major Changes in Seven Watersheds in YSR Kadapa district (Units in hectares)

S. No	District Name	Vegetation Cover			Cropland			Plantation			Water bodies		
		Pre	Post	Change	Pre	Post	Change	Pre	Post	Change	Pre	Post	Change
1	Mallela	4577	4951	374	881	1378	497	23	29	6	198	239	41
2	Chinna chappalli	2495	3410	915	620	1280	660	8	21	13	246	276	30
3	Gopavaram	5113	5303	190	301	660	359	75	96	21	461	486	25
4	Dhodium	219	2241	2022	222	800	578	9	9	0	107	129	22
5	K Yerragudi	910	3143	2233	326	400	74	19	32	13	467	495	28
6	Verrabelli	4738	6121	1383	1507	1710	203	775	1293	518	403	441	38
7	Uppalur	2674	5350	2676	385	1115	730	29	46	17	243	250	7
Total		**20726**	**30519**	**9793**	**4242**	**7343**	**3101**	**938**	**1526**	**588**	**2125**	**2316**	**191**

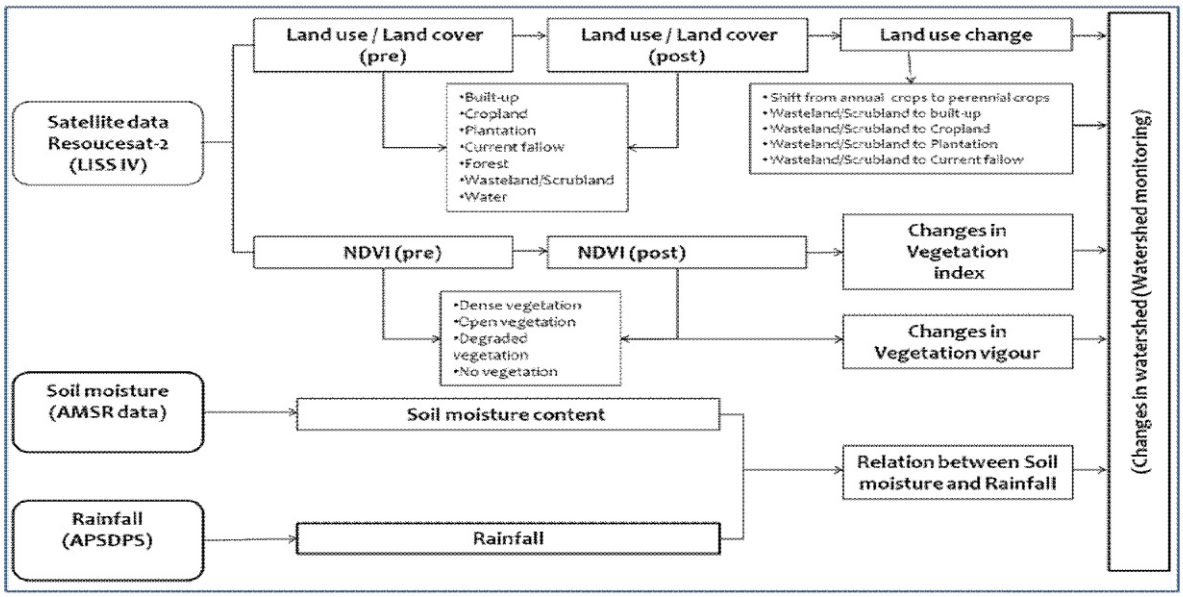


Fig. 2. Methodology followed in the study area

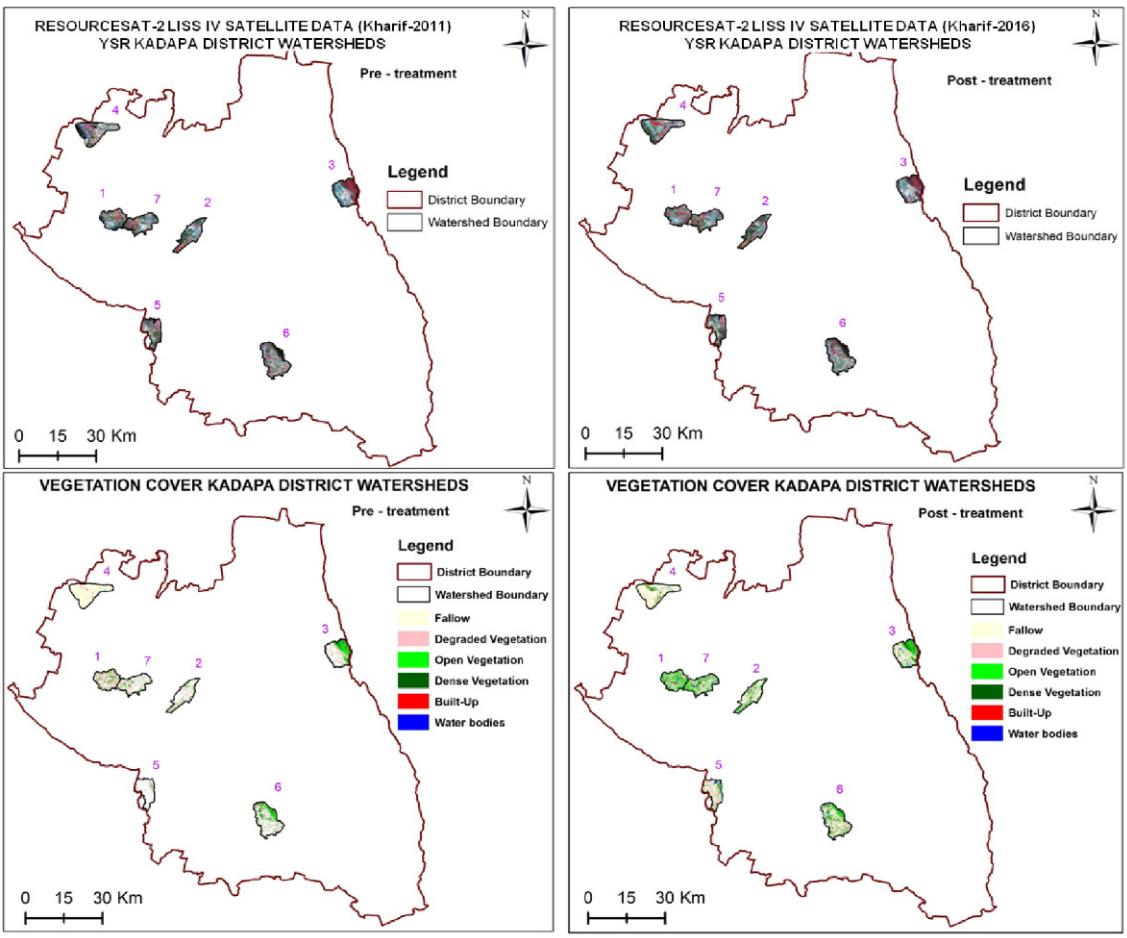
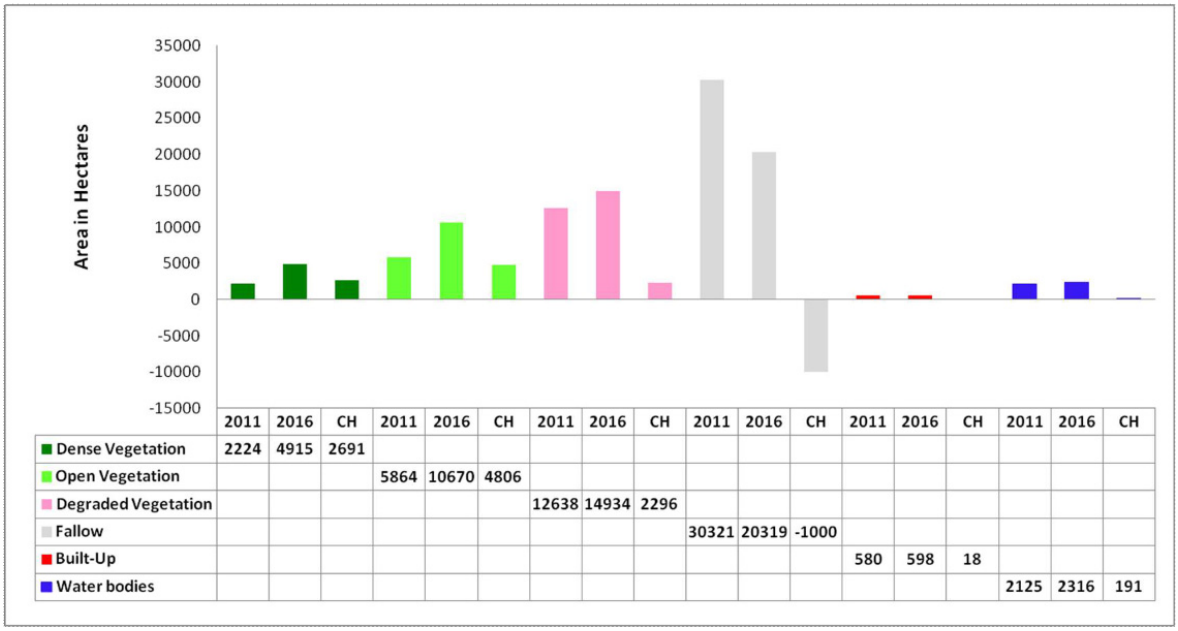


Fig. 3. Comparision of Vegetation Cover maps



	2011	2016	CH	2011	2016	CH	2011	2016	CH	2011	2016	CH	2011	2016	CH	2011	2016	CH
Dense Vegetation	2224	4915	2691															
Open Vegetation				5864	10670	4806												
Degraded Vegetation							12638	14934	2296									
Fallow										30321	20319	-1000						
Built-Up													580	598	18			
Water bodies																2125	2316	191

Fig. 4. Distribution of vegetation cover change

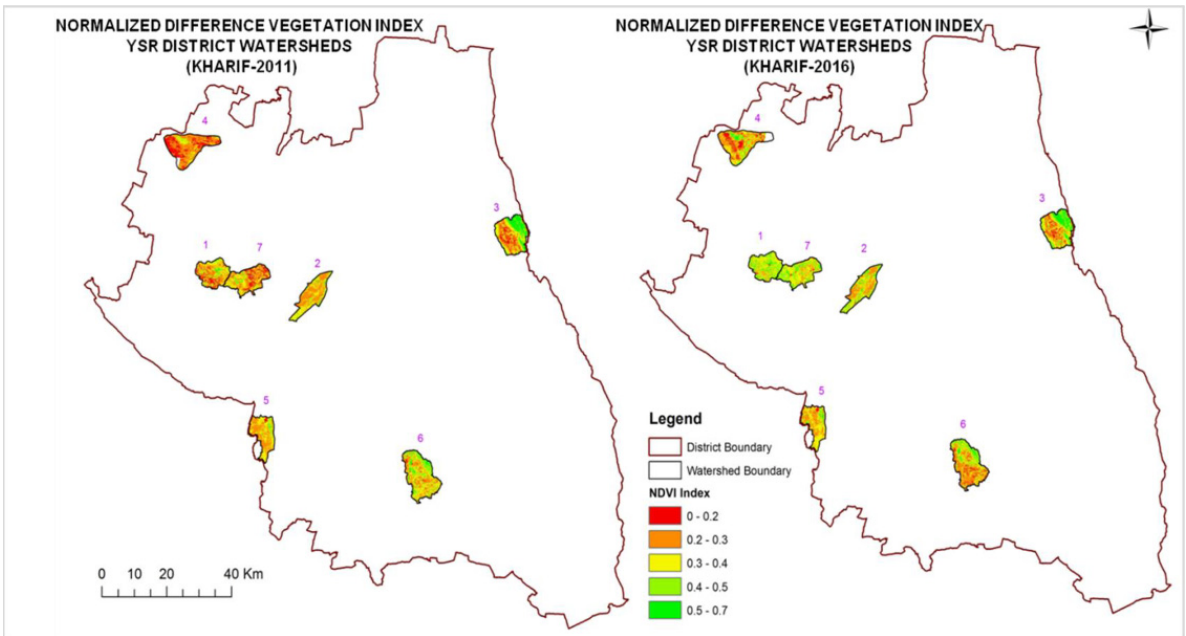


Fig. 5. Comparision of normalized difference vegetation index

plantation area which *i.e.* 588 ha. There is a increase in cropland which is about 4242 ha to 7343 ha between 2011 and 2016. It is also noted that cropland has increased at the cost of current fallow land. The output of NDVI classification indicates that there is an increase in dense, open and degrades vegetation categories, which is due to the watershed development activities. NDVI studies indicated that there is a decrease in fallow category and the overall vegetation vigour

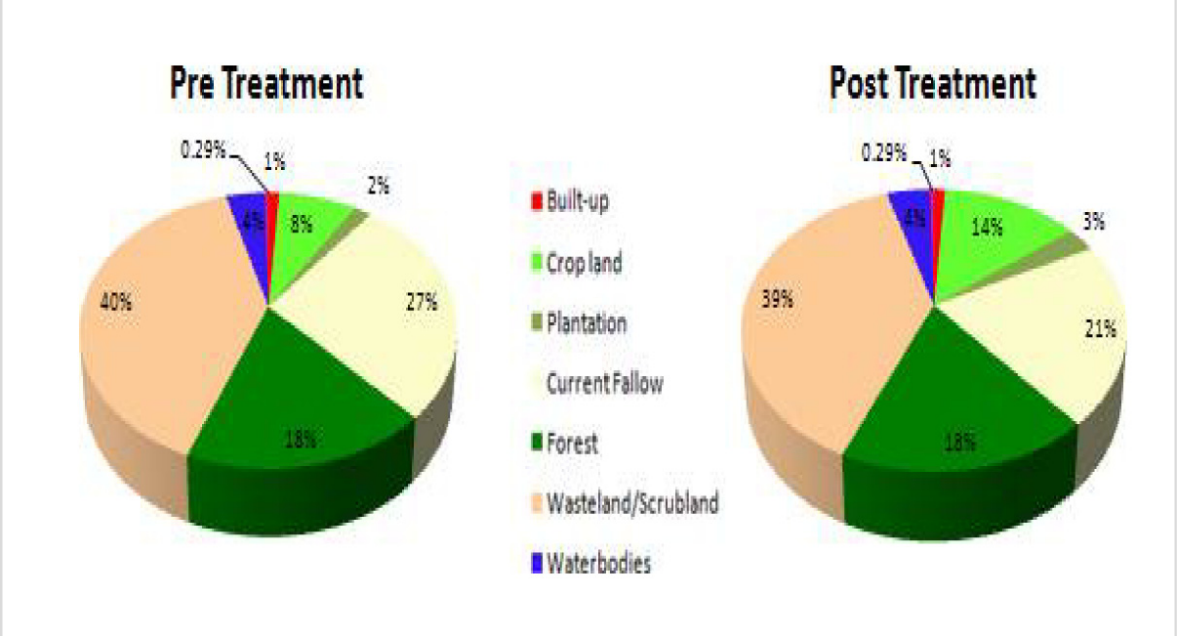


Fig. 6. Comparision of land use / land cover maps

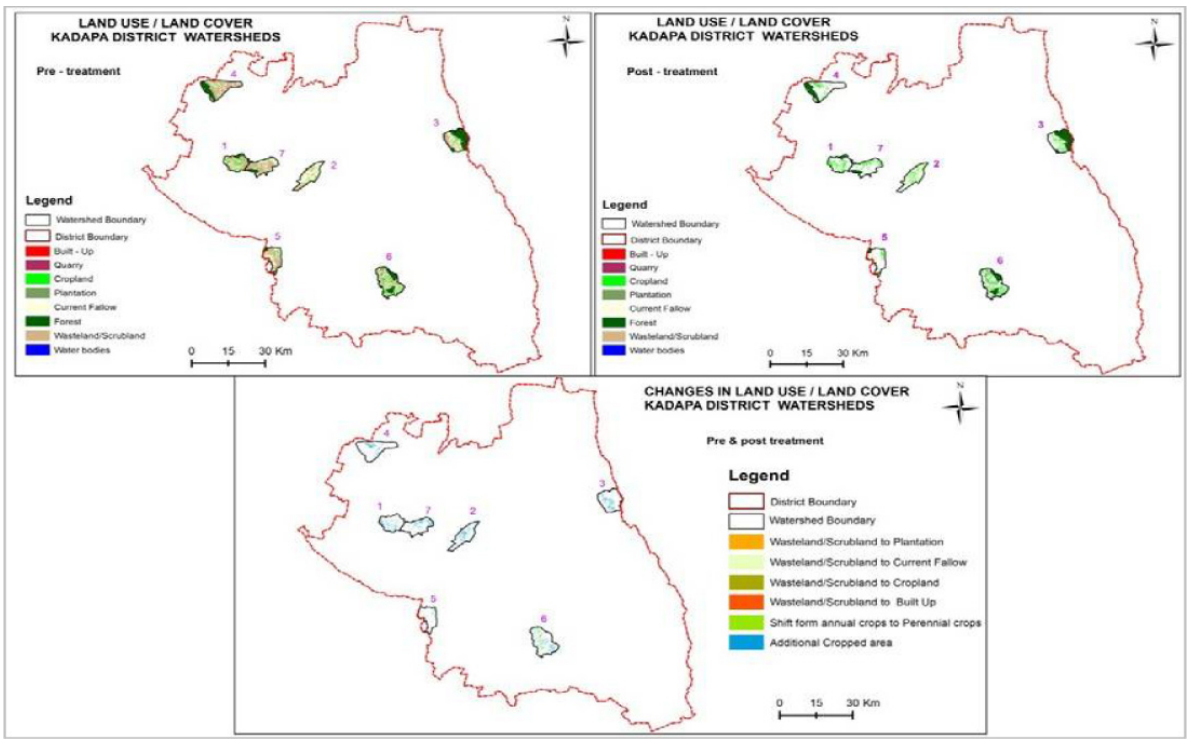


Fig. 7. Land use / Land cover distribution

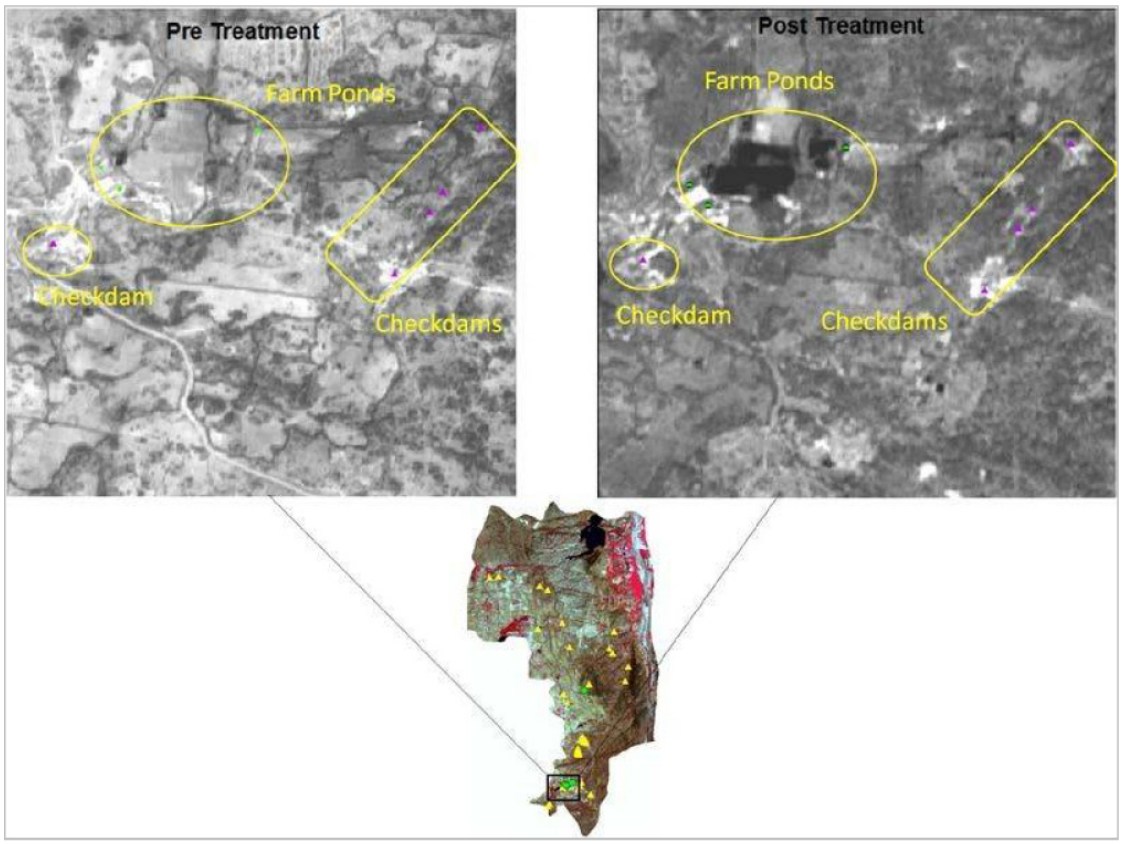


Fig. 8. Major activities in watershed project area

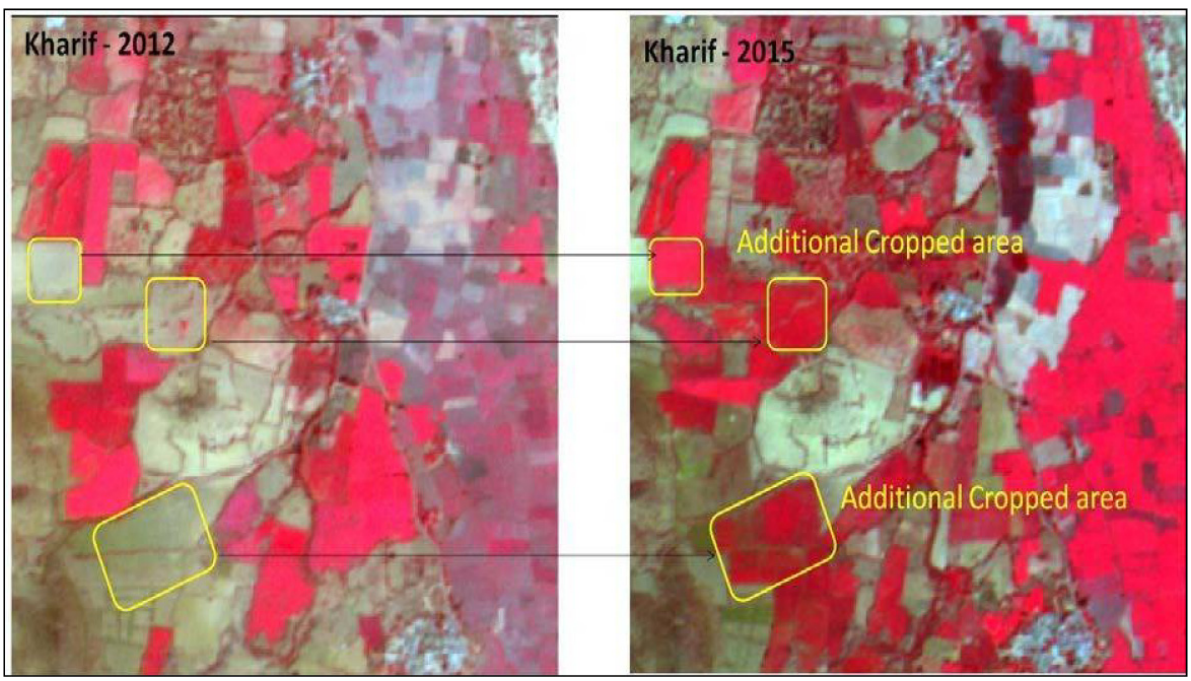


Fig. 9. Major changes in watershed project area

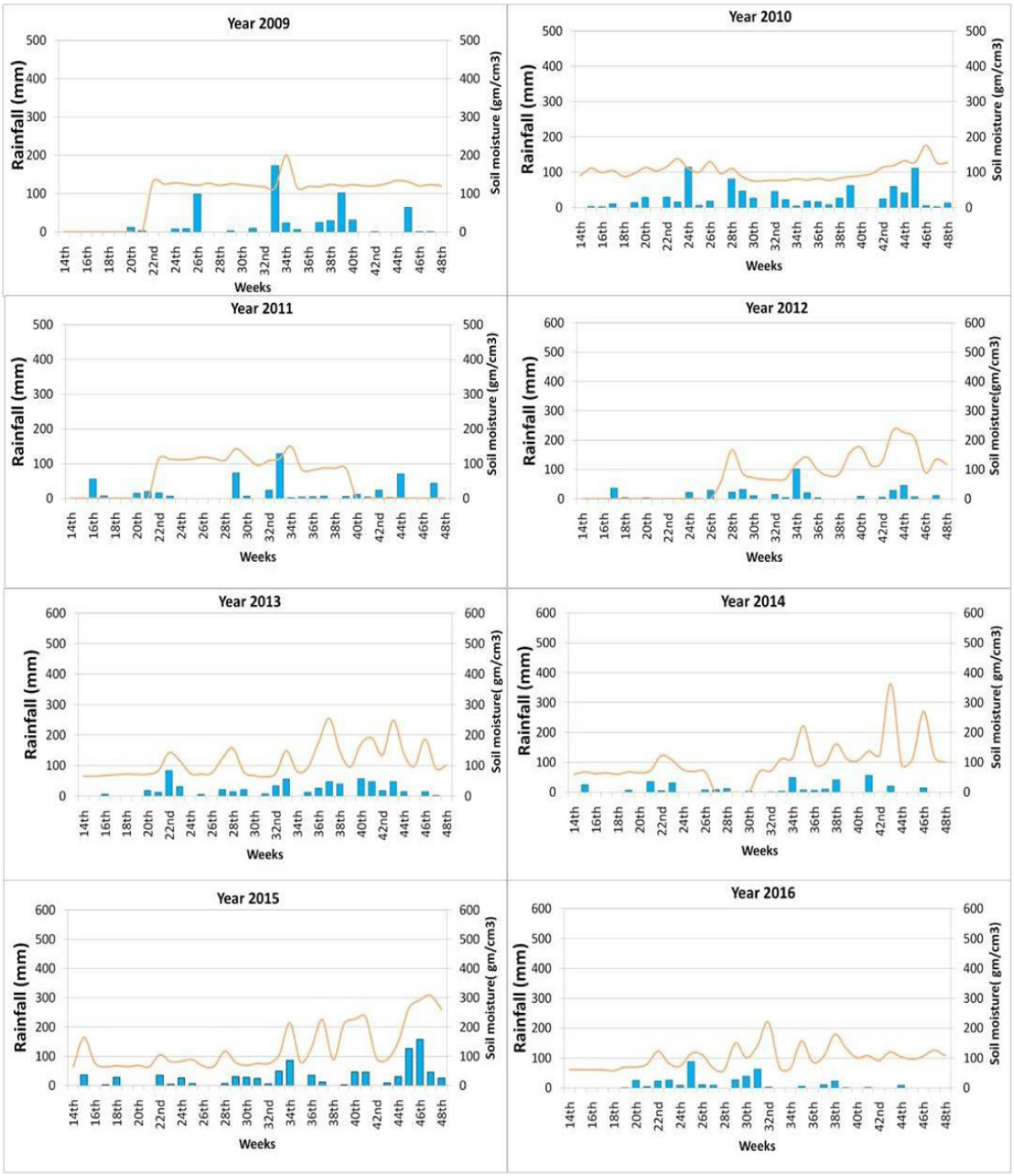


Fig. 10. Weekly soil moisture Vs. Rainfall in the watershed during April - November months (2011-2016)

has been increased during 2011 and 2016. The major changes in the watersheds of the district are also presented.

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ANALYSIS OF NUTRITIONAL AND CHEMICAL PROPERTIES OF MELGHAT HONEY FOR QUALITY CHARACTERISTICS

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ABSTRACT

In this study, the Melghat honey samples were analyzed for their nutritional and chemical properties. The samples were collected from four different locations in Melghat in the year 2019. A number of factors such as carbohydrates, energy, sugar profile, protein, HMF, acidity, iron, calcium, and sodium were detected. The data was compared to published data and specifications given in the Bureau of Indian Standards (BIS) manual. The data confirmed that the honey samples from Melghat fell into the category of special grade as specified by BIS. It is concluded that the Melghat honey is of outstanding value, with good healing and antimicrobial properties. It is very less susceptible to fermentation, very pure, and unadulterated. There is a requirement for more studies to discover the assortment of properties of Melghat honey for its commercialization.

Keywords: Amravati, Chemical, Chikhaldara, Honey, Melghat, Nutritional properties

INTRODUCTION

Melghat is a tribal region positioned in the laps of the Satpuda hills with huge forests. It is a collective area of the Sanctuary of Wan and Melghat as well as Gugamal National Park that lies in two tehsils of Amravati district *i.e*., Chikhaldara and Dharni (Bhoyar *et al*., 2018). Malnutrition amongst children is the most severe crisis in this region. Nutritional quality of food is the most important parameter of its choice because human health and its maintenance are precisely dependent on its quality. Thus, the problem of malnutrition can only be overcome by consuming nutritional food. Honey is among the most important forest products of Melghat. Almost all the honey produced in the Melghat is generated by the wild honey bees. Due to the magnificent bio-diversity of the Melghat woods, a supportive atmosphere is present for the nurture of honey bees (KVIC, 2019).

Honey is an ancient medicine used for good health and longevity (Khupse *et al*., 2017). Melghat honey has been used extensively by tribals for centuries as a food and medicine, so it must be of high quality. There was a lot of research carried out worldwide to explore the various properties of

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honey, but no work was found regarding the analysis of Melghat honey. In this study, an attempt was made to explore the chemical and nutritional properties of Melghat honey. The honey from the Melghat may be proven as one of the premier quality and it may get global recognition.

MATERIALS AND METHODS

The study was conducted in the year 2019. Honey samples were collected from four dissimilar locations of the Melghat forest (H1, H2, H3, and H4) and stored with due precautions. The samples were prepared as per the FSSAI (2015). Most of the chemical and nutritional parameters prescribed by the agencies working for the standardization of honey, such as carbohydrates, total sugars, reducing sugars (glucose and fructose), non-reducing sugar (sucrose), proteins, free acidity, hydroxymethylfurfural (HMF), and minerals (sodium, iron, and calcium), were included for the quality evaluation of Melghat honey. Sugars and HMF were determined by using the methods given in BIS (1994-2000), while free acidity was measured as IHC (2009). Proteins and calcium were estimated as per Ranganna (2007). Similarly, iron and sodium were estimated by following the methods in FSSAI (2016).

RESULTS AND DISCUSSION

Carbohydrates and energy

About 95% of the dry matter of honey is in the shape of carbohydrates, which are mostly in the form of sugars and most of the properties of honey are related to its sugar profile (Bogdanov *et al*., 2008). The values were found to be ranging from 78.12% to 80.50% with a standard deviation (SD) of 0.93. Honey is regarded as an instant source of energy due to the presence of rapidly digestible glucose and fructose. The energy values were ranging from 314.72 to 325.24 Kcal 100 g^{-1} (Table 1).

Table 1. Carbohydrate and sugar profile of Honey samples

S No.	Properties	Honey samples				Mean	SD
		H1	H2	H3	H4		
1	Total carbohydrates (g 100g^{-1})	80.24	79.32	80.50	78.12	79.545	**0.93**
2	Energy value (K cal 100g^{-1})	325.24	320.88	324.8	314.72	321.41	**4.22**
3	Total sugar (g 100g^{-1})	79.54	74.96	79.27	74.67	77.11	**2.30**
4	Sucrose (g 100g^{-1})	3.36	2.62	4.24	2.96	3.295	**0.61**
5	Total Reducing Sugars (g 100g^{-1})	76.18	72.34	75.03	71.71	73.815	**1.85**
6	Glucose (g 100g^{-1})	36.92	35.47	35.12	35.76	35.818	**0.68**
7	Fructose (g 100g^{-1})	38.13	35.93	39.12	34.84	37.005	**1.70**
8	Fructose : Glucose Ratio	1.03	1.01	1.11	0.97	1.03	**0.05**
9	Glucose : Water Ratio	2.00	1.87	1.86	1.88	1.903	**0.05**

Table 2. Other characteristics and nutrients of Honey samples

S No.	Properties	Honey samples				Mean	SD
		H1	H2	H3	H4		
1	Total Protein (Mass %)	1.07	0.90	0.70	0.56	0.81	0.19
2	Free Acidity (Meq kg^{-1})	21.21	27.12	20.03	32.17	25.13	4.87
3	HMF (mg kg^{-1})	29.73	08.10	12.56	37.86	22.06	12.18
4	Iron (mg $100g^{-1}$)	1.05	0.68	1.84	1.73	1.33	0.48
5	Calcium (mg $100g^{-1}$)	11.7	1.38	5.40	6.65	6.28	3.68
6	Sodium (mg $100g^{-1}$)	33.82	5.29	17.04	21.34	19.37	10.20

Total sugars (TS)

Total sugars ranged between 74.67 and 79.54 g 100 g-1. It encompasses both reducing and non-reducing sugars. It was reported that honey is a saturated solution of at least 22-25 different sugars (e.g. maltose, rhamnose, maltotriose, iso-maltose, turanose, maltotetraose, etc.) among which glucose and fructose are predominant (Abeshu and Gelata, 2016). Among the honey sample, H1 recorded highest TS of 79.54%, followed by H3 (79.27%), H2 (74.96%), and H4 (74.67%). No limit was specified by BIS for the content of total sugars, but it appeared to be at an optimum level. The current data is in accordance with Shobham *et al*. (2017) (78.0-88.0%), Krishnasree and Mary (2015) (65.21%), and Manukumar *et al*. (2013) (64.88-73.08 %).

Sucrose (non-reducing sugar)

The sucrose of the samples was ranging from 2.62 to 4.24%. Among the sample, H3 was highest in sucrose (4.24%), followed by H1 (3.36%), H4 (2.96%), and H2 (2.62%). The values were within the range specified by the Bureau of Indian Standards (BIS) (maximum 5%), thus falling into the category of special grade (BIS, 1994-2000). Shobham *et al*. (2017) suggested that the higher the sucrose content, the greater the chances of adulteration (an indication of the added sugar). It also indicates that the honey is under-ripened due to incomplete inversion of sugar. Thus, all the honey samples under examination were neither adulterated nor under-ripened. Lots of researchers investigated honey samples and found the sucrose content similar to that reported by Amabye (2017) (1.01-2.57%) and Atul *et al*. (2018) (0.74-3.95%).

Total reducing sugars (TRS)

Dextrose and levulose (*i.e.* glucose and fructose) are the key and largest reducing sugars of honey. Total reducing sugar, glucose, and fructose ranged from 71.71 to 76.18%, 35.12 to 36.92%, and 34.84 to 39.12% respectively. The values were within the BIS ranges for special grade honey. Boussaid *et al*. (2018) (67.56-74.31%) and Atul *et al*. (2018) (64.91-71.39%) found similar data.

Fructose to glucose (f/g) ratio

The f/g ratio was greater than 1 in the samples H1, H2, and H3, while it was 0.97

(close to one) for sample H4. As per the BIS, there should be a minimum of 1 for special grade honey. Thus, all the samples are of special grade. Boussaid *et al*. (2018) reported that honey with a higher amount of fructose is sweeter and has fewer tendencies of granulation than the higher glucose honey. If glucose is present in a higher amount, it crystallizes fast with low water content. The f/g ratio depends upon its floral source, so it is also used as one of the criteria for the identification of the floral source of honey (Bogdanov, 2011; Chin and Sowndhararajan, 2019; Da-Silva *et al*., 2016). The results were in accordance with the study carried out by Gairola *et al*. (2013) (1.03-1.08).

Glucose to water ratio (g/w ratio)

As per Kavapurayil *et al*. (2014) the granulation tendency and the granulation index can be detected with the help of the f/g ratio. It is also important for forecasting the granulation tendency of honey, as at low water levels the process of crystallization of glucose is initiated. There are no specifications given for the g/w ratio by any authorized agency. However, Gairola *et al*. (2013) and Sohaimy *et al*. (2015) demonstrated that honey with a g/w ratio less than 1.7 is non-granulating, whereas honey with a g/w ratio greater than 2.1 is susceptible to rapid granulation. The studies by Bogoviku and Gedeshi (2015), Kavapurayil *et al*. (2014), and Almasi and Basavarajappa (2019) affirmed that the varying amount of sugars in honey depends upon reasons such as the sugar profile of the nectar, the enzymes present, crops in the area of collection, climatic conditions, storage, as well as geographical location. Sugars influence an assortment of honey properties such as density, stickiness, and viscosity. The hygroscopic nature of honey, responsible for its wound healing capacity, is due to its sugar profile.

As revealed by Shobham *et al*. (2017), Amabye (2017), Abeshu and Gelata (2016), Da-Silva *et al*. (2016), and Bogoviku and Gedeshi (2015), the sugars make honey an instant source of energy and immune to spoilage by preventing the growth of microorganisms. H_2O_2 formed during the oxidation of sugars is responsible for many of the therapeutic properties of honey. As suggested by Krishnasree and Mary (2015) honey can be used in bakery products instead of sugar. In addition, it serves as a functional food for enhancement of flavor, colour, and shelf life.

Other characteristics and nutrients

Other than moisture and sugars, many other nutrients are also present in honey in small amounts and influence the quality and properties of honey significantly. In this study, some important parameters such as total protein, free acidity, hydroxymethylfurfural (HMF), sodium, iron, and calcium were detected.

Total protein

Proteins were found in the Melghat honey in a very diminutive amount (SD 0.19). The maximum amount of protein was found in the sample H1 (1.07%), followed by H2 (0.9%), H3 (0.7%), and H4 (0.56%) (Table 2). The considerable amount of protein indicates the good quality of honey. The results were similar to the values reported by Amabye (2017)

(0.46-1.04%) and Atul *et al.* (2018) (0.16–0.70%). Almasi and Basavarajappa (2019) (2.56-3.82%) and Sohaimy *et al.* (2015) (1.69-4.67%) got the results towards the higher side. Boussaid *et al.* (2018) found that the differences in the protein content are due to factors like type of nectar, plant of origin, amount and quality of pollen, and type of bee. Initially in the nectar, proteins are present in a very tiny amount but are added to the honey through the pollen, enzymes secreted by the bees, and microorganisms. Bogdanov, (2011) postulated that the diastase enzyme activity of honey is used as an indication of the freshness of honey. It was indicated that analysis of pollen protein might be useful for the identification of the source and naturalness of honey.

Acidity

As per Atul *et al.* (2018) and Manukumar *et al*. (2013), honey is always acidic in nature and the acidity is due to the presence of various organic acids as well as inorganic ions, e.g. phosphate. Sereia *et al*. (2017) suggested that it is also due to the production of gluconic acid as a result of the action of the glucose oxidase enzyme on glucose. The free acidities of the honey samples in this study ranged from 20.03 to 32.17. All values were well below the maximum value prescribed by Agmark (2008) (less than 40 meq kg^{-1}). The results were significantly analogous with the studies done by Chin and Sowndhararajan (2019), (7.8-42.7 meq/kg), and Atul *et al*. (2018), (14.17-40.17 meq kg^{-1}).

Manukumar *et al*. (2013) stated that the reason for the acidic nature of honey is due to the process of fermentation. Shobham *et al.* (2017) stated that the season of harvesting the honey also affects its acidity. It was reported that low acidity is an indication of the absence of fermentation, thus the freshness of honey. Boussaid *et al.* (2018) and Abeshu and Gelata (2016) added that the low acidity supports the therapeutic properties of honey. According to Bogdanov (2011), Balos *et al*. (2018), and Da-Silva *et al*. (2016), the acidity of honey influences the taste and flavor as well as some physical properties of honey.

Hydroxymethylfurfural (HMF)

Hydroxymethylfurfural (HMF) is a cyclic aldehyde compound produced by the degradation of sugars through the non-enzymatic browning reaction. Some minerals and acids are also responsible for the reaction. A significant amount of HMF was found in the honey samples under examination (8.10-37.86 mg kg^{-1}) (Table 2). Though there was a significant difference found in their values, the HMF content was comfortably within the range specified by the standard agencies (maximum 80 mg kg^{-1}) (BIS, 1994-2002; Agmark, 2008). HMF and the color of honey are related to each other. The darker honey samples had higher HMF as compared to the light-colored samples. The other properties did not show any significant relationship with the HMF. According to Bogdanov (2011), HMF is almost non-existent in honey at first but forms during prolonged storage. There are more chances of the formation of HMF in more acidic honeys. HMF is the cause of cytotoxicity in the skin, mucous membranes, and upper respiratory tract. It might be responsible for mutagenicity, carcinogenicity, etc. On the other hand, it is reported to have beneficial properties as it has antiallergic, anti-sickling, anti-hyperuricemic,

anti-inflammatory, and antioxidative potential. Shapla *et al*. (2018) and Da-Silva *et al*. (2016) revealed that the formation of HMF in honey is affected by to the storage temperature, f/g ratio, water activity, pH, acidity, etc. The use of a metallic container and thermal stress are also responsible for the formation of HMF.

The results of Manukumar *et al.* (2013) (1.75-27.87), Gairola *et al*. (2013) (13.8-36.86), and Harun *et al*. (2017) (1.07-30.69) were found to be analogous to the current data. The data by Bogoviku and Gedeshi (2015) (6-17.1) and Krishnasree and Mary (2015) (30.01) were also compared.

Minerals

Amabye (2017) mentioned that plenty of minerals such as calcium, sodium, iron, potassium, magnesium, phosphorous, manganese, copper, nickel, zinc, iodine, etc. are found in honey in lesser amounts but are useful for assessing the floral source of honey because the mineral content is significantly dependent on the floral source and geographical location. In the present study, minerals such as iron, sodium, and calcium were detected. Dhahir and Hemed (2015) and Da-Silva *et al*. (2016) disclosed that the floral basis of the nectar from which the honey is made and the geological location have a remarkable effect on its mineral profile. The dark-colored honey contains a higher concentration of minerals than the lighter honey. The wrong handling of honey also affects the mineral content, which is of anthropogenic origin. The honey from polluted areas is found to have a higher concentration of minerals.

The iron was found in a very diminutive amount in the Melghat honey samples (0.68 to 1.84 mg kg^{-1}) and had a similarity with the findings of Boussaid *et al*. (2018) (0.83-3.54 mg kg^{-1}) and Almasi and Basavarajappa (2019) (0.1-1.46 mg kg^{-1}). Pande and Jude (2019) confirmed the presence of iron in the honey qualitatively. No authorised body specified the iron content, but the values are similar to those suggested by Abeshu and Gelata (2016) in their research (1.0-3.4 mg kg^{-1}).

The calcium content of the Melghat honey samples ranged between 1.38 and 11.7 mg kg^{-1}. Pande and Jude (2019) confirmed the presence of calcium in honey qualitatively. The values were concurrent with the data by Almasi and Basavarajappa (2019) (0.61-12.97 mg kg^{-1}) and Abeshu and Gelata (2016) (4-30 mg kg^{-1}). Boussaid *et al.* (2018) (113.85-221.07 mg kg^{-1}) obtained higher calcium values.

Sodium was found in the range of 5.29 to 33.82 mg kg^{-1} with SD 10.20 in the Melghat honey. Pande and Jude (2019) also confirmed the presence of sodium in their honey samples qualitatively. The values reported by Abeshu and Gelata (2016) (0.6-40 mg kg^{-1}), Boussaid *et al.* (2018) (251.34-521.22 mg kg^{-1}) and Almasi and Basavarajappa (2019) (0.25-6.31 mg kg^{-1}) are given in the brackets.

CONCLUSIONS

The honey samples that were examined were found to be of excellent quality. All the parameters were found well within the limits specified by various regulatory agencies. Furthermore, the results showed that all the honey samples from Melghat fell into the

special grade as per the specifications of honey given by the Bureau of Indian Standards (BIS). From the data, it can also be postulated that the Melghat honey samples must have good therapeutic properties. It is suggested that there is a need for more research to explore the properties of Melghat honey for its branding.

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PROXIMATE AND PHYTOCHEMICAL PARAMETERS OF LEAVES OF MEDICINAL PLANT *Murraya koenigii*

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ABSTRACT

The purpose of this research work is to evaluate the proximate and phytochemical components of *Murraya koenigii* leaves from Vadodara and Anand cities of Gujarat for their efficacy before incorporation into the formulation. *Murraya koenigii* leaves were collected from June-July in the year 2021. *Murraya koenigii* leaves have been used to control diabetes. The leaves were evaluated by determining physicochemical parameters including total ash, acid insoluble ash, water-soluble ash, and moisture content. Phytochemical parameters included total phenolic content, total flavonoid content, and total tannin content in terms of gallic acid, quercetin, rutin, and tannic acid equivalents, respectively. The quantitative proximate investigation of *Murraya koenigii* plant leaves showed leaves of Anand city have a total ash content 15.66±0.32% w/w, acid-insoluble ash 0.59±0.01% w/w, moisture content 1.12±0.03% w/w respectively compared to Vadodara city total ash content 12.29±0.08% w/w, acid-insoluble ash 0.20±0.02 %w/w, moisture content 1.31±0.12 %w/w, respectively. However, Anand city leaves have a lower water-soluble capacity of 0.91±0.06% w/w compared to Vadodara city at 7.34±0.40% w/w. In this study, leaves of Vadodara city showed a high quantity of total phenolics, total flavonoids, and total tannin phytoconstituents 101.50±0.92 mg of GAE/g, 163.83±0.87 mg of RT /g, 128.16±0.76 mg of TAE/g compared to Anand city 61.58±0.62 mg of GAE/g,126.66±1.04 mg of RT / g, 64.16±1.44 mg of TAE/gconcerning gallic acid, rutin, and tannic acid. However, the leaves of Anand city showed a high quantity of total flavonoids 101.16±1.28 mg of QE/g compared to Vadodara city at 59.0±0.09 mg of QE/g concerning quercetin.

Key words: Curry leaves, *Murraya koenigii*, Phytochemical parameters, Proximate parameters.

INTRODUCTION

Diabetes is a lifestyle disorder that impacts fat loss, carbohydrates, and proteins. It is distinguished by a rise in blood sugar after any meal. The polygenic disorder results from either hormone deficiency or malfunction. By statistics, 2.8% of the entire planet's population suffers from this sickness, and it's expected to extend to over 5.4% by 2025. Diabetes needs early treatment (Kazi, 2014).

From the rutaceae family, the *Murraya koenigii* plant also known as curry leaves has

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been chosen especially the leaves for this research, because the plant is widely cultivated in Asian countries. In *Murrya koenigii* leaves are used to treat diabetes but there is very less research on an antidiabetic compound in them. *Murrya koenigii* is often used as a sympathomimetic, anti-dysenteric, and hyperlipidemia diabetes treatment (Nouman *et al*., 2015). In India, curry leaves are a popular ingredient that is grown commercially for well-known medicinal and nutritional purposes.

Various quality control tests for medicinal plant products have been devised by the World Health Organization (WHO). Based on identity, content, purity, and additional physical, chemical, and biological properties, the manufacturing process is determined by quality control (Ameh *et al*., 2010). For the advantageous application of herbal plant parts in modern medicine, physicochemical standardization is very significant. Identifying the health benefits of phytochemicals is an essential step in drug and functional food development. Examination of the leaves of selected plants is wanting a lot of scientific investigation on medication potential in Gujarat. Therefore, the research work was conducted to investigate the leaves of *M. koenigii* plants with a clear scientific protocol. This plant extract could be used to make many semi-synthetic remedies to treat a variety of life-threatening illnesses.

MATERIALS AND METHODS

Collection and processing of plant material

Murraya koenigii leaves were collected from June-July of the year 2021 in Vadodara and Anand, Gujarat, India. and were fresh and healthy. The collected sample was washed well to eliminate dirt and leaves were separated. The separated leaves were shade dried and made into a powder using a mixer grinder. The powder is placed inside a clean flask by the petroleum ether over time. Periodically enthused the content. Through filtration, a micelle is parted from the marc at end of extraction (Abubakar and Haque, 2020).

Analysis of proximate properties

Determination of total ash

A precisely weighed quantity of the shade dried powder of *Murraya koenigii* leaves was burned until carbon-free ash was found. It was at that time cooled and weighed. The percentage of total ash was calculated concerning the shade-dried powder (Mukherjee, 2019).

Determination of acid-insoluble ash

In 25 ml of 2 Molar, hydrochloric acid obtained ash was boiled for 5 minutes and filtered through an ash-free filter paper. The insoluble material was retained on the filter paper and washed through hot water. On the petri plate, the percentage of acid-insoluble material was burned to a certain weight. Ash is calculated with shade-dried plant powder (Mukherjee, 2019).

Determination of water-soluble ash

After boiling for 5 minutes with 25 metric capacity units of distilled water, the ash was cooled and the insoluble matter was collected on ashless paper. The paper was washed in hot water before being lit. By dividing the weight of ash by the weight of water-insoluble matter, the weight of soluble ash was calculated (Mukherjee, 2019).

Determination of moisture content

An accurately weighed amount of the shade dried powder sample was taken on a plate and the initial weight was taken. In an oven, the crude drug was heated and weighed. This technique was continued until the persistent weight was found. Within the proportion with relevant shade dried plant powder the moisture content of the sample was calculated. (Mukherjee, 2019).

Analysis of phytochemical parameters

Determination of total phenolic content (TPC)

The method used for the total phenolic content was working with the folin-Ciocalteu chemical agent (Phatak *et al*., 2018; Dahlia *et al*., 2017). An aliquot of all of the herbal extract and the standard acid solution was supplemented with folin–Ciocalteu chemical agent and solution. After some time, added sodium carbonate. The tube was incubated or hatched for 20 minutes. The solution's optical density of 760 nm was measured by employing a photometer in contrast to the blank. The extract's content of total phenolic was decided by the folin-ciocalteau chemical agent and it was represented by mg of gallic acid (GAE) correspondent per gram of extract.

Determination of total flavonoid content (TFC)

The method used for the total flavonoid content was working by a colorimetric procedure of aluminum chloride. (Wang and Jiao,2000; Phatak *et al*., 2018). It is grounded on extract added to sodium nitrite. After incubation, add aluminum chloride, followed by sodium nitrite, and distill water. The measurements of flavonoids are correlated to the color of concentration. Total flavonoid can be assessed by a 415 nm wavelength as a rutin (RT) and quercetin (QE) equivalent. It was expressed as mg of rutin and quercetin correspondent per g of extract.

Determination of total tannin content (TTC)

The method used for the total tannin content was the phenol-denis method (Mcdonald *et al*., 2001). The plant extract was assorted through folin's phenol reagent and then added sodium carbonate andallowed at normal temperature. Total tannin can be assessed at a wavelength of 700nm absorbance was set down. As a tannic acid correspondent, the matter of total tannic (TAE) was expressed in mg per g of extract.

Statistical analysis

The values were represented as mean ±SD (standard deviation) and the data obtained from this study was subjected to an analysis of variance (ANOVA) and significance was determined at $P<0.05$ (Adusei *et al*., 2019).

RESULTS AND DISCUSSION

From *Murraya koenigii* plant leaves, using standard procedures, proximate and phytochemical parameters were estimated (Table 1 and Table 2).

Analysis of proximate parameters

The results of total ash value, acid insoluble ash, water-soluble ash, and moisture content determination are given in Table 1.

Determination of total ash

The determination of ash is usually helpful for the detection of an inferior product, exhausted medicine, and a lot of sandy or earthy matter; it's more particularly applicable to

Table 1. Determination of total ash value, acid insoluble ash, water-soluble ash, and moisture content of *Murraya koenigii* leaves

	Ash Content			
City	Total ash content (% w/w)	Acid insoluble ash value (% w/w)	Water soluble ash value (% w/w)	Moisture content (% w/w)
Vadodara	12.29±0.08*	0.20±0.02*	7.34±0.40*	1.31±0.12*
Anand	15.66±0.32*	0.59±0.01*	0.91±0.06*	1.12±0.03*

*significant at the $p<0.05$ level

pulverized medicine (Grover *et al*., 2014). The total ash content of plant leaves of Anand city is highest at 15.66±0.32%w/w compared to Vadodara city at 12.29±0.08%w/w. That means the leaves of anand city have a higher quantity of total inorganic compounds compared to Vadodara city. In past studies, curry leaves showed the total ash content of the powder is formed to be 7.2% (Asema *et al*., 2021).

Determination of acid insoluble ash

Acid insoluble ash takes a look at the technique accustomed to quantifying the quantity of silicious compound obtainable in the sample. Inorganic chloride compounds are soluble in water and they'll undergo filter whereas testing. Therefore, solely silicon dioxide compounds can retain on the filter, this silicon dioxide compound may be quantified by weight difference (Grover *et al*., 2014). The acid-insoluble ash content of leaves of anand city has a higher quantity of 0.59±0.01% w/w of silicious compound compared to vadodara city at 0.20±0.02% w/w. In past studies, curry leaves showed that acid insoluble ash was found to be 35.6%. (Asema *et al*., 2021).

Determination of water-soluble ash

To observe the presence of material soluble in water, water-soluble ash is employed. The water-soluble ash shows a larger reduction than the overall ash and is so used as a crucial indicator for the existence of exhausted material substituted for the real articles (Sharma and Bhattacharya, 2017). The water-soluble ash content of leaves of Vadodara city has a higher quantity of 7.34±0.40 %w/w of material soluble in water compared to anand city 0.91±0.06 %w/w. In past studies, curry leaves showed water-soluble ash of 10.4 %. (Asema *et al*., 2021).

Determination of moisture content

If the moisture content is high, the plant may be simply deteriorated because of fungus and microorganism growth. Therefore, Low moisture content might forestall the sample from microorganism infection throughout storage (Pandey *et al*., 2012). The moisture content of leaves of anand city has a low quantity of 1.12±0.03% w/w compared to vadodara 1.31±0.12% w/w.

Analysis of phytochemical parameters

Murraya koenigii plant extract contains several phytoconstituents such as total flavonoid,

Table 2. Total phenolic content, total flavonoid content, and total tannin content of *Murraya koenigii*

City	Total phenolic content (mg of GAE/g)	Total flavonoid content (mg of QE /g)	Total flavonoid content (mg of RT /g)	Total tannin content (mg of TAE/g)
1. Vadodara	101.50±0.92*	59.0±0.09*	163.83±0.87*	128.16±0.76*
2. Anand	61.58±0.62*	101.16±1.28*	126.66±1.04*	64.16±1.44*

Note: *significant at the p<0.05 level; GAE=Gallic acid; QE= Quercetin; RT=Rutin; TAE=Tannic acid

total tannin, and total phenolic contents of quercetin, rutin, tannic acid, and gallic acid correspondent respectively (Table 2).

Determination of total phenolic content (TPC)

The total amount of phenol was measured by using the activity curve. All the activity graphs showed a correlation of linear (r) with positive which is near +1. These graphs showed that as the value of concentration increases, so will the amount of absorbance. In this study, Vadodara has a high quantity of 101.50±0.92 mg of GAE/g of phenolic compounds compared to Anand 61.58±0.62mg of GAE/g, respectively. In previous studies, a phytochemical parameter of leaves of *Murraya koenigii* was found to have a phenolic content of 168 mg/g GAE in the alcohol-water extract and 59.2 mg/g GAE in the extract of aqueous (Tachibana *et al*., 2001), with extracts of aqueous, found 59.2 mg/g GAE (Devatkal *et al*., 2012), 2.214 mg/g GAE and 2.591 mg/g GAE were detected in the extract of aqueous and methanolic, respectively (Phatak *et al*., 2018).

Determination of total flavonoid content (TFC)

Flavonoids are powerful antioxidants with anti-inflammatory properties that have been accustomed to preventing diseases sucha as polygenic disorders, cancer, and neurodegenerative diseases. Quercetin's working operations are pleiotropic, involving inhibition of intestinal aldohexose absorption, secretory, insulin-sensitizing activities, and improved aldohexose utilization in peripheral tissues (Eid and Haddad, 2017). The antihyperglycemic impact of rutin embraces a decrease in carbohydrates absorption from the small viscus, inhibition of tissue gluconeogenesis, an increase in tissue aldohexose uptake, stimulation of internal secretion from beta cells, and the langerhans island, which protects against degeneration (Ghorbani, 2017). Total flavonoid contents within quercetin and rutin that all the calibration graphs showed that strong positive linear correlation (r) that is near +1. These graphs showed that as the value of concentration increases, so will the value of absorbance. In rutin equivalent, the Vadodara sample has a high quantity of

163.83±0.87 mg of RT/g of flavonoids compared to the Anand sample 126.66±1.04 mg of RT/g, respectively. In the quercetin equivalent, Anand has a high quantity of 101.16±1.28 mg of QE/g of flavonoids compared to Vadodara 59.0±0.09 mg of QE/g, respectively. However, there are only few studies on quercetin as a phytoconstituents in curry leaves. In past studies, curry leaves showed total flavonoid content in aqueous extract and methanolic extract which were found at 2.737 RT mg/g and 5.248 RT mg/g correspondingly (Phatak *et al*., 2018). Another report found that the total flavonoid content of curry leaves with diethyl ether extract had 7.43 ± 0.03 mg/g (Igara *et al*., 2016).

Determination of total tannin content (TTC)

Tannins are polyphenolic compounds with diverse structures. They are split into main two groups, specifically hydrolysable and condensed. The principles of the tannins are calculable by folin-Denis's methodology. The non-ratio oxidation of molecules containing a phenolic resin hydroxyl radical is primarily responsible for this. Tannins react with phosphotungstic molybdic acid in an alkaline solution to produce an intensely coloured blue solution (Jain and Dixit, 2004). Total tannin contents were calculated by using a standardization curve. All the standardization graphs showed a strong positive linear correlation (r) which is not far from +1. Vadodara samplehas a 128.16±0.76 mg of TAE/g high quantity of tannin content compared to Anand sample64.16±1.44 mg of TAE/g respectively. However, there are only few studies on tannic acid as a phytoconstituents in curry leaves.

CONCLUSIONS

The quantitative proximate investigation of *Murraya koenigii* plant leaves showed leaves of Anand city have a higher quantity in total ash content, acid-insoluble ash, and moisture contentcompared to Vadodara city. However, Anand city leaves had a higher water-soluble capacity. Also, the phytochemical investigation of *Murraya koenigii* plant leaves showed the existence of quantities of total phenolics, total flavonoids, and total tannins. *Murraya koenigii* plant showed that leaf portions contain anti-diabetic compounds *viz*., gallic acid, rutin, quercetin, and tannic acid. In this study, leaves of Vadodara city showed a high quantity of total phenolics, total flavonoids, and total tannin phytoconstituents compared to Anand concerning gallic acid, rutin, and tannic acid. However, leaves of anand city showed a high quantity of total flavonoid concerning quercetin. There are very few studies on *Murraya koenigii* for proximate and phytochemical properties for antidiabetic activity in Gujarat. Even so, additional studies using in-silico docking, or *in-vivo* models are required to confirm this property.

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EMOTIONAL MATURITY OF HIGHER SECONDARY SCHOOL STUDENTS OF ERNAKULAM DISTRICT, KERALA

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ABSTRACT

The study aimed to analyze the emotional maturity of higher secondary school students in Kerala. Using a simple random sampling, 100 adolescents between the age of 16 and 17 years from five higher secondary schools situated in the Ernakulam district of Kerala were selected for the study. The data was collected from December 2021 to March 2022. The standardized emotional maturity scale developed by Dr. Yashvir Singh and Dr. Mahesh Bhargava (1990) was used to collect the data. The results indicated that nearly fifty per cent of the students (41%) were in the condition of 'extremely unstable'. The difference between girls and boys in the level of emotional maturity was not significant, but girls showed higher emotional maturity than boys. Adolescents from rural areas showed higher emotional maturity than adolescents from urban areas, and the difference was significant concerning, emotional regression, social maladjustment, personality disintegration and lack of independence. Further, it is found that emotional instability, regression, social maladjustment, personality disintegration and lack of independence are positively correlated with each other.

Keywords: Adolescents, Emotional Maturity, Ernakulam,Higher Secondary Students, Kerala

INTRODUCTION

Adolescence is the period that marks the transition from childhood to adulthood. The process of 'emerging' to achieve 'identity' is defined as adolescence. The word adolescence comes from the Latin word "adolescere", which means "to mature" or "to grow." Adolescence is a time of biological, cognitive, and socio-emotional transformation that occurs between childhood and maturity. Emotional maturity is a process in which a person's personality strives for higher emotional and physical well-being, both interns physically and intrapersonal. Emotional maturity refers to the achievement of an adult degree of emotional development, which includes emotional control in social situations (Shimsiya and Parambat, 2016). An increased emotional maturity is required to lead a successful existence. It is also true that our emotional maturity level has a constant

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influence on our actions. Emotions are the complex conditions that underpin sensations, actions, and physiological changes like joy, fear, fury, and excitement. It's a severe state marked by actions and experiences that are out of the ordinary. Emotional maturity is defined as the equilibrium between a people's inner and outside emotional expressions in various settings. It mold's an individual's attitude and behaviour, teaches responsibility, aids decision-making, and fosters healthy interpersonal relationships. In general, we can define it as a person's ability to regulate his emotions rather than allowing them to control him. It is one of the most potent essences for personal development (Marami, 2018).

Emotional maturity is regarded as one of the most important determinants in the development of an individual's personality, behaviour, and attitudes and it aids in the improvement of interpersonal relationships and self-worth. Emotional maturity is an important factor in forming teenagers' personalities, attitudes, and behaviour, such as accepting responsibility, making decisions, working in groups, developing good relationships, and boosting self-worth. The history of a person's relationships has a significant impact on his or her emotional development. Adolescence is a time when emotions have a strong influence on one's behaviour. Adolescents are highly emotional, they have difficulties expressing their emotions properly, and they are frequently over-reactive, whereas an emotionally matured teenager efficiently deals with his problems and develops integration between his feelings and behaviour (Jose and Sujatha, 2015). A high level of awareness of the responsibilities and emotions is critical for effective and efficient pedagogy, strategies, and approaches in educational institutions (Dipavali and Pritiben, 2021).

The objectives of the study are to find out the level of emotional maturity among secondary school students, to find out the intercorrelation between sub-variables of emotional maturity among secondary school students, to compare the difference in emotional maturity among male and female secondary school students and to compare the difference in emotional maturity among rural and urban secondary school students

MATERIALS AND METHODS

The sample for the study comprised 100 adolescents from five higher secondary schools situated in Ernakulam district of Kerala selected through a simple random sampling method. The sample consisted of both male and female students between the age of 16 and 17 years. Adolescents from both urban and rural areas were considered for the study. The data was collected from December 2021 to March 2022. The standardized Emotional Maturity Scale developed by Dr. Yashvir Singh and Dr. Mahesh Bhargava (1990) was used to collect the data. The scale contains 48 items belonging to five broad factors of emotional maturity including a) emotional unstability, b) emotional regression, c) social maladjustment, d) personality disintegration and e) lack of independence. Each statement of the scale scored 5,4,3,2 and 1 for the responses very much, much, undecided, probably and never, respectively. The factors emotional unstability, emotional regression, social maladjustment, and personality disintegration contains 10

items each while the factor lack of independence contains only eight items. Hence, the maximum score can be 240 and the minimum score can be 48. As per the obtained total scores, respondents with scores falling between 50 - 80 were considered extremely stable, respondents with 81-88 were considered moderately stable, respondents with 89-106 scores were considered stable and respondents with scores between 107-240 were considered as extremely unstable. A higher score means lower emotional maturity and vice versa. The reliability of the scale was determined by test-retest and internal consistency by administering it to a group of students of the age group of 15 to 25 (n=600) including boys and girls, with a time interval between two testing of 6 months. The product-moment correlation coefficient r between the two testings was 0.75. The validity of the scale was 0.64.

After taking permission from the authorities, the emotional maturity scale was administered to adolescents with instructions to complete all questions honestly. Since the scale developed is for Indian culture and employed a much larger population within the same age brackets, the standard criteria developed on the level of emotional maturity is followed without any modifications for this study. The data was analyzed using SPSS 25 with mean, standard deviation, frequency, Karl Pearson correlation and t-tests.

RESULTS AND DISCUSSION

Level of emotional maturity among secondary school students

Table 1 demonstrates, the level of emotional maturity among secondary school students, it is inferred through analyzing mean scores of the level of emotional maturity of the students.

Table 1 shows the number and percentage of adolescents for the various levels of emotional maturity scale. 41 percent of the students were in the condition of 'extremely unstable' followed by 29 percent in 'unstable' condition. About 21 percent of students show an extremely stable level of emotional maturity and only nine per cent of students were in the state of moderately stable. The results were in line with the study by Lakshmi and Krishnamurthy (2011) which states that the majority of Coimbatore district's higher secondary students are emotionally

Table 1. Level of emotional maturity of Secondary school students (n=100)

S.No.	Dependent variable	Category	Respondents	
			Frequency (f)	Percentage (%)
1	**Level of emotional maturity**	Extremely Stable (50 -80)	21	21
		Moderately Stable (81-88)	9	9
		Unstable(89 – 106)	29	29
	x= 100.28	Extremely unstable	41	41
	SD=24.096	(107 – 240)		
	Total		**100**	**100**

Table 2. Inter correlation between sub-variables of emotional maturity (n=100)

S. No	Particulars		Emotional regression	Social maladjus-tment	Personality disinte-gration	Lack of indepe-ndence
1	Emotional unstability	Correlation Sig	712** .000	527** .000	384** .000	.267** .007
2	Emotional regression	Correlation Sig.		.595** .000	.472** .000	.342** .000
3	Social maladjustment	Correlation Sig			509** .000	.547** .000
4	Personality disintegration	Correlation Sig				.702** .000

**. Correlation is significant at the 0.01 level (2-tailed).

unstable and Marami (2018) reported that the highest number of higher secondary students in Kokrajhar district was emotionally immature. The results are contrary to the conclusion by Biswas (2018) who stated that all students at the higher secondary school showed a stable level of emotional maturity. Bindu and Vajeela (2015), in their study, found that the level of emotional maturity was moderate among secondary students. The Higher secondary students who were not using the internet regularly were more emotionally mature than internet users (Kumar, 2012).

Intercorrelation between sub-variables of emotional maturity among secondary school students

Table 2 and Figure 1 inferences Intercorrelation between sub-variables of emotional maturity of secondary school students (n=100), and is obtained by performing Karl Pearson Correlation.

Table 2 and Figure 1 depict the inter-correlation between sub-variables of emotional maturity among higher secondary school students. From the table, it can be inferred that all the variables show a positive correlation with each other. Emotional unstability and emotional regression showed a high correlation (r=.712, p=<0.01) followed by the correlation between personality disintegration and lack of independence (r=.702, p=<0.01). The least correlation was found between emotional unstability and lack of independence (r=.267, p=<0.01). It implies that if any of the sub-domain of emotional maturity could modify, there could bring significant level changes in all other domains of emotional maturity. The studies analyzing the correlation of the subdomains were a few. However, from various studies, it can be understood that there are various influential determinants to managing the emotional maturity of adolescents. According to Duhan *et al.* (2017), there existed

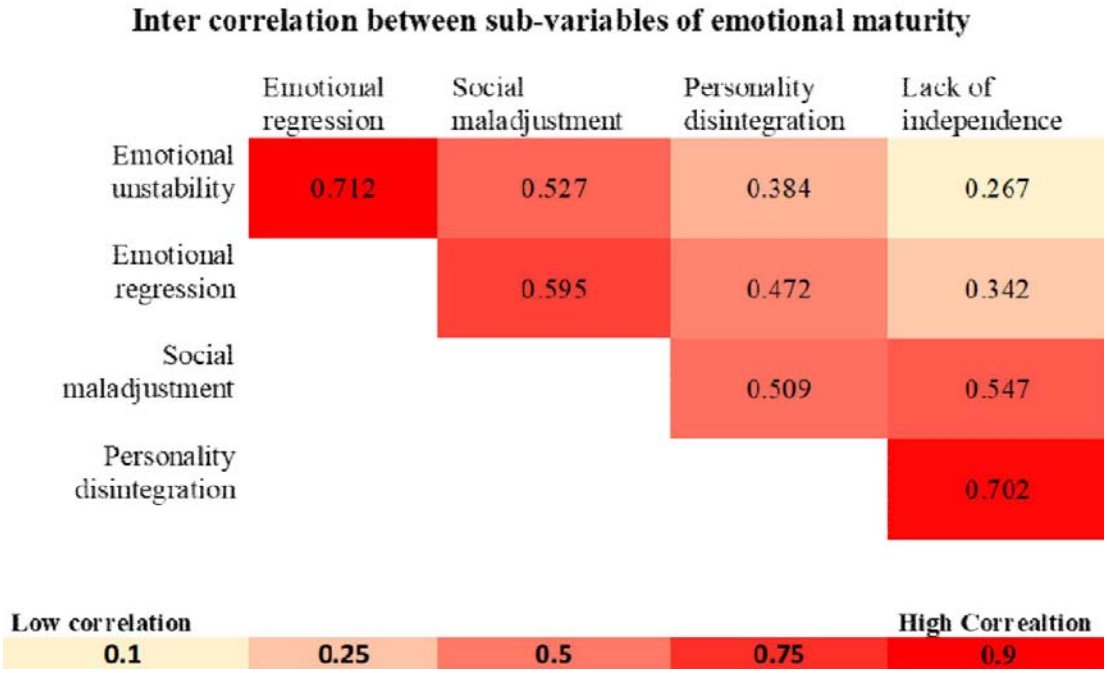

Fig. 1. Inter correlation between sub-variables of emotional maturity

a negative correlation between age and emotional maturity of adolescents and a positive correlation between their father's occupation and their educational level. Similarly, Brar (2017) found that there existed a strong correlation between altruism and the emotional maturity of adolescents. Djafar *et al.* (2018) reported that as the adversity quotient

Table 3. Emotional maturity among girls and boys secondary school students

S.No.	Particulars	Gender	Mean ($\bar{x}$)	SD (ó)	t	Sig (p)
1	Emotional unstability	Girls	22.73	6.998	-.427	.670
		Boys	23.34	5.066		
2	Emotional regression	Girls	20.18	7.015	-1.928	.057
		Boys	23.10	6.499		
3	Social maladjustment	Girls	20.28	5.314	-2.623	.010*
		Boys	23.38	5.467		
4	Personality disintegration	Girls	17.75	5.339	-1.724	.088
		Boys	20.21	8.687		
5	Lack of independence	Girls	16.21	4.523	-1.412	.161
		Boys	17.90	7.173		

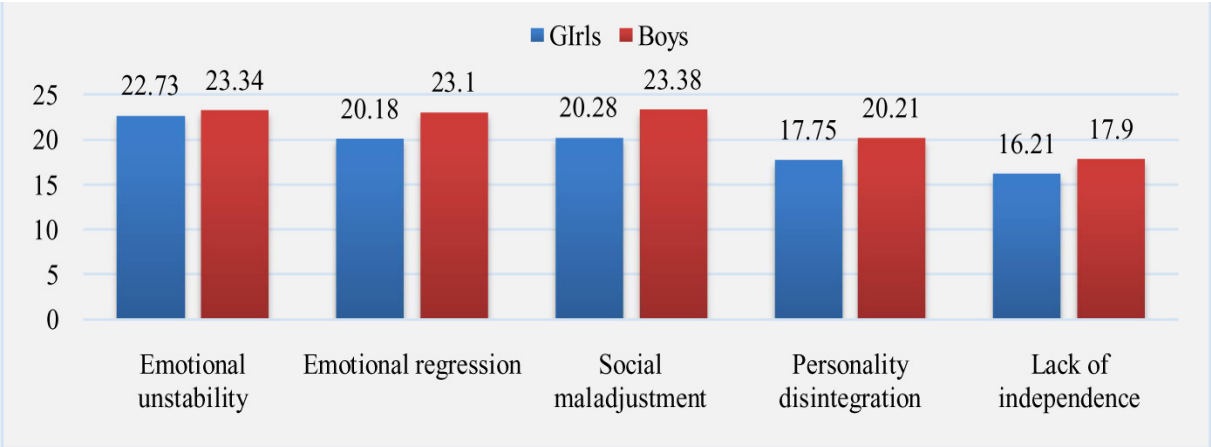

Fig. 2. Emotional maturity among girls and boys secondary school students

or the ability to deal with the adverse events in life improves, adolescents' emotional maturity also could improve.

The difference in emotional maturity among male and female secondary school students

Table 3 shows the emotional maturity among girls (n = 71) and boys (n = 29) secondary school students obtained by performing Independent t-test.

Table 3 and figure 2 explores the difference in emotional maturity among higher secondary boys and girls. Emotional unstability (x=23.34, ó = 5.066), emotional regression (x=23.10, ó = 6.499), social maladjustment (x=23.38, ó = 5.467), personality disintegration (x=202, ó = 6.49) and lack of independence (x=17.90, ó = 7.173) were found to be higher in boys than girls.

Although the difference between boys and girls were not significant with respect to Emotional unstability (t = -.427, p >.05), Emotional regression (t = -1.928, p >.05), Personality disintegration (t = -1.928, p >.05) and Lack of independence (t = -1.412, p >.05). However the Social maladjustment (t = -2.62, p <.05) was significantly higher in boys than girls.

The results imply that girls have better emotional maturity and boys are showing higher levels of Emotional unstability, Emotional regression, Social maladjustment, Personality disintegration and Lack of independence. The results of the present study are supported by Tiwari and Ojha (2014) who stated that adolescent girls possess a better emotional maturity than adolescent boys. Jose and Sujatha (2012) found that adolescent girls are having higher emotional maturity than adolescent boys. Malliick *et al.* (2014) also reported that there is a significant difference between the boy and girl students regarding the level of emotional maturity. The results are contrary to the conclusion that male adolescents have higher emotional maturity than female adolescents (Shafiq and Rubeena, 2016) and according to Visvanathan (2011) boys were said to have greater emotional maturity than girls. Marami (2018) reported that both male and female students are emotionally immature.

Furthermore, the study points out that gender could be considered as a grouping factor in the case of Social maladjustment only because the differences were insignificant in Emotional unstability, Emotional regression, Personality disintegration and Lack of independence domains of emotional immaturity. In corroboration with the current results, Kaur (2013) concluded that there is no substantial difference in the emotional maturity levels of boys and girls in senior secondary schools in Chandigarh. There are no gender differences in emotional maturity among government higher secondary school students in the Surat district of Gujarat (Dipavali and Pritiben, 2021).

The difference in emotional maturity among rural and urban secondary school students

Table 4 and figure 3 show the Emotional maturity among rural (n= 67) and urban (n = 33) secondary school students elicited by performing an Independent t-test.

Table 4 and figure 3 show the difference in emotional maturity between rural and urban higher secondary students. Emotional unstability (x=24.27), emotional regression (x=23.00), social maladjustment (x=23.18) and personality disintegration (x=21.03) were found to be higher in urban students than in rural students. Urban students (x=19.91) lack independence more than rural students (x=15.61). And the difference between rural and urban students is not significant in Emotional unstability ($t = -1.485$, $p > .141$), but there is significant difference in Emotional regression ($t = -2.015$, $p < .05$), Social maladjustment ($t = -2.622$, $p < .01$), Personality disintegration ($t = -2.857$, $p < .01$) and Lack of independence ($t = -2.959$, $p < .01$). Thus, it can be stated that students in rural area possess more emotional maturity than students in urban

Table 4. Emotional maturity among rural and urban secondary school students

S.No.	Particulars	Gender	Mean ($\bar{x}$)	SD (ó)	t	Sig (p)
1	Emotional unstability	Rural	22.24	6.448	-1.485	.141
		Urban	24.27	6.419		
2	Emotional regression	Rural	20.06	7.011	-2.015	.047*
		Urban	23.00	6.538		
3	Social maladjustment	Rural	20.19	5.335	-2.622	.010**
		Urban	23.18	5.405		
4	Personality disintegration	Rural	17.19	6.083	-2.857	.005**
		Urban	21.03	6.766		
5	Lack of independence	Rural	15.61	5.405	-2.959	.004**
		Urban	18.91	4.882		

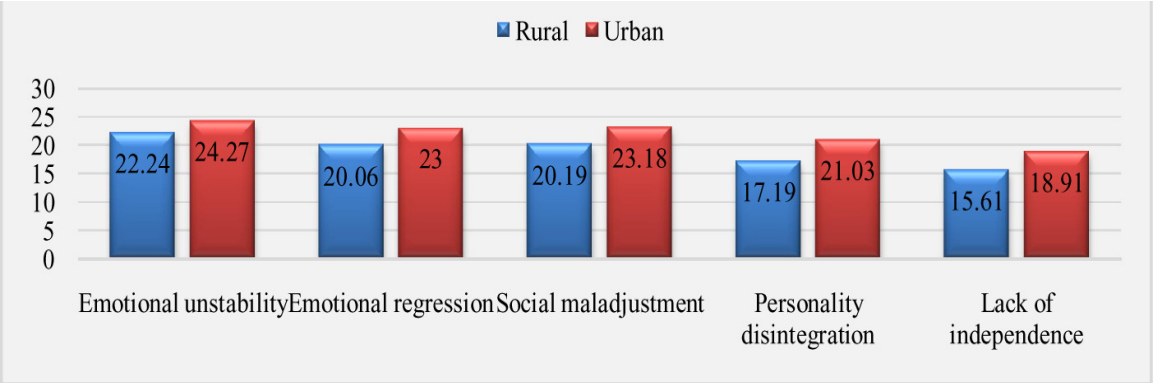

Fig. 3. Emotional maturity among rural and urban secondary school students

area. This finding is not in line with the studies by Dipavali and Pritiben (2021), Marami (2018), Soni, Jadab and Chetia (2015) and Singh (2012) who reported that there is no difference between urban and rural higher secondary students regarding emotional maturity. Whereas Malliick, Singh, Chaturvedi and Kumar (2014), found that there is no huge contrast among rural and urban higher secondary students regarding the level of emotional maturity.

CONCLUSIONS

Nearly half of the secondary students (41%) were in the level of extremely unstable condition. Even though the difference between girls and boys is not significant, emotional maturity was found higher in girls than boys. Adolescents from rural areas showed higher emotional maturity than adolescents from urban areas, and the difference was a significant difference concerning, Emotional regression, Social maladjustment, Personality disintegration and Lack of independence. As far as the intercorrelation is concerned, it is found that emotional instability, regression, social maladjustment, personality disintegration and lack of independence are positively correlated with each other.

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ASSESSMENT OF THE SATISFACTION LEVEL OF CONSUMERS TOWARDS ENERGY EFFICIENT SOLAR PRODUCTS IN COIMBATORE CITY

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ABSTRACT

The data of 400 households using one solar device from Coimbatore city was gathered between July 2019 and January 2020.The magnitude of the satisfaction level of consumers based on gender, age and qualification was calculated, t-test of equality of means was applied to understand the mean score of satisfaction level among males and females. Similarly, ANOVA was performed to know the mean score of satisfaction level among different age groups and qualifications. The outcome of the study substantiated that consumer satisfaction level towards energy efficient solar products was significantly determined by socio-demographic factors of consumers. The results of study disclosed that almost thirty-five percent of participants were satisfied with the aspect easy installation of solar devices whereas nearly 28.5 percent of the participants were highly satisfied. Whereas, 47.5 of percent participants were satisfied by easy operation and maintenance of solar devices. A significant number of participants (44.8 percent) were satisfied with the durability of the solar device. Twenty-four percent of the solar device users communicated that they are highly satisfied with the availability of after sales-services.

Keywords: Consumers, Energy efficiency, Satisfaction level, Socio-demographic, Solar devices

INTRODUCTION

Over the last few decades, consumer satisfaction has been a key principle for all the companies. Companies are well-informed in determining the role of their consumer satisfaction foroverall success. Additionally, many researchers had acknowledged the role of consumer satisfaction in developing and supporting a strategic competitive profitability and communicated that adapting to consumer needs and changing alternatives is a necessity for long term success of a company (Drosos*et al.,* 2018). The studies on consumer satisfaction and the evaluation of outcomes provide policy-makers with anunderstandingof the motivations and satisfaction of consumers(Cheng *et al*., 2019). Many researchers have formulated several characteristics and dimensions

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inmeasuring customer satisfaction levels. Consumer satisfaction is expressed as needs of consumers are met and filled and hence, the consumption experience is positive.

Consumer satisfaction generally depends on the quality and the performance of the product. At present-days, many establishments have approved total quality management (TQM) programs, in order to enhance the standards of their products. The quality of the product has a direct influence on the performance of the product and therefore it influences consumer satisfaction level (Strenitzerova and Gana, 2018).

Venkatraman and Sheeba (2014) explained that marketing strategies depends upon the attitude of the consumers. The perception towards solar devices is certainly changing due to several reasons such as an increase in the use of solar devices and benefits of using solar devices over electrical devices. Energy consumption is increasing as new gadgets are being introduced in the market. This increases the percapita consumption level of electricity. The gap between the demand for electricity and availability are also gradually increasing. The fly rocketing price of petroleum and its product have made the consumers to think of an alternative. Thus, making the consumers to opt for a viable solar devices.In recent scenario consumption of electricity is high that comes with high prices, hence, consumers are opting for solar devices as an alternative solution. Energy produced from solar energy replaces the conventional sources of energy as solar energy can fulfill the electricity needs of consumers. The research work was aimed at realizing the satisfaction level of consumers towards solar devices based on socio-demographic profile such as gender, age and qualificationin Coimbatore city and also to provide valuable suggestions to the solar industries based on the consumer's satisfaction level.

MATERIALS AND METHODS

Coimbatore city has motivated the researcher to conduct the study as solar energy has emerged as a viable option among the residents of Coimbatore city and there are many solar equipment selling shops in the city.The sample size of the study was 400 who were using at least one solar device.The information on the solar device users in the city was collectedin June 2019 from the website of TEDA (Tamilnadu Energy Development Agency) (https://teda.in). Among those who were using at least one solar device, 1300 respondents were enlisted with TEDA. Respondents were selected using convenience sampling method. An interview schedule was framed for collecting data and participants were interviewed at their convenient timings. Before conducting the main study interview schedule was pre-tested among 50 participants and modifications were made accordingly. Personal interview was conducted between the months of July 2019 to January 2020.

RESULTS AND DISCUSSION

The surveyor of the study had gathered data on the satisfaction level of consumers on certain aspects of solar products and the percentage analysis presented (Table 1). The participants were requested to mark their satisfaction level on the five-point rating scale. The ranking were as follows, 1- Highly

Table 1. Satisfaction level of consumers on the aspects of solar devices (n=400)

S. No.	Aspects	Highly dissati-sfied	Dissati-sfied	Neither dissat-isfied nor satisfied	Satis-fied	Highly sati-sfied	
1	Easy Installation	22 5.5	52 13.0	73 18.3	139 34.8	114 28.5	n %
2	Easy operation and maintenance	1 0.3	47 11.8	20 5.0	190 47.5	142 35.5	n %
3	Durability	19 4.8	58 14.5	29 7.2	179 44.8	11 28.7	n %
4	Produce sufficient energy	43 10.8	72 18.0	66 16.5	114 28.5	105 26.3	n %
5	Availability of after sales service	67 16.8	82 20.5	86 21.5	69 17.3	96 24.0	n %

dissatisfied, 2- Dissatisfied, 3- Neither dissatisfied nor satisfied, 4- Satisfied, and 5-Highly satisfied.

From the Table 1, it is illustrated that in the case of easy installation of solar devices 18.3 percent of participants expressed they are neither dissatisfied nor satisfied. The main cause of neither dissatisfaction nor satisfaction revealed by participants was cost of solar home systems which is expensive than buying an AC, Washing machine, TV etc. Almost thirty-five percent of participants were satisfied with the same aspect because they got returns on their investment made during the installation of solar devices. Participants those who were highly satisfied with the aspect of easy installation of solar devices were 28.5 percent because installation of solar device was supervised by the team of experts. Solar experts guided them during electrical connections, safety certifications, space managements, etc. Thus, making the installation of solar device easy.When participants were asked to mark their satisfaction level on easy operation and maintenance of solar devices, 47.5 of percent participants expressed they are satisfied followed, by 35.5 percent of participants expressing highly satisfied.Solar experts educated the participants with the operation of solar devices during the installation of the device and solar panels don't require much upkeep, except that they have to make sure that panels are free from dirt and dust. The above points were the basis of satisfaction among the consumers. Dissatisfied participants were 11.8 percent,whereas, less than one percent of participants were highly dissatisfied. The reason for dissatisfaction mentioned by the participants was unfamiliarity with the technology, solar devices are available with many other small parts such as battery, panel, etc. which makes the use and operation difficult. A significant number of

Table 2. Mean score of satisfaction level based on the gender (n=400)

S. No.	Gender	Aspects of solar devices		
		Mean	S.D	n=400
1	Male	17.97	4.02	189
2	Female	18.30	4.02	211
	Total	18.14	4.02	400

participants (44.8 percent) were satisfied with the durability of the solar device, whereas, 28.7 percent were highly satisfied.Participan-ts revealed that they bought good quality deviceswhich ar-e highly priced and at the same time durable. Among the surveyed participants, 14.5 percent and 4.8 percent were dissatisfied and highly dissatisfied respectively. The researcher noted that solar panels installed by these participants are unable to withstand extreme weather conditions such as rain, wind etc. which makes the lifespan of the panels short. Satisfied participants indicating that solar devices produce a sufficient amount of energy were 28.5 percent and a similar percent was observed participants expressing highly satisfied 26.3 percent. Participants unraveled that installation of panels comes with the battery backup that stores the surplus energy generated. Excess energy can be utilized during power outages, rainy, cloudy days. Nearly 17% of the participants were neither dissatisfied nor satisfied with the energy produced by the solar panels installed by them, the researcher observed that participants didn't installed panels according to the usage. Twenty-four percent of the solar device users communicated that they are highly satisfied with the availability of after sales-services and 17.3 percent were satisfied. During the survey participants disclosed that they underwent customer training that included how to deal with solar devices as a whole. Although16.8 percent were highly dissatisfied with the above-mentioned aspect of the solar devices because they are not aware whom to contact in case problem arises.

Furthermore, the mean score of satisfaction level was determined based on socio-demographic factors. The mean score of satisfaction level based on the gender of the participants is measured (Table 2).

The mean score of satisfaction level for males was 17.97 which was less than for females 18.30. The difference between the score of satisfaction level between males and females was statistically tested using the following null hypothesis and the results are given below.

H0: The mean score of satisfaction level does not differ significantly between males and females.

H1: The mean score of satisfaction level differ significantly between males and females.

Table 3 t-test for equality of means

T	df	Significance
0.821	398	NS
Critical value: 1.966		

NS- Non-significant

The t-test for equality of mean was calculated to test the null hypothesis. The calculated value is 0.821 which is less than the critical value of 1.966 at the 5 percent level which infers that there is no significant difference in the mean scores of satisfaction level between males and females. The researcher noticed that both males and females were satisfied with the usage of energy efficient solar products because solar products generated sufficient amount of energy and additional energy can be stored in batteries for later use. Thus, the null hypothesis is accepted. Kumar and Singh (2018) conducted an empirical study on gender perception towards energy efficient solar products, the study interpreted that mean score of both male and female was 4.2277 and 4.1667, respectively which is almost same indicating there is no difference in the perception of males and females regarding solar energy is independent source of energy. Similarly, perception of male and female was found same i.e., 2.7624 and 2.5238 respectively for the statement solar products can enhance property value. In statement 'Solar products are easily available in the market' value for male was 3.5941 and for females was 3.5952 which is almost same. The results depicted there is no difference in perception of consumers towards energy efficient solar products with respect to male-female perception.

The mean scores of satisfaction level based on the age of the participants is measured Table 4.

The mean score of satisfaction level of age group 66-75 years was 19.3 which is higher than other age groups. Meanscore satisfaction level of 56-65 years of age group was 16.39 which is marginally higher than the age group of 46-55 years (16.79). The mean sore of satisfaction level for the age group 25-35 years was 18.92 slightly higher than the age group of 36-45 years 18.69.

The difference among the mean scores of satisfaction level of all age groups was statistically tested using the following null hypothesis.

H0: The mean scores of satisfaction level do not differ significantly among different age groups of participants.

H1: The mean scores of satisfaction level differ significantly among different age groups of participants.

Table 4. Mean scores of satisfaction level based on the age (n=400)

S. No.	Age(years)	Aspects of solar devices		
		Mean	S.D.	n=400
1	25-35	18.92	3.85	123
2	36-45	18.69	3.94	122
3	46-55	16.79	3.68	67
4	56-65	16.39	3.94	64
5	66-75	19.83	4.07	24
	Total	18.14	4.02	400

Table 5.ANOVA for aspects of solar devices

S.No.		Sum of Squares	Df	Mean Square	F	Sig.
1	Between Groups	497.884	4	124.471	8.276	**
2	Within Groups	5940.993	395	15.040		
3	Total	6438.877	399			
4	Critcal Value	3.367				

ANOVA test was performed to verify the null hypothesis (Table 5). The calculated value F-value is 8.276 which is higher than the critical value of 3.367 at 1 percent level. Thus, it is inferred that there is a significant difference in the mean scores of satisfaction among different age groups. Participants in the age group of 66-75 years as these participants were found to have additional time to engage themselves in pursuing more information on solar products when compared to other age groups. Respondents in the age group of 25-35 years, 36-45 years and 46-55 years are either busy in their educational lives or in their occupational lives. Thus, they do not find time in pursuing knowledge on energy efficient solar products which results in low satisfaction level among them. As the ANOVA test indicated 'significant' hypothesis is rejected and alternative hypothesis is accepted. Faiers and Neame (2006) examined whether or not there were differences between responses of the age groups of the 'early majority'. Differences were found using standard tests to compare means of response. However, the comparison of the mean values showed that whilst a statistical difference in response value existed, the actual response did not change, for example all respondents thought that the payback time was too long, but the people aged over 50, thought it was longer than those aged under 50.

According to the study carried out by Kalpanadevi (2019), level of awareness on availability variable differs significantly based on age category, as the calculated significance was less than the actual significance ($p < 0.05$). Hence, there existed a significant difference of opinion on level of awareness on availability based on age category.

The mean score of satisfaction level was calculated based on qualifications of all the participants (Table 6).

The mean score of satisfaction level among illiterates was 19.87 which was higher than other educational qualification followed by graduation Degree holder 18.63. The mean score of satisfaction level among participants who went up to school was 17.17 which was higher than professionally qualified participants 16.75.

The difference among the mean score of satisfaction level of all the qualifications was statistically tested using the following null hypothesis.

H0: The mean scores of satisfaction level do not differ significantly among different qualifications of participants.

Table 6. Satisfaction level based on the qualifications(n=400)

S. No.	Qualification	Aspects of solar devices		
		Mean	S.D.	n=400
1	Illiterate	19.87	4.20	90
2	School	17.17	3.86	111
3	Degree holder	18.63	3.55	122
4	Professional	16.75	3.90	77
5	Total	18.14	4.02	400

H1: The mean scores of satisfaction level differ significantly among different qualifications of participants.

ANOVA test was performed to verify the null hypothesis. The calculated value F-value is 183.339 which is higher than the critical value of 3.831 at 1 percent level (Table 7). Thus, it is inferred that there is a significant difference in the mean scores of satisfaction level among different qualifications. Participants with higher qualification had many sources such as books, newspapers, T.V. etc. for the better understanding of the energy effect products and their understandings can guide them in operating the solar products effectively. In contrast respondents with poor qualification do not take part in activities that will promote intellectual growth having the effect of less satisfaction towards solar energy efficient products. As the ANOVA test indicated 'significant' null hypothesis is rejected and alternative hypothesis is accepted.

CONCLUSIONS

The study revealed that majority of consumers were satisfied with the aspects of solar devices operated by them. The aspect with which most the respondents were satisfied was easy to operate and maintain.The study disclosed thatconsumer satisfaction levels towards solar devices wasinfluenced by many factors such as age, gender, and qualification of the respondents, and this satisfaction level of consumers seems to be appreciative.The researcher suggests that the solar industries need to satisfy the consumer's needs by

Table 7. ANOVA for aspects of solar devices

S.No.		Sum of Squares	Df	Mean Square	F	Sig.
1	Between Groups	550.016	3	183.339	12.329	**
2	Within Groups	5888.861	396	14.871		
3	Total	6438.878	399			
4	Critical Value	3.831				

** Significant at 1% level

developing device that are innovative yet providing cost-benefit to them and new techniques with the aim of attracting a new number of consumers, and retaining old consumers.

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AN ANALYTICAL STUDY ON WOMEN EMPOWERMENT THROUGH SOCIAL MEDIA

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ABSTRACT

The study conducted during 2021–22 aimed to evaluate the socio-demographic profile of educated homemakers between the age group of 34 and 54 to recognize the influence of social media and to realize the impact of social media on women home makers. The adoptive structuration theory was used to enhance homemakers' capacities by improving their technology acceptance among people who are unable to work independently and compelled to rely on their spouses for financial assistance. The results of the study showed that 90 percent of the homemakers were familiar with online commerce and social media utilization, which isn't always feasible for earning additional money by homemakers because they're overburdened with domestic responsibilities. However, the respondents could gain valuable insights into technology adoption.

Keywords: Empowerment, Home Maker, Social Media, Women

INTRODUCTION

Home-making means managing a household. It may not have been considered employment, an opportunity, or punishment; it was a regular household chore. The homemaker can be either a man or a woman. But women were stereotyped to do homemakers' duties, and house chores were considered women's responsibilities (Adamokulicz and Rocha Valente, 2017). According to the Oxford dictionary, when husbands move to jobs, they stay at home to constantly cook, clean, and protect their toddlers. Women's participation in the household was generally voluntary and strenuous to their societal expectations, which would affect them psychologically more than economically (Jamil *et al*., 2019). According to a report by the Indian Labour Organization (Steven Kapsos, 2013), women sought economic integrity but were denied it because of their gender limitations and stereotypes. Historically, gender assumptions affected their jobs and incomes, such as their caste, religion, and marital status (Tripathi and Bhattacharjee, 2012). Indian law dictates that women are considered equal to men, which often does not work practically.They were frequently perceived as disadvantaged and persecuted by family members, ancestors, and society.

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Indian institutions adhere to a patriarchal society, and women's contributions and growth are not appreciated.The homemaker got inadequate recognition or attention and endured humiliation at home (Zaman *et al*., 2010). Nowadays, men and women get jobs and earn equally. In India, many in the patriarchal setup claim that women 'fit' the role of a homemaker and hence it is not imperative to recognize their contributions to their family.(Lal Chandani, 2021). Social media empowered women in social, emotional, financial, political, and physical spheres to get along with that. Homemakers received innumerable updates and theydon't feel alone at home (Tanavathi, 2018). According to an OECD development (Loiseau and Nowacka,2015), social media assists homemakers who are involved by household activities. Homemakers could create new creative videos, design blog or vlog posts. During this indistinguishable period, they could take fame and money for their work. Homemakers should develop their abilities and areas of interest through social media. They'd grow upto defend their coherence against discrimination, domestic violence, and harassment via social media platforms (Madhu Kumari, 2020).

Theoretical framework

Giddens adoptive structuration theory (1994) was used to examine the study. According to the adoption structuration theory, a group of people or organizations use information technology for their job or activities to promote understanding and effectiveness within the specific work. People were adopting information technology in groups or organizations focused on developing outcomes. Social media had a role in the technological and resource-based progress of homemakers. The adoptive tendency of social media emphasizes the importance of theory, and a group of homemakers should be recognized and adopted for daily routine. It deals with grave changes and generates intuition in their lives. (Kauffman and Techatassanasoonorn, 2011).The study aimed to seek out the socio-demographic background of the women respondents, understand the impact of social media usage on women homemakers, and identifythe homemaker's main areas of social media usage. The study assumed that educated women who stayed home wouldn't comprehend how social media works and functions properly.

MATERIALS AND METHODS

The study was conducted during the year 2021–22. The researcher employed interview method for gathering data, and a well-prepared interview schedule was used to collect datathrough face-to-face interaction among 100 women homemakers aged between 34 and 54 years. The samples were collected randomly from the Pattom area of Thiruvananthapuram, Kerala. The collected data was analysed and interpreted through percentage analysis.

Empowerment: Empowerment means change, choice, and power. It is the process of change in a group of people or an individual. If people had little or no power and ability to make choices that affect their lives. Empowerment is the stage of gaining strength for women in order to comprehend their rights and carry out their duties to others and to

Table1.Socio-Demographic Profile of the Respondents (n=100)

S. No.	Category	f	%
Age			
1	34-40	50	50
2	41-54	60	60
Religion			
1	Hindu	40	40
2	Christian	60	60
Educational Qualifications			
1	Graduation	80	80
2	Post-graduation	20	20
Monthly Income of the Family (Rs.)			
1	< 100000	60	60
2	100001-200000	30	30
3	> 300000	10	10
Spouse Job			
1	Retired employee	20	20
2	Government employer	30	30
3	Private job	20	20
4	Business	30	30
Type of the Family			
1	Nuclear	60	60
2	Joint	40	40

themselves in the most effective manner (Sobha Rani, 2021).

RESULTS AND DISCUSSION

The virtual earth would get knowledge and information within seconds. Social media convey it worldwide and are technologically savvy (Teun Siebers *et al*., 2022).

Table 1 indicates the socio-demographic background of respondents. The study revealed that, out of 100 female respondents, the majority (60 percent) lived in Christian communities. And the majority of the homemakers (80 percent) were graduates, and 20 percent of the respondents had a postgraduate degree. But most of them were engaged in household work and giving birth to children. The respondents were dependent on their husband's income. They were government employees (30 percent), businessmen (30 percent), private employees (20 percent), and retired regime employees (20 percent). The data showed that 60 percentof respondents lived in a nuclear family.

Figures 1 and 2 illustrates the phone usage habits of the respondents. Figure 1 shows that cent percent of respondents had a smartphone. Figure 2 shows that 80 percent of respondents kept their smartphone handy all the time. Those who do not use them for most of the time also tend to keep smartphones handy. The functional flexibility and portability of smartphone bring up people (Sarwar and Rahim, 2013).

Figure 3 shows that cent percent of homemakers use social media. According to 2019 report by the Indian Express, WhatsApp has become a social communication tool. Figure 4 shows that 60 percent of homemakers use both Facebook and Whats App, while 40 percent use exclusively WhatsApp. Whats App has the potential to overtake Facebook in terms of popularity in India.

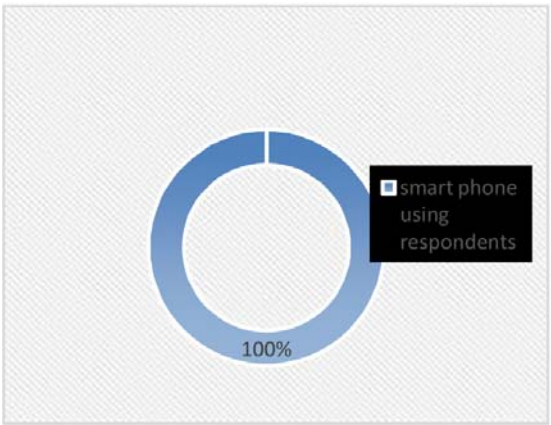


Fig.1. Respondents smart phone usage

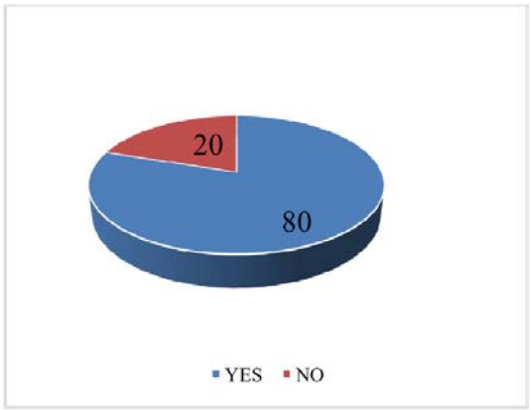
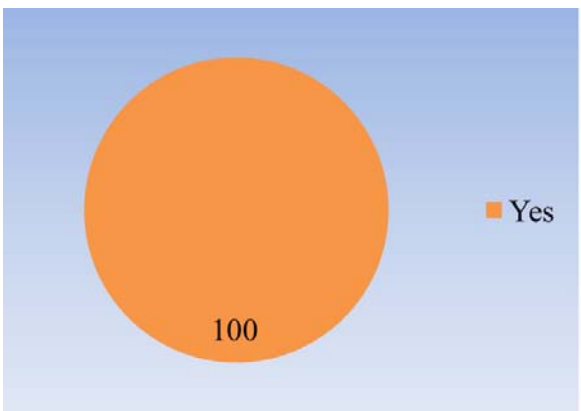


Fig.2. Respondents who kept smartphone handy



.Fig. 3. Respondents Account details on social media

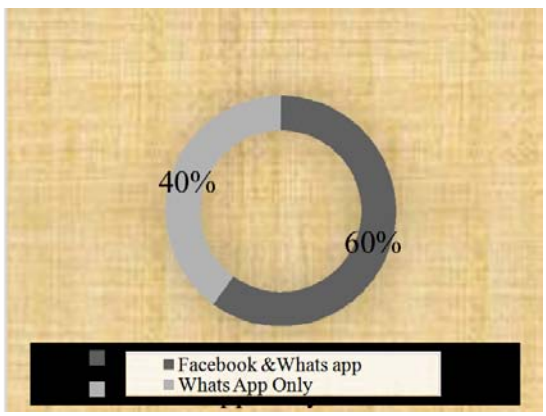


Fig. 4. Respondents preferred Apps

Figure 5 shows that the majority (30 percent of respondents) chose social networking applications for communication and 30 percent for past time. Social media help to form social relationships and unlimited interaction (TemelEginli and Ozmelek, 2018). Figure 6 depicts that respondents chose an application based on their preferences and interests. The majority (60 percent) were active on their preferred websites. At the same time, 40 percent were infrequent users.

Figure 7 shows that 50 percent of the respondents spent less than one hour on social media, but 50 percent of them spent 1 to 2 hours on social media in a day. These findings indicated that homemakers who were active on networking sites when free from household activities and wanted to be more productive. Fig. 8 represents the free time and hobbies of the respondents. Seventy percent of the respondents had 1-2 hours of free time per day after household activities. In the same way, 20 percent of the respondents got less than one hours of free time, and 10 percent of them had more than 3 hours of free time and were more able to fulfill their hobbies.

Figure 9 indicates the respondent's major hobbies in their leisure time. The

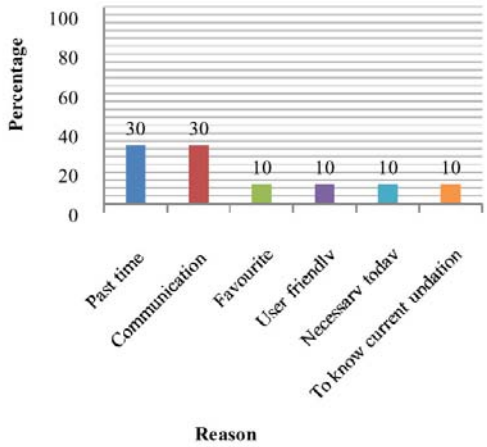


Fig. 5. Respondents reason for choosing social networking apps

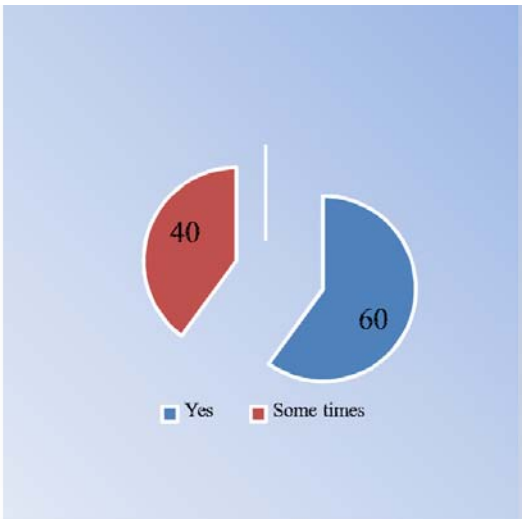


Fig. 6. Respondents who are active on social media sites

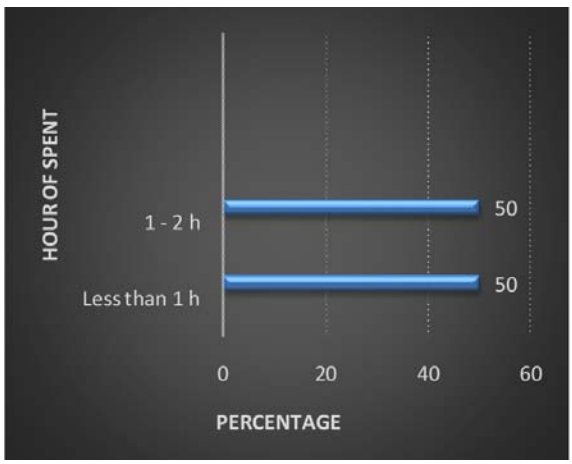


Fig.7. Respondents time spent on browsing social media

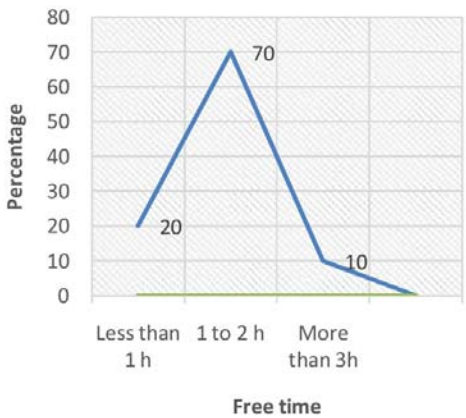


Fig. 8. Respondents free time per day

majority (40 percent) were interested in listening to music. This pattern indicated that social media provided opportunities to utilize their leisure time and be more productive. Figure 10 shows that the majority(80 percent) of the respondents agreed that social media was helpful in their daily routine. Figure 10 shows that a cent percent of respondents' husbands knew about their social media usage and none of them maintained secret accounts. This kind of habit helps to prevent misuse of social networking sites because social media had become a haven for scammers and cybercrime (Bhavana Arora, 2016).

Figure 11 shows the information related to the respondents' daily news analysis. The majority (60 percent) of respondents got their news from either television, newspapers, or both. Furthermore, 30 percent of respondents rely solely on social media sites for news. As seen here, homemakers were interested in traditional media due to its availability. Many

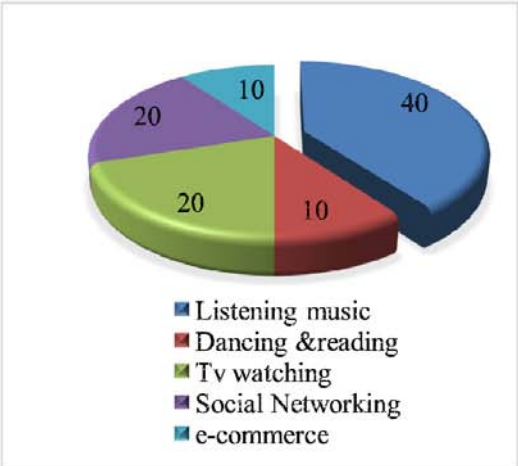


Fig. 9. Respondents major hobbies to pursue in leisuretime

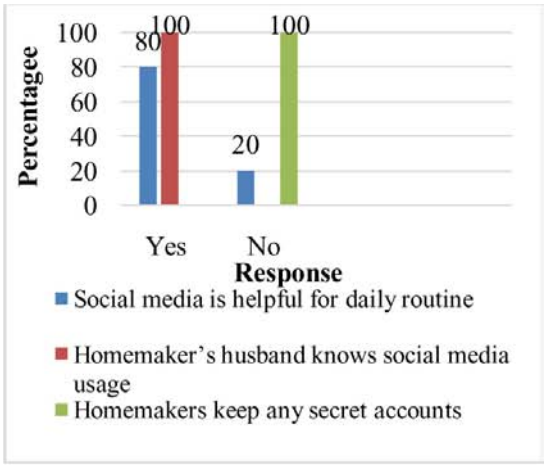


Fig.10. Respondents social networking usage ina day

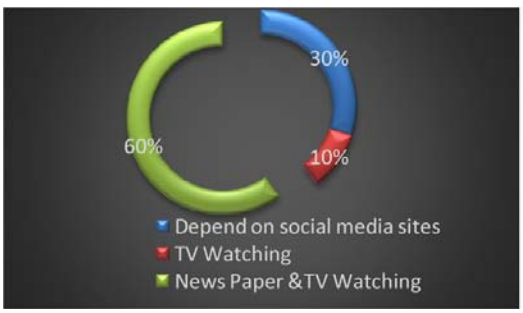


Fig.11. Respondents' various channels usage to get news updates everyday

Fig.12.Respondents knowledge about online transactions

people use social media platforms for news rather than social interaction or entertainment (Rafique *et al.*, 2020).

Figure 12 examines respondents' knowledge of online transactions and e-commerce. The majority (80 percent) respondents were aware of internet transactions, payment services, sales, the importance of online e-commerce etc. This indicates that people were aware of significant areas of social media where an online transaction would provide opportunities to manage their money from home in a fast and quick way (Sravika, 2022).

Figure 13 shows homemakers' knowledge of popular applications for present-day usage. The homemakers (90 percent) said Flipkart and Amazon were their e-commerce sites. The respondents knew Swiggy (80 percent) and Uber Eats (80 percent) food ordering apps and they order food and pay via online. A majority (70 percent) of homemakers use PAYTM and net banking (30 percent) for their financial activities. OYO was popular for guest rooms/hotels and provided secure stays for travellers. Respondents could book rooms through this application anywhere. This instance showed that they knew travel-related engagements

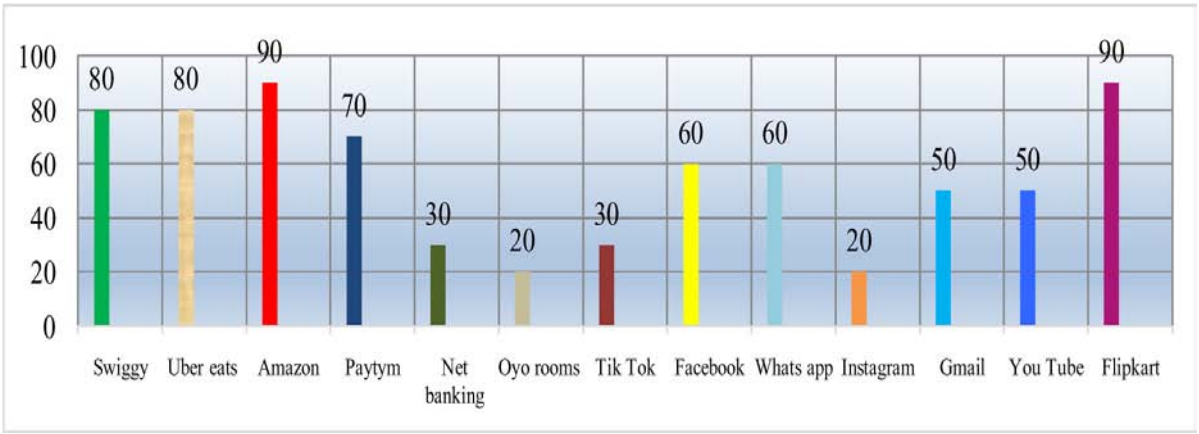


Fig.13. Respondent's knowledge level about various applications

might prioritize safety and security. This indicated that social networking sites were used to promote business and can harness to accomplish travel and reduce travel due to online services (Rahuman and Janet Mary, 2020).

TikTok is a video-making application (30 percent) and respondents are interested about this application, at the same time they use Facebook (60 percent), WhatsApp (60 percent), and Instagram (20 percent) for online chatting and messaging purposes. The reason might be due to the fact that the homemakers were interested in communicating with their friends and beloved ones and use WA and FB on a daily basis. Gmail was an online e-mail service that help to commuincate messages from one person to another. Fifty percent of the respondents recognized and are familiar with Gmail. YouTube is a video browsing and video-making application and 50 percent of respondents were browsing YouTube channels.

Table 2 denotes respondents' knowledge about income through social media. Social media generates revenue from new video production and uploads, news channels, blogs, and if a video goes viral, more exposure and income for the content. People could create videos or share self-created content in their spare time (Szu Chuang Li *et al.*, 2022). A majority (80 percent) of the respondents had no clarity or knowledge of online websites, blog

Table 2. Respondents' knowledge about income through social media (n=100)

S. No.	Category	No of Respondents	Percentage
		Online websites /Blog /Channel	
1	Yes	20	**20**
2	No	80	**80**
		Details of Income generation	
1	Yes	20	**20**
2	No	80	**80**

channels, or online income generation through social media.

CONCLUSIONS

After entering into the institution of marriage, the respondents did not focus on career advancement, their own income, and settled into household activities, mainly depending on their spouse or family income. In such a situation, women homemakers rely on socializing through social media or social networking. The majority of homemakers were unaware of the scope of income generation through social media, but they had basic ideas about social networking sites. Proper training could lead these homemakers to greater success on social media and relief from household activities. They get more ideas about technology adoption and would get opportunities to generate their own income through social media activities in their free time. It would mean the possibility and applicability of the theory. The study found that homemakers aged between 34 and 54 were not generating their own income even though they were well-educated. The study noticed that nuclear family structure was one of the reasons for the above findings. In this situation, women's use of social networking showed that the adoptive structuration theory was applicable, and therefore women can be empowered by prioritizing their use of social networking. In other words, women empowerment is possible here if they are made more aware of the importance of social media in helping them grow at personal level.

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PERCEPTION OF YOUNG CONSUMERS ON KHADI IN THE PANIPAT DISTRICT, HARYANA

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ABSTRACT

The main aim of this research was to analyse the knowledge and awareness level of youth regarding the khadi fabric in the district of Panipat, Haryana. The study carried out the relationship between characteristics of both buying behaviour and its acceptability among youth. A totalof 292 adults, between the age of 18 and29 years, were selected as respondents. It was reported that 62% of youth, did not find khadi clothing a pocket-friendly option. It was seen that 40% of consumers were aware of only cotton khadi and 56% accepted it for its high comfort value. Similarly, 70% of respondents felt that khadi fits all age groups. It was noticed that nearly 20% of youth were not using or buying khadi at all. It was also observed that nearly 20% of the respondents preferred khadi to be used in home textiles only such as draperies, bed linens, blanket covers, etc.Whereas, 62% of youth felt khadi clothing was expensive. It was concluded that consumers were having a positive attitude towards khadi. It was noticed that along with comfort, youth prefer fashionable clothing that is relatively cheap.

Key Words: Buying behaviour, Consumer awareness, Khadi acceptance,Perception, Youth preference

INTRODUCTION

According to the Khadi &Village Industries Commission Act 1956, “khadi means any cloth woven on a handloom from cotton, silk or woolen yarn- handspun in India or from the combination of any two or all of such yarns. In the year of 1953, the Indian government established the All India Khadi and Village Board (AIKVB). Later, in 1957 the name was changed to KVIC (Khadi & Village Industries Commission). The Indian government established the KVIC board which ensures positive measures to be taken to promote the khadi sector and actions in direction of betterment of khadi in the market. Khadi is a brand itself and represents itself as a symbol of self-reliance. It was observed that youth are quite sensitive to this idea and are ready to accept khadi but are not ready to compromise with the latest fashionable looks. The study’s main aim is to study the acceptability, knowledge, and awareness of khadi among the youth of Panipat district, Haryana**.** Rita and Mukhtar (2018) in their study reported that consumers prefer the current trends and emphasize more on design, price, and

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then brand. Vandana (2020) reported that new-age khadi products are not for the masses due to less supply in the market and reported them as costly**.** Clothing for youth is a way of showing their personality, their character, what they are, and who they are. Since the purchase decision is made only when the consumers are already aware of that product or when they want to try out new things under any influence. It was noticed that khadi is not promoted ata suchlevel so it can influence youth's decision of using it as their clothing choice. Kaurand Rathod (2017) claimed in their study that the inclination of the youth is more towards the international and other domestic fashion brands in comparison to the brand khadi. During the research, awareness of khadi clothing among youth was observed but they were not opting for it, that's why the market of khadi as abrand and loyal customers definitely needs to be built. "A brand perceived with several image attributes is preferred because those attributes are congruent with the consumer's different image reflections" (Malikul, 2012)."Buying behavior is the study of how people buy when they buy, and why they buy**"** (Blackwell, 2006). Furthermore,it was noticed that consumers are often persuaded by brand names, advertisements, and promotions by celebrities. Knowledge and awareness of any product are greatly influenced by these factors. Familiarity with brand names, exposure to advertisements, and new promotional strategies need to be built to target youth to make khadi a fabric for youth.

MATERIALS AND METHODS

The proposed study is descriptive and is mainly based on primary data, collected in the year December 2021. The questionnaire prepared for the study consisted of different sections that seek information regarding the demographic profile, khadi awareness, and consumer behaviour towards its acceptance. The data was collected through a well-structured questionnaire via google forms.The locale of the study was the four blocks of Panipat district namely Israna, Madlauda, Samalkha, and Panipat.The sample for the study was selected using purposive and convenient sampling

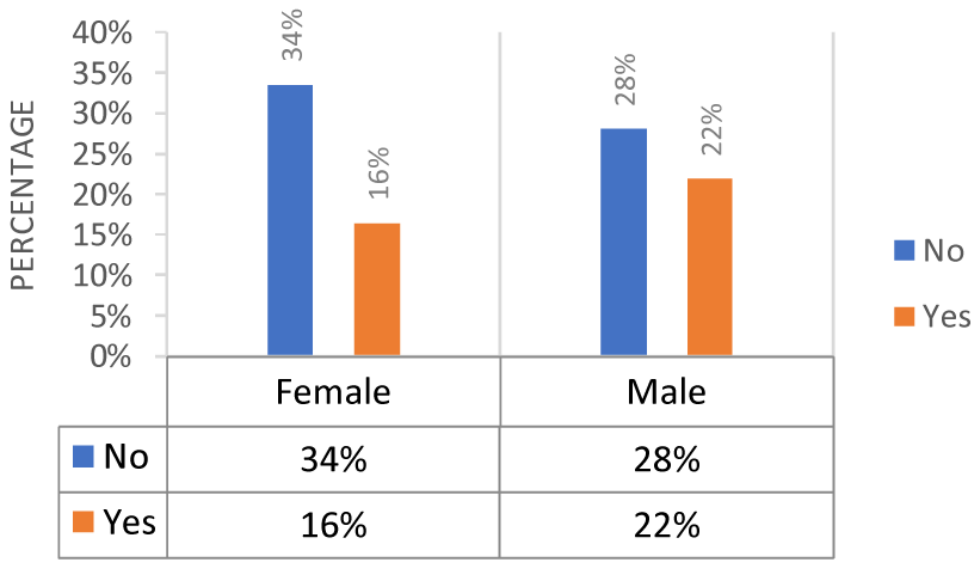


Fig 1. Percentage of youth perceiving khadi as a pocket-friendly option

techniques. The sample size was 292, wherein, 146 were male respondents and 146 were female respondents.The sample was equally divided according to gender and place of residence in four blocks of the Panipat district of Haryana where the close-ended questionnaire was executed among the youth. Partial responses were not considered for analysis.Statistical tools applied weredescriptiveand to check the correlation of variables phi-coefficient, and Cramer's V were applied.

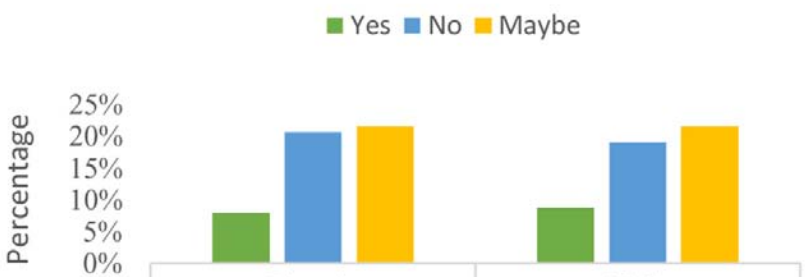
RESULTS AND DISCUSSION

Figure 1 indicates the frequency of the perception of both male and female respondents in the study. It was reported that 62% of youth, did not find khadi clothing economical. It also showedthat the majority of female respondents (34%) and male respondents (28%) did not find khadi pocket friendly. The study mainly focused on youth where the major section belongs to the student sector which was seen as quite price-sensitive. It would be justified to assume that youth seek budget-friendly clothing, and as per responses youth did not perceive khadi clothing as an affordable option. It was observed that only 16% of females and 22% of males considered khadi as an affordable option.

Figure 2 indicates the frequency distribution of perception of the youth of the Panipat district. The data shows that very few percent of respondents felt that khadi is trendy. Only 8% of female candidates and 9% of male candidates perceived khadi as contemporary clothing. The majority of respondents (40%) did not find khadi on fleek. Similarly, data revealed that 43% percent of both male and female respondents who were unacquainted with khadi clothing, had no opinion about khadi being trendy or not trendy. Thus, it was understood that there is a lack of awareness in their region about the latest updates regarding khadi among consumers. It was noticed that only 17% of consumers believed khadi has still gravitate and can be stylish. Because of the incognizance of respondents, it was concluded that there is a lack of awareness of the latest updates regarding khadi among consumers.

Correlation of categorical data

Phi and Cramer's V both are chi-square-based measures of association, used to know



	Female	Male
Yes	8%	9%
No	21%	19%
Maybe	21.58%	21.58%

Fig 2. Perception of youth for khadi being trendy

the relationship between categorical variables. Both indicate the strength of the relationship between the values 0.00-1.00 where 0 indicates no relationship and 1 indicates perfect association. It provides the strength of the relationship where the closer these measures are to 0.00, the weaker the relationship, and the closer to 1.00, the stronger the relationship. Values between 0.00 and 1.00 can be described as weak, moderate, or strong. Values are interpreted based on Cohen's rule of thumb as shown in Table 1. The test was applied to check the relationship between the gender and the buying of khadi and in Table 2. The relationship between gender and acceptance of khadi as a trendy option. With respect to gender a weak relationship was found with the buying and acceptance of khadi which revealed that buying and acceptance of khadi is not gender oriented.

Correlation analysis using Phi coefficient: The correlation analysis was conducted to check the relationship and strength between variables.It was found that buying behaviour of khadi has a weak positive correlation with gender (0.112) (Table 1).

Statistically, a weak positive correlation between gender and buying of khadi was observed. It states that buying behaviourof consumers towards khadi is non-dependent on gender.The result is supported by small effect size.

Correlation analysis using Carmer's V

Cramer's V = "(X2/n) / min (c-1, r-1)

In which,

X2: It is the Chi-square statistic;

N: It represents the total sample size

R: It is equal to the number of rows;

C: It is equal to the number of columns

Table 1. Correlation analysis (n = 292)

S.No.	Purchased khadi for clothing	No	Yes	total
1.	Female	98	48	146
2.	Male	82	64	146
3.	Total	180	112	292

Rphi = (ad-bc)/sqrt((a+b)*(b+d)*(a+b)*(c+d)

Numerator = 2336; Denominator= 20729.943; Rphi Value = 0.112

Table 2. Correlation analysis (n = 292)

S. No.	Khadi's acceptance as a trendy option	Maybe	Yes	No	Total
1.	Female	63	23	60	146
2.	Male	63	25	58	146

X2 = 0.117, n = 292, R = 2, C = 3, V= 0.02

Table 3. Knowledge and awareness on khadi among youth (n=292)

S.No.	Questions	Response	f	%
1.	Khadi is what type of fabric?	Obtained from plant(cellulosic)	154	52.7
		Synthetic	56	19.2
		Obtained from animal (Animal fibre)	25	8.6
		No idea	57	19.5
2.	Number of khadi fabric garments you possess in your wardrobe	0	58	19.9
		1-3	172	58.9
		4-6	58	19.9
		7-9	1	0.3
		10 and above	3	1.0
3.	How do you prefer to wear khadi?	Casual wear	88	30.1
		Occasional wear	69	23.6
		Used in home textiles	56	19.2
		Festive wear	41	14.0
		Party wear	9	3.1
		None of the above	29	9.9
4.	Which mode do you prefer for khadi shopping?	Khadi stores	161	55.1
		Local stores	60	20.5
		Online stores	32	11.0
		Exhibitions	26	8.9
		Private retailers	13	4.5
5.	What variety of khadi fabric you are aware of?	Khadi cotton	118	40.4
		Khadi silk	27	9.2
		Khadi wool	18	6.2
		All the above	109	37.3
		None	20	6.8

The Cramer's correlation test was conducted to check the relationship among variables. The result showed a statistically weak positive relation between acceptance of khadi as a trendy option among consumers concerning gender (Table 2).This result is supported by small effect size.

From Table 3, it is clear that nearly half of the respondents had knowledge regarding khadi cotton origin but they did not have background knowledge of raw materials of other varieties. Very few percentage of the respondents knew that khadi is also available from animal fibre (8.6%). Similarly, 19.2% were familiar with the synthetic (polyvastra) khadi. The majority of respondents own at least one khadi garment. Approximately 20% did not own khadi outfits in any form. It was discovered that 19.9% had four to six khadi outfits whereas only 1% had more than ten garments. It was noticed that nearly 30% preferred to wear khadi on a casual basis, 24% for occasional wear. Approximately 3% believed that it can be worn as a party outfit and 14% preferred it as afestive wear option. The respondents preferred khadi for occasional and casual wear and weresatisfied with its quality. The acceptance during festivities and parties is seen very less as consumers perceived khadi unfit for such occasions. Nearly 20% of the respondents believed that khadi is to be used for home textiles only whereas, almost 10% did not desire khadi in any form. Most of the consumers preferred to buy khadi from khadi stores (55%) and local stores (21%) rather than e-commerce. It was noticed that only 4.5% of respondents opted for private retailers. It was observed that the majority was aware of the 'cotton khadi' variety (40.4%). Nearly 38% were aware of all three varieties *i.e.,* khadi cotton, khadi silk, and khadi wool. It was understood that approximately 7% were not aware of either of the varieties. It was seen that a meagre percentage of respondents were aware of other varieties than khadi cotton.

From Table 4, it is noticed that the majority of youth putforth the comfort factor (55.4%) amongst other factors such as cost-effective (19.5%), appealing & fancy (18.4%), and last durability (6.5%) while making purchases. It was noticed that the majority of respondents nearly 70% felt that khadi fits all age groups. Approximately 5% of the respondents felt that khadi is fit only for youth. From the Table 4, it was understood that color/design were the major attributes that customer seeks first in the garment followed by comfort with the percentage of 82% and 56%, respectively. It was noticed that celebrity style (7.8%) was not much accepted by people. Similarly, people are not much affected by brand names also (7%). Afroza and Urmila (2018) reported in their study that while shopping for an outfit, customers gradually emphasize first design, price, and then brand. It was understood that nearly 57% of respondents prefer comfort values, 82% go for color and design variation first while purchasing apparel, and nearly 28% accept khadi for its looks and texture. Moreover, 30% of the respondents accepted that khadi has limited color and design variety and 18% of people did not find khadi trendy. One of the major reasons found for the non-acceptance of khadi was the price. Nearly 31% of the respondents accepted khadi as a high-priced fabric. Similarly, 30% of the respondents accepted that khadi has limited color and design variety and 18% of people do not find khadi trendy. Nearly 14% did not approach khadi due to the unavailability of stores. The reasons observed to opt for other

Table 4. Buying and acceptance behaviour of khadi by youth (n=292)

S.No.	questions	Available Options	frequ-ency	Percentage distribution%
1.	As a youth what do you look for in the garment?	Comfort	162	55.47
		Budget-friendly	57	19.52
		Appealing/ fashionable	54	18.49
		Durability	19	6.50
2.	What do you think khadi is fit for what age group?	For all age groups	205	70.20
		Middle-aged	38	13.01
		Old aged	33	11.30
		Youth	16	5.47
3.	While shopping for clothes what qualities do you prefer first?	Comfort	166	56.84
		Color/ design	82	82.08
		Celebrity style	23	7.87
		Brand name	21	7.19
4.	Reasons for khadi preference?	National symbol	138	47.26
		Looks & appeal	81	27.73
		Good image of the brand	45	15.41
		Good advertising	28	9.58
5.	What factors influence you to buy other brands over khadi?	More variety in color / design/trend	113	38.69
		Availability	64	21.91
		Quality of other brands	62	21.23
		Price	53	18.15
6.	Reason for non-acceptance of khadi	High cost	92	31.50
		Limited color, style variety	90	30.82
		Do not find trendy	54	18.49
		Non-availability	40	13.69
		Poor fabric performance	16	5.47

brands over khadi were the availability of more colors and varieties in design as per the latest fashion trends (38.69%), better quality in other brands (21.2%) and, and easy availability (21%), and price factor with 18%.

CONCLUSIONS

The youth of the Panipat district did not perceive khadi as their clothing option because they did not find it trendy (40%). It was reported that the (16%) female section looked a far more budget-friendly fashion as compared to the male. The majority of respondents (38%) did not find it budget-friendly. High percentage of consumers opt for other brands over khadi because of more design/color availability. Thus, it was understood that most respondents were unaware of the khadi clothing line. Today when most of the shopping is done via e-commerce and during covid also the denizens used to spend time on the internet, purchasing of khadi via e-commerce (11%), showed that khadi could not make its place to the top and acceptance of khadi is still lagging. A positive perception towards khadi can be seen among youth, but a level of acceptance seen is rare. With a percentage of 7.87%, it was clear that celebrity style was not much accepted by people rather comfort factor (58%) was favored over it. Similarly, the factor brand name (7%) was not found impactful. Thus, it was concluded that the youth of Panipat which majorly belong to the rural section found unaffected by brandsrather than preferred the qualities such as comfort, price, and varieties available.However, quality of khadi clothes was not found a factor for its non-acceptance. The reason for preferring khadi was patriotism among youth and considered khadi as a national symbol(47%). Good image of the brand (15.4%) and advertising (9.5%) were the least accepted factors which affected buying of khadi and thus concluding that neither the khadi is greatly advertised nor it could build itself as a brand. It was reported that somehow khadi had failed to establish itself as a brand among young consumers.

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DETERMINANTS OF INSTABILITY IN RICE PRODUCTION: EMPIRICAL EVIDENCE FROM UTTAR PRADESH

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ABSTRACT

This research examined the determinants of the instability in rice production, which enhances the total rice productivity in Uttar Pradesh. The study analysed the relations among variables used for the analysis from 1991 to2019.The application of the Auto Regressive Distributed Lag technique (ARDL)was used to approximate various determinants. The area under net irrigation, un-irrigation, and rainfall positively affect rice production. In contrast,un-irrigation and annual rainfall showed a positive but statistically insignificant impact on rice production in the long run. While in the short run, all determinants had a negative and significant effect on total rice production convergence towards in-equilibrium, shown by the error correction term - 0.42.

Keywords: ARDL, ECM, Instability, Irrigation, Rice Production.

INTRODUCTION

Uttar Pradesh is the country's fourth-biggest state. The state has a total area of 246413 km^2 with various physical characteristics ranging from plains to Vindhyan highlands. The state is split into two physiographic regions: the Gangetic plains and the southern plateau. Gangetic plains cover the majority of the state in terms of farming. With a population density of 776 per square km. Uttar Pradesh is the most populated state of India with the population density of 776 persons per sq.km. With 225 lakh agricultural families, the state has 16.49 percent of the country's population (Source:www.censusindia.gov.in). Agriculture is the most significant sector in the state because around 80% of the population lives in rural areas and 75% of the total employees are directly or indirectly involved in cultivation/farming, accounting for 27% of the state's GDP. Agriculture is the state's primary income source for most families. Major crops grown in the state are rice, wheat, maize, sugarcane, chickpea, pigeon pea, mustard, lentil, urd, and moong. The majority portion of agricultural land is utilized to cultivate main cereal crops such as rice and wheat. Rice is the most important crop in Uttar Pradesh, which is cultivated in 5.90 million hectares, accounting for 13.5 percent of total rice production in India.

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Uttar Pradesh has a favourable climate, wide expanses of fertile soils, sunlight, and abundant water supplies; cropping intensity is 153 percent. U.P. state ranks third in rice production in the country. Rice cultivation in the state is particularly fragile and risky due to complicated ecological conditions characterized by frequent floods, droughts or both. Yield has stagnated at 2.0 t ha^{-1} from 2009 to 2010 due to unpredictable rainfall distribution, producing excess water stagnation/drought or both in various years. Rice farming is practiced on a small to large scale in all 72 districts of Uttar Pradesh (It is included in practically every meal and is farmed on most rural farms). Uttar Pradesh is the country's third-largest producer of rice. In the state, annual rice output is roughly 12 metric tonnes. Rice is mostly grown during the *Kharif* season (wet season) on around 5.90 million hectares, with just 35000-40000 hectares planted during the Zaid season (summer season). Boro rice is planted only in heavily flooded regions of roughly 3000 acres or more, primarily in the eastern districts of Uttar Pradesh. The state's average production is roughly 2 t ha^{-1}.

This study main objectives were to report the causes of variations in rice production in Uttar Pradesh; to investigate the long-run relationship between instability and rice production, andto suggest some policies to improve the level of reducedinstability.

This research is significant for improving rice production, trade exchange earnings, and job opportunities in Uttar Pradesh. Therefore, decent agricultural growth is a prerequisite for achieving inclusive growth, reducing poverty levels, developing the rural economy, and enhancing farm incomes.

Agricultural production is becoming more unstabledue to various causes, including irregular rainfall patterns, inadequate irrigation coverage, and increased frequency and intensity of natural catastrophes.(Sinha *et al.,* 2011). Furthermore, the insufficient coping capability of most farm households and the country's weak institutional system has significantly exacerbated susceptibility to agricultural hazards in many sections of the country (Mrutyunjay andMamata, 2006).This insecurity has also harmed the country's food management and macroeconomic stability (Chand and Raju, 2009). Drought, floods, and cyclones are the key climatic threats in the eastern region of India, and they are primarily responsible for the rising insecurity in agricultural productivity. Odisha, one of the states in the country's East, is renowned as India's "disaster capital" since the state is heavily impacted by natural disasters yearly (Mahapatra and Patra, 2020).The study emphasized boosting pulse crop production through technological interventions and extending pulse crop acreage (Ansari *et al*., 2022).

MATERIALS AND METHODS

The study is based on secondary data collected from the RBI indicator of India, Economic Survey, and Statistics Handbook. The sample span for the research is 29 years, *i.e.* from 1991 to 2019.

Selected Variables

RICE - Dependent variable

IRRIGATION- Independent variable
NON-IRRIGATION - Independent variable
ANNUAL RAINFALL - Independent variable

Hypothesis Formulated

H0 = There is no instability in rice production in the Uttar Pradesh state
H1 = The rice production in the U.P. is instable

Autoregressive Distributed Lag Model

ARDL approach is used to analyze the source and determinant of the instability of agricultural production in Uttar Pradesh. ARDL bound testing process *(Pesaran et al.,* 2001*)* is elastic. It requires that variables in the model specification can be either integrated at order 0 or 1, that is, I (0) or I (1). This model of estimation gives efficient consequences even for small samples. Variables can be attributed to different leg lengths in the model. The ARDL equation is as follows:

Equation (3) is the ARDL model, which indicates the long-run and short-run association between the dependent and independent variables. α_0 is the intercept term. The short-run co-efficient of variables are α1, α2, α3, α4, α5, explanatory variables, while the long-run coefficient of variables is α4, α5, and α6. In contrast, μt is the stochastic error, containing all the equation's omitted variables.

Econometric Model

The econometric model of this study is given below:

RIC= â0 + â1(IRR)+â2(UN-IR)+â3(ANR)+ μ …… (1)

in which,

RIC = RICE

IRR = IRRIGATION

UN-IR = UN IRRIGATION

ANR = ANNUAL RAINFALL

â0 = Intercept

â1, â2, â2, â3, = Slope Coefficient

μ = Error Term

Long-Run Relationship of ARDL Model

$$Y_t = \beta_0 + \beta_1 Y_{t-1} + \cdots + \beta_q Y_{t-p} + \alpha_0 X_t + +\alpha_1 X_{t-1} + \alpha_2 X_{t-2} + \alpha_K X_{t-K} + u_K \ldots\ldots\ldots\ldots\ldots\ldots 2$$

Whereas, the unrestricted vector error model is given below

$$\Delta(\text{RICE})_t \alpha_0 + \sum_{i=1}^{p} \text{RICE}_{t-1} + \sum_{i=0}^{p} \alpha 1\ \text{IRRIGATION}_{t-1} \sum_{i=0}^{p} \alpha 2\ \text{UN} - \text{IRRIGATION}_{t-1} +$$

$$\sum_{i=1}^{p} \alpha 3\ \text{ANNUAL RAINFALL}_{t-1} + \alpha 4\ \text{RICE}_{t-1} + \alpha 5\ \text{U. N.} - \text{IRRIGATION}_{t-1} +$$

$$\alpha 6\ \text{ANNUAL RAINFALL}_{t-1} + \mu t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3$$

$$\Delta(\text{RICE})_t \alpha_0 + \sum_{i=1}^{p} \delta o \text{RICE}_{t-1} + \sum_{i=0}^{p} \delta 1$$

$$\text{IRRIGATION}_{t-1} \sum_{i=0}^{p} \delta 2\ \text{UN} - \text{IRRIGATION}_{t-1} +$$

$$\sum_{i=1}^{p} \delta 3\ \text{ANNUAL RAINFALL}_{t-1} \ldots\ldots\ldots\ldots\ldots\ldots\ldots 5$$

The long-run association between the dependent and independent variables is given in the form of the equation.

$$\Delta(\mathrm{RICE})_t = \gamma_0 + \sum_{i=1}^{p} \delta o \mathrm{RIC}_{t-1} + \sum_{i=0}^{p} \gamma 1\ \mathrm{IRR}_{t-1} + \sum_{i=0}^{p} \gamma 2\ \mathrm{UN} - \mathrm{IRR}_{t-1} +$$

$$\sum_{i=1}^{p} \gamma 3\ \mathrm{ANR}_{t-1} \ldots\ldots\ldots\ldots\ldots\ldots 6$$

(ECMt-i) ECM indicates the short-run impact on x and y variables and speed of adjustment

$$\Delta Yt = \eta + \delta t\text{-}i + \lambda(\mathrm{ECMT\text{-}I}) + \mu t \ \ldots\ldots\ldots\ldots 7$$

In the equation, δ indicates the short-run effect, and λ indicates the adjustment speed.

RESULTS AND DISCUSSION

Table 1. Descriptive analysis of dependent and independent variables

S.No.	Statistics	Rice	UN-Irrigation	Irrigation	Annual Rainfall
1	Mean	11925.30	3945.690	12928.93	726.1390
2	Median	11780.00	3558.000	13085.00	779.3000
3	Maximum	15545.30	6757.000	14392.00	987.1000
4	Minimum	9411.400	2146.000	10542.00	101.9500
5	S.T.Deviation	1664.713	1411.224	1083.138	177.7615
6	Skewness	0.269175	0.393053	-0.434386	-1.511132
7	Kurtosis	2.219778	1.851075	2.276464	6.345975
8	Jarque-bera	1.085769	2.341739	1.544573	24.56496
9	Probability	0.581070	0.310097	0.461955	0.000005

Note: Calculated by the Author through Eviews-10 Software

Error Correction Model: Short Run

This technique determines the short-run association between the gross domestic product and other independent variables. The short-run error correction equation is given below

Time series data consist of 29 years of annual observations from 1991 to 2019.The data in Table 1 shows that the average instability of Rice is 11925.30 with an elaborate of 1664.713. The irrigation rate is 12928.93 with a std.deviation of 1083.138. The average or mean value for un irrigationis 3945.690 with a std.deviation of 1411.224. The mean value for annual rainfall is 726.1390 with the std. deviation of 177.7615. The variables,Rice and un-irrigation, are positively skewed. Irrigation and annual rainfall, are negatively skewed. Kurtosis statistics of the variables indicated that Rice, irrigation, and un-irrigation are platykurtic (lower peak or short-tailed) because their value is less than 3. Variable annual rainfall is Laptokurtic (long-tailed or high peak) because its value is greater than 3. The results indicated that Rice's Jarque-Bera P (Probability) value is 0.58, which is greater than 10%. Therefore, we accept the

Table 2. Correlation analysis of dependent and independent variables

S. No.	Variable	Rice	Irrigation	Un-irrigation	Annual rainfall
1	Rice	1.00	0.720	-0.664	0.006
2	Irrigation	0.720	1	-0.983	-0.217
3	Un-irrigation	-0.664	-0.983	1	0.251
4	Annual rainfall	0.006	-0.217	0.251	1

Note: Calculated by the Author through Eviews-10 Software

null hypothesis which means data is normally distributed. Jarque-Bera's P-value of irrigation is 0.46, which is greater than 10%; we accept the null hypothesis, which means data is normally distributed. Therefore, the Jarque-Bera P-value of all the others variables except annual rainfall is greater than 10%; we accept the null hypothesis because the data is normally distributed. The P-value of Jarque-Bera of annual rainfall is 0.000005, which is not normally distributed.

All the variables are significantly correlated with Rice except Un-irrigation. The variable Rice is negatively correlated with Un-irrigation. Irrigation and annual rainfall are positively correlated with Rice.The same variables, irrigation and irrigation, unirrigation and unirrigation, annual rainfall, and annual rainfall fully depend on each other. The association between Rice and un-irrigation is negative -0.664 because r < I0.30I. The degree of association between annual rainfall and un-

Table 3. Unit root test analysis of dependent and independent variables

S. No.	Variable	Level		First difference		Second difference		
		Inter-cept	Trends and Inter-cept	Inter-cept	Trends and Inter-cept	Inter-cept	Trends and Inter-cept	Decis-ion
1	Rice	-1.28 (0.62**)	-4.79 (0.003*)	-10.06 (0.00*)	-9.87 (0.00*)	-5.11 (0.00*)	-4.96 (0.00*)	I(1)
2	irrigation	-1.98 (0.29**)	-3.81 (0.03*)	-7.48 (0.00*)	-7.78 (0.00*)	-5.80 (0.00*)	-5.63 (0.00*)	I(1)
3	Un-irrigation	-2.28 (0.18**)	-1.86 (0.64**)	-5.60 (0.00*)	-5.81 (0.00*)	-5.43 (0.00*)	-5.30 (0.00*)	I(1)
4	Annual rainfall	-5.32 (0.00*)	-5.34 (0.00*)	-6.85 (0.00*)	-6.76 (0.00*)	-5.90 (0.00*)	-5.79 (0.00*)	1(0)

Note: Calculated by the Author through Eviews-10 Software

irrigated is 0.251, and the correlation is low because I0.30I < r < I0.70I. The degree of association between Rice and annual rainfallis 0.0.006, which showed a weak correlation.

Table 3 shows the stationary and non-stationary individual variables. The stationary time series data is required to avoid erroneous regression analysis because getting excellent findings and predicting using a non-stationary series is impractical. The Augmented Dickey-Fuller test showed that some variables are stationary at the level and others are stationary at the first difference. The results indicated that Rice is integrated at 1st difference, and the t-statistic value is -10.06 with 0.00 probability value. The irrigation is also stationary at 1st difference with a t-statistic value of -7.48 with a probability value of 0.00. The un-irrigation is integrated at 1st difference with the t-statistic value is -5.60 with a 0.00 probability value. The annual rainfall is stationary at a level with the t-statistic value of -5.32 with a probability value of 0.00. Time series analysis showed that all the variables are integrated into different orders. Thus, no co-integration exists among variables, and we can use the ARDL model.

Bound Test

This econometric technique is employed to identify both short- and long-term causal correlations.

The short-run and long-run coefficient estimates of the ARDL model is many studies as showed by (Kwofie and Ansah, 2018; Reda and Nourhan (2020); Ceesay and Fanneh; 2022).

The critical values of the upper and lower bounds, I(1) and I(0), are shown in the Table 4. The observed F-statistic value is 7.25, which is more than F-Statistics' upper limit. Based on the results, the researcher rejected the null hypothesis and accepted the alternative hypothesis, which explains the long-term relationship between the variables. The bound test for co-integration indicates the long-run association between the variables.

Table 5 shows the results of the long-run ARDL model, which indicate that the co-efficient value of irrigation is significant in the long run. It reflectsa positive association with rice annual growth rate, meaning if one-unit increasesthe rice rate, the irrigation yearly growth rate will likely rise by 3.64 percent. The co-efficient value of un-irrigation is statistically insignificant and positively related to annual rice growth in the long run. In the long run, the reason for insignificant and positive relationships is the lack of modern technology due to the shortage of electricity, and

Table 4. ARDL Bound test analysis of dependent and independent variables

Test Statistics	Value	significance	I(0)	I(1)
F- Statistics	7.25	10%	2.37	3.2
K	3	5%	2.79	3.67
		2.5%	3.15	4.06
		1%	3.65	4.66

Note: Calculated by the Author through Eviews-10 Software

Table 5. Long run ARDL analysis of dependent and independent variables

S. No.	Variable	Coefficient	Std. Error	t-Statistic	Prob.*
1	IRRIGATION	3.643169	1.198249	3.040411	0.0058
2	UN_IRRIGATION	1.770409	0.878775	2.014634	0.0558
3	ANNUAL_RAINFALL	1.061123	1.248426	0.849969	0.4041
4	C	-41907.59	18299.81	-2.290057	0.0315

Note: Calculated by the Author through Eviews-10 Software

most farmers are poor and incapable of purchasing quality seeds. Therefore, there is a positive effect of unirrigation on Rice but insignificant. The coefficient of annual rainfall is statistically insignificant in the long run, but it reveals a positive association with rice annual growth rate. It means that some areas are suitable for rainfall and some area for drought areas.

Table 6 shows that rice production is the most important variable in the long and shortrun. The value of the short-runECM coefficient is -0.42, which is negative and significant. This negative and significant coefficient of error correction model indicates the presence of a long-run causal relationship. The value of short-run ECM indicated the speed of adjustment from equilibrium to disequilibrium. The R^2 is 0.60, revealing 60% variation in Rice (Dependent variable) due to the change in independent variables. It is exactly 60 % in the model, the r square explains that more than 60% is the best model goodness of fit. It is indicated that the above independent variables satisfy the impact of rice production, or that the null hypothesis was rejected and the alternative hypothesis was accepted. Hence, it is proved that rice production is instable.

The results of ECM are shown in Table 6.

Table 6. Short run ARDL analysis of dependent and independent variables

S.No.	Variable	Coefficient	Std. Error	t-Statistic	Prob.
1	D(UN_IRRIGATION)	-0.846412	0.116805	-7.246385	0.0000
2	CointEq(-1)*	-0.420708	0.151722	-2.772885	0.0108
3	R-squared	0.604561	Mean dependent var		137.5000
4	Adjusted R-squared	0.589352	S.D. dependent var		238.3340
5	S.E. of regression	152.7288	Akaike info criterion		12.96395
6	Sum squared resid	606478.1	Schwarz criterion		13.05911
7	Log-likelihood	-179.4954	Hannan-Quinn criter.		12.99304
8	Durbin-Watson stat	2.032598			

Note: Calculated by the Author through Eviews-10 Software

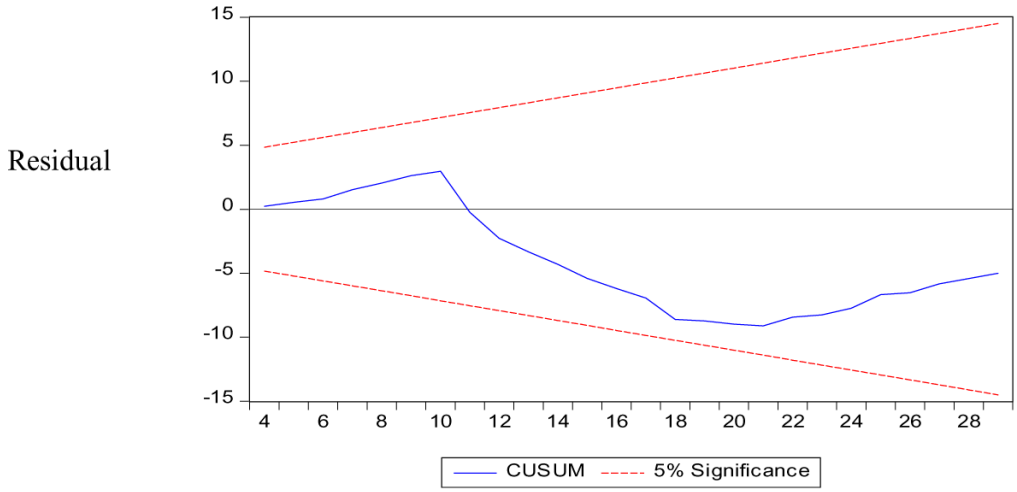

Fig. 1. Cusum Test analysis of dependent and independent variables

STABILITY OF THE MODEL

The cumulative sum of recursive residuals (CUSUM) indicated the stability of the model concerning short-run and long-run relationships between variables. The graph of the cumulative sum of recursive residuals is given above.

In Fig.1, the time series data was plotted on a horizontal axis and residual along the vertical axis to check the stability of the model. CUSUM is used to check the stability and accuracy of the estimated model. Fig. 1 confirms that the estimated model satisfies the stability condition as there is no root lying outside the significance level. Fig. 1 shows that CUSUM is within the range of 5% critical lines. The graph does not cross this critical boundary. Hence, itis concluded that themodel is stable and has a small gap due to the rainfall and unirrigated being insignificant.This correct specification model rejects the null hypothesis at the 5% significance level.

CONCLUSIONS

The results of the ARDL model showed that all the independent variables, including irrigation, un-irrigation, and annual rainfall in the long and short run, are significantly, insignificantly, and positively related to the agricultural production of Uttar Pradesh. The value of R-square in the research indicated that the independent variable substantially influence the dependent variable.It showed that the above independent variables satisfy the impact of rice production, or that the null hypothesis is rejected.The model is the goodness of fit.

Uttar Pradesh is an agricultural state, so agricultural growth is vital forthe economic development in the state. Increased agricultural productivity fulfills not only domestic needs but also creates surplus goods for exports and earns hard-needed foreign exchange. The advancement in the agriculture sector and the better use of land resources are essential for

reducing food scarcity and poverty. Due to modern technology, our research results showed that irrigation's has positive effect and significantly correlated. Un-irrigation is positive and insignificantbecause most farmers are poor and incapable of purchasing quality seeds. Annual rainfall is also positive and insignificant because some areas are drought areas tothe agricultural production ofRice in UttarPradesh.

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PERCEPTION OF RURAL YOUTH TOWARDS FARMING AS AN OCCUPATION IN PUNJAB

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ABSTRACT

The purpose of the research was to study the perception of the 200 rural youth studying in class 10th/11th/12th aged 14-19 years in Punjab state towards farming as an occupation. Economic, socio-cultural, personal, physical and psychological factors were worked out to measure the perception of youth towards farming as an occupation. The findings of the study revealed that nearly three fourth of the respondents (71.5%) perceived that farming was not economically profitable occupation and they were dissatisfied with the income earned from farming. Nearly half of the sample (49%) agreed that other occupations can be undertaken along with farming as farming is seasonal and gives enough time to be involved in other subsidiary occupations. Most of the respondents (91%) agreed that farmers can earn throughout their life as there is no retirement age for farming. Youth (95.5%) also perceived that farming has as a low social status and it was also considered as physically laborious occupation by 97.5 percent of the respondents and most of the youth (98%) viewed that farming is associated with health risks due to exposure to heat, cold, dust and chemicals. However, majority (84%) of the youth believed that hard work in farming kept them healthy. More than three fourth of the sample youth (78.5%) dislike farming and were disinterested. Three fourth of the respondents (75%) were dissatisfied with income from farming as it was insufficient to fulfil their family expenditure.

Key words: Farming, Occupation, Perception, Punjab Agriculture and Rural Youth

INTRODUCTION

Agriculture plays a significant role in the Indian economy as it contributes to 17% of the total GDP and provides livelihood to over 60% of the population (Kant, 2019). The future of Indian agriculture depends largely on the perception of rural youth towards farming as an occupation. It is observed that constraints in farming are on the rise and these constraints could lead farm families to opt for other alternative occupations for living. The rapid growth and diversification of developmental activities have resulted in a much needed expansion of employment opportunities, but, at the same time, has triggered rural -to-urban

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migration. This trend has inadvertently resulted in the shift of farm labour to non farm sectors.

With growing urbanization, better literacy standards and greater skill attainment by rural youth, one of the tremendous threats which India is facing in the field of agriculture is whether the youth belonging to farming families would opt for farming as their future occupation or, owing to growing scope in other areas, would go ahead with diversified occupation. Aspiring farmers, including the farmer's son, are being compelled to go in to divergent employment. Do we ever hear parents saying that their son/daughter will take up agri business? Parents find farming to be a non-prestigious, highly laborious and 24 × 7 type of occupation, the output from which is dependent not only on one's own labour but mostly on nature, government policies, etc. Agriculture in the present scenario appears to be so unattractive to young people and they are turning away from agricultural or rural occupations (White, 2012). In a survey, it was found that less than 10% percent of rural youth were engaged in farming activities whereas about 18.6 percent youth were involved in non farm activities and they were earning higher wages by Rs.50 than the agricultural workers in Ludhiana and Bhatinda districts of Punjab (Leavy and Smith, 2010).

Based on the foregoing analysis, it is critical to comprehend how the youth perceive farming as an occupation particularly in Punjab. Perception is never a result of individual experiences. It is formed through an interaction with the entire environment that one is exposed to and his visualisation of particular situation or event. Hence, a pan Punjab data from different agro - climatic zones from a representative sample of one male child of the family who were studying in either class 10th/ 11^{th} /12^{th} was necessary to understand the perception of rural youth towards farming as an occupation. Keeping this in view, the study was conducted to analyse the factors contributing to perception of school going youth towards farming as an occupation.

MATERIALS AND METHODS

The study was conducted in Punjab state during 2017-2021 covering all the five agro-climatic zones of Punjab. Punjab has 23 districts. Out of these, two districts were selected randomly from each zone, thus, a total of ten districts were selected for the study. From each selected district, one block in which the main city or some other main city is situated and second block far away from the city was selected. Hence, twenty blocks were selected for the study.

A total of 10 farm families actively engaged in farming as their major family occupation were selected from each block through random sampling. Data was collected from one male child studying in class 10^{th} /11^{th} /12^{th}. It was studied using statements prepared for the purpose on a specific scale and responses were obtained from youth studying in class 10/11/12 between 14-19 years of age. The total sample size of the study was 200.

Measurement of the variable perception: It refers to the way in which farming is regarded, understood and interpreted by farm family members as an occupation on economic, socio- cultural, personal, physical and psychological

dimensions. A scale consisting of 19 statements regarding economic factors, 17 to measure socio-cultural factors, 8 for physical, 11 to measure personal factors and 16 for psychological factors was developed. Thus, a total of 71 statements were constructed for the study. The responses for each statement were rated on a five point continuum. Positive statements were assigned score 5 to 1 for strongly agreed to strongly disagreed and negative statements were assigned reverse score from 1 to 5 for strongly agreed to strongly disagreed.

Mean Score: Mean score was calculated by adding score of each statement for each factor on the basis of agreement and disagreement and divided by number of statements. Mean score for each of the factors was also worked out individually. Data was analyzed using frequency, mean and percentages and ranks assigned on the basis of mean score.

RESULTS AND DISCUSSION

Perception of youth towards economic factors associated with farming as an occupation: Data as shown in Table 1 reveals that very large percentage (93.0%) of sample youth agreed that farming was associated with low income and profit making was difficult having mean score of 1.36 contributed mostly in negative perception of youth and only 20% of youth agreed that farming was economically profitable occupation. The reason could be that farm returns have been decreased due to an increase in land rents which was supported by 87.0 percent of youth with lowest mean score of 1.30 and it was most contributing factor in perceiving agriculture in a negative light. The vast majority (90%) of youth responded that diversification in farming can save family expenditure incurred by the family on the purchase of the produce having mean score of 4.13 and it was second most contributing factor in positive perception of children towards economic factors of farming as an occupation. The highest mean score (4.19) was obtained for the fact that farmers can earn throughout his/her life as there was no retirement age in farming. Ramesh and Madhavi (2015) found that agriculture occupation was an economically profitable among farm families as agricultural activities were based completely on family labour which used their children as helpers to provide a non-paid working force. Adejboh *et al.* (2016) also found a negative perception of students towards farming as an occupation due to poor income from farming. Sawant *et al*. (2014) discovered that the majority of the students perceived agriculture as a stepping stone to other occupations, but that the job required enormous capital.

The majority (82%) of children responded that other occupations were more lucrative due to less risk in monetary returns having mean score of 1.48. Kumar *et al.* (2019) discovered that the high risk associated with farming due to dependency on nature followed by the high cost of inputs were the principal economic factors leading to farming families shunning farming. Researcher (Singh, 2015) of Uttar Pradesh also reported that farmers could not fulfil their basic needs only through farm income.

Table 1: Distribution of youth according to their perception towards economic factors of farming as an occupation

(n=200)

S.No.	Statements	SA		A		U		D		SD		Mean	Rank
		f	%	f	%	f	%	f	%	f	%	score	
Physical factors													
1.	Paid labour can be substituted with family labour to earn more profit from farming.	13	6.5	23	11.5	6	3.0	70	35	88.0	44.0	1.97	XI
2.	Farming is associated with low income.	98	49.0	88	44	3	1.5	3	1.5	8.0	4.0	1.72	XIII
3.	Farming is becoming highly mechanized leading to increased cost of investment.	102	51.0	72	36	13	6.5	4	2	9.0	4.5	1.70	XIV
4.	Income from farming is too less in comparison to other occupation.	165	82.5	16	8	4	2.0	8	4	6	3.0	1.36	XVIII
5.	Small farmer's daily income is more in comparisons to labours.	47	23.5	14	7	22	11.0	65	32.5	52	26.0	2.47	VIII
6.	Farmers are not satisfied with their household economic condition.	138	69.0	19	9.5	4	2.0	18	9	21	10.5	1.85	XII
7.	Low income from farming results in farmers committing suicides.	146	73	33	16.5	7	3.5	8	4	6	3	1.49	XVI
8.	It is possible to earn high profit from farming.	57	28.5	25	12.5	4	2.0	23	11.5	91	45.5	2.58	VI
9.	Farmers are not sure about their income from farming till their produce is sold in the Mandis.	140	70	5	2.5	45	22.5	0	0	0	0	1.58	XV
10.	Occupations other than farming are more lucrative.	158	79.0	8	4.0	9	4.5	13	6.5	12	6.0	1.48	XVII
11.	Many other income generating allied activities can be undertaken along with farming.	78	39.0	26	13.0	3	1.5	13	6.5	80	40.0	2.92	V

Table 01 Contd.

Table 01 Contd.

S.No.	Statements	SA		A		U		D		SD		Mean	Rank
		f	%	f	%	f	%	f	%	f	%	score	
Physical factors													
12.	Diversification of crops can help to save expenditure to be incurred by family of purchase of the produce.	89	44.5	91	45.5	7	3.5	5	2.5	8	4.0	4.13	II
13.	Profitability in farming decreases due to inadequate storage facilities.	50	25.0	19	9.5	82	41.0	19	9.5	30	15.0	2.49	VII
14.	Farmer organisation is mandatory for defending farmers' interest in their negotiation with intermediaries.	121	60.5	8	4.0	6	3.0	7	3.5	58	29.0	3.22	III
15.	Returns from farm has decreased due to increase in land rents	109	54.5	65	32.5	6	3.0	7	3.5	13	6.5	1.30	XIX
16.	One can earn throughout his/her life as there is no retirement age in farming.	154	77.0	29	14.5	2	1.0	3	1.5	12	6.0	4.19	I
17.	Engagement in farming leaves abundant time for undertaking subsidiary occupations.	74	37.0	22	11.0	5	2.5	57	28.5	32	16.0	3.18	IV
18.	Agriculture commodities are perishable and its improper storage can cause heavy loss to farmers.	56	28.0	38	19.0	78	39.0	11	5.5	17	8.5	2.35	IX
19.	Farming is economically profitable occupation.	16	8.0	19	9.5	22	11.0	69	34.5	74	37.0	2.21	X

* f= frequency and %= percentage

*SA= Strongly Agree, A= Agree, U=Undecided, D=Disagree and SD= Strongly Disagree

Table 2: Distribution of youth according to their perception towards socio - cultural factors of farming as an occupation

(n=200)

S.No.	Statements	SA		A		U		D		SD		Mean	Rank
		f	%	f	%	f	%	f	%	f	%	score	
Physical factors													
1.	Status of farming stands at lowest ladder as the occupation in the society	181	90.5	10	5.0	2	1.0	6	3.0	0	0	1.33	XVI
2.	Farmers are not considered professionals.	96	48	32	16	14	7.0	52	26.0	6	3.0	1.34	XV
3.	Parents guide their children to leave farming and go to cities in search of other jobs.	47	23.5	121	60.5	3	1.5	13	6.5	16	8.0	1.14	XVII
4.	Farm family desire their children to select high status occupation.	29	14.5	39	19.5	69	34.5	12	6	51	25.5	1.35	XIV
5.	Farming is a status symbol for farmers in Punjab.	169	84.5	27	13.5	5	2.5	0	0	0	0	2.88	VI
6.	Family values and love increases as a result of children working in farming along with their parents and siblings.	67	33.5	78	39.0	33	16.5	12	6	10	5.0	3.63	II
7.	Family members can effectively manage their family responsibilities along with farming.	57	28.5	63	31.5	4	2.0	58	29	18	9.0	3.75	I
8.	Farming help to maintain family and social bonds	132	66	63	31.5	0	0	3	1.5	2	1.0	3.35	IV
9.	High income is possible through farming for maintaining high living standards.	34	17.0	75	37.5	2	1.0	30	15.0	59	29.5	2.76	VII
10.	Farming is done because this has been done by previous generations.	102	51.0	76	38.0	3	1.5	12	6.0	7	3.5	1.91	X

Table 02 Contd.

Table 02 Contd.

S.No.	Statements	SA		A		U		D		SD		Mean	Rank
		f	%	f	%	f	%	f	%	f	%	score	
11.	No one values a farmer in the society.	79	39.5	26	13.0	16	8.0	64	62.0	15	7.5	2.50	VIII
12.	Salaried employment is seen as the more prestigious occupation in comparison to farming.	170	85.0	11	5.5	3	1.5	9	4.5	7	3.5	1.78	XII
13.	Girls do not want to marry a farmer as it means living in a village.	80	40.0	15	7.5	2	1.0	29	14.5	74	37.0	3.03	V
14.	Farmer is not the first choice of girls for a groom due to less income.	141	70.5	27	13.5	4	2.0	6	3.0	22	11.0	2.05	IX
15.	Agriculture land help in finding the good match for children.	121	60.5	8	4.0	6	3.0	7	3.5	58	29.0	3.38	III
16.	Occupations involving physical work are considered low grade	109	54.5	65	32.5	6	3.0	7	3.5	13	6.5	1.75	XI
17.	Younger generation looks down upon physical work.	154	77	29	14.5	2	1.0	3	1.5	12	6.0	1.46	XIII

* f= frequency and %= percentage

*SA= Strongly Agree, A= Agree, U=Undecided, D=Disagree and SD= Strongly Disagree

Socio- cultural factors associated with farming as an occupation: Perception of youth associated with socio-cultural factors is depicted in data as shown in Table 2 reveals that with vast majority (90%) of youth perceived low social status of farming as a occupation having second least (1.33) mean score which contributed to forming a negative perception for socio-cultural aspects of farming as an occupation. Perceptions of students on career prospects in agriculture were poor societal value of farmers (Adejoh *et al.* 2016). Majority of youth (83.5%) stated that were guided by their parents to go for other jobs and it was second most important factors that contributed to negative perception of youth. The vast majority (90%) of youth viewed salaried employment as prestigious than farming and they felt that no one values a farmer in the society having a mean score of 1.78 which lead to negative perception among youth. However, they agreed (65%) that having agriculture land can help to find good match for youth with mean score of 3.83 which was third most important aspect for forming positive perception regarding socio-cultural factors and farming (72.5%) helps to keep the family together (social bonding).

More than half of the respondents (60%) stated that farmers can effectively manage their family responsibilities along with farming having highest mean score (3.75) contributed mostly in forming positive perception towards socio-cultural factors. Nearly three fourth of the youth (72.5%) agreed that farming with parents and siblings can improve social bonding within the family and society as well increases love among the family members obtained second highest mean perception score (3.63) which lead towards positive perception regarding farming as a occupation. Similar results were also reported by Kumar *et al.* (2019) in Gujarat who also found that the majority of farm families expressed that they would like to offer high social status to youth by providing higher education. Lack of family support to continue farming and lack of encouragement from family members also leads to youth avoiding farming as a occupation. Lack of recognition was also an important factor. Widiyanti *et al.* (2019) revealed that the majority of the youth agreed that farming had low social status and some youth with neutral attitudes stated that they would like to continue to work with their parents and manage the land inherited from the parents. Onima *et al.* (2017) in their study on attitude of farmers towards farming as an occupation in Gujarat found that majority (74.28%) of farmers agreed that farmers were least privileged category in the modern society. Bhuva *et al.* (2017) concluded that more than half (52.38%) farmers felt farming stands at lowest ladder as occupation in the society, but at the same time revealed that 53.33 per cent of the farmers were strongly agreed that farming provides freedom to manage work time by self. Few also reported (15%) sense of pride in being a farmer (Sood, 2014).

Perception towards physical factors of farming as an occupation: Data revealed in Table 3 indicates that the most of the respondents (96%) perceived farming to be physically laborious having a mean score of 1.07 contributed mostly in forming negative perception among rural youth and 98.5% percent mentioned health risks due to

Table 3. Distribution of youth according to their perception towards physical factors of farming as an occupation

(n=200)

S.No.	Statements	SA		A		U		D		SD		Mean score	Rank
		f	%	f	%	f	%	f	%	f	%		
Physical factors													
1.	Farming needs hard work	181	90.5	11	5.5	2	1.0	2	1.0	4	2.0	1.07	VIII
2.	Marrying a farmer means physically hard life.	96	48.0	32	16.0	16	8.0	52	26.0	4	2.0	2.32	IV
3.	Hard works in farming keep farmers healthy	47	23.5	121	60.5	3	1.5	13	6.5	16	8.0	3.87	I
4.	Farming do not involve drudgery laden activities anymore.	29	14.5	39	19.5	71	35.5	12	6.0	49	24.5	2.58	III
5.	Farmer is always at risk due to exposure to extreme heat, cold and dust	172	86	25	12.5	2	1.0	0	0	1	0.5	1.17	VII
6.	Farming involves health risk due to the handling of chemicals.	67	33.5	78	39.0	33	16.5	12	6.0	10	5.0	2.31	V
7.	Farming helps to keep one healthy through involvement in physical work	57	28.5	63	31.5	4	2.0	58	29.0	18	9.0	3.37	II
8.	Farming involves a lot of physical work.	132	66.0	63	31.5	2	1.0	2	1.0	1	0.5	1.42	VI

* f= frequency and %= percentage

*SA= Strongly Agree, A= Agree, U=Undecided, D=Disagree and SD= Strongly Disagree

exposure of heat, cold, dust and chemicals with a mean score of 1.17, but the majority (84.0%) of sample youth believed that hard work in farming kept them healthy having the highest mean score of 3.87, which led to the formation of positive perception. Nearly three-fourth (70.00 %) of farmers in Gujarat also strongly agreed that farming involved hard physical work (Bhuva *et al,* 2017).

Perception towards personal factors of farming as an occupation: More than three fourth (78.5%) of youth dislike farming and 91.0 percent were disinterested in farming with a mean score of 1.32 contributing to the formation of a negative perception as shown in Table 4. Agrawal and Agrawal (2017) and (Sood, 2014) reported that the interests of farmers were important in farming and their occupational satisfaction affected their incentive to invest in farming. (Akubari, 2017), Adejoh *et al.,* 2016) and (Jayne, 2010) found that young people were usually not interested in this field of work, in large part due to their perception of farming being antiquated and unprofitable. This can be attirubuted to that the majority of youth were not participating in farming activities along with their parents, so they were unable to feel the pleasure of satisfaction of feeding others. Almost 60.0 percent of sample youth disagreed with the statement that people working in cities can also work in agriculture as a occupation. However, 42.0 percent of youth stated that use of new technologies/practices can help to increase farming income placed at second rank in forming positive perceptions towards personal factors among youth and the vast majority (92.0%) agreed that farmers are their own master and can do their occupation according to their own wishes and timings had the most dominant effect (3.68 mean score) on positively perceiving agriculture.

Data indicated in Table 4 shows that majority (80.0%) youth did not enjoy farming and were uninterested in it. They felt that their parents were forced to do farming due to a lack of other options for livelihood and considered that farming was only for uneducated people. Narain *et al.* (2015) found that about 92.0 per cent of farmers in the Buldelkhand region of Uttar Pradesh were practising farming due to a lack of any other options. The results are in accordance with Prasad *et al.* (2006) in Tamil Nadu and Manoranjitham *et al.* (2010) and Kumar *et al.* (2019) also found that the personal factors had the dominant effect on perceiving agriculture in poor light. Farmers were not interested in farming and were uninterested in bringing youth into the farming occupation. The majority of the farm families were not interested due to work in harsh weather conditions and desired to avoid drudgery-oriented work. Widiyanti *et al.,* (2019) indicated that youth had a positive perception of farming because of the independence factor and authority to manage time and resources in farming and make farming an alternative work choice because the job opportunities and requirements in the formal sector are becoming more and more difficult.

Perception towards psychological factors of farming as an occupation: More than half of the respondents (66.5%) were dissatisfied with income from farming and it was not sufficient to meet their family expenditure. Most of the youth (94.0%) believed that debt had driven farmers to commit suicide. A study was conducted on farmer's suicides at national level (Government of India,

Table 4: Distribution of youth according to their perception towards personal factors of farming as an occupation

(n=200)

S.No.	Statements	SA		A		U		D		SD		Mean score	Rank
		f	%	f	%	f	%	f	%	f	%		
PPersonal factors													
1.	I enjoy farming.	19	9.5	8	4.0	16	8.0	32	16.0	125	62.5	1.98	VI
2.	I have an interest in farming.	7	3.5	8	4.0	3	1.5	29	14.5	153	76.5	1.32	XI
3.	Farming is chosen as an occupation when no other option is available.	172	86.0	3	1.5	2	1.0	8	4.0	15	7.5	1.39	X
4.	Farming is not just an occupation; it is the way of life.	19	9.5	13	6.5	25	12.5	28	14.0	115	57.5	1.91	VII
5.	Farmers enjoy hard work.	19	9.5	8	4.0	6	3.0	32	16	125	62.5	1.90	VIII
6.	There is no master in farming.	79	39.5	105	52.5	4	2.0	2	1.0	8	4.0	3.68	I
7.	Use of new technologies/practices can help to increase income from farming	43	21.5	43	21.5	72	36.0	7	3.5	35	17.5	3.33	II
8.	Farming gives me happiness and satisfaction.	8	4.0	5	2.5	67	13.4	30	15.0	88	44.0	2.39	IV
9.	Farming is for the uneducated people.	143	71.5	3	1.5	2	1.0	9	4.5	43	21.5	1.88	IX
10.	People employed in cities can also do farming for better income as well as for their passion.	45	22.5	16	8.0	21	10.5	35	17.5	83	41.5	2.13	V
11.	Physical work adversely effects the health	56	28.0	24	12.0	11	5.5	35	17.5	74	37.0	3.16	III

* f= frequency and %= percentage

*SA= Strongly Agree, A= Agree, U=Undecided, D=Disagree and SD= Strongly Disagree

Table 5: Distribution of youth according to their perception towards psychological factors of farming as an occupation

(n=200)

S.No.	Statements	SA		A		U		D		SD		Mean	Rank
		f	%	f	%	f	%	f	%	f	%	score	
Psychological factors													
1.	Income from farming is sufficient to fulfil the basic needs of family members.	25	12.5	39	19.5	3	1.5	30	15.0	103	51.5	2.15	V
2.	Farming helps to protect family heritage.	55	27.5	115	57.5	18	9.0	3	1.5	9	4.5	3.93	II
3.	Indebtedness has pushed the farmers for committing suicides.	120	60.0	68	34.0	2	1.0	10	5.0	0	0	1.50	X
4.	Farming as it is the very stressful occupation.	165	82.5	27	13.5	5	2.5	2	1.0	1	0.5	1.21	XII
5.	Farmer has no social status resulting in low self- esteem.	104	52.0	17	8.5	59	29.5	12	6.0	8	4.0	2.18	IV
6.	Psychological stress and depression are very common among farmers.	125	62.5	25	12.5	47	23.5	2	1.0	1	0.5	1.75	VIII
7.	Economic hardship causes stress to farmers	127	63.5	22	11	47	23.5	3	1.5	1	0.5	1.76	VII
8.	Farming is dependent on many factors.	131	65.5	55	27.5	10	5	4	2.0	0	0	1.46	XI
9.	Farmer is his own master.	56	28.0	122	61.0	4	2.0	1	0.5	17	8.5	4.04	I

Table 05 Contd.

Table 05 Contd.

S.No.	Statements	SA		A		U		D		SD		Mean	Ra-
		f	%	f	%	f	%	f	%	f	%	score	nk
10.	Crops are always at risk of pest and disease attack.	180	90.0	16	8.0	4	2.0	0	0	0	0	1.11	XV
11.	Farming has become increasingly risky due to unpredictable weather conditions.	176	88.0	21	10.5	3	1.5	10	5.0	0	0	1.12	XIV
12.	Farmers are committing suicide.	161	80.5	34	17.0	4	2.0	1	0.5	0	0	1.19	XIII
13.	Farmers commit suicide because they cannot satisfy their family needs.	158	79.0	22	11.0	6	3.0	6	3.0	8	4.0	1.57	IX
14.	Farming is a satisfying occupation	19	9.5	14	7.0	10	5	38.0	19	119	59.5	1.93	VI
15.	Farming is satisfying as it helps to feed people	14	7.0	34	17.0	64	32	44.0	22	44	22.0	2.26	III
16.	Fluctuations in farm income makes farming very risky occupation	187	93.5	7	3.5	2	1.0	1	0.5	3	1.5	1.08	XVI

* f= frequency and %= percentage

*SA= Strongly Agree, A= Agree, U=Undecided, D=Disagree and SD= Strongly Disagree

2020) to determine the causes of farmer's suicides identified that indebtedness and farming related issues were the prominent causes among Indian farmers. A very large percentage (96%) perceived farming as a occupation with a lot of uncertainty like fluctuating income and this occupation entirely depends on weather and market price policies and it was a stressful occupation due to economic reasons associated with pests and diseases 2014) had the most dominant effect (1.08 mean score) on negatively perceiving psychological aspect of agriculture as an occupation. Farmer is his own master had the most dominant effect (4.04 mean score) on positively perceiving psychological factors associated with agriculture.

It was found that farming was satisfying occupation for less than 20% of families. The psychological satisfaction can be attributed to independence as the majority of the youth believed that they could be their own master in this occupation. The majority (85%) of youth pointed out that farming helps in protecting our heritage (3.93 mean score), whereas farming was a satisfying occupation (1.93 mean score) for very low percentage (16.5%) of youth and nearly one fourth (24%) of youth derived satisfaction by feeding others through farming with a mean score of 2.26 (Table 5). The findings of Getnet and Asrat (2012) also indicated that farming was difficult and stressful work. Farmers were found to have an increased prevalence of psychological morbidity, depression and levels of anxiety than non-farmers.

CONCLUSIONS

The findings implicated that one can earn throughout his life through farming, but income from farming was too less and fluctuating in comparision to other occupations. The negative aspects of the socio - cultural factors was that parents guide their children to go to cities and search employment. The positive aspects was that family members can effectively manage their family responsibilities along with the farming. Farming was considered as physically laborious by the youth (97.5%). However, they believed that hard work kept them healthy. Youth dislike farming and were disinterested in it and it was considered as a stressful occupation (75%). Perception of youth towards farming as an occupation plays a very important role in determining the future of farming as an occupation and retaining youth in agriculture in India.

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ESTIMATION OF PINEAPPLE PRODUCTION IN MANIPUR - A STATISTICAL APPROACH

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ABSTRACT

The main objective of this paper was to compare the compound growth rate model, exponential smoothing model and ARIMA model on pineapple production in Manipur. Time series secondary data was utilized for this analysis. From the study, it was recorded that the value of R^2 for the compound growth rate model, exponential smoothing model and autoregressive integrated moving average model of production, suggested that out of the total variation 83.2%, 75.4%, and 85.2%, respectively was explained by the independent variable on the pineapple production of Manipur. In 2020 pineapple production in Manipur was 166483 MT and in the years 2021, 2022, 2023, 2024 and 2025 it could be 160403 MT, 181650 MT, 175174 MT, 177148 MT, 176546 MT, respectively based on the fitted ARIMA (1,1,2) model, in which the production fluctuates which might be due to the fluctuation in the past years' data of production.

Keywords: ARIMA, Compound growth rate, Exponential smoothing model, Manipur, Pineapple.

INTRODUCTION

Manipur could be considered as one of the proper regions for the growth of horticulture. It was one of the richest sources of different crops *i.e*. various kinds of fruits, vegetables, spices, medicinal plants, ornamental plants and aromatic plants. Further, there was an acceptable opportunity and possibility for pineapple cultivation in the hills area of Manipur. Pineapple has the second largest production next to rice. It was one of the most popular tropical fruit which was largely produced in Manipur due to the suitable agro-climatic conditions. The pineapple varieties extensively planted in Manipur are 'Kew' and 'Queen'. Manipur was one of the leading pineapple-producing states in the northeastern states of India. Senapati was the largest pineapple-producing district in Manipur producing 29067MT with an area of 3724 ha under pineapple cultivation in 2018-19 (Government of Manipur, 2014). Economically the fruits had also become the backbone of a sizeable section of farmers who had been cultivating them as their major source of income (Chanu *et al.,* 2014).To promote the healthy growth of horticulture, it was essential to develop horticulture marketing and improve the transport system as the present low level of horticulture

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production was due to its perishable nature coupled with improper marketing facilities. Pineapple was one of the largest produced horticulture crops and it was the firmness of an enormous section of farmers as their major cause of income. It was essential to develop the horticultural market for the promotion of healthy growth of horticulture in Manipur. Hence, it was imperative to discuss the growth of the pineapple to facilitate the state to draw up convenient policies and upgrade production. The main objective of this study conducted in January 2021 for one year was to compare the compound growth rate model, exponential smoothing model and autoregressive integrated moving average (ARIMA) model of pineapple production in this region.

MATERIALS AND METHODS

In this study, time series secondary data of pineapple production for the period 1994 to 2020 collected from the Horticulture department, Economics and Statistics Department, Manipur, Government of Manipur and related institutions were used, to fit the model. This study was conducted in January 2021 for one year. For data analysis, the Compound growth rate model, exponential smoothing model and autoregressive integrated moving average **(**ARIMA) models were fitted by using the least square estimation method.

THE MODELS

Compound growth rate model

The model for calculating the compound growth rate was given below:

$$Y_t = Y_0(1+r)^t$$

Where, Y_t= production at time t, Y_0= constant (base year production), t= time periods in years and r= compound growth rate

In order to analyze easily by taking logarithm on both sides, we get

$$LnY_t = LnY_0 + t\ Ln(1+r)$$

$LnY_t = A+Bt$, $A = LnY_0$, $B = Ln(1+r)$ and B=regression coefficient

Compound growth rate (%) = (Antilog B-1)*100

Exponential smoothing model

Exponential Smoothening model is one of the most popular forecasting methods that we have used to predict the immediate future from time series data (Sharma *et al.,* 2015). Exponential smoothing method of prediction uses the weighted average of past observations to predict upcoming values (Shastri *et al.,* 2018).

The weighted average till the current period t for n observations Y_t, Y_{t-1}, ... $Y_{t-(n-1)}$ is

$$S_t = \frac{1*Y_t+(1-\alpha)Y_{t-1}+(1-\alpha)^2Y_{t-2}.....+(1-\alpha)^{n-1}Y_{t-(n-1)}}{1+(1-\alpha)+(1-\alpha)^2+\cdots+(1-\alpha)^{n-1}}$$

$$S_{t+1} = \frac{1*Y_{t+1}+(1-\alpha)Y_t+(1-\alpha)^2Y_{t-1}.....+(1-\alpha)^{n-1}Y_{t-(n-2)}}{1+(1-\alpha)+(1-\alpha)^2+\cdots+(1-\alpha)^{n-1}}$$

The simplest form of exponential smoothing is given by the formula

$$S_{t+1} = \acute{a}Y_t + (1-\acute{a})S_t$$

in which, S_{t+1}= Forecast value at the time t+1, S_t= Current forecast value, á = Smoothing factor (0< á<1), Y_t= Actual value at time t.

The best value of á can be chosen based on the criteria which can give the smallest mean square error. The speed at which the older responses were dampened (smoothed) was a function of the value of á. When á was close to 1, dampening was quick and when á was close to 0, dampening was slow.

The ARIMA Model

ARIMA is one of the classical time series models of non-stationary time series analysis. ARIMA model allows for an explanation by its past or lagged values and stochastic error terms (Vijay and Mishra, 2018). ARIMA (p,d,q) model is defined as

$$\varphi(B)\nabla^{d}X_{t} = \theta(B)U_{t}$$

in which, B is the backward shift operator defined by

$$B^{m}X_{t} = X_{t-m} \qquad (m = 0,1,2,3,\dots,p)$$

$\varphi(B)$ is the autoregressive operator of order "p" defined by

$$\varphi(B) = 1 - \varphi_1 B^1 - \varphi_2 B^2 - \cdots - \varphi_p B^p$$

∇ is the backward difference operator defined by

$$\nabla X_t = X_t - X_{t-1} = (1 - B)X_t$$

∇^{d} means the d^{th} difference operator of the series values X_t

$\theta(B)$ is the moving average operator of order "q" defined by

$$\theta(B) = 1 - \theta_1 B^1 - \theta_2 B^2 - \cdots - \theta_q B^q$$

is the white noise process having a normal probability distribution with mean zero and variance σ_u^2

An ARIMA(p,1,q) model (Hossian and Abdulla, 2015) is given by

$$\varphi(B)\nabla X_{t} = \theta(B)U_{t}$$

$$i.e. W_t = \varphi_1 W_{t-1} + \varphi_2 W_{t-2} + \cdots + \varphi_p W_{t-p} + U_t - \theta_1 U_{t-1} - \theta_2 U_{t-2} - \cdots - \theta_q U_{t-q}$$

$$where, W_t = X_t - X_{t-1}$$

There are four stages in the ARIMA process.

1) Identification: The input series for ARIMA needs to be stationary, that is, it should have a constant mean, variance, and autocorrelation through time. Therefore, usually, the series first needs to be differenced until it is stationary (Chitra *et al.,* 2015). The stationarity of the series was obtained by taking first-order differences. After obtaining the stationarity of the series the order of p and q were identified from the corellelogram of the autocorrelation function (ACF) and partial autocorrelation function (PACF), respectively.

2) Estimation of parameter: Least square estimation is used for estimating the parameter.

3) Diagnostic checking: For diagnostics checking about the assumption of the model, techniques like Box-Ljung statistics (autocorrelation test), autocorrelation function and partial autocorrelation function of the residual (test for goodness of fit) were used. The criteria for having the lowest Akaike's Information Criteria (AIC) or Bayesian Information Criteria (BIC) were to be satisfied.

Box-Ljung test:

It was used to test the autocorrelation among the residuals. The residuals should not be correlated and the correlation should be small if the models fit well. Box-Ljung statistic Q for a time series Y of length n is given as

$$Q(m) = n(n+2)\sum_{j=1}^{m}\frac{r_j^2}{n-j}$$

Where,

r_j = the accumulated sample autocorrelations

m= the time lag

We reject the null hypothesis H_0 that our model doesn't show a lack of fit and accept the alternative hypothesis H_1 that the model shows a lack of fit if

$$Q > \chi^2_{1-\alpha,}$$

Where, = the value found on the chi-square distribution table for significance level á and h degree of freedom.

When the Box-Ljung test was applied to the residuals of an ARIMA model, the degrees of freedom h must be equal to m-p-q, where p and q are the numbers of parameters in the ARIMA(p,q) model.

4) Forecasting: The model that satisfies all the diagnostic checks were considered for forecasting (Panasa *et al.,* 2017).To analyse the data, SPSS software package version 23 was used.

RESULTS AND DISCUSSION

Compound growth rate model

Analysis of the data showed that the regression coefficient of the production was significant at 5% level of significance as shown in Table 1.

Table 2 showed that the compound growth rate was 3.6% and the value of R^2 was 0.832 which means that 83.2% of the variation could be explained by the independent variable. It indicates that pineapple production has a growth rate the extent of 3.6% and it was statistically significant. The findings of the study were in line with the previous research by Singh *et al.* (2016) who reported that the production of pineapple in Manipur has a significant positive growth rate.

Exponential smoothing model

Table 3 shows that the value of the smoothing factor *i.e*. alpha (á) was found to be 0.592 and it was performing the best for pineapple production with the minimum mean square error value.

Table 4 shows that for the fitted exponential smoothing model of pineapple production, the value of R^2 was 0.754 which means that 75.4% of the variation can be explained by the

Table 1. Estimated regression parameters of pineapple production for the period 1994-2020

Crop	Aspect		Value	t value	Sig.
Pineapple	Production	**Constant**	56661.566**	19.639	.000
		Coefficient(B)	1.036**	314.631	.000

**** indicates significant at 0.05 level of significance**

Table 2. Model summary for the fitted compound growth rate model

Crop	Aspect	CGR (%)	R	R^2	SE
Pineapple	Production	3.6**	0.912	0.832	0.129

**** indicates significant at 0.05 level of significance**

Table 3. Exponential smoothing model of pineapple production for the period 1994 to 2020

Crop	Aspect	á estimate	SE	t value	Sig.
1) Pineapple	Production	0.592**	0.201	2.952	0.007

**** indicates significant at 0.05 level of significance**

Table 4. Summary of statistics of fitted exponential smoothing models

Crop	Aspect	Fit statistics						
		R^2	RMSE	MAPE	MAE	Normalized BIC	Ljung-Box Statistics	
							Statistics	Sig.
Pineapple	Production	0.754	15167.570	10.803	10907.692	19.376	22.342	0.172

independent variable. From the Box Ljung test, it was found that the p-value = 0.172 which strongly suggests that there was no autocorrelation among the residuals of the fitted model for the pineapple production at 5% level of significance. Therefore, this model was recommended for the future forecast. By using an exponential smoothing model forecast was done, the actual and forecasted values of pineapple production were depicted in Fig 1.

Autoregressive integrated moving average (ARIMA) Model

For forecasting pineapple production, the stationarity of the series was checked by examining the graph or the time plot of the data. From this test, the time sequence of production was found to be non-stationary. For achieving the stationarity of the series, differenced of order 1 was sufficient. The graphical representation of the original series in Fig 2 clearly indicates

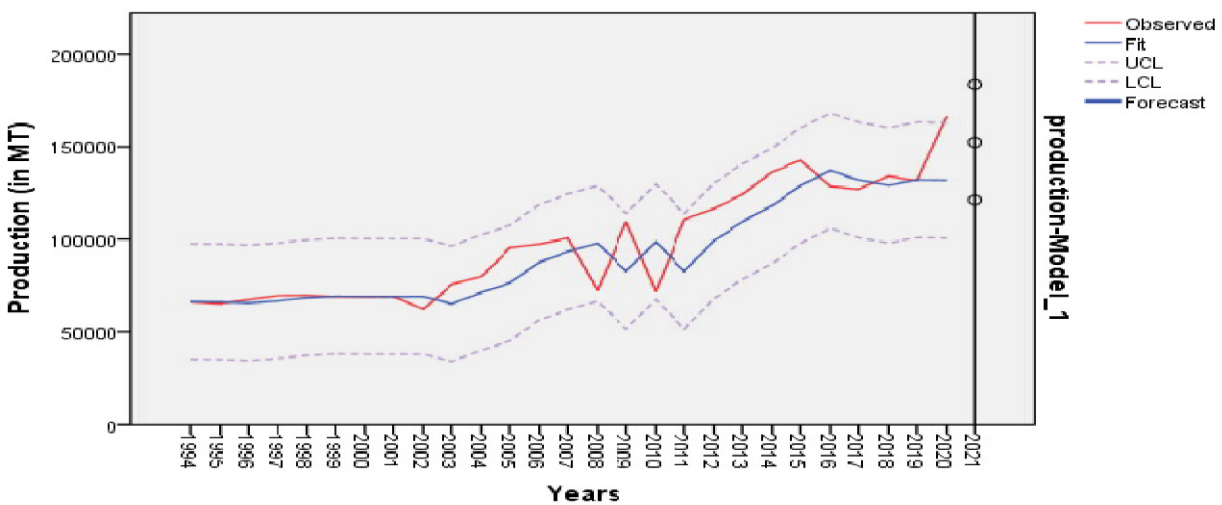

Fig.1. Forecasting of pineapple production by exponential smoothing model

Fig.2. Graphical representation of the original series of pineapple production

Table 5. Autocorrelation function and partial autocorrelation function of differenced data of pineapple production.

	Production				
Lag	**Auto correlation function**	**Partial Auto correlation function**	**Lag**	**Auto correlation function**	**Partial Auto correlation function**
Lag 1	-.565	-.565	Lag 9	.219	.167
Lag 2	.383	.095	Lag 10	-.225	.172
Lag 3	-.224	.038	Lag 11	.152	.067
Lag 4	-.053	-.284	Lag 12	-.167	-.066
Lag 5	-.204	-.511	Lag 13	-.026	.014
Lag 6	.235	.041	Lag 14	-.030	.092
Lag 7	-.121	.294	Lag 15	.085	-.105
Lag 8	.124	-.127	Lag 16	-.030	-.051

that the original production series doesn't shows constant variance. In this case, the series obtain stationary after the first order difference.

Table 5 shows the autocorrelation function (ACF) and partial autocorrelation function (PACF) of pineapple production. Looking at the

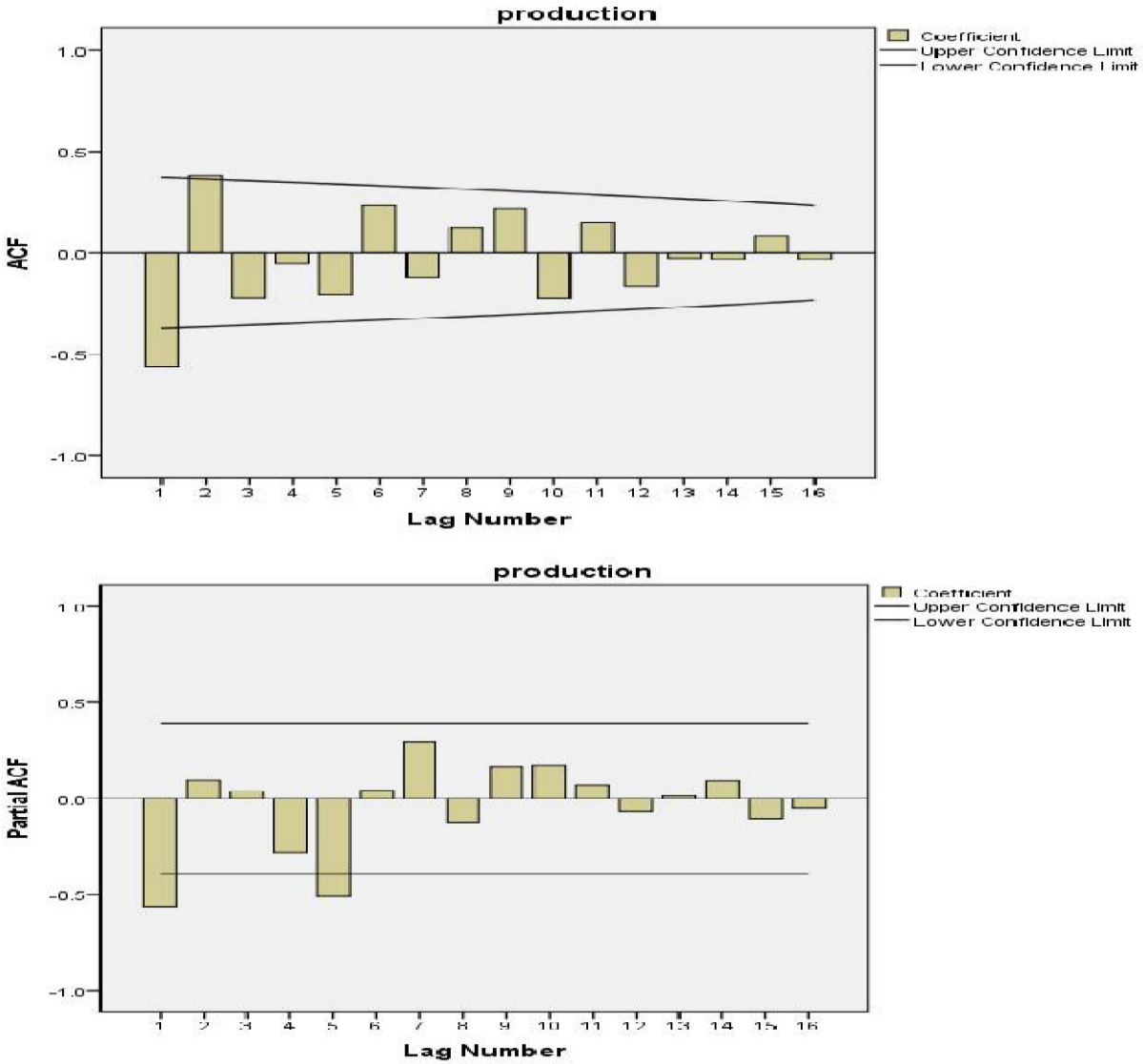

Fig.3. Graphical representations of ACF and PACF of differenced data of Pineapple production

correlogram of the ACF and PACF of differenced series of production as shown in Fig. 3, the value of the parameters p and q were determined and estimated.

Having the lowest value of AIC and Normalized BIC, ARIMA(1,1,2) for the production of pineapple as shown in Table 6 was found to be the most suitable model. From the Ljung-Box test, it was found that the p-value was 0.411 which strongly suggests that there was no autocorrelation among the residuals of the fitted ARIMA(1,1,2) model for production at 5% level of significance. The parameter estimates of the fitted ARIMA(1,1,2) for production was shown in Table 7. Therefore, this model was recommended for the future forecast.

Table 8 shows the ACF and PACF of residual of the fitted ARIMA model of pineapple production.

Table 6. Summary of statistics of fitted ARIMA models

Crop	Aspect	Model	Fit statistics								
			Stationary R^2	R^2	RMSE	MAPE	MAE	Normalized BIC	AIC	Ljung-box statistics	
										Statistics	Sig.
Pineapple	Production	ARIMA (1,1,2)	0.509	0.852	12230.624	8.209	8187.507	19.199	570.51	15.578	0.411

Table 7. Parameters of fitted ARIMA model for pineapple production

Sl. no.	Coefficients	Estimates	Std. Error	t-value	p-value
1)	AR(1)	-0.305	0.239	-1.274	0.215
2)	MA(1)	0.084	0.275	0.306	0.762
3)	MA(2)	-0.995	5.455	-0.182	0.857

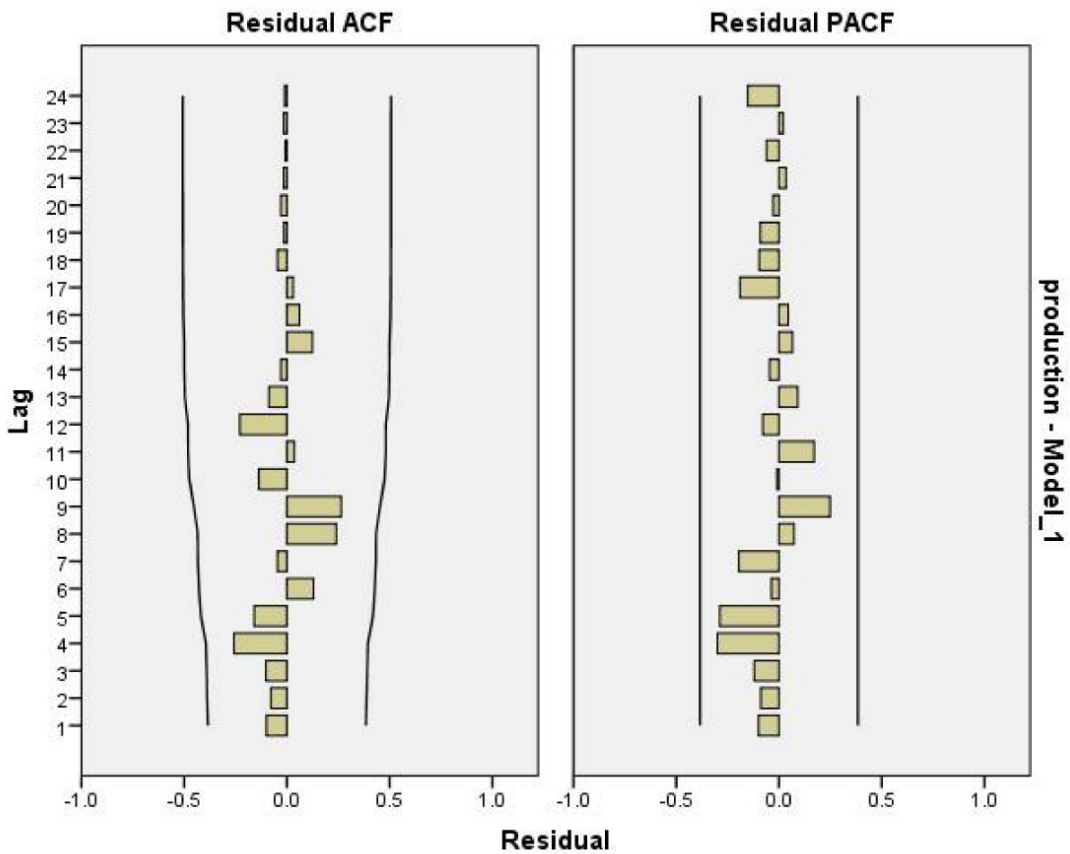

Fig.4. ACF and PACF of residual of the fitted ARIMA model of pineapple production

Table 8. ACF and PACF of residual of the fitted ARIMA model of pineapple production

	PRODUCTION								
Lag	**ACF**	**SE**	**PACF**	**SE**	**Lag**	**ACF**	**SE**	**PACF**	**SE**
1	-.099	.196	-.099	.196	13	-.088	.254	.091	.196
2	-.078	.198	-.089	.196	14	-.029	.255	-.045	.196
3	-.102	.199	-.121	.196	15	.124	.255	.066	.196
4	-.258	.201	-.300	.196	16	.061	.257	.046	.196
5	-.158	.214	-.288	.196	17	.031	.258	-.190	.196
6	.129	.218	-.037	.196	18	-.046	.258	-.096	.196
7	-.045	.221	-.195	.196	19	-.014	.258	-.090	.196
8	.240	.221	.073	.196	20	-.029	.258	-.028	.196
9	.264	.231	.249	.196	21	-.016	.259	.035	.196
10	-.137	.242	-.010	.196	22	-.008	.259	-.060	.196
11	.037	.245	.172	.196	23	-.015	.259	.021	.196
12	-.229	.246	-.078	.196	24	-.012	.259	-.152	.196

It was further confirmed that the fitted model was good and quite satisfactory to the given data as the ACF and PACF of residual of the fitted ARIMA model for the production were flat as shown in Fig. 4 *i.e*., in the correlogram of the residuals, all the lags lies within the confidence limit. Therefore, considering all the graphical and formal tests, it was found that the model ARIMA(1,1,2) was the best-fitted model to forecast pineapple production in Manipur. According to Hossian and Abdulla (2015), ARIMA(0,2,1) model is the best-fitted model and adequately used to forecast Pineapple production in Bangladesh since graphical representations of the residuals for the fitted ARIMA(0,2,1) model suggested that there was no significant pattern and hence there is no autocorrelation among the residuals.

Table 9. Future forecasted production of pineapple predicted by ARIMA models

Sl. No.	**Year**	**Future prediction for pineapple**
		Forecasted value for production(in MT)
1)	2021	160403
2)	2022	181650
3)	2023	175174
4)	2024	177148
5)	2025	176546

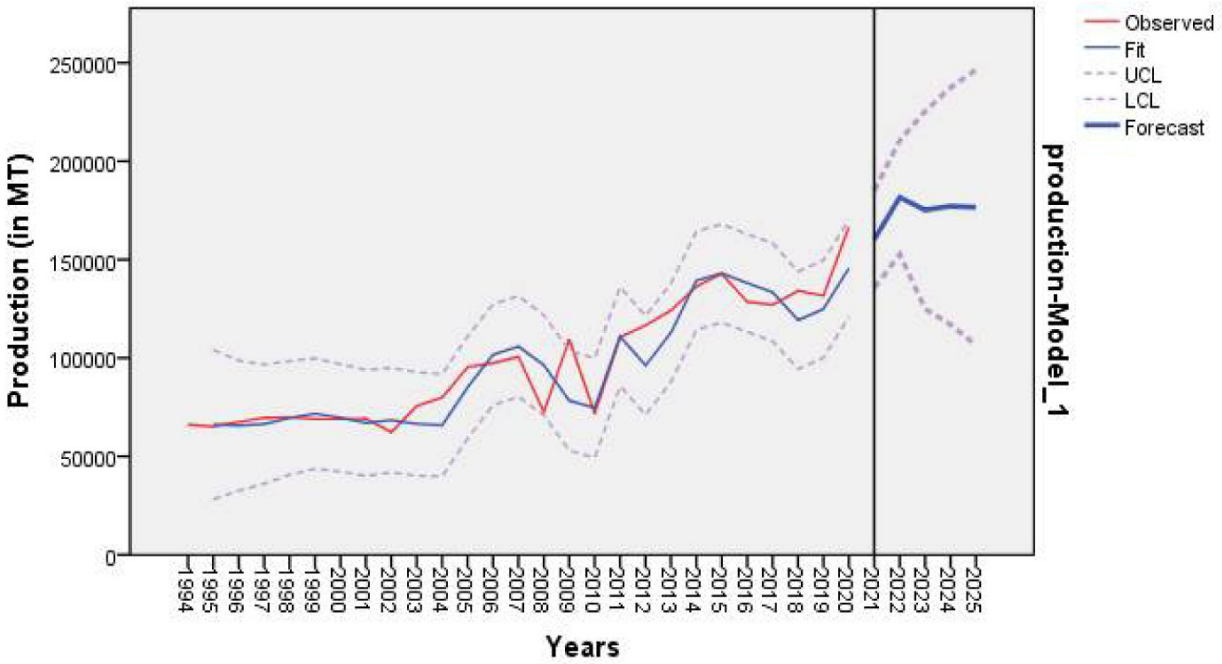

Fig.5. Graphical representation of original and forecasted pineapple production

Forecast data for pineapple production for the years 2021, 2022, 2023, 2024 and 2025 were shown in Table 9. The graphical representation of the observed and predicted value for pineapple production was shown in Fig 5.

Table 10 shows the comparison of the compound growth rate model, exponential smoothing model and ARIMA model. It revealed that the ARIMA model was good compared to the compound growth rate model and exponential smoothing model since it has the highest R^2 value compared with the compound growth rate model and exponential smoothing model.

CONCLUSIONS

It was reported that the compound growth rate model explained 83.2%, of the total variation in pineapple production by the independent variable which was considered, whereas 75.4%, of the production of variation, was explained by the exponential smoothing model. Similarly, 85.2%, of the production of variation was explained by the ARIMA model. Therefore, in this case, ARIMA (1,1,2) model was found as a good

Table 10. Comparision of R^2 value for Compound growth rate model, exponential smoothing model and ARIMA model

Particular	R^2 value		
	Compound growth rate model	Exponential smoothing model	ARIMA (1,1,2) model
1) Production	0.832	0.754	0.852

model compared to the compound growth rate model and exponential smoothing model since it has the highest R^2 value. Based on the fitted ARIMA (1,1,2) model the forecasted value of pineapple production in Manipur in the years 2021, 2022, 2023, 2024 and 2025 were 160403 MT, 181650 MT, 175174 MT, 177148 MT and 176546 MT, respectively, in which the production fluctuates which might be due to the fluctuation in the past years data of production.

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Research Note
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CRITICAL ANALYSIS OF VALUE CHAIN: A CASE OF MANGO PROCESSING VARIETIES IN CHITTOOR DISTRICT OF ANDHRA PRADESH

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In India, Andhra Pradesh leads in the area under mango with 14.72%, while Uttar Pradesh leads in production of mango with 23.47% with highest productivity, followed by Andhra Pradesh with 22.63% i.e., 4.6 million tonnes, and then Karnataka, Bihar, Gujarat, Tamil Nadu, Odisha, West Bengal, Jharkhand, and Maharashtra. In Andhra Pradesh, Chittoor district contributes production of 15.5 lakh tonnes covering 1.12 lakh ha.Of these 26000 ha have table variety mango trees such as Benishan (Banginapalle), Neelum, Dashehari, Kesar, Himayath etc. While 86000 ha have the Totapuri mango variety, which is mainly used by the industry to make pulp. The industry is concentrated in Chittoor district and is a main hub for the export of mango pulp to different nations. (APEDA, 2022).Value chain refers to "the set of actors (private, public, and service providers) and the sequence of value-adding activities involved in moving a product from production to the final consumer," in agriculture they can be thought as is a "farm to fork" set of processes and flows. Farmers, input suppliers, private traders, processors, exporters, and consumers are all a part of mango value chain. (Nandika and Jayasree, 2017). As a result, the following objectives were set for the research:to identify major actors and their roles, and major constraints faced by them in value chain of mango, and mapping and analysing the agri value chains for major mango varieties grown in Chittoor (Rekha Priyadarshini, 2015).

The Chittoor district was purposively selected for the analysis, as it occupies first place in Andhra Pradesh's Mango production. Based on highest mango production areas in the district, two mandals and two villages from each mandal were selected for the study. A total of 40 mango growing farmers from the four villages, five input suppliers, five pre-harvest contractors, five traders, five wholesalers, five retailers, five exporters, five mango processors, five consumers were selected from the district. The required data was gathered using the survey methods with the help of a pre-tested schedule for 2021-22.

Through a primary survey, information about mango value chains, their costs and margins, marketingand value addition facilities,

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and constraints faced by various stakeholders was collected. The data was analysed to accomplish specific objectives by using the value chain mapping technique, price spread analysis, Acharya's approach for marketing efficiency and Garrett ranking technique.

Costs and returns in Mango cultivation

As per the findings of the study, the only production costs borne by farmers in mango farming were the mango orchard maintenance costs.

Value Chain Mapping and the Value Chain Analysis of Mango: The mapping of mango value chain in Chittoor considers the core value chain functions, actors, and product flows. The value chain's core functions or processes included mango production, primary movement of produce, processing, and secondary movement of products to final consumers. Input suppliers, producers, pre-harvest contractors, traders, institutional buyers, processors, exporters, wholesalers, retailers, and final consumers were among the various value chain actors.

Value chain 1: (Farmers – APMC trader – Processor – Domestic/International buyers)**.** While selling produce in the APMC market, the farmers were facing weightage loss and commission charges each 5% and receiving a net price of Rs. 16490 per ton (Table 3). The APMC trader overlooks the loading/unloading, grading/sorting and auctions in the market yards and were selling the produce to the

Table 1. The average of total costs incurred by farmers for raising orchard

S. No	Particulars	Average costs/acre (Rs)	Percent
1	Manuring	1230	10.23
2	Fertilizers	1760	14.64
3	Irrigation	2580	21.47
4	Inter Cultivation	1220	10.15
5	Plant Protection	2755	22.92
6	Land Tax	50	0.41
7	Labour	2420	20.14
8	Miscellaneous	0	0
9	Total Cost	12015	100

Table 2. Yields and returns of major varieties grown in Chittoor district

S.No.	Particulars	Totapuri	Benishan	Neelum
1	Yield in tonnes / acre	2.44	2.85	2.18
2	Price / ton (Rs.)	21,100	30,080	36,680
3	Gross returns / acre (Rs.)	51484	85728	72962
4	Net returns / acre (Rs.)	39,469	73,713	60,947

processors while putting the margin of 6 per cent of consumer's price. The processors play a major role of value addition to the mango, changing the form of mango fruit into the mango pulp, and distributes the mango pulp to the domestic or international buyers. Generally, 25% of pulp was domestically marketed and remaining 75% was exported to other countries. The processors margin constitutes 19.76% in terms of domestic sales and it is around 20-25% more than domestic market in terms of international markets. The producer's share was 38.8% of the consumer's price in this value chain.(Grant Thornton, 2019)

Value chain 2: (Farmers – Village level trader – Processor – Domestic/International buyer).While selling the produce to the village level traders, farmers pay no commission, instead village level traders after aggregating the produce from the respective village farmers, bears the weightage losses while selling the produce to the processors. The village level traders put the net margins of about 3.5% of the consumer's purchasing price. The processors play a major role of value addition to the mango and distributes the mango pulp to the domestic or international buyers. The processors margin constitutes approximately 20%. The producer's share was 43.76% of the consumer's price in this value chain. (Kumari *et al*., 2018)

Value chain 3: (Farmers – Pre harvest contractors – APMC trader – Processor – Domestic/International buyer).The farmers sold their mango orchards to pre – harvest contractors for an agreed upon price which is around 23.53% of the consumer's purchasing price. Farmers does not involve in marketing of the produce. The PHCs bear all maintenance costs and marketing costs while marketing the produce in APMC market. PHCs margin was found to be 4.7%.Then the produce flows through the hands of APMC traders to the processors where major value addition takes place. The producer's share was 23.53% of the consumer's price in this value chain.

The price spread for the three value chains 1, 2 and 3 were Rs.26010, Rs.23900, Rs. 32500, respectively. Less the difference between price paid by the consumer and net price received by the producer, more the efficiency of the chain. Therefore, among the three value chains, the value chain 2 is said to be more efficient due to the lesser price spread. The producer's share in consumer's rupee was found to be 38.8%, 43.76%, 23.53% in value chains 1, 2 and 3, respectively. In the chain 2, the producer's share in consumer's rupee was highest hence said to be more efficient (Rangegowda*et al*., 2016).If the value-added costs and margins in a chain are low, then that chain is considered as chain with highest marketing efficiency. Therefore, in this scenario, the value chain 2 is said to have the high market efficiency. Finally, the VC2 where farmers were selling their produce to village level traders were gaining high producer's share, making this chain highly efficient.(MusabhirMehdhi*et al*., 2016). The constraints faced by farmers were undesirable climatic conditions, leading to lower yields, high input costs, high market commissions and less access to marketing information. (Saripalle and Madhuri, 2019). The traders faced the

Table 3. Marketing costs, margins, price spread, producer's share and marketing efficiency of processed variety mango

PROCESSING VARIETY		Value chain 1		Value chain 2		Value chain 3	
S. No	**Actor**	**Costs per ton (Rs.)**	**% in CP**	**Costs per ton (Rs.)**	**% in CP**	**Costs per ton (Rs.)**	**% in CP**
1	FARMER						
	Producer's Sale price	21,100	49.65	21100	49.65	10000	23.53
	Total MC	4610	10.85	2500	5.88	0	0.00
	Producer's net price	16490	38.80	18600	43.76	10000	23.53
2	PRE-HARVEST CONTRACTOR						
	Purchasing price					10000	38.31
	Total MC					9100	21.41
	Margin					2000	4.71
	Sale price					21000	49.41
3	VILLAGE LEVEL TRADER						
	Purchasing price			21,100	49.65		
	Total MC			3100.00	7.29		
	Margin			1500.00	3.53		
	Sale price			25700.00	60.47		
4	APMC TRADER						
	Purchasing price	21100	49.65			21100	49.65
	Total MC	2450	5.76			2450	5.76
	Margin	2550	6.00			2550	6.00
	Sale price	26100	61.41			26100	61.41
5	PROCESSOR						
	Purchasing price	26100	61.41	25700	60.47	26100	61.41
	Total MC	8000	18.82	8000	18.82	8000	18.82
	Margin	8400	19.76	8800.00	20.71	8400	19.76
	*Domestic sale price	42500	100	42500	100	42500	100
	*Internation al price	55250		55250		55250	
	PS	**26,010**		**23,900**		**32,500**	
	P's S	**38.8**		**43.76**		**23.53**	
	ME	**0.388**		**0.78**		**0.31**	

PS – Price spread P's S – Producer's share ME – Marketing efficiency

MC – Marketing costs CP – Consumer's price

problems such as price fluctuations, limited supply due to lower yields and high competition from institutional buyers. (Kumar *et al*., 2019 and Saroj *et al*., 2021). And the constraints faced by processors were high working capital requirements for the purchase of raw material.

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Research Note
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AWARENESS OF FARMERS TOWARDS RYTHU BHAROSA KENDRAS(RBKs) PRODUCTS AND SERVICES IN PRAKASAM DISTRICT OF ANDHRA PRADESH

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Andhra Pradesh is referred to as India's rice bowl and is one of the major agricultural states in India. The Gross Value Added (GVA) registered is 18.8 percent in the year 2021-22.While agriculture and allied sectors reported a growth rate of 14.50 percent, agriculture alone witnessed a 6.30 percent growth rate. With the increase in the population, the demand for agricultural products has increased day by day (Times of India,2022).

The Andhra Pradesh government launched Rythu Bharosa Kendras (RBK) for the farmers as one-stop solution for all agriculture and allied firms' products and services on May 30, 2020(Government of Andhra Pradesh 2020). The RBK concept is one of the six initiatives that were nominated by the center for the UN awards (New Indian Express,2022). Officials from the Department of Agriculture have proposed the establishment of a total of 5,531 godowns, cold storage and collection centres (News Minute,2022). RBKs are a one-stop solution for all farm needs at the village level only. These RBKs are monitored jointly by the Department of Agriculture, Horticulture, AP Seeds, Sericulture, Fisheries, and Animal husbandry. The newly formed RBKs have digital kiosks and apps to assist the farmers in buying the Agri inputs like seeds, fertilizers, pesticides, livestock feeds, and veterinary medicine and the staff will deliver the product at an accurate time for the market price. The success of RBKs depends upon the knowledge of farmers on services provided through RBKs and the attitude of farmers toward the functioning of RBKs. In this context, it is necessary to study the performance of RBKs in terms of the effectiveness of RBK services as perceived by farmers.

The study was conducted to analyse farmer's awareness towards products and services offered by Rythu Bharosa Kendras (RBKs),mainly in the Prakasam district of Andhra Pradesh.Theobjective is to study the awareness of farmers towards Rythu Bharosa Kendras (RBKs) products and services in the Prakasam district of Andhra Pradesh.

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MATERIALS AND METHODS

The study was conducted in Prakasam district of Andhra Pradesh during the second quarter of 2022-23. Out of thirteen mandals in the Markapur revenue division of Prakasam district, two mandals were selected randomly namely Giddalur and Komarolu for the study. Three villages were selected purposively from each mandal that had highest number of farmers. The villages selected from the Giddalur Mandal were Munlapadu, Yellupalli and Ambavaram and from Komarolu Mandal were Balireddypalle, Pursohampalle and Thatireddypalle. A total of six villages having RBKs were purposively chosen for the study. Twenty beneficiary farmers were randomly selected from each of the RBKs of that particular village for the survey thus making the totalsamplesize120 farmers.

Farmers Awareness towards RBKs Products and Services

The awareness of sample farmers towards Rythu Bharosa Kendras products and services was measured by a schedule that comprises twodimensions namely unaware and aware. The response of the respondents was taken on a two-point continuum namely unaware and aware.The scores given for the statements were '1'and '0' for 'aware' and 'unaware' respectively.

The awareness score of the respondents was then classified into 3 categories based on mean and standard deviation as shown below:

S. No	Category	Score
1.	Low level	Below mean- S.D
2.	Medium level	Between mean ±S.D
3.	High level	Above mean +S.D

Awareness is the ability to directly know and perceive or be conscious of events, objects, thoughts or sensory patterns**.** The study objective was operationalized as farmers' awareness level about products and services offered by Rythu Bharosa Kandra's (RBK). Inorder to measure this variable, the farmers were questioned about their awareness of RBK goods and services. As a result, the farmers' feedback was noted as yes with a score of "1" and no with a "0". The farmers were grouped into three categories namely low, medium and high based on mean and S.D.

A scale was developed to assess farmer's awareness towards Rythu Bharosa Kendras products and services. The scale contained 16 statements about RBKs, covering all aspects of products and services offered by RBKs. The respondents were classified into three groups based on their total score: "low", "medium" and "high" with a mean (11.56) and standard deviation (1.679) serving as a check to measure.Table 1 showed that, overall sample farmers had 82 per cent medium level of awareness towards Rythu Bharosa Kendras while 10 per cent of the sample farmers had a high level of awareness and the remaining 8 per cent of the farmers had a low level of awareness towards RBKs products and services. These findings were supported by the findings of Bunker (2018), Babu (2019) and Kumbalep (2018). The reasons might be due to the fact that the RBKs are publicized by the Govt. of. A.P. through various channels of information and the Govt. of India also appreciated the RBK model of A.P. for dissemination of information and other services at the doorstep of the villages.

Table 1.Level of awareness of the RBK scheme by the sample farmers (n=120)

S.No	Level of awareness	Frequency	Percentage (%)
1	Low awareness (<9.88)	10	8%
2	Medium awareness (9.88-13.23)	98	82%
3	High awareness (>13.23)	12	10%
	Total	120	100.00
		MEAN =11.56	**SD =1.679**

Table 2. Farmer's awareness of Rythu Bharosa Kendras products and services (n=120)

S.No	Awareness about RBK	Farmers		Total score	Mean score	Rank
		Unaware NR	Aware NR			
1	RBK is a one-stop solution for agriculture and allied activities	0	120	120	1	I
2	RBK also supplies Agri inputs to the farmers (seeds, fertilizers etc.)	11	109	109	0.91	II
3	Digital kiosk is available at RBK f or placing an order of Agri inputs.	13	107	107	0.89	III
4	RBK area of operations is confined to Revenue village as a Unit	15	105	105	0.88	IV
5	RBK has all the information about agriculture & allied supporting schemes offered by the state government	20	100	100	0.83	V
6	RBK supplies livestock feed to the farmers	20	100	100	0.83	VI
7	E-Karshak (Digital crop records) is maintained by RBK staff by capturing crop images and geo-tag the location of the crop	24	96	96	0.80	VII
8	Enrollment and Processing for Input Subsidy and crop insurance are done at RBK	25	95	95	0.79	VIII
9	There are agriculture & allied audio-visual aids like charts, boards and	28	92	92	0.77	IX

Table - 2 contd..

S.No	Awareness about RBK	Farmers		Total score	Mean score	Ranks
		Unaware n	Aware n			
	books displayed at RBK to create awareness regarding current works & new technological advancements.					
10	Agriculture Asst & Veterinary Asst are the staff available at RBK for guidance.	28	92	92	0.77	X
11	RBK assesses the yield and damage of crops and those records are maintained.	40	80	80	0.67	XI
12	Veterinary services like medication, guidance regarding maintenance and feed, etc.	46	74	74	0.62	XII
13	RBK disseminates information related to agriculture & allied firms via WhatsApp groups.	56	64	64	0.53	XIII
14	RBK provides extension services like farm school, weather forecasting information, soil, seed and water testing, etc.	60	60	60	0.50	XIV
15	RBK provides marketing services like market price information and MSP procurement services.	68	52	52	0.43	XV
16	Formation and credit linkage of 4S groups (JLG) is done at RBK?	78	42	42	0.35	XVI

n =NO.OF RESPONDENTS

Farmers' general awareness of the products and services offered by RBKs was anticipated to be known through this study's focus on the sample area's farmers. The 16 statements used to determine farmers' products and services provided by Rythu Bharosa Kendras is given in Table 2.

The scores of '0' and '1' were assigned to the level of unawareness and awareness respectively. Mean scores were found and the aspects were assigned a ranking based on the mean score. Table 2 shows the results of a sample of farmers and the ranking of the statements. The high awareness statements:

RBK is a one-stop solution for agriculture and allied activities; RBKs were also selling agri-inputs (seeds, fertilizers, etc.,) had a mean score of 1.0 and 0.91. The statements with low awareness are offering marketing services such as market price data and MSP procurement services and formation and credit linkage of 4S groups (JLG) having a score of 0.43 and 0.45, respectively.

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