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SURVEY FOR CHICKPEA FUSARIUM WILT IN ANDHRA PRADESH

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ABSTRACT

The survey on Fusarium wilt was conducted to record the incidence, prevalence and distribution of the disease in major chickpea cultivated areas of Andhra Pradesh *i.e.,* Kurnool, Prakasam, Nellore, YSR Kadapa, Anantapuramu and Guntur districts during *rabi* 2014-15. The wilt disease was recorded in the range from 0.2% to 15.2% during the survey at different crop growth stages. Lower mean wilt incidence (average wilt incidence at three stages- vegetative, flowering and pod formation stages) of 5.9% was observed in Nellore district, whereas, the higher mean wilt incidence of 8.32% was found in Kadapa district. Out of all the 30 mandals surveyed, Kondapuram, Nellore district and Ongole, Prakasam district recorded lower mean wilt incidence of 2.0%. Atmakur (Kurnool dist.) and Vajrakarur (Anantapuramu dist.) were observed with higher mean wilt incidence of 9.7%. Fusarium wilt was reported in the range from 0.5% to 15.2% at vegetative stage, 0.2% to 12% at flowering stage and 7.5% to 8% during pod formation stage.

Key Words: Chickpea, Fusarium wilt, Survey, Andhra Pradesh

INTRODUCTION:

Chickpea is one of the main pulse crops cultivated in Andhra Pradesh (A.P.) as well as in India. In A.P, it was cultivated in an area of 5.2 lakh ha with a production of 5.88 lakh tons during 2017-18 **(**IIPR, 2019) and productivity of 1132 kg ha^{-1}. Several factors were noticed for yield losses in chickpea and is reported that the crop is attacked by about 52 pathogens (Nene *et al*., 1984). Among the pathogens, Fusarium wilt caused by *Fusarium oxysporum* f.sp*. ciceris,* is one of the important pathogen that causes yield losses in chickpea.This disease was reported in 32 countries across six continents (Singh *et al*., 2014). Important symptoms of wilt include collapsing of the infected plants at seedling stage and drooping of petioles, rachis and leaflets in grown plants retaining the dull green colour (Pande and Sharma, 2012). Though there was no external rotting of wilting plants, the plants exhibited dark brown discoloration of xylem. Highly susceptible varieties show symptoms within 25 days after sowing (DAS). More losses were caused by early wilting than late wilting and seeds obtained from the chickpea plants with late wilt symptoms are lighter than seeds obtained from healthy plants (Haware and Nene, 1980). Depending on agro climatic conditions and varietal susceptibility yield losses were reported ranging from 10% to 100% (Warda *et al*., 2017).

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MATERIAL AND METHODS

An extensive roving survey was conducted in farmers fields covering the six major chickpea grown districts of Andhra Pradesh *viz*., Kurnool, Prakasam, Anantapuramu, Kadapa, Nellore and Guntur *viz.,* vegetative, flowering and pod formation stages during *rabi* 2014-15 to report the Fusarium wilt occurrence, distribution and incidence. In each district, five mandals were selected. From each mandal, a total of five villages were chosen for the survey. In each surveyed field, a plot size of 1.0 m^2 × 1.0 m^2 was selected at five locations diagonally to record the disease incidence. The plants were carefully examined for wilt symptoms to identify the disease affected plants and then wilt incidence was calculated. Disease affected plants and disease-free plants were counted per meter square and per cent disease incidence was calculated as below:

$$\text{Wilt incidence (\%)} = \frac{\text{Number of wilted plants}}{\text{Total number of plants}} \times 100$$

In order to assess disease incidence, various agronomic practices followed by farmers in different chickpea eco systems were recorded by using a common data format. Data on different parameters *viz*., variety grown, soil type, area surveyed and stage of the chickpea crop were recorded (Ghosh *et al*., 2013).

RESULTS AND DISCUSSION

Widely distributed Fusarium wilt incidence was observed in all the chickpea grown areas during survey. Survey also provided details about the intensity over the period of time. Among the six districts surveyed, lower mean wilt incidence of 5.9% was found in Nellore district, whereas, the higher mean wilt incidence of 8.32% was observed in Kadapa district. Other districts *viz.,* Anantapuramu, Kurnool, Prakasam and Guntur recorded mean incidence of 7.28%, 7.77%, 6.6% and 6.74% respectively. In different mandals surveyed, Atmakur (Kurnool dist.) and Vajrakarur (Anantapuramu dist.) were observed with higher mean wilt incidence of 9.7%, whereas, Kondapuram mandal of Nellore and Ongole mandal of Prakasam district recorded low mean wilt incidence of 2.0% (Table.1). Among the different villages, Bramhanapalli village, Tadipatri mandal found with low mean wilt incidence of 0.2% and higher average wilt incidence of 15.5% was recorded in Vaddamanu (Kasinayana mandal) and Peddajuturu (Vemula mandal) villages of YSR Kadapa district. Data of wilt incidence in different mandals of six surveyed districts were represented in Fig.1. Similarly, Anuragi and Sharma (2016) reported wilt incidence of 0% to 36% during survey in Bhundelkhand region. Sankar *et al*. (2018) surveyed in four districts of Tamilnadu such as Coimbatore, Dindigul, Dharmapuri and Tiruppur during *rabi*, 2015 and observed more than fifty per cent incidence (57.33%) in Gomangalampudur, Tiruppur district on cultivar JAKI-9218 and 34% incidence was recorded on CO4 cultivar at Idigarai in Coimbatore district.

During the survey, the disease incidence was observed in the range of 0.5% to 15.2% at vegetative stage, 0.2% to 12% at flowering, and 7.5% to 8% at pod formation stage. Apart from wilt, dry root rot, black root rot and collar rot

Table 1. Survey for Fusarium wilt of chickpea in major chickpea growing districts of Andhra Pradesh

S.No.	District name	Disease incidence (%)		Mandal name	Disease incidence (%)	
		Range	mean		Range	Mean
1.	Kurnool	0.8-12	7.77	Yemmiganur (Y.nur)	5.2-10.5	07.94
				Orvakal (O.kal)	5.0-10.0	08.30
				Atmakur	7.5-12.0	09.70
				Kodumur	5.4-10.0	07.88
				Vuyyalawada (V.wada)	1.0-12.5	05.32
2.	Prakasam	1.5-10.3	6.6	Torlupadu	7.0-9.0	09.10
				Giddalur	7.6-10.3	08.88
				Ongole	1.5-4.0	02.00
				Valletivari palem (V.V.Palem)	2.5-9.0	06.50
				Addanki	4.0-7.5	06.60
3.	YSR Kadapa	2.5-15.2	8.32	Proddutur	5.8-10.0	07.76
				Vemula	7.5-12.0	09.10
				Pendlimarri (P.marri)	2.5-15.2	08.42
				Kasinayana (K.nayana)	5.0-10.2	07.14
				Duvvur	8.0-12.0	09.20
4.	Anantapura -mu (ATP)	0.2-10.0	7.28	Vajrakarur	8.5-12.0	09.70
				B.K.Samudram (B.K.S)	2.1-10.0	05.22
				Tadipatri	0.2-5.5	02.70
				Parigi	7.5-10.0	09.10
				Roddam	6.0-9.0	08.70
5.	Nellore	0.5-12	5.9	Duttalur	6.0-12.0	08.62
				Chejarla	5.0-7.5	06.70
				Kaligiri	5.0-10.0	06.70
				Vinjamur	4.5-6.5	05.40
				Kondapuramu (K.purmu)	0.5-5.0	02.00
6.	Guntur	4-12	6.74	Chilkaluripeta (C.peta)	5.0-10.0	07.20
				Pedanandipadu (P.padu)	4.0-8.0	05.30
				Tullur	5.5-12.0	08.10
				Nadendla	5.0-8.0	06.90
				Edlapadu	5.0-7.0	06.20

were observed during survey, dry root rot incidence was found higher than Fusarium wilt at the maturity stage. At this stage, the crop was exposed to high temperature and moisture stress and these conditions were favourable for *Rhizoctonia bataticola* (Sharma *et al*., 2016). Also, during vegetative stage, Fusarium wilt was appeared as widely spread in the field. Sharma and Pande (2013) reported that moisture stress and high temperature are important factors for causing infection by *R.bataticola.* Therefore, this disease was found high from flowering stage to maturity stage. During the survey, high wilt incidence was recorded in patches particularly under ill-drained conditions in farmers' fields. It was observed that JG-11 was the principal variety grown by chickpea farmers during survey and apart from JG-11, cultivars *viz.*, NBeG-3, KAK-2, JAKI-9218 and local cultivar *i.e.* Annegeri were also found in some places. In majority of the districts, it was grown as sole crop, however, at some places farmers grew preceding crops such as blackgram and greengram in Guntur, Nellore and YSR Kadapa districts; maize, onion, korra and vegetables in Kurnool district. In Anantapuramu district, groundnut, horsegram, korra were grown as preceding crops and in Prakasam district, bajra, variga, and sesamum were the preceding crops to chickpea.

Gangwar *et al*. (2013) conducted survey on Fusarium wilt of chickpea in Rajasthan for

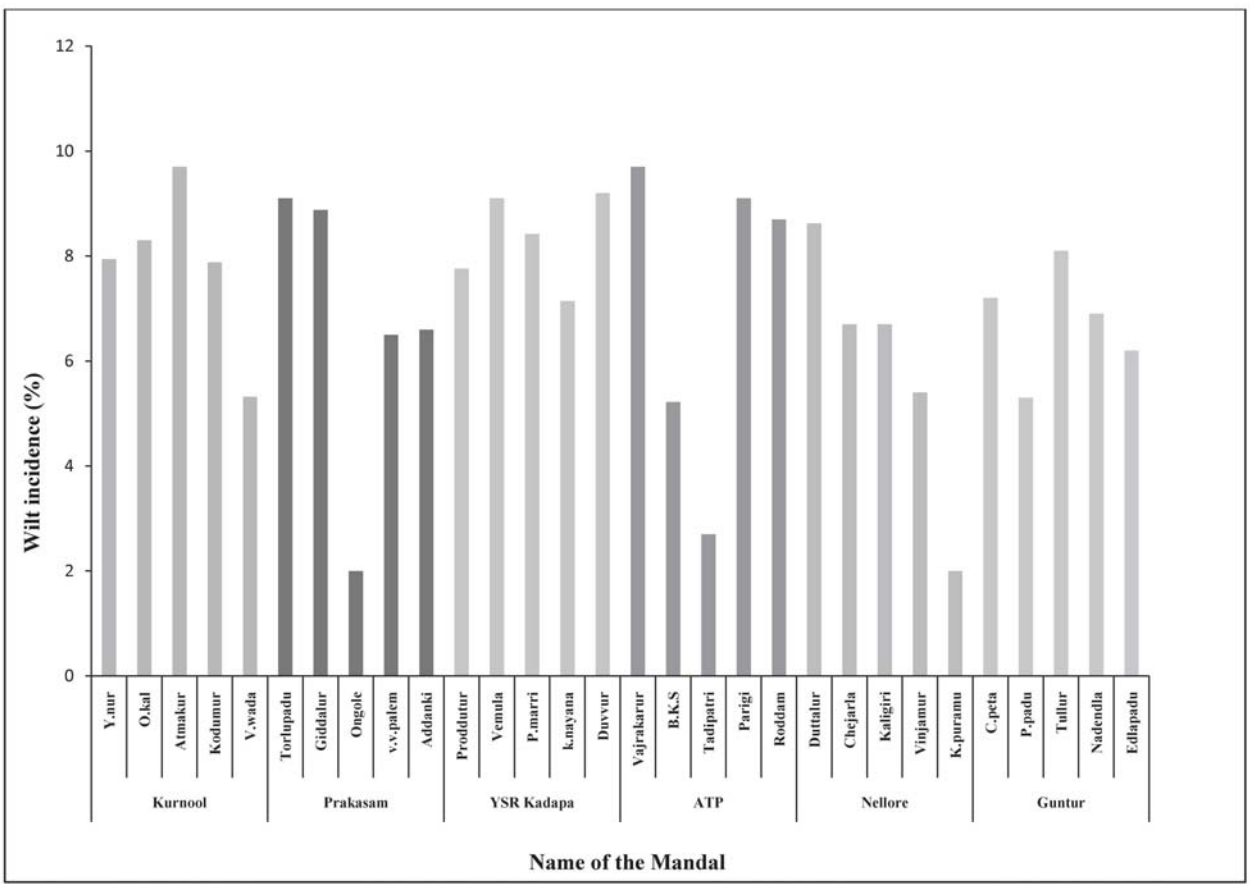

Fig.1. Bar diagram representing wilt incidence (%) in different mandals of surveyed districts in Andhra Pradesh

two years *i.e.*, 2011-12 and 2012-13 and observed the disease in all the surveyed areas with incidence varying from 27.43% to 45.88% having an average of 37.48%. The disease was observed high in the seedling stage *viz.*, 23.96% and 21.9% during 2011-12 and 2012-13, respectively with 4.5% and 14.6% at maturity stage during 2011-12 and 2012-13, respectively. In this study, high wilt incidence was observed at vegetative stage than pod formation stage. Ghosh *et al*. (2013) conducted survey for chickpea diseases in 2010-2011 during *rabi* in four states such as Andhra Pradesh, Madhya Pradesh, Karnataka and Chhattisgarh and Fusarium wilt, dry root rot and collar rot in all four states, whereas, black root rot disease was only in A.P and Karnataka states. In A.P., Fusarium wilt incidence was higher in chickpea followed by dry root rot, collar rot and black root rot diseases and wilt incidence recorded is in the range of 9.86 % -18.76%.

In this survey, Fusarium wilt was observed in the range of 0.2% to 15.2% at various growth stages of the crop and more severity was noted during vegetative stage. This study apprises the state of Fusarium wilt disease in chickpea which is essential to understand the disease situation and plan the disease management strategies.

CONCLUSION

During the survey, Fusarium wilt was recorded in the range of 0.5% to 15.2% at vegetative stage, 0.2% to 12% at flowering stage and less incidence *i.e*., upto 8% was noted during pod formation stage in Andhra Pradesh.

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NUTRITIONAL AND ANTIOXIDANT POTENTIAL OF LYOPHILIZED WHEAT GRASS JUICE AND SHOOT POWDERS

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ABSTRACT

Young wheatgrass is rich in vitamins, minerals, chlorophyll, bioactive compounds, and fiber. In this study, phytochemicals, proximate analysis, amino acids, individual polyphenols, minerals, and antioxidants of lyophilized wheatgrass juice powder and shoot powder were estimated. Both the samples (juice and shoot powders) showed the presence of phytochemicals such as alkaloids, tannins, cardio-glycosides, coumarins, flavonoids, carbohydrates, etc. Further more, HPLC analysis of individual polyphenols showed that the juice powder had significantly higher (P <0.05%) quercitin, sinnapic acid, chlorophyll, and essential amino acids like valine, threonine. Wheat grass juice powder have shown significantly higher (p<0.05%) Fe and Zn than shoot powder. Juice powder had significantly more (P<0.05) total polyphenols (15.20±1.0 mg/g), total flavonoids (6.27±0.68 mg/g) than shoot powder, and DPPH activity with IC_{50} 1.48±0.15 mg/g. This study highlights the nutritional benefits of wheatgrass juice powder as lyophilization could reduce losses of nutrients and antioxidants. These findings confirm that lyophilized wheatgrass juice powder is medicinally important with bioactive compounds, antioxidant capacity, and have significant potential to incorporate in functional food products those can be used to enhance the health benefits of consumer.

Keywords: Phytochemicals, HPLC, Polyphenols, DPPH activity

INTRODUCTION

Wheat (*Triticum aestivum*) is the second most cultivated and vital staple cereal food in India and young wheatgrass is nutrient-rich. It finds uses in the traditional system of medicine to treat various ailments (Rajesh *et al*., 2011). It holds a substantial amount of protein, vitamins, minerals (Ca, Mg, iron, zinc), phenolics, flavonoids, fiber, and bioactive components such as chlorophyllin, quercetin, rutin, and sinapic acid compared to seed kernel. Wheatgrass contains about 70 percent of chlorophyll out of total chemical constituents (Swati *et al*., 2010). Many accredited biological properties to wheatgrass include bodybuilding activity (Marvaha *et al*., 2004), antidiabetic (Chauhan, 2014), anti-cancer (Dey *et al*., 2006), anti-inflammatory and antiaging (Smith *et al*., 2000), blood pressure reduction, heavy metal detoxification, and immune system modulation (Suriyavathana *et al*., 2015). Fresh wheatgrass juice is recommended for daily consumption due to the fact that it possesses maximum therapeutic qualities (Walters, 1992). It reduces the toxic side effects of chemotherapy in breast

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cancer patients (Bar-sela *et al*., 2007). A substantial number of phenolic compounds including flavonoids contained in wheat grass extract can reverse the effect of ROS (Reactive Oxygen Species) mechanism by various pathways and reduce cancer (Calzuola *et al*., 2004). Wheatgrass also exhibits a preventive effect on oxidative DNA damage (Falcioni *et al*., 2002). Today wheatgrass is one of the important and widely used supplemental health food and available in many health foods stores as fresh produce, tablets, frozen juice, and powder. The major utilization of wheatgrass juice is due to its antioxidant action which consists of high bioflavonoids such as apigenin, quercitin, and luteolin. Its pharmacological properties due to its enzymes *viz.,* protease, analyze, lipase, superoxide dismutase, cytochrome oxidase, bioactive components, and nutrient content make it a functional food and nutraceutical. The study was carried out to examine the phytochemical screening of bioactive components, nutritive composition and antioxidant properties of lyophilized wheatgrass juice powder and shoot powder with an objective of sculpting it as a neutraceutical and to develop functional food products.

MATERIAL AND METHODS

Cultivation of wheat grass and sample preparation

Wheat seed variety 'HD 3086' was collected from Indian Agricultural Research Institute (IARI), New Delhi. Wheat seeds were sown in the laboratory garden in an area of 50 sq. ft with enough shade and water. Plant samples from these seeds were collected on the 9th day of its growth and shoots were of 10 cm height above the soil (Dhaliwal *et al*., 2015) and washed thoroughly by deionised autoclaved (Ultra-pure water deionizer PURELAB® Ultra systems) water and then separated into two equal parts. Then, wheatgrass juice was squeezed from the first part by the mechanical extraction method using a juicer (Phillips juicer, HR 185) and stored in the deep freezer (Blue star chest model No.304) for pre-freezing at -40° C for 24 hrs. Next, the stored juice was lyophilized (commercial lyophilizer system, Li-LYfo-55) and collected as juice powder. Immediately sample was packed in polypropylene pouches in dry room and stored. The other half of the shoots were ground as paste, lyophilized and collected as shoot powder. This shoot powder was also stored in polypropylene pouches and sealed immediately. Both the sample powders were analysed and compared for different properties.

Extraction of plant material

Lyophilized wheatgrass powder was subjected to Soxhlet extraction by using solvents such as double distilled water and 70% ethanol. Ten grams of each sample was weighed, homogenized and transferred into two different conical flasks and one hundred mL of solvent was added and shaked using shaking water bath at 60° C for 40 min. Each solvent extract was allowed to flash evaporate to dryness. Water extract was also obtained to know the solubility of components in pure water which was immediately lyophilized and used for further studies. As wheatgrass is consumed in the form of juice, a freshly prepared crude wheatgrass sample was also used. Wheatgrass powder was dissolved in ethanol

and double distilled water and an extract supernatant was utilized for various experiments (Garima Shakya *et al*., 2014).

Qualitative phytochemical screening of lyophilized wheat grass powder

The screening of phytochemical constituents was carried out with 70% ethanolic extract and aqueous extract of wheatgrass to analyse the presence of different bioactive components as per standard methods (Kokate *et al*., 2001).

Proximate analysis

Moisture, ash and fat were analysed by standard AOAC methods of analysis (2005). Carbohydrate by difference method from the levels of nutrients analysed and fiber content by Automatic fiber analyser. Nitrogen content was estimated by standard Kjeldahl method and total protein content was calculated using a conversion factor of 6.25.

Total chlorophyll content

Chlorophyll content was determined using the dimethyl sulfoxide (DMSO) method (Ghumman *et al.*, 2017).

Water soluble vitamins analysis by HPLC

B complex vitamins (thiamine, riboflavin, niacin, folic acid, pyridoxine) and vitamin C analysis were carried out using a High-Performance Liquid Chromatographic system (Shimadzu-UFLC Prominence), equipped with an autosampler (Model-SIL 20AC HT) and UV-Visible detector (Model-SPD 20A). The data was recorded using LC-solutions software. Extracted samples of 100 mg was filtered through 0.45 µm filter tips and aliquots of 20 µL from this solution were injected into the HPLC by using auto-sampler. Analytical reversed-phase C-18 column (ODS column, 250 × 4.6 mm, 5 µm, Phenomenex, Inc.) was used for the separation. The mobile phase consisting of a mixture of buffer and methanol in the ratio of 96:4 (v/v) was delivered at a flow rate of 1 ml/min with UV detection at 210 nm. 20 µL aliquots of the standard solutions and sample solutions were injected (Nazmul Hasan *et al*., 2013).

Amino acid analysis by HPLC

Agilent chromatography system 1260, USA having an auto-analyzer and PDA detector was used for analysis.The amino acid separation was achieved using RP C-18 column (250 mm x 4.5 mm and 0.5 um particle size) using linear gradient elution with a mobile phase A with 3% (v/v) tetrahydrofuran in 17 mM sodium acetate trihydrate [pH 7.2 adjusted using 2% (v/v) glacial acetic acid], while mobile phase B was a mixture of 85 mM sodium acetate trihydrate [pH 7.2 adjusted using 2% (v/v) glacial acetic acid]–Acetonitrile–methanol (1:2:2 v/v/v). The analysis was carried out with a flow rate of 0.8 mL/min at 280 nm with a gradient system.100 mg of both wheatgrass extract samples were added to 1mL of 6N HCl and 0.1N HCl followed by solid-phase extraction with activated the sep-pack C18 column by using methanol. A solution consisting of 0.1% tetrahydrofuran (TFA) in water was added twice. The amino acids were derivatized with o-phthalaldehyde reagent (OPA) and 9-fluorenylmethyl chloroformate (FMOC) reagent by programming of auto-

sampler. The eluted samples containing amino acids were then analysed by the Agilent HPLC system with the above condition.

Determination of individual polyphenols by HPLC

Identification of individual polyphenols was completed by the method of Hartl and Stenzal (2007) with slight modifications using HPLC analysis with Agilent chromatography system. The best solvent system as a mobile phase for the study consisted of methanol to water in the ratio of 80:20 along with 0.1% TFA, with a flow rate of 1.0 mL/min and detection of the component was achieved at 200 to 400 nm at ambient temperature. The HPLC peaks of analytes were confirmed and quantified with known reference standards by comparing their retention times (Anand Rojoria *et al*., 2015).

Mineral composition

Minerals in the wheatgrass powder were determined using inductive coupled plasma - optical emission spectrophotometer (ICP-OES) at vimta Labs, Hyderabad (Matthew *et al.*, 2011).

ANTIOXIDANT ANALYSIS

DPPH radical scavenging activity

For free radical scavenging activity, the lyophilized wheatgrass powders (10mg) were dissolved in 100 mL of methanol for 2 hours in the dark. Freshly prepared 5mL of DPPH (0.1 mM) was added to 100 µL extract and incubated for 30 min. The absorbance of DPPH was taken at 517 nm. Methanol was taken as solvent blank. The reduction of the purple colour of the DPPH solution to pale colour gave the percentage of Inhibition (Tripathi, 2017).

IC_{50} value

One parameter (IC_{50}) inhibition concentration was introduced for the interpretation of the results from DPPH method. IC_{50} was the amount of sample necessary to decrease the absorbance of DPPH by 50%. Ascorbic acid was used as a standard.

Total phenolic content

The total polyphenol content of the ethanolic extract was analysed using Folin-Ciocalteu reagent according to the protocol designed by Makkar *et al*. (2003). Briefly, 1 mL of various concentrations of the sample was mixed with 0.5mL of 1N Folin-Ciocalteu reagent and added 2.5 mL of 5% sodium carbonate. After incubation for 40 min in a dark room, absorbance was measured at 725 nm using a spectrophotometer (Agilent technologies, cary 60 Uv-vis). Gallic acid dissolved in methanol was used as a standard. The total phenolic content was reported in terms of µmole of gallic acid equivalents/g of extract (GAEs).

Total flavonoids content

The aluminium chloride method was used for flavonoid content estimation (Zhishen *et al*., 1999).500 µL of ethanolic extract was mixed with 150 µL of 10% aluminium chloride. The absorbance of the reaction mixture was measured at 530 nm with a double beam spectrophotometer. A calibration curve was repaved using a standard solution of rutin

hydrate (0.05-0.5mg/ml). Final results were expressed as mg rutin equivalents/g of sample.

Statistical analysis

The results are presented as the mean ± SD of triplicate observations. All the data were analysed for analysis of variance (ANOVA) using randomized design with the least significant difference (LSD) at 0.05 levels by using the SPSS 13-Windows students version software.

RESULTS AND DISCUSSION

Qualitative phytochemical screening

Preliminary qualitative phytochemical screening was carried out with 70% ethanolic extract and aqueous extract for lyophilized wheatgrass powder. It showed the presence of different types of bioactive compounds such as alkaloids, tannins, cardiac-glycosides, coumarin, terpenoids, tannins in ethanolic extract (Table 1). The aqueous extract showed the presence of amino acids, carbohydrates, saponins and flavonoids. These screenings exhibited a good range of primary metabolites and a wide range of secondary metabolites. These results correlate with a study conducted by Suryavathana *et al*. (2015).

Proximate analysis of lyophilized wheat grass powder

Results of proximate analysis of lyophilized wheatgrass shoot and juice powders are shown in Table 2. There was a significant difference $P< 0.05$ for moisture, fat, protein and carbohydrates but no significant difference ($P>0.05$) for fiber and energy content of shoot and juice powders. Fat and moisture content

Table 1. Qualitative Phytochemical screening of lyophilized wheat grass shoot powder

Phytochemicals	70% ethanol	Aqueous extract
Alkaloids	+	-
Carbohydrates	-	+
Proteins	-	+
Phenols	+	+
Tannins	+	+
Saponins	-	+
Cardiac glycosides	+	-
Flavonoids	+	+
Steroids	-	-
Terpenoids	-	+

(+) Indicates presence of compounds, **(-)** Indicates absence of compounds

were almost less in lyophilized juice powder which contributes to good stability in storage than WSP. Results revealed that wheatgrass has a significant source of nutrients. The results are in corroboration with the studies of Ghumman *et al*. (2017).

Table 2. Proximate composition of lyophilized wheat grass powder

Parameters	WSP	WJP
Moisture (%)	2.56±0.27[a]	1.56±0.08[b]
Protein(g)	23±1.08[a]	19.26±0.54[b]
Fat (g)	4.52±0.19[a]	0.8±0.12[b]
Carbohydrate (%)	62.83±4.2[b]	71.99±1.19[a]
Ash (%)	2.52±0.42[a]	1.13±0.63[b]
Fiber (g)	4.52±0.55[a]	4.26±0.39[a]
Energy (Kcal)	384.0±8.18[a]	372.2±2.64[a]

[a–b]Mean within each row with different superscripts are significantly ($p \leq 0.05$) different.

WSP= Wheat grass shoot powder, WJP= Wheat grass juice powder

Total chlorophyll content

Results of chlorophyll content shown in Fig.1 states that values are significantly different at P< 0.05 level between shoot powder and juice powder. The reason is due to the fact that chlorophyll is more soluble in water and shown maximum solubility in juice powder than the shoot powder. Higher chlorophyll content helps in higher radical scavenging activity. Chlorophyll acts as an antioxidant (Lanfer *et al*., 2005), chelation of pro oxidations (Kamat *et al*., 2000)

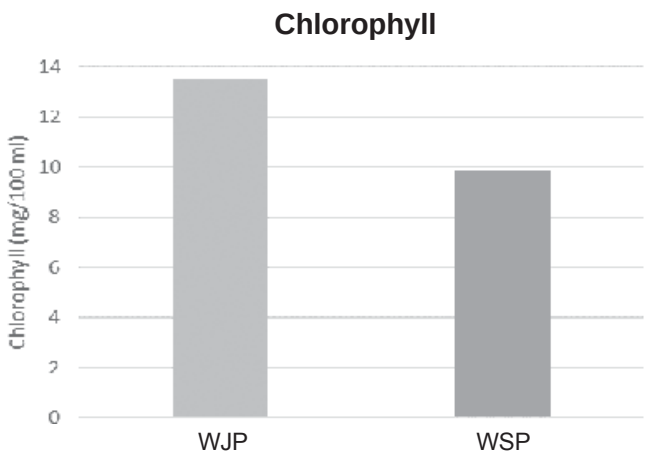

Fig. 1. Chlorophyll content in different samples

Analysis of water-soluble vitamins with HPLC

Table 3. Water soluble vitamins in wheat grass juice and shoot powder samples

Vitamins	WJP (mg/100 g)	WSP (mg/100g)
Thiamine	1.73±1.0[b]	16.17±5.29[a]
Riboflavin	2.2±0.61[a]	2.54±1.0[a]
Niacin	18.91±0.1[b]	4.99±1.0[a]
Pyridoxine	11.74±0.1[a]	7.17±0.44[b]
Folic acid	9.07±0.1[a]	0.83±0.46[b]
Vitamin C	1.92±0.22[b]	39.55±8.08[a]

Values are expressed as mean ±SD (n = 3);

[a–b]Mean within each row with different superscripts are significantly ($p \leq 0.05$) different.

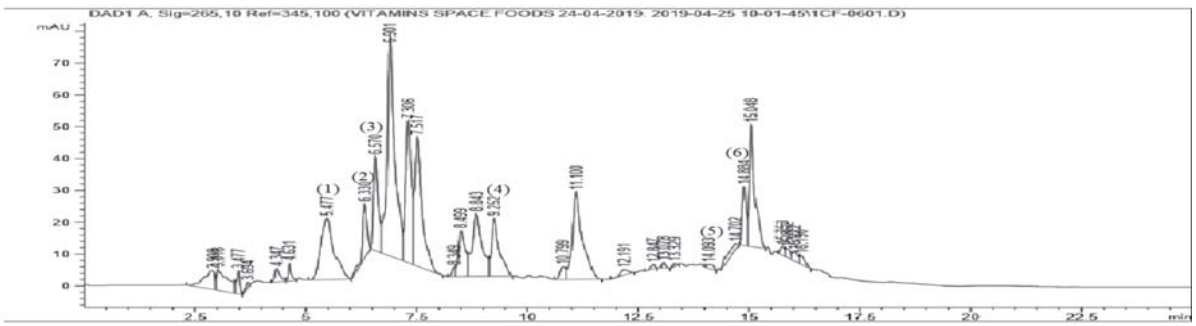

Fig. 2. HPLC chromatogram of lyophilized wheat juice powder

(1) Vitamin C, (2) Niacin, (3) Thiamine, (4) Pyridoxine, (5) Folic acid, (6) Riboflavin

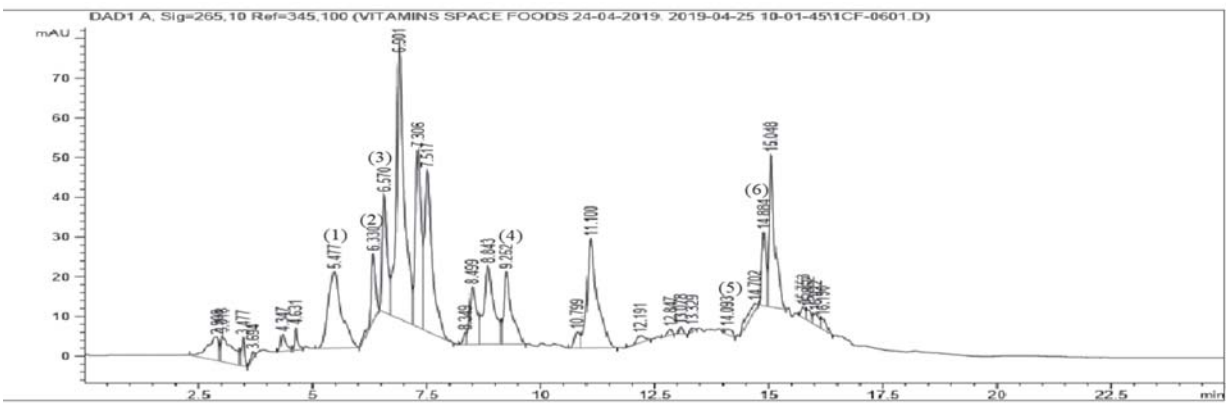

Fig. 3. HPLC chromatogram of lyophillized wheat shoot powder

(1) Vitamin C, (2) Niacin, (3) Thiamine, (4) Pyridoxine, (5) Folic acid, (6) Riboflavin

and binds to carcinogenic molecules, (Endo *et al*., 1985), thus act as an antioxidant by scavenging free radicals. The results coincide with the studies of Rattanaane Echomchan *et al*. (2016).

Results of HPLC analysis of water-soluble vitamins of juice powder and shoot powder are tabulated in Table 3. Results showed that except riboflavin, all other vitamins significantly varied between juice and shoot powder samples. WSP had higher vitamin content than juice powder. Among the B vitamins, thiamine was more *i.e.* 16.17 mg/100 g and least was folic acid with 0.83 mg/100 g in shoot powder (Fig. 3), whereas in juice powder (Fig. 2) thiamine was 1.73 mg/g and least was vitamin c was 1.92 mg/100 g, but in shoot powder, vitamin C content was more (39.5 mg/100 g). The reason may be the polarity and solubility of vitamins in the aqueous extract.

Amino acid analysis by HPLC

Composition of different amino acids in lyophilized juice powder and shoot powder is presented in Table 4 and shown HPLC chromatograms of lyophilized samples. The aminoacid analysis showed the presence of 17-20 different peaks in both the samples. Among them, 12 were identified and in that

Table 4. Composition of amino acids in wheat grass juice powder and shoot powder samples

Amino acids	WJP (mg/g)	WSP (mg/g)
Arginine	1.7±0.62[b]	6.1±0.90[a]
Serine	0.57±0.26[a]	0.22±0.12[a]
Threonine	1.16±0.21[a]	0.97±0.34[a]
Valine	1.76±0.68[b]	0.45±0.15[a]
Methionine	0.17±0.15[b]	1.03±0.29[a]
Isoleucine	0.58±0.43[b]	2.6±0.64[a]
Leucine	0.22±0.18[b]	2.69±0.70[a]
Lysine	0.13±0.11[a]	0.19±0.07[a]
Proline	0.50±0.26[a]	0.24±0.18[a]
Aspartic acid	2.71 ± 0.22[a]	1.53 ± 0.01[b]
Cysteine	ND	0.46
Glutamic acid	2.36± 0.08[a]	2.56± 0.02[a]

Values are expressed as mean ±SD (n = 3);

[a–b]Mean within each row with different superscripts are significantly ($p \leq 0.05$) different.

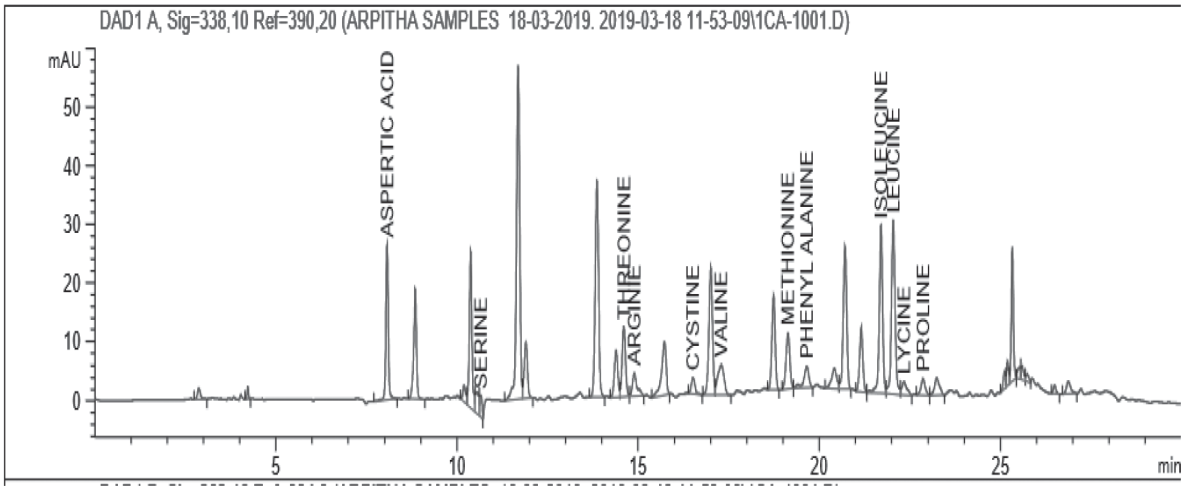

Fig. 4. HPLC chromatogram of lyophillized wheat grass juice powder

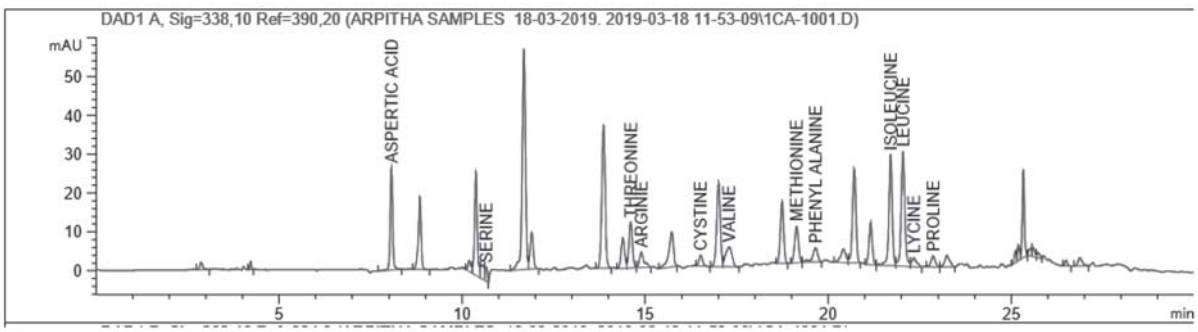

Fig. 5. HPLC chromatogram of lyophillized wheat grass shoot powder

8 are essential amino acids. There was no significant difference at P>0.05 level for serine, threonine, lysine and glutamic acid in both the samples. However, the significant difference at P<0.05 level was observed with arginine, valine, methionine, isoleucine, proline and aspartic acid. Cysteine is not detected in WJP. Both samples have shown essential amino acid composition.

All phenolic compounds except vallinin, catechin, epicatechin and epigallocatechin gallate (EGCG) remaining all phenolic compounds were present in higher amount in juice powder (Table 5 &Fig. 6) with a significant difference at P<0.05 level than in shoot powder (Table 5 & Fig. 7). Lyophillized wheat juice powder shown the highest amount of sinapic acid i.e 15.70±0.05 mg/g and a low amount of vallinin i.e 0.05±0.01 mg/g compared to other phenolic compounds whereas lyophilized wheatgrass shoot powder showed no significant difference at P>0.05 in coumaric acid, ferrulic acid with juice powder. These results coincide with the study conducted by Ghumman *et al*. (2017).

Composition of individual polyphenols

Table 5. Composition of individual polyphenols in wheat grass juice powder and wheat grass shoot powder samples

Standards (mg/g)	WJP	WSP
Gallic acid	1.44±0.02[a]	1.29±0.02[b]
Tannic acid	1.59±0.01[a]	1.23±0.01[b]
Quercetin	12.44±0.01[a]	3.25±0.01[b]
Rutin hydrate	2.01±0.04[a]	1.94±0.04[b]
Vanillic acid	0.99±0.01[a]	0.55±0.01[b]
Vanillin	0.041±0.01[a]	0.05±0.01[a]
Catechin	0.468±0.01[b]	2.56±0.01[a]
Epicatechin	0.054±0.02[a]	0.08±0.02[b]
Sinapic acid	15.70±0.05[a]	11.76±0.01[b]
Caffeic acid	0.054±0.01[b]	0.61±0.03[a]
Chlorogenic acid	0.88±0.03[a]	0.17±0.01[b]
EGCG	0.019±0.01[b]	0.22±0.17[a]
Ferrulic acid	2.29±0.05[a]	2.29±0.01[a]
Coumaric acid	0.44±0.01[a]	0.49±0.01[a]

Values are expressed as means ±SD (n = 3);
[a–b]Mean within each row with different superscripts are significantly ($p \leq 0.05$) different

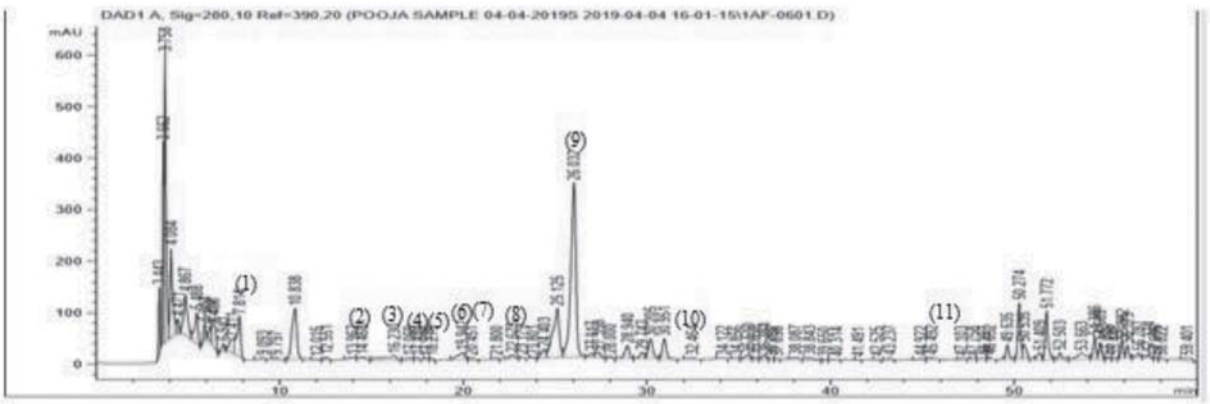

Fig. 6. HPLC chromatogram of polyphenols of lyophilized wheat grass juice powder

1. Gallic acid, 2. Catechin, 3. Chlorogenic acid, 4. Epigallocatechingallate (EGCG), 5. Vanillinic acid, 6. Epicatechin, 7. Vanillin, 8. Tannic acid, 9. Sinapic acid, 10. Rutin hydrate, 11. Quercitin

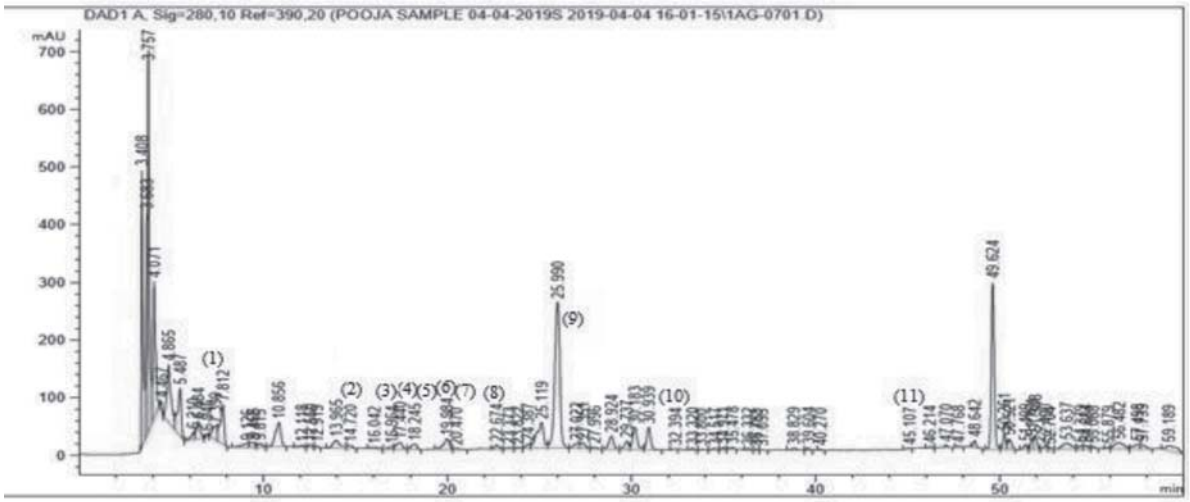

Fig. 7. HPLC chromatogram of polyphenols of lyophilized wheatgrass shoot powder

1.Gallic acid, 2. Catechin, 3. Chlorogenic acid, 4. Epigallocatechin gallate (EGCG), 5. Vanillinic acid, 6. Epicatechin, 7. Vanillin, 8. Tannic acid, 9. Sinapic acid, 10. Rutin hydrate, 11. Quercitin

Table 6. Composition of minerals in wheat grass juice powder and wheat grass shoot powder

S. No	Name of Minerals (mg/kg)	WJP	WSP
1	Copper	28.03±0.41^{a}	20.38±0.47^{b}
2	Manganese	59.73±0.61^{b}	123.14±0.51^{a}
3	Magnesium	1954.68±10.49^{b}	2601.41±8.69^{a}
4	Iron	1601.54±11.09^{a}	1425.07±10.63^{b}
5	Zinc	44.09±0.44^{a}	28.88±0.6^{b}
6	Sodium	353.54±1.78^{b}	578.26±1.86^{a}
7	Selenium	0.2039±0.0^{a}	0.1768±0.0^{b}
8	Calcium	4433.22±20.86^{b}	4893.77±10.04^{a}

Values are expressed as means ±SD (n = 3);

$^{a–b}$Mean within each row with different superscripts are significantly ($p \leq 0.05$) different.

Mineral analysis by ICP-OES

Mineral content was more and significantly varied (P<0.05) level in lyophilized juice powder and shoot powder (Table 6). WSP had shown a high amount of calcium followed by magnesium and then iron where as WJP had shown the highest amount of iron. These results coincide with the studies of Kulkarni *et*

al. (2006). Zinc and magnesium are important for anti-oxidant activity. Manganese acts as a cofactor for super oxidase dismutase enzyme. Zinc is an activator for many plant enzymes (Zago *et al*., 2000) and Magnesium is the central element of the porphyrin ring of chlorophyll. Studies clearly showed that Ca and Mg are higher and this result coincides with studies of Ben-Arye *et al*. (2002).

ANTIOXIDANT ANALYSIS

Lyophilized juice and shoot powders in respect of antioxidant potential were shown in Fig. 8 & Fig. 9. Results revealed that there was a no significant difference at P>0.05 level between the samples for DPPH activity with IC_{50} value 1.48±0.15 mg/g compared to shoot powder IC_{50} value 1.32±0.05 mg/g (Fig 9). Total phenolic content and flavonoid content was found to be significantly higher (p<0.05%) *i.e.* 1520 mg/100 g and 627 mg/100 g respectively, in juice powder than shoot powder (Fig 8). The reason might be due to the fact that the juice powder was aqueous extract, hence, phenolics and flavonoids showed better solubility and activity. Results are in agreement with the studies of Kulkarni *et al*. (2006). Phenolic

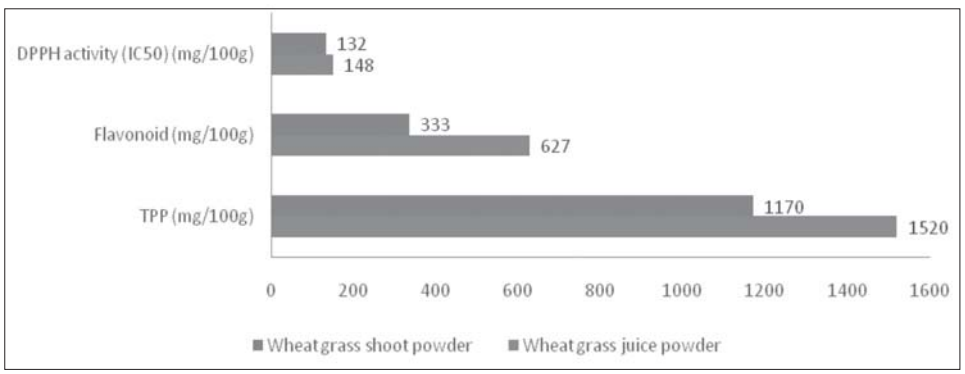

Fig. 8. Antioxidant potential of lyophilized wheat grass powders

DPPH radical scavenging activity

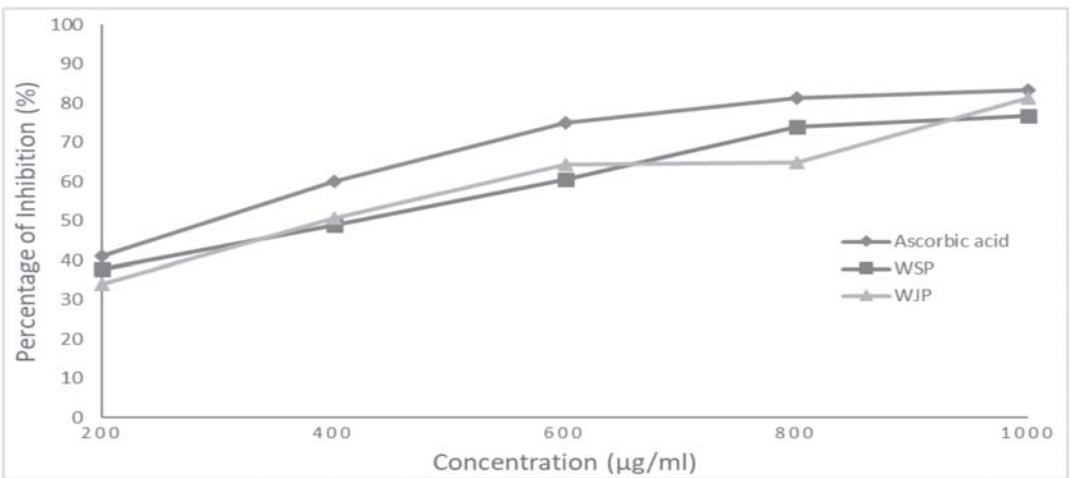

Fig. 9. DPPH activity of lyophilized wheat grass juice and shoot powders

compounds including flavonoids are most responsible for radical scavenging activity. These possess many hydroxyl groups including o-dihydroxy group which has a very strong radical scavenging effect and antioxidant power. Results are consistent with the Yang *et al*. (2001) where it was concluded that wheat grass reached maximum antioxidant potential after seven days of plant growth.

CONCLUSION

The qualitative phytochemical analysis of lyophilized wheatgrass juice powder and shoot powder showed the presence of a wide range of phytochemical constituents. Proximate analysis, HPLC analysis of individual polyphenols shown better results in juice powder than shoot powder. However, HPLC analysis of water-soluble vitamins of lyophilized wheatgrass juice powder shown good essential amino acid composition. Results of antioxidant analysis clearly revealed the high antioxidant activity of juice powder. Wheatgrass juice powder has better nutritional properties with more bioactive components and it can be used to design functional food products which can be used to enhance the health benefits of consumer.

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POST- HARVEST PROCESSING OF IRRADIATION ON QUALITY PARAMETERS OF MUSHROOMS

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ABSTRACT

Effect of irradiation at different doses on shelf life and quality parameters of mushrooms was studied during 2015-17. Irradiation was done by using gamma irradiation at 0.25 kGy and 0.75 kGy doses. Results of the study revealed that PLW, colour(L*, a* and b* values), moisture and fibre in mushrooms were significantly reduced among non-irradiated. Whereas, slight but insignificant changes were noticed in moisture, carbohydrate, fibre and protein content of irradiated mushrooms at 0.25 kGy. Sodium content and potassium content of mushrooms was significantly increased in all the samples.Gamma irradiation of mushrooms maintained the overall quality without determinant to their physico-chemical quality along with increased shelf life of mushrooms.

Key Words: Mushroom, Irradiation, Shelf life, Food Processing, Agriculture, Quality

India is the second largest producer of fruits and vegetables in the world. A vegetable crop plays an important role in Indian agriculture due to their short duration nature, high yields, nutritional richness, economic viability and ability to generate on-farm and off-farm employment. Post-harvest losses are high in fruits and vegetables (20-40%) (Vanitha *et al*., 2013).Hence, processing is very important to extend the shelf life, bythis thefarm produce can be preserved. Food preservation is an action or a method of maintain foods at a desired level of properties or nature for obtain maximum benefits. The principal method of preservation is based on inhibition, inactivation and avoiding recontamination (Rahman, 2007). The process is currently moving from an art to an interdisciplinary science.

Innovative technologies in preservation are being developed in food processing industry that can extend shelf life; minimize risk can improve sensory,functional, and nutritional properties and environment friendly. The search was ever on for newer methods of food preservation with the least change in nutritional composition and sensory qualities. Irradiation is one of the latest methods in food preservation.Food irradiation technology has unique merits over conventional methods of preservation as this process does not lead to loss of flavour, odour, texture, and freshness. Food irradiation promises to offer effective means for minimizing these losses, thereby increasing the availability and stimulating exports. Export development authorities, food industry, farmers, commodity boards, traders, and exporters of agricultural

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produce can be benefited by the use of radiation processing technology. The application of low dose irradiation can be effectively used to extend the shelf life of some fruits and vegetable produce by delaying ripening and/or sprouting and also minimize the nutritional losses by controlling microorganisms (Farzana, 2006).

Mushrooms which belong to the fungi kingdom, has much awareness as food among all segments of population and also possess the functional properties. Button Mushroom (*Agaricus bisporus*) is the popular variety, fetches high price, still dominating the Indian and International market. It contributes about 90% of total countries production and its global share of about 40%. Due to huge functional benefits, its demand and consumption is increasing day to day among the consumers. Mushrooms are the only vegetative source of vitamin D, which is very important for normal bodily functions and especially regarding the deposition of calcium in bones. They are most perishable in nature possessing 85%-95% of moisture; because of this high moisture its shelf life becomes a major problem for the storage.Presently, mushroom has been recognized universally as a highly nutritive food and is getting more importance as medicinal/ functional food.The nature of Button mushrooms are very delicate and have a short shelf life of 3 to 5 days at 2^0C and around 1 to 2 days under ambient conditions which is an impediment to the distribution and marketing of the fresh produces. Because of the perishable characteristic of mushroom there is a need to increase the shelf life (Okechukwu *et al*., 2011). With the gamma irradiation processing the quality and quantity of bioactive components was enhanced and also increases the shelf life of mushrooms. The research was mainly aimed to study the effect of Gamma Radiation processing on physical and nutritional parameters of mushroom (2015-17).

MATERIAL AND METHODS

Sample collection - The fresh mature mushrooms (*Agaricus bisporus)* free from physical defects were obtained from commercial mushroom growers at Hyderabad. Immediately after harvesting, mushrooms were cleaned and then packed in high density polyethylene covers each with 200g due to light weight and also to avoid the damage of mushrooms during processingandstorage.

Irradiation Process - In this study mushrooms were irradiated by the use of Gamma (d) Irradiation chamber unit at Quality control lab, ProfessorJayashankar Agricultural University, Hyderabad. The source for the radiation processing was cobalt -60. In the study, the low dose levels (0.25 kGy and 0.75 kGy) were employed to irradiate Mushrooms to know the effect of radiation processing. **Physical parameters-**The physiological loss in weight (PLW) is the main sign of quality indicator and loss in weight is the major factor which affects the fruit or vegetable quality and quantity during storage.Mushrooms the colour itself indicates the quality because of its sensitivity to colour. **PLW** : PLW was determined by periodical

weighing of mushroom samples and calculated by dividing the weight change during storage by the initial weight.**Colour:**The colour of mushrooms was analyzed by using the Colour - Hunter lab manual for Colour Flex spectrocolourimeterMaster colour data (CEILAB 10 /D65). In colour measurement, the L* value indicates Lightness, a* indicates hue and b* indicates the value of brightness of the samples.**Proximate analysis -** Proximate analysis provides information on the nutritional and biochemical composition. The proximate analysis was analysed by using standard analytical protocols and procedures. The moisture, fibre and protein content were estimated by standard methods AOAC (2005). The carbohydrate content was estimated by the standardprocedure (Raghuramulu *et al*., 1983). **Minerals** - Potassium and Sodium were estimated in mushrooms by the standard testing method followed by Ranganna (2001).

Experimental period : The analysis was analysed at initially (**Initial phase**) and at the end of the experimental period (**Final phase**). The irradiated mushrooms at 0.25 kGy ($\mathbf{I_1}$), 0.75 kGy ($\mathbf{I_2}$) and non-irradiated mushrooms (**NI**) were stored for a period of 21 days. The results of the study were compared among the initial and final phase of the experiment.

The statistical analysis was completed by using SPSS-20 version. The control and experimental samples was analyzed by using the paired sample test, ANOVA (repeated measures mixed model ANOVA).

RESULTS AND DISCUSSION

Physical parameters of mushrooms - The physical parameters include the physiological loss in weight and colour in terms of L*(lightness), a*(hue) and b* (brightness) was observed in non-irradiated and irradiated mushroomsduring the experimental period.

PLW- The results (Table 1) revealed that there was a slight decrease in weight of mushrooms irradiated at 0.25 kGy and 0.75 kGy when compared to non-irradiated mushrooms. The PLW in non-irradiated samples of mushroom was more from initial to final phase (100g to 90.33g) of the experimental period compared to the mushrooms irradiated at 0.25 (100.33g to 91g) and 0.75 kGy (100g to 91g). The statistical analysis show a significant difference in PLW of all the samples from initial to final phase of experimental period.

Storage losses of fresh produce in India are high due to high temperature and humidity. Respiration is the main metabolic sequence sensitive to alteration in temperature. Mushrooms are one of the most perishable vegetable and lost its quality immediately after harvest.The weight difference of Mushrooms was due to mainly evaporation of water from the fruit or vegetable surface as a result of respiration, transpiration rate and Co_2 loss during respiration (Mami *et al*., 2013).

Table 1. Gamma Irradiation effect on Physical Parameters of Mushrooms

Treatments	PLW (g)			Colour								
				L*			a*			b*		
	Initial Phase	Final Phase	t-value (p-value)	Initial Phase	Final Phase	t-value (p-value)	Initial Phase	Final Phase	t-value (p-value)	Initial Phase	Final Phase	t-value (p-value)
NI	101±1.00	90.33 ±1.53	8.00* (0.015)	80.36 ±0.04	61.17 ±0.12	425.56** (0.000)	2.94 ±0.02	4.79 ±0.04	71.18** (0.000)	17.23 ±0.01	17.23 ±0.02	1.00@ (0.423)
I_1	100.33 ±1.53	91±1.00	10.58** (0.009)	80.82 ±0.12	70.65 ±0.04	117.95** (0.000)	2.95 ±0.04	5.60 ±0.07	142.60** (0.000)	18.40 ±0.02	17.33 ±0.02	74.10** (0.000)
I_2	100 ±2.00	90.00 ±1.00	17.32** (0.003)	83.78 ±0.03	76.25 ±0.05	361.72** (0.000)	3.50 ±0.02	6.09 ±0.03	139.73** (0.000)	21.25 ±0.02	17.33 ±0.09	63.39** (0.000)
F-value p-value)	0.318@ (0.739)	0.538@ (0.609)	---	1925.73** (0.000)	31128.28** (0.000)	---	428.07** (0.000)	587.07** (0.000)	---	76888.46** (0.000)	3.025@ (0.123)	---

* - Significant at 1% level;**- Significant at 5% level; @- Not Significant

These results are in accord with the findings reported by Fernandes *et al*. (2012). The effect of the irradiation on physical parameters of *Lactarius delicious* a wild edible mushroom, pertaining to weight loss profiles during eight days of storage were similar in irradiated and non-irradiated samples (Fernandes *et al*., 2012). The PLW was mainly due to evaporation of water from surface of vegetable as aeffect of respiration and transpiration rate during storage.

Colour- Whiteness of mushrooms is often used as important index of visible quality as rapid discolouration occur after harvest (Gormely, 1975).The gamma irradiation affected the lightness (L* value), hue (a*) and brightness (b * value) of colour, which were increased immediately in irradiated samples when compared with non-irradiated samples. The colour values L*, a*, and b* were statistically significant between non-irradiated and irradiated samples instantly after irradiation. The maximum increase was noticed in mushrooms irradiated at 0.75 kGy followed by 0.25 kGy and non-irradiated samples. During the storage period of mushrooms rapid changes occurred in colour (L*, a* and b*) values. The lightness of mushrooms was increased (decrease of L* Value) in the non-irradiated and irradiated samples. The a* value (hue) was also increased in non-irradiated and irradiated samples of mushrooms from initial to final phase of experimental period whereas the brightness (b* Value) was decreased from initial to final phase (Table1) in all samples during the experimental period.A significant difference was observed in L* Value (brightness) and a * Value (hue) among non-irradiated and irradiated samples of mushrooms. No significant difference was observed in b* value (brightness) of mushrooms among the treated and non-treated samples during the experimental period.

Most of the researchers agree that irradiated mushrooms retain their original skin colour for longer periods or darken less rapidly than non-irradiated samples (Fernandes *et al*., 2012). The increase of L* value indicate the whiteness of mushrooms, a* value is for hue and b* value indicates brightness of mushrooms. The colour L*, a* and b* values might be related to a secondary effect of water radiolysis, which results in the production of chemical kinds such as hydrated electrons, hydroxide radicals or hydrogen atoms might oxidize colour compounds such as carotenoids (Kim *et al*., 2008). The colouration change in mushrooms upon irradiation is still the subject of some controversies. The colour values L*, a* and b* of mushrooms was improved by irradiation process. The mushrooms irradiated at 0.75 kGy shows most effective in retention of colour compared to non-irradiated sample. The irradiation process inhibits the polyphenol oxidase which condenses to form the brown melanin pigments, hence improving the appearance and colour.

Nutrient analysis of mushrooms

Moisture - The difference in moisture content between treated and non-treated mushrooms was stastically significant immediately after irradiation. The reduction in moisture content of non-irradiated mushrooms was more (Fig. 1) from initial (91.23%) to final Phase (79.01%) of the experimental period compared with mushrooms irradiated at 0.25

kGy (92.20% to77.42%) and 0.75 kGy (92.00% to 77.53%). The statistical analysis showed a significant difference in moisture content of all samples from initial to final phase of experimental phase as well as between non-treated and treated mushrooms among the irradiated samples at 0.25 kGy and 0.75 kGy moreover, no significant difference was observed in moisture content. The reason for increase in moisture content was that ionizing radiations has a direct effect on matter due to ionization or excitation of its molecules by quanta of radiation. However, it also has an indirect effect produced by radiolysis of nature which thenreact with the molecule of the irradiated substance. When the water content is low, changes depends mainly on the direct effect of radiation, but when the moisture increases, the importance of the indirect effect increases progressively.

Wild mushrooms were subjected to different processing methods (fresh, frozen and dried) and subjected to gamma irradiation at 0, 0.5, 1.0 kGy. The moisture content among the gamma irradiation doses (0, 0.5, 1.0 kGy) decreased immediately after the radiation process but no significant difference was observed (Fernandes *et al*., 2014). The irradiation process did not affect moisture percentage in mushrooms; the maximum retention was observed in 0.75 kGy irradiated mushrooms. The results indicate a positive influence of irradiation on the respiratory behaviour of vegetable during long term storage of low temperature.

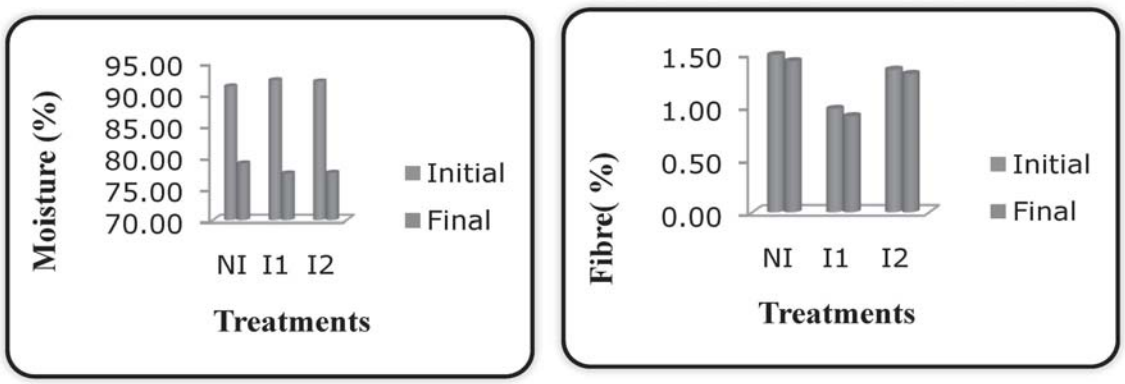

Fig.1. Effect of Gamma irradiation on moisture and fibre content of mushrooms

Fibre- The slight reduction in fibre content of mushrooms samples irradiated at 0.25 kGy and 0.75 kGy when compared to non-irradiated mushrooms. Among irradiated mushrooms, the decrease in fibre content was more in 0.25 kGy (0.98%) than 0.75 kGy (1.35%) irradiated sample when compared to non-irradiated mushrooms (1.49%). The fibre content in non-treated mushrooms exhibit slight reduction (Fig. 1) from initial (1.49%) to final (1.43%) phase of the experimental period compared to mushrooms treated at 0.25 (0.98% to 0.93%) and 0.75 kGy (1.35% to 1.31%). The statistical analysis showed a significant difference in fibrecontent of non-irradiated sample, whereas, no significant difference was observed in treated (0.25 kGy and 0.75 kGy) samples from initial to final phase of experimental period.

Fibres are generally stable to processing,

storage and cooking, but may lose in peeling and other removal steps during processing. The loss in fibre may be attributed to thermally induced hydrolysis of complex carbohydrates within the cell wall (Rickman *et al*., 2007). Fibre content in mushrooms was found to be slightly affected by irradiation processing during the experimental period. However, the decrease of fibre was noticed, minimum loss was observedamong irradiated mushrooms at 0.75 kGy followed by other samples.

Carbohydrate - The carbohydrate content of mushrooms were decreased with increasing trend of dosage whereascompared with the non-treated samples. Results indicate slight reduction of carbohydrate content from initial to final phase of non-irradiated (4.23% to 4.17%) and irradiated mushrooms at 0.25 kGy (3.84% to 3.78%) & in 0.75 kGy (2.53% to 2.51%) during the experimental period (Fig.2). Statistically no significant difference was observed in non-irradiated and irradiated samples of mushrooms from initial to final phase of the experimental period. Similar trend was reported in the study on composition of button mushrooms treated with UVB light or sunlight. The carbohydrate content was decreased in UVB exposed and sunlight exposed mushrooms when compared with the non-irradiated sample (Simon *et al.,* 2011).

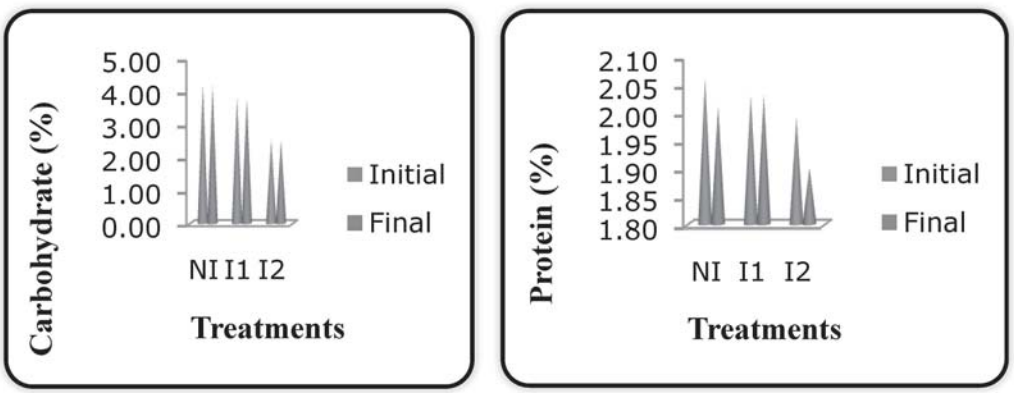

Fig. 2. Gamma irradiation effect on protein content of mushrooms

The protein content of mushrooms was estimated in non-irradiated and irradiated samples,the results revelaed that there was a slight reduction of protein content in mushrooms irradiated at 0.25kGy and 0.75 kGy when compared with non-irradiated samples. The statistical analysis showed a significant difference ($p<0.05$) in protein content of irradiated and non-irradiated mushrooms immediately after irradiation. No drastic changes in protein content, but for slight reduction during storage from initial to final phase of the experimental period (Fig.2) in non-irradiated (2.06%to 2.01%) and in irradiated mushrooms at 0.25 kGy (2.03% to 2.00%) and 0.75 kGy (1.99% to 1.90%) samples. The reduction in protein content was statistically not significant in non-irradiated and irradiated (0.25 kGy) mushrooms from initial phase to final phase of the experimental period, whereas,it was significant inmushrooms irradiated at 0.75 kGy. During the end of experimental phase difference in protein content in all samples irrespective of the treatments was statistically

significant ($p<0.01$). The results are in line with Mami *et al.*(2013) who carried out a study on improvement of shelf-life and postharvest quality of white button mushroom by ^{60}Co γ-ray irradiation.

The differences in proximate composition were due to degradation reactions such as scissions of the C-N bonds in the backbone of polypeptide chain. The dose dependent irradiation has been attributed to de-polymerization and delignification of the plant matrix (Bhat *et al*., 2009). This might be reason for the slight variation in carbohydrate, fibre and protein content of the mushrooms initially.

Minerals

Initially the sodium content increased in mushrooms irradiated at 0.25kGy and 0.75 kGy with the increase of dose levels. The change in sodium and potassium content in mushrooms was found to be significant among non-treated and treated samples.The increasing trend in sodium content from initial phase to final phase of the experimental period was high in non-irradiated mushrooms (8.70mg to 10.20mg) than in mushrooms irradiated at 0.25 (9.10mg to 9.70mg) and 0.75 kGy (10.17mg to 10.33mg). A considerable increase of potassium levels was noticed in non-irradiated sample (308.13mg to 361.33mg), followed by mushrooms irradiated at 0.25kGy (289.33mg to 392.08mg) and 0.75 kGy (269.67mg to 403.33mg) from initial to final phase of the experimental period. The sodium content was more in non-treated mushrooms, whereas, potassium content was more in treated mushrooms from initial to final phase of the experimental period (Table 2).

The nutritional quality of minerals in food depends on their quality as well as their bio availability. The bio availability of key minerals is significantly affected by the fibre, phytic acid and tannin content of foods. The minerals content of food is influenced by chemical stability, extent of processing, environmental factor, and the form in which foods are delivered also can impact their stability.The effect of physicochemical and functional properties of lotus seed flour exposed to low and high doses of gamma radiation (0-30 kGy) was observed (Bhat *et al.*, 2009),which showed a slight decrease of sodium levels and no change in potassium levels. Wyatt and Ronan (1983) conducted a study on effects of processing on the sodium: potassium and calcium: phosphorus content in foods and concluded that processing had a significant effect on the potassium and sodium content in canned peaches. Blanching process caused a significant increase in sodium and potassium content. However, there were no abundant studies available on the effect of radiation processing on the mineral content.

Generally, minerals do not degrade on irradiation, however, a change in their oxidation state might occur. The mineral concentrations might naturally be present between each individual sample. The possible reason for decrease of some minerals might be due to the presence of certain antinutrients at higher concentrations that could have increased on irradiation and possibly be capable of chelating the minerals cations, forming insoluble complexes leading to reduced bio availability of trace minerals.

Table 2. Gamma irradiation effect on mineral composition of mushrooms

Treatments	Sodium (mg/100g)			Potassium (mg/100g)		
	Initial Phase	Final Phase	t-value (p-value)	Initial Phase	Final Phase	t-value (p-value)
NI	8.70±0.10	10.20±0.10	12.99** (0.006)	308.33±1.53	361.33±1.15	91.79** (0.000)
I_1	9.10 ±0.10	9.70 ±0.10	6.00* (0.027)	289.33±4.62	392.00±2.00	35.33** (0.001)
I_2	10.17 ±0.15	10.33 ±0.15	1.890@ (0.199)	269.67 ±2.08	403.33 ±1.53	72.02** (0.000)
F-value (p-value)	119.38** (0.000)	23.15** (0.002)	---	120.15** (0.000)	554.26** (0.000)	---

* - Significant at 1% level; **- Significant at 5% level; @- Not Significant

The actual mechanism for decrease in some minerals is still incomprehensible, which needs further investigation. The mineral content of mushrooms is influenced by chemical stability, extent of processing and environmental factors.

CONCLUSION

Mushrooms irradiated at 0.25 kGy was least affected in PLW, colour, moisture, protein,fibreand carbohydrate content than at 0.75 kGy.The irradiation process did not affect moisture percent in mushrooms, the maximum retention was observed in 0.75 kGy irradiated mushrooms, the decrease in carbohydrate, fibrecontent and in protein content in irradiated mushrooms was due to degradation reactions such as scissions of the C-N bonds in the backbone of polypeptide chain. The irradiation of mushrooms increases the mineral content. Usually minerals do not degrade on irradiation, but a change in their oxidation state might occur. This study revealed that gamma irradiation in low doses has satisfactorily increase the shelf life of foods.

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DRAINAGE CO-EFFICIENT FOR MOLE DRAINS TO RECLAIM DEGRADED VERTISOLS OF GODAVARI BASIN

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ABSTRACT

Determination of drainage co-efficient for mole drains for Kapileswarapurammandal, East Godavari district of Andhra Pradesh was carried out by considering 26-Years daily maximum rainfall events, normal daily rainfall, Weibul's (5-Year Return Period) rainfall event, cumulative 10-day to 1-day maximum rainfall value, best fitting distribution (5-Year Return Period) value. Among all, Weibul's (5-Year Return Period) rainfall event and best fitting distribution (5-Year Return period) rainfall are close to each other and hence, the observed 1-day maximumrainfall event, which is also arrived using Weibul's method *i.e.* 157.0 mm of 1-day maximum event was considered for estimation of corresponding direct runoff. An event of 157.0 mm rainfall has potential for damaging the surface layers of the vertisols by ponding and subsurface layers by waterlogging. To evacuate both surface and subsurface matrix for avoiding the land degradation, effective drainage systems are to be designed and made functional. To do so, the direct runoff was estimated using SCS-CN method which is found to be 101.4 mm needs to be drained. The difference between the 1-day maximum rainfall event and the direct surface runoff (101.4 mm) is the abstraction amount available for preferential flow into the mole drains, i.e.55.6 mm d-1. This becomes the drainage co-efficient requirement for the mole drains of the study area, which can be used in Hooghoudt's equation to arrive at the mole drain spacing. In this study, mathematical models were developed for estimation of mole drain co-efficient (M.D.C.) for the study area and found that the it relates to 1-day maximum with 2nd order polynomial equation with co-efficient of determination of 0.9911 and it relates to return period with logarithmic equation with co-efficient of determination of 0.9869.

Key Words: Mole drainage Co-efficient, Return period, Weibul's method, SCS-CN method, Sugarcane, Ponding, Waterlogging.

INTRODUCTION

Agricultural drainage is the removal and disposal of excess water from surface and subsurface slabs of the agricultural fields. The primary source of excess water in an agricultural field is rainfall,field to field runoffs and seepage from nearby water bodies. This causes waterlogging. The National Commission on Agriculture, 1976 defined waterlogging as a situation of watertable causing saturation of crop root zone soil, resulting in restriction to air circulation, decline in oxygen and increase in carbon dioxide levels. Scott and Batchelor (1979) defined waterlogging as ponding of water over an area of crop land. Seasonal waterlogging occurs due to heavy rainfall or splash runoff, frequently

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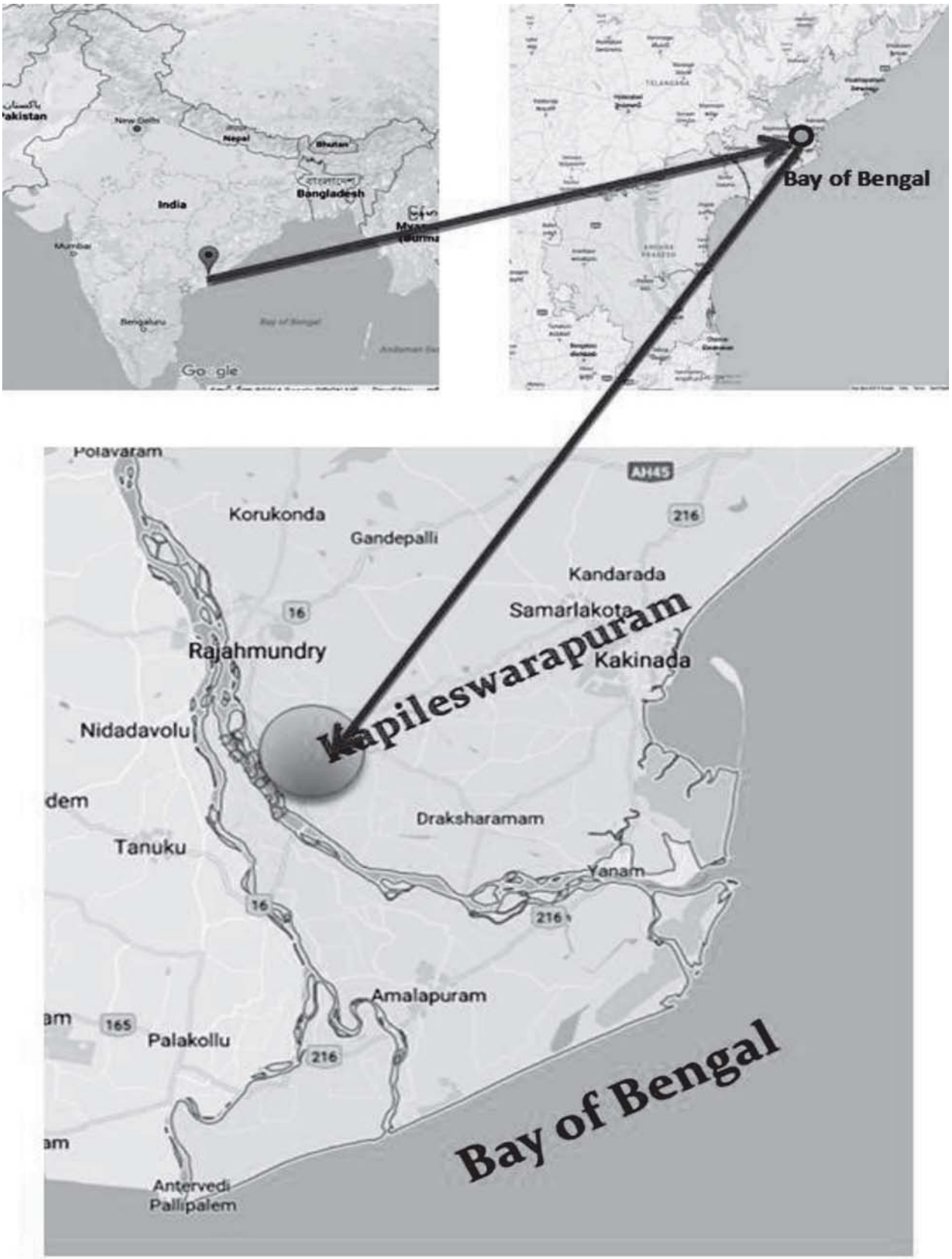

Fig. 1. Map of the study area, Kapileswarapuram

super saturating the soils for more than a week period. Out of 147 mha of degraded lands, 14.30 m ha is under waterlogging which includes 1.66 mha of wasteland (Maji*et al.,* 2010). The waterlogged soils can be successfully reclaimed using any one or combination of surface, subsurface and mole drains.

Gebrehiwot (2018) reported that the Ethiopia's agricultural production has been challenged by severe waterlogging and salinity.Lack of functional drainage system significantly contributed to waterlogging and salt build-up in irrigated fields, for which a mole drainage system is advised.

Radha *etal.* (2017) reported that waterlogging is a serious environmental constraint for optimum growth, yield and juice quality of sugarcane crop.Gomathi*et al.* (2014) reported that waterlogging drastically reduces the growth and survival of sugarcane, which leads inreduction of cane yield to the extent of 15–45 %. Under such conditions, subsurface drainage is considered as a most suitable approach for controlling these waterlogging conditions especially in vertisols. This drainage also facilitates water and salt balancing in the rootzone so as to facilitate favorable environment for the crop growth and contains the water table at suitable level; Gates and Grismer, 1989). The sugarcane crop is very sensitive to waterlogging conditions, especially, when it crosses 1400 cm-days sum of excess water index.

Drainage need is quantified in terms of drainage co-efficient. The purpose of surface or subsurface drainage of agricultural land is to prevent water from ponding on land and in the soil thus prevent damageto crops by removing excess water in a timely manner and aerate and desalinise the root zone of the soil. The drainage co-efficient of an area depends on 1-day maximum rainfall amount received in the area of interest and the duration of crop waterlogging tolerance. A model was developed to predict drainage rates from a flat tile-drained basin, using a probability analysis ofdrainage rates for the 11-year period from 1962 through 1973. Probability analysis is a sound way of choosing drainage co-efficient for designing and evaluating tile drainage systems (Sharma and Irwin, 1976).

The study (2017-2018) is conducted for reclaiming the waterlogged sugarcane fields of East Godavari district of Andhra Pradesh using mole drainage systems to enhance the yield.

MATERIAL AND METHODS

The study area is located in the Kapileswarapurammandal of East Godavari district of Andhra Pradesh, India (Fig. 1). East Godavari district is one of the agriculturally productive districts of the state. The sugarcane is cultivated in 17,000 hectares in the district during 2011-12 and the same is reduced to 10,000 hectares by 2017-18, *i.e.* at a decreasing rate of 1167 ha per year. Withdrawal from sugarcane cultivation owing to waterlogging and salinity problems resulting in poor yield, other associated farm mechanization and marketing constraints which collectively made sugarcane cultivation nonprofitablein the district. The soils of Kapileswarapuram mandal are very deep deltaic black cracking vertisols, very fine, imperfectly drained with very high available

water capacity. The normal rainfall of district is 1218 mm. More than half of the rainfall is received during south-west monsoon i.e. 758 mm (62 %). However, fairly large while a large portion of the district also benefits from the north-east monsoon (344 mm) received during October and December months.

The rainfall of Kapileswarapuram is in the range of 498 mm to 1814 mm. The long period (1990-2015) average annual rainfall is 1193 mm and out of these 26 years, there are 12 years, whose annual rainfall is above 26 years average. 1-day maximum rainfall of this area is 248.6 mm, whose fall matches with the cropping season *kharif with* predominant crops of Paddy/ Sugarcane causing waterlogging and failure of crop or reduction in growth and yields, rendering farmers with yield penalties. The rainfall analysis revealed that this area receives rainfall more than state average (990 mm) for 19 years including 5 extreme rainfall years of more than 1500 mm annual rainfall. Large one day rainfall events falling on vertisols pose a problem of waterlogging (surface and subsurface) in almost every year.

The drainage co-efficient is defined as it is the design capacity of thedrainage system and is typically expressed as a depth of water removed in 24 hours (mm day^{-1}). A drainage coefficient should be chosen such a way that it will economically remove excess water from the top part of the root zone within 24 to 48 hours.In the present case, the drainage co-efficient is determined considering the differences of overland flow, matrix flow and preferential flow phenomena. The design of surface drainage systems is done to handle the overland flow, subsurface drainage systems (tile or corrugated perforated pipe) to handle the matrix flows and watertable rise, whereas the mole drainage systems are designed to handle the preferential flows out of abstraction.

Preferential flow refers to the uneven and often rapid movement of water and solutes through porous media through fractures, warmholes, root holes, cracks, etc. The daily rainfall data of 26 years (1990-2015) of Kapileswarapuram was collected and subjected to statistical analysis to determine the 1-day maximum rainfall for the expected life of mole drainage systems of 5 years return period.

There are many probability distributions that have been found to be useful for hydrologic frequency analysis. In the study, Weibull's distribution function was used for arriving at the probability of chance of occurrence of maximum rainfall event for the study area. The daily maximum rainfall data were analyzedfor computation of 1-day maximum probable rainfall amount at 4 to 100 percent probability using Weibull's equation:

$$P = \frac{m}{n+1}$$

where,

P is the probability of occurrence,

m is the rank of the observed rainfall value after arranging them in descending order of magnitude and n is the total number of yearsof record.

RESULTS AND DISCUSSION

Rainfall analysis

The month wise daily rainfall data distribution

of the Kapileswarapuram station revealed that the rainfall is highly varying between 0 and 248.6 mm (Fig. 2) spanning from January to December. It can be inferred from the Figure 2 that the sugarcane crop in this region suffers from surface inundation for 6 months from June to November, which if not attended, results in a damage to the land, water and crop productivity. This situation alarms for facilitation of drainage systems to stop the menace of surface and subsurface waterlogging in the study area.

It is found that the 1-day maximum rainfall events are falling in the range of 42.6 to 248.6 mm in 26 years spanning from 1990-2015. The simple mean of the 1-day maximum is found to be 119.6 mm. The probability analysis of the 26 years data revealed that a 1-day maximum event of 157.0 mm (Fig. 3) is occurring with 5- year return period, which is used in determination of the mole- drainage co-efficient for the study area, Kapileswarapuram.

The analysis of the annual rainfall of the study region revealed that there are 11 years whose annual rainfall is above 26 years mean i.e. 1193 mm and 19 annual events which are more than 26 years mean and 7 events less than the average rainfall of the state of Andhra Pradesh (Fig. 4). The probability analysis was conducted for arriving at the 1-day maximum rainfall of the study area with a return period of 5 years as the effective life span of the mole drainage systems is estimated to be 3-5 years.

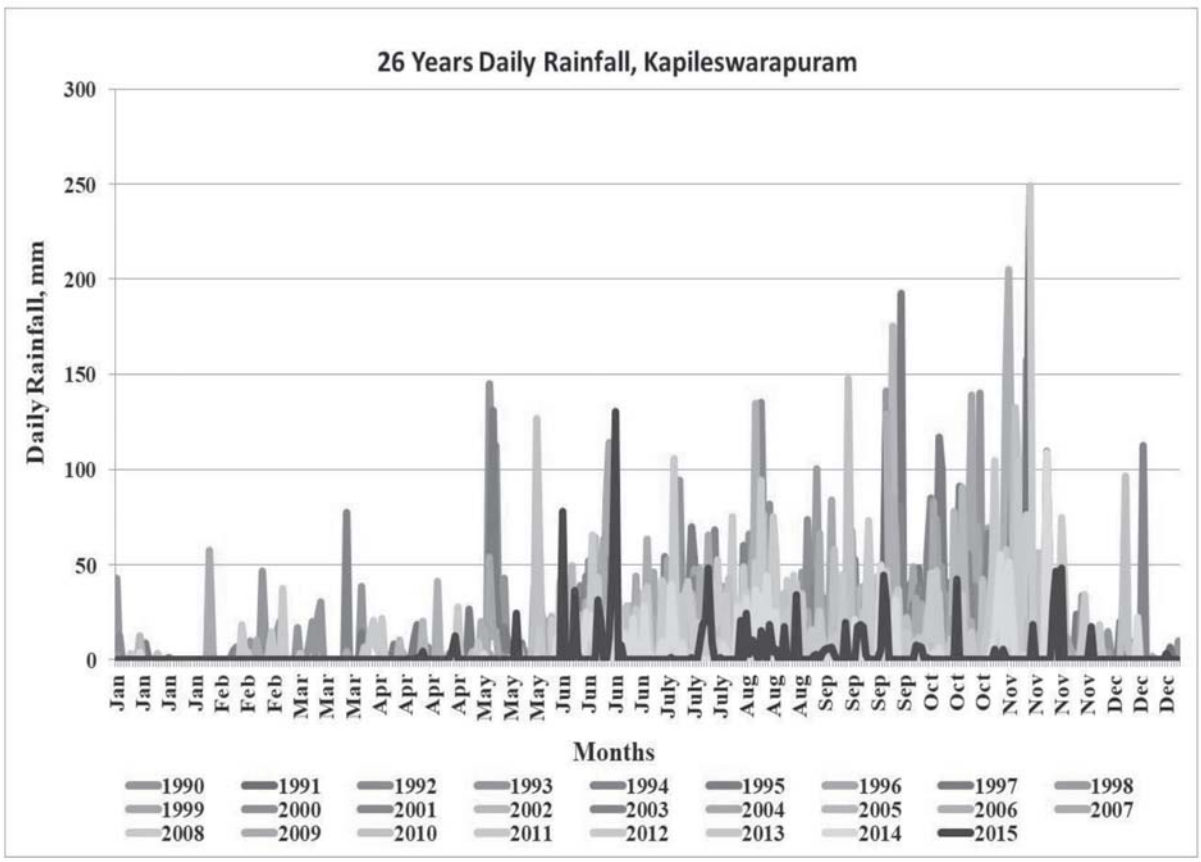

Fig.2. Daily rainfall variability in Kapileswarapuram in 26 years (1990-2015)

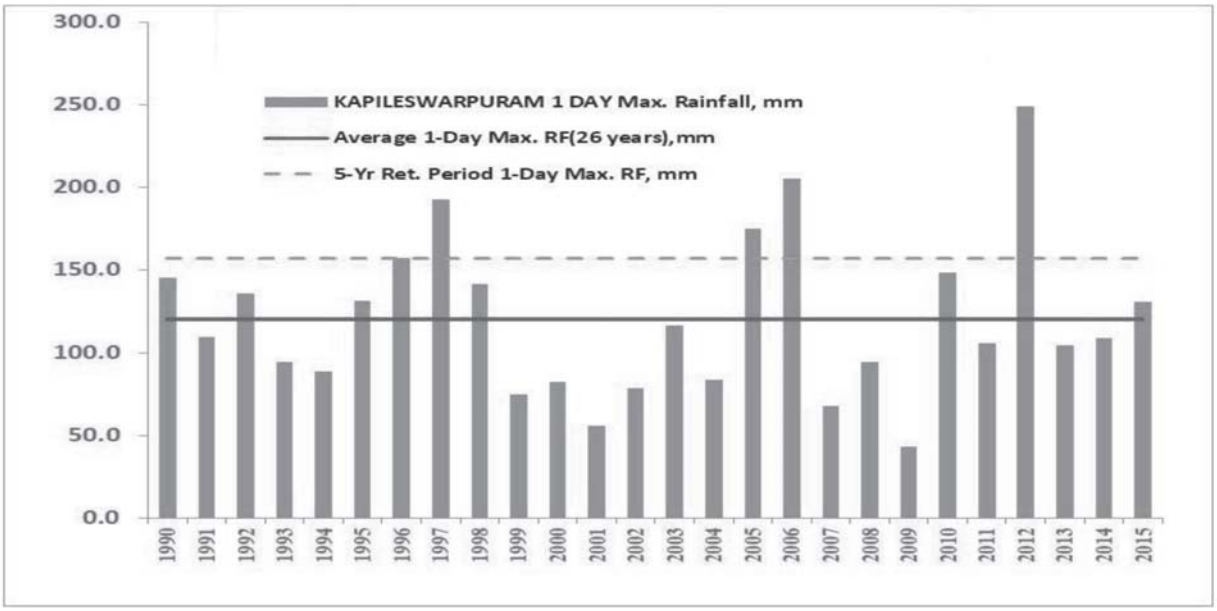

Fig.3. 1-Day maximum rainfall variability in Kapileswarapuram

The actual surface runoff/overland flow produced for the 1-day maximum rainfall event with 5-years return period i.e. 157.0 mm is 101.4 mm, and rest 55.60 mm becomes abstraction into the soil (Table 1). Out of the total rainfall received on the field, part of it becomes overland flow, which is removed by the existing surface drainage system in the fields. The rest, 55.60 mm will enter into the soil matrix through the process of infiltration and percolation and travel as interflow before it joins the groundwater table, causing it to rise. If the soil is at field capacity,the difference between soil saturation and soil field capacity moisture content, will be available for gravitation flow.If this component is not removed from the soil matrix, it will congest the most active soil-plant-nutrient matrix and causes hypoxia (deficient oxygen condition) or in extreme cases, causes anoxia (complete absence of oxygen), greatly affecting the nutrient conversion and uptake, in addition to various physiological changes in the plant system of sugarcane. The soil moisture constants of present experimental site indicate that 0.4m deep and 0.5m deep, 27mm and 34mm of abstraction respectively is sufficientto saturate the soil slab above mole drains. This means that if the drains are designed to remove the entire 55.60 mm abstraction, automatically, the smaller events will be taken care. In case of too small rainfall events, which become effective rainfall, the mole drainage channels can be closed by turning the outlet piped L-bend upwards, thus, controlled drainage can be exercised to take advantage of the effective rainfall.

To save the sugarcane crop from ill effects of waterlogging, the sub-surface is to be decongested by providing sub-surface drainage facility. If the preferential flow paths are created at this point, the removal of the gravitational water component of the abstracted portion of the rainfall will be easily achieved. The mole drainage, a simple, low-cost and instantaneous

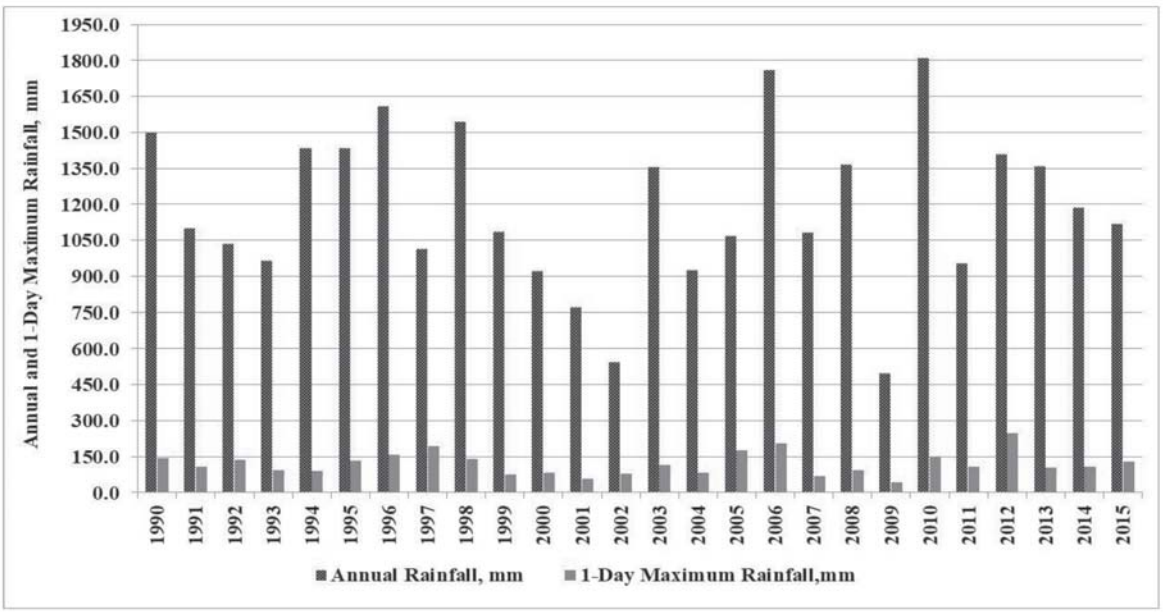

Fig. 4. Annual and 1-Day maximum rainfall distribution in Kapileswarapuram

sub-surface drainage system facility will do this job for the soil–plant-nutrient matrix by removing the preferential flows.

An attempt has been made in the study to rationalise the estimation of drainage co-efficient for the mole drainage system design. It is revealed from the Table 1 that the additional drainage facility like mole drains become essential in all the years. This also helps in evacuating the surface waterlogging due to seepage or baseflow, if any, coming from the nearby water bodies which are in hydraulic connection with the sub-soil layers upto 0.4m – 0.5 m depth, as per the depth of the mole drains installed.

The determination of drainage co-efficient was cross verified with the various options by considering rainfall events of 26-Year daily maximum value, Normal daily value, Weibulls(5-Year Return Period) value, Cumulative 10-day to 1-day maximum value, Best Fitting Distribution (5-Year Return Period) value as presented in the Table 2. It is found that among all, the Weibulls (5-Yearreturn Period) value and Best Fitting Distribution (5-Year return period) value are close to each other and hence, the real rainfall event value of 157.0 mm of 1-day maximum event considered for estimation of corresponding direct runoff is found to be appropriate.

The mole drainage co-efficient is separated from the total drainage co-efficient of the region in order to rationalise the difference between the overland flows, preferential flows and matrix flows. The contribution of matrix flow into the mole drains will be conceptually avoided by facilitating the fractures for preferential flow into the mole drain channels. The finally arrived mole drainage co-efficient for the study area is about 55.60 mm d^{-1} (Table 1).

Based on the review made for this study, it is found that many have focused on the empirical selection of the mole drain spacing, without considering the drainage co-efficient. The

Table 1. Estimation of mole drainage co-efficient

S.No.	Year	1 DAY Max. Rainfall, mm	Year	Daily Max. Rainfall, mm (Descending Order)	Rank Number, m	Probability, P= m/(n+1)	Return Period, T=1/P, Years	Rainfall, mm	Direct Runoff / Overland flow, (Surface drainage Co-efficient), mm	Abstraction available for Preferential flow (Mole Drainage Co-efficient),mm d^{-1}
1	1990	144.8	2012	248.6	1	0.04	27	248.6	186.2	62.4
2	1991	109.2	2006	204.6	2	0.08	14	204.6	144.9	59.7
3	1992	135.0	1997	192.2	3	0.12	9	192.2	133.4	58.8
4	1993	94.0	2005	174.8	4	0.15	7	174.8	117.4	57.4
5	1994	88.6	**1996**	**157.0**	**5**	**0.19**	**5**	**157.0**	**101.4**	**55.6**
6	1995	130.8	2010	147.6	6	0.23	5	147.6	93.0	54.6
7	**1996**	**157.0**	1990	144.8	7	0.27	4	144.8	90.5	54.3
8	1997	192.2	1998	140.8	8	0.31	3	140.8	87.0	53.8
9	1998	140.8	1992	135.0	9	0.35	3	135.0	81.9	53.1
10	1999	74.4	1995	130.8	10	0.38	3	130.8	78.3	52.5
11	2000	81.8	2015	130.2	11	0.42	2	130.2	77.8	52.4
12	2001	55.4	2003	116.2	12	0.46	2	116.2	65.8	50.4
13	2002	78.2	1991	109.2	13	0.50	2	109.2	59.9	49.3
14	2003	116.2	2014	108.4	14	0.54	2	108.4	59.3	49.1
15	2004	83.4	2011	105.8	15	0.58	2	105.8	57.1	48.7
16	2005	174.8	2013	104.4	16	0.62	2	104.4	56.0	48.4
17	2006	204.6	2008	94.4	17	0.65	2	94.4	47.9	46.5
18	2007	67.6	1993	94.0	18	0.69	2	94.0	47.6	46.4
19	2008	94.4	1994	88.6	19	0.73	1	88.6	43.3	45.3
20	2009	42.6	2004	83.4	20	0.77	1	83.4	39.3	44.1
21	2010	147.6	2000	81.8	21	0.81	1	81.8	38.1	43.7
22	2011	105.8	2002	78.2	22	0.85	1	78.2	35.4	42.8
23	2012	248.6	1999	74.4	23	0.88	1	74.4	32.6	41.8
24	2013	104.4	2007	67.6	24	0.92	1	67.6	27.7	39.9
25	2014	108.4	2001	55.4	25	0.96	1	55.4	19.4	36.0
26	2015	130.2	2009	42.6	26	1.00	1	42.6	11.7	30.9

Table 2. Comparision of Mole drainage co-efficient determined using different approaches

Item Description	26-Year. Daily Maximum	Normal 1-Day Maximum Rainfall	Weibulls Method, 5-Year Return Period, 1-Day Max.	Best Fitting Distribution out of 71 distributions, Generalised Logistic distribution, CUMFREQ software
Rainfall,mm	**248.60**	**119.60**	**157.00**	**158.96**
CNI	78.00	78.00	78.00	78.00
S	71.64	71.64	71.64	71.64
Ia= 0.1*S	7.16	7.16	7.16	7.16
0.9*S	64.5	64.5	64.5	64.5
Direct Runoff/Overland flow, mm \ (SCS-CN Method) (Surface Drainage Co-efficient), mm/day	186.2	68.7	101.4	103.1
Mole Drainage Co-efficient, mm/day	62.41	50.92	**55.6**	55.83

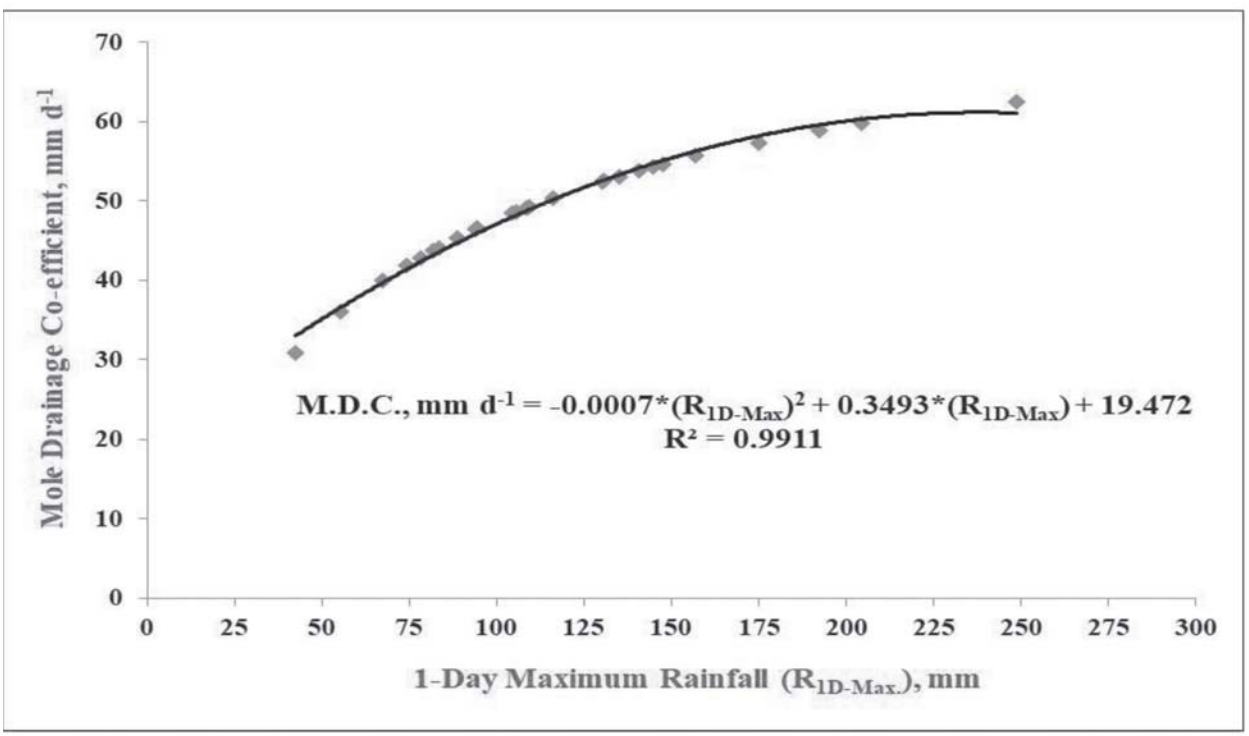

Fig.5. Model for mole drainage co-efficient vs 1-Day maximum rainfall for Kapileswarapuram

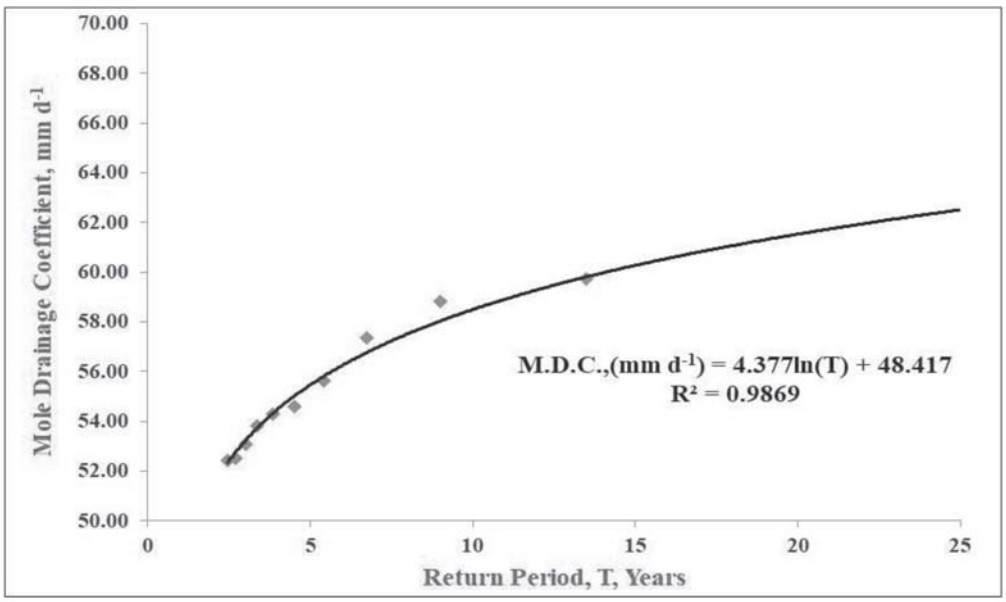

Fig. 6. Mathematical model for mole drainage co-efficient vs return period for Kapileswarapuram

Table 3. Mathematical models developed for Mole drainage co-efficient

Relationship between		Mathematical Model Developed	R^2 Value
Mole Drainage Co-efficient (M.D.C.), mm d^{-1}	1-Day Maximum Rainfall ($R_{1D\text{-}Max.}$)	M.D.C (**mmd^{-1}**)=-0.0007*($R_{1D\text{-}Max}$)^2+0.3493* ($R_{1D\text{-}Max.}$) +19.472	0.9911
	Return Period(T), Years	M.D.C (**mmd^{-1}**)= 4.377*ln(T) + 48.417	0.9869

present study establishes a scientific relationship between the preferential flow, drainage co-efficient and the mole drain spacing for effective mole drainage and thus reducing the land degradation due to waterlogging to enhance sugarcane yields. The preferential flow is the main component identified as drainage co-efficient for the design of the mole drain spacing using Hooghoudt's equation. Analysis of rainfall data using the procedure developed in this study gives the rational and new approach for arriving mole drainage co-efficient to determine spacing for moling of vertisols.

CONCLUSION

Among the different approaches studied, the Weibulls (5-Year Return Period) value and Best Fitting Distribution (5-Year Return period) value are close to each other and hence, the observed rainfall event value (157.0 mm of 1-day maximum), which is also arrived using Weibuls method was considered for estimation

of corresponding direct runoff. The corresponding abstraction amount is found to be 55.6 mm d^{-1}, which needs to be drained through preferential flows. This becomes the drainage co-efficient requirement for the mole drains, which can be used in Hooghoudt's equation to arrive at the mole drain spacing for designing of mole drain spacing to effectively reclaim the degraded lands for further crop development. The new procedure developed in this study exemplifies the capability to use analytical solutions like Hooghoudt's equation for design of mole drain spacing.

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INFORMATION NEEDS OF RURAL PREGNANT WOMEN IN GUNTUR DISTRICT

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ABSTRACT

The study (2018-'19) focused to identify the information needs of rural pregnant women by adopting exploratory research design in order to address the existing knowledge gaps. A sample size of 90 rural pregnant women from nine villages of Guntur district were selected for the study. Results indicated that majority of the pregnant women have expressed their information needs on antenatal registration process, laboratory tests, obstetric complications, high risk pregnancy, nutrition during pregnancy, etc. Awareness about various Govt. schemes and programmes was appreciable among the pregnant women as great majority (87.77%) of the respondents availed them. Information sources for the pregnant women were mainly parents (91.11%) which ranked first, followed by health department (88.88%) which ranked second, and Department of Women Development and Child Welfare (86.66%) which ranked third.

Keywords: Information needs, Rural, Pregnant women, Guntur District.

INTRODUCTION

Pregnancy is a crucial period in women's life. It is a physiological condition where great care should be taken during this phase as it involves the dual life of mother and foetus. In rural India, much significance is not given considering it as a normal condition. Hence whatever information that was given by their family members, elders and neighbours were taken into consideration for their health care leading to various complications in pregnancy sometimes resulting in increasing Maternal Mortality Rate (MMR) and Infant Mortality Rate (IMR). This is due to lack of adequate knowledge and information availability to the rural folk in India. Hence, there is a great need to empower the rural pregnant women with scientific knowledge and technological development in the field of health.

There is a declination in Maternal Mortality Rate (MMR) from 130 per one lakh live births in 2014-16 to 122 per one lakh live births in 2015-17. However, the study was formulated on pregnant women as the state of Andhra Pradesh have not shown any change in the ratio (GoI,2017).This approach will contribute indirectly to reach the Millennium Development Goals by reducing complications of rural pregnant women thereby decreasing maternal mortality rate and infant mortality rate.

Mulauzi and Daka (2018) revealed that maternal health information is a foundational

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element of women's positive health during prenatal period, childbirth and the postnatal period. All around the world, a lot of attention is provided on mother and child health care, but still many maternal information needs are unfulfilled. Rural women generally possess inadequate information and education on health care during pregnancy and as a result, the mortality rate during child birth is still high, chiefly in developing countries. Hence, the study was focused on identification of information needs of rural pregnant women.

MATERIAL AND METHODS

This study was conducted in Guntur district of Andhra Pradesh during the year 2018-19. Three mandals and three villages from each mandal were selected randomly. Ten pregnant women were selected from each village, thus, making a total sample of ninety respondents from nine villages for the study. After thorough literature survey, an interview schedule was developed using dichotomous items such as 'Unaware' and 'Aware' duly assigning '1' and '2' scores respectively to elicit the informational needs on prenatal and postnatal care from the pregnant women. Based on the total score of each type of information the highest score given for the 'unaware' option represents the information gap and were finalised as the information needs of the selected pregnant women.

RESULTS AND DISCUSSION

Information needs during prenatal period

Identifying the information needs of the selected respondents is vital to assess the existing knowledge gaps of the pregnant women on prenatal care. Prenatal period refers to the stage in which a baby develops from a single cell after conception into an embryo and later into a foetus *i.e.* during the period of pregnancy.

Table 1. Classification of rural pregnant women based on the information needs during prenatal period (n=90)

S. No.	Information need	Unaware		Aware	
		Frequency (f)	Percentage (%)	Frequency(f)	Percentage(%)
1.	Expected date of delivery calculation	88	97.77	2	2.22
2.	Antenatal registration	53	58.88	37	41.11
3.	Symptoms during the pregnancy	52	57.77	38	42.22
4.	Laboratory investigations	47	52.22	43	47.77
5.	Scanning	48	53.33	42	46.66
6.	High risk pregnancy	73	81.11	17	18.88
7.	Obstetric complications	77	85.55	13	14.44
8.	Nutrition during the pregnancy	68	75.55	22	24.44
9.	Personal care to be taken during the pregnancy	48	53.33	42	46.66

Information needs during prenatal period includes expected date of delivery (EDD) and its calculation, antenatal registration, symptoms during pregnancy, laboratory investigations, scanning, high risk pregnancy, obstetric complications, nutrition during pregnancy and personal care to be taken during pregnancy.

The results (Table 1) revealed that majority of the pregnant women were unaware about information on calculation of Expected Date of Delivery (97.77%) followed by obstetric complications during pregnancy (85.55%) high risk pregnancy (81.11%), nutrition during pregnancy (75.55%), antenatal registration (58.88%), symptoms during pregnancy (57.77%), scanning (53.33%), personal care to be taken during pregnancy (53.33%) and laboratory investigations (52.22%). The answer 'unaware' by the respondents was considered as information needs.

Kamali *et al*. (2017) in their study on information needs of pregnant women in Iran, reported that most of the pregnant women needed information about care of the foetus development and growth, pregnancy nutrition, special tests during pregnancy and vaccination in pregnancy etc.

Although many pregnant women were aware about various components of prenatal care, they were eager to know the latest and detailed information due to increasing number of abortions at first time conception and complications during past pregnancy. Hence, the pregnant women preferred the detailed information on the above aspects.

Information needs during postnatal period

Information needs during postnatal period included nutritional care, postpartum threat signs of mother, new born care and personal care to be taken after delivery.

Majority of the rural pregnant women needed information on postpartum threat signs of mother, new born care (93.33%), nutritional

Table 2. Categorization of rural pregnant women based on the information needs during postnatal period (n=90)

S. No.	Information need	Unaware		Aware	
		Frequency	Percentage	Frequency	Percentage
1.	Nutritional care during postnatal period	77	85.55	13	14.44
2.	Postpartum threat signs of mother	89	98.88	1	1.11
3.	New born care	84	93.33	6	6.66
4.	Personal care to be taken after delivery	28	31.11	62	68.88

care during postnatal period (85.55%) and personal care to be taken after delivery (31.11%).The reason behind expressing the requirement of above information might be the lack of knowledge and excessive information availability and accessibility which leads to dilemma among the pregnant women (Table 2).

Superstitions on Pregnancy

Superstitions are any beliefs or practices that are prevailing in the society due to false conceptions. There are various kinds of superstitions regarding pregnancy and the study focused on the existing superstitions.

Table 3. Classification of respondents based on their superstitions (n=90)

S. No.	Superstitions	Not existed		Existed	
		Frequency (f)	Percentage (%)	Frequency (f)	Percentage (%)
1.	Food	4	4.44	86	95.56
2.	Medical	62	68.88	28	31.12
3.	Social	5	5.55	85	94.45

Results indicated that superstitions during pregnancy were existing among the respondents and they were categorised as food, medical and social superstitions. A great majority of the women had superstitions regarding food (95.55%) followed by social (94.44 %) and medical superstitions (31.11 %) (Table 3). The reasons for existing superstitions were due to the outdated taboos, myths prevailing in the rural families which were deep rooted and transferred from generation to generation. The other major causes might be due to the lack of scientific knowledge about pregnancy.

Awareness on Government schemes and programmes

In order to benefit the rural pregnant women, Govt. implements various schemes and programmes to maintain the health of both the pregnant women and the children. Hence, awareness about such schemes and programmes among the pregnant women helps to access the benefits.

The results revealed that 87.77 per cent of pregnant women were aware about current schemes of Government, while 12.22 per cent of the respondents were unaware about the schemes and programmes (Fig.1).

The increased awareness on the schemes and programmes among pregnant women was due to its higher rate of adoption, as these services were offered by the initiation of local extension units such as anganwadi centres and Primary Health Centres (PHC's). The current schemes and programmes such as *Janani Suraksha Yojana, Anna amruthahastham, and*

Pradhan Manthri mathru Vandana Yojana are effectively implemented by the government and various monetary and non-monetary benefits re given to the pregnant women irrespective of the caste and creed. Hence, the information related to schemes and programmes for the pregnant women is not considered as information need.

Information source

In order to gain any information, the source of information plays an essential role by providing knowledge (Table 4). Among the family and friends, the major information source was parents (91.11%) followed by in-laws (80.00%), relatives (36.66%), neighbours (27.77%) and friends (5.55%).

Awareness of rural pregnant women on Government Schemes & Programmes (n=90)

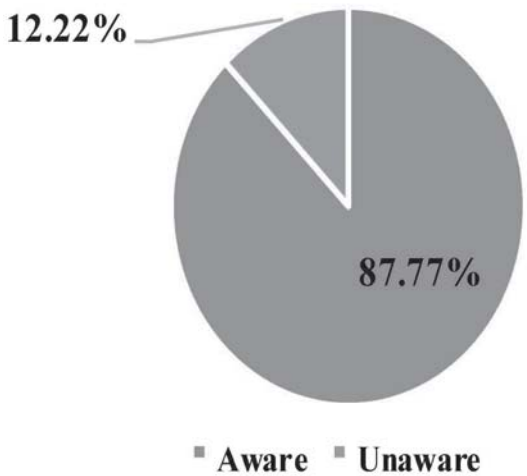

Fig. 1. Pie diagram showing the awareness of Government schemes and programmes of rural pregnant women

Among the extension personnel, information source for pregnant women was health department (88.88%) followed by Anganwadi centre from Women Development and Child Welfare Department (86.66%).

Information source for pregnant women from media was less and it was as followed in the order from internet (20%), television (16.66%) and newspaper (2.22%). The reason could be due to the lack of knowledge and accessibility to media and its usage. A meagre per cent of pregnant women (2.22%) expressed other sources such as school teachers, Non-Government Organizations etc as the information source.

With regard to rank order of the Information source for the selected respondents on care during pregnancy, parents (91.11%) were placed in first rank followed by Health Department – in second rank (88.88%) and Department of Women Development and Child Welfare – in third rank (86.66%), in-laws – in fourth (80.00%) and relatives – in fifth rank (36.66%).

Table 4. Classification of respondents based on their information source (n=90)

S. No.	Category	Frequency (f)	Percentage (%)	Rank order
1.	**Family and friends**			
	Parents	82	91.11	I
	In-laws	72	80.00	IV
	Relatives	33	36.66	V
	Neighbours	25	27.77	
	Friends	5	5.55	
2.	**Extension personnel**			
	Health department	80	88.88	II
	Department of Women Development and Child Welfare	78	86.66	III
3.	**Media**			
	Newspaper	2	2.22	
	Television	15	16.66	
	Internet	18	20.00	
4.	**Any other sources (school teacher, NGO, etc.)**	2	2.22	

The Rank 'I' was given to parents as they were the most trustworthy, experienced and well informed members in the society, wherein, women can freely share and express their views. Extension personnel from Health Department were placed in Rank 'II' due to their reliable technical expertise and frequent interactions with the pregnant women.

Onuoha and Amuda (2013) reported that majority of the respondents (93.4%) stated that doctors were the most available source of information followed closely by the nurses, prenatal health education classes, television, friends and family members etc.

CONCLUSION

Results revealed that information needs of pregnant women during prenatal period were on calculation of expected date of delivery followed by obstetric complications during pregnancy, high risk pregnancy, nutrition during pregnancy, etc. Information needs during

postnatal period were on postpartum threat signs of mother, new born care, nutritional care during postnatal period and personal care to be taken after delivery. Awareness about various government schemes and programmes was appreciable among the pregnant women as a great majority of the respondents availed them. Major information source for pregnant women were parents followed by health departments.

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CASE STUDY ON GROUNDNUT CULTIVATION IN COASTAL SANDY SOILS IN SPS NELLORE DISTRICT OF ANDHRA PRADESH

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ABSTRACT

The case study was undertaken to document the cultivation practices from seed to seed and issues related to the intensive cultivation of groundnut crop in coastal sandy soils during Rabi season of2018-19. A total of around 4000 acres is spread in a single patch of area, wherein, farmers from 10 habitations in three revenue villages cultivate groundnut as mono crop as their main livelihood since last three decades as a common group activity. The farmers are following their own groundnut cultivation package of practices tried and tested by themselves to suit their coastal sandy soils ecosystem. The unique cultivation practices the farmers are following include taking up uniform crop calendar, use of single variety *viz.,* TAG 24,seed rate 200-240 kg of kernels per acre, use of own seed, sowing by seed drill, cent percent seed treatment, use of higher doses of weedicides, higher rate of fertilizer application, sprinkler irrigation, contract mode of labourfor operations and sheep penning.Some of the identified constraints as perceived by the farmers include lack of advanced suitable short duration varieties, lack of recommended package of practices, lack of combined harvester and threshers, labour shortage during peak season, water shortage during drought years and no storage facility. SWOT analysis indicates some of the important aspects to be strengthened, attended and addressed for sustainable development of groundnut cultivation in the study area.

Keywords : Groundnut cultivation, Coastal sandy soils, Package of practices,Constraints in cultivation and SWOT analysis.

INTRODUCTION

India has an extended coastline of approximately 7516.6 km (mainland 5422.6 km and Island Territories 2094 km) (CCZMCSB, 2020) and the State of Andhra Pradesh is one of the coastal stateshaving974 kmlength (EDB,2020) of coastal lands. SPS Nellore district is one of the coastal districts of Andhra Pradesh which is having a coast line of 163 km length (CPO, 2018) of Bay of Bengal on East.

Groundnut is an important commercial crop in Andhra Pradesh cultivated in an extent of 7.35 lakh hectares(DES, 2018) in various types of soils but predominantly grown in red soils. As groundnut crop grows well in loose textured soils, it is being cultivated in some locations of coastal sandy soils in SPS Nellore, Prakasam, Guntur and Krishna districts of Andhra Pradesh.

Coastal sandy soils are predominant along the coast line and are characterised by light texture with poor nutrient status, low Cation

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Exchange Capacity (CEC) and soil organic matter coupled with low microbial activity, deficit in zinc and boron (Singravel *et al.,* 2005). To add, these coastal sandy soils have low water holding capacity, low fertility and non-suitability for majority of crops, thus creating complex management problems for farmers to cultivate crops (Caldwell *et al.,* 2005). In spite of the adversities due to poor soil conditions, still, farmers are cultivating groundnut crop with unique local practices for sustaining their livelihood in their coastal sandy soils.

One such case is coastal sandy soils in Vidavaluru mandal of SPS Nellore district in Andhra Pradesh. Spread across ten habitations in three revenue villages of the mandal, a stretch of around 4000 acres in a single geographical areais under intensive monocropping of groundnut crop since last three decades. Groundnut cultivation is the only livelihood for all the farmers in study area. The farming community comprises majorly of small and marginal farmers with an average land holding ranging from 3 to 20 acres. Earlier, farmers cultivated yam, vegetables, greens in their sandy soils, and later all the farmers switched to cultivation of groundnut crop (as mono crop) since last three decades because of higher returns. All the farmers in the area adopted similar cultivation practices like following one crop calendar, common package of practices, common set of inputs, group marketing, etc. Presently, a set of recommended groundnut cultivation practices are available for red loamy soils and red soils, but they are largely differing from the practices being followed by the farmers in the study area.As the cultivation in coastal sandy soils required entirely a new set of practices and inputs with varied doses and their mode of application, farmers started cultivating groundnut crop with their own practices and refining them on a trial and error basis since last three decades.At present, farmers were practicing a set of cultivation practices like more seed rate, excess fertilizer application, dense plant population, single variety cultivation, more frequent irrigation, etc., which are entirely different from the regular groundnut cultivation practices available for red sandy loamy soils.

The farmers cultivating groundnut in coastal sandy soils were in need for location specific groundnut production technology for reduction of cost of cultivation and more quality yield. Case studies will explore complex interventions of the farming community in special conditions (Yin, 2003). To feed the research and extension systems with a real-time situation of groundnut cultivation in coastal sandy soils, this case study was taken up to understand the various cultivation practices, inputs usage patterns, returns, etc. The study aimed at documenting farmers' practices such that these can be taken up by the research system to develop a suitable groundnut production technology for coastal sandy soils. Further, the study also aimed to document the constraints as perceived by famers and to identify the Strengths, Weaknesses, Opportunities and Threats (SWOT) of cultivating groundnut in coastal sandy soils.

MATERIAL AND METHODS

A descriptive case study design was adopted for the purpose and cultivation of groundnut in coastal sandy soils in real-life context in which it occurred was studied (Yin, 2003)ten habitations in three revenue villages *viz.,* Varini,Utukuru and Mudhivarthi of Vidavaluru mandal of SPS Nellore District during *Rabi* season of 2018-19.In the study area,three Focus Group Discussions (FGD) were conducted involving 20 key informant cultivating farmers.The key informants were selected based on their experience in the groundnut cultivation (more than ten years). Focus group discussion is a technique where a researcher assembles a group of individuals to discuss a specific topic, aiming to draw from the complex personal experiences, beliefs, perceptions and attitudes of the participants through amoderated interaction, Morgan, 1996).

An open-ended format was prepared to document diverse aspects during FGD in a systematic way covering cultivation aspects from seed to seed and other related aspects. The content collected during group discussion was cross checked with the selected key informants in the study area and later entire cultivation practices from seed to seed was arranged in a systematic schemata and constraints being faced by the farmers while cultivating the groundnut crop in coastal sandy soils were recorded.To get more insight into the pros and cons, strengths, weaknesses, opportunities and threats (SWOT) analysis was also carried out cultivation in Coastal sandy soils more sustainable by addressing major issues of concern.

RESULTS AND DISCUSSION

The cultivation practices being followed by the farmers in the study area and observations recorded (Table 1) are as follows:

Table 1. Cultivation practices followed by the farmers in Coastal sandy soils

Aspects	Practices followed by the farmers	Observations
Seasons	First Season - May 15th -June 15th to October Second season - December to March	Farmers cultivate in two seasons. All the farmers follow the similar crop calendar.
Variety	TAG 24	Since last ten years farmers were cultivating only one single variety *viz.,* TAG 24. Farmer preference for this variety was due to its short stature, early maturity (less than 100 days), suitable for high density sowing, higher yield and availability of market for table purpose.
Source of seed	Own seed stored in gunny bags	All the farmers retain their own seed for the next season and this is happening since decades. This helped them for taking timely sowing. Use of own seed also reduced the cost to incur for the seed procurement besides maintaining quality of the seed.

Table 1 Contd...

Table 1 Contd...

Aspects	Practices followed by the farmers	Observations
Seed rate and spacing	Seed rate 200-240 kg kernel per acre of land	Very high seed rate was used for dense planting (100 plants per square meter).
Preparatory cultivation	Tractor drawn Cultivator	Entire operation was done on per acre contract basis for all the farmers at the same time.
Sowing	Tractor mounted seed drill	Complete sowing operation in the entire area is undertaking with tractor mounted seed drill on contract hire basis@ Rs. 1000 per acre. Some innovative farmers in the study area brought seed drills ten years before and now all the farmers were using the 16 tyned seed drill for sowing operation.At present, many farmers now own these type of seed drills.
Seed treatment	Seed treatment with Mancozeb 45 and Carbendazim	Each and every farmer follow seed treatment without fail to curtail soil borne pathogens.
Weed management	**Pre-emergence:** Pendimethalin (or) Butachlor @2 -2.5 litre per acre (or) Pendimethalin 1litre + Butachlor 1 litre in 200 litres of water by power sprayers (8-9 tanks per acre) **Post emergence:** Two hand weedings at 20 and 40 days after sowing	Pre-emergence weedicides were being applied at higher rate than the recommended (recommend dose @1 litre peracre. Crop was maintained weed free for the entire season with two hand weedings manually.
Manures	FYM @ 2 t per acre per year	In spite of less availability and high cost during the sowing season all the farmers are still applying at least two tonnes of FYM per acre.
Fertilizers	Basal: Urea - 50kg per acre; SSP 150 kg per acre I Topdressing at 20DAS: 28:28:0 @ 50 kg per acre; Urea@ 25 -50 kg per acre II Top dressing at 40 DAS: 50 kg of 14:35:14 per acre and Urea @ 25-50 kg per acre. Gypsum @200 kg per acre III Top dressing at 60 DAS: Urea @ 25-50 kg per acre	When compared to the recommended dose of fertilizers for red loamy soils, farmers in the study area were applying very high dose of fertilizers. Due to more leaching of nutrients, very high plant density and continuous irrigation for every three to five days during the entire crop season, farmers opted for applying more fertilizers to replenish the nutrient availability to the crop. Farmers were resorting to use of complex fertilizers to overcome the labour shortage that is required for mixing and application of straight fertilizers.

Table 1 Contd...

Table 1 Contd...

Aspects	Practices followed by the farmers	Observations
Irrigation water management	Sprinkler irrigation for entire area	Entire area is under sprinkler irrigation systems. Water is available in tube wells at 20 feet depth. Irrigation was given for every three to five days for the entire crop season. Recently, some farmers adopted micro sprinklers (@10 raisers per acre) to save water. For all the fields, irrigation operations were done by specially skilled labour on contract basis @ Rs.2000 per month per acre. One skilled man has been engaged for every six acres.
Pest and Diseases	Insects *viz.,*Spodoptera and diseases viz.,leaf spots, Stem and Bud necrosis are common	A total of 8-9 sprays with different mix of agro-chemicals were applied during one cropping season as per the availability of chemicals.
Harvesting & Heaping	Manual harvesting	Harvesting was done with 25 women labour per acre. Some farmers were completing the harvesting on contract basis @ Rs. 5000 per acre. After harvesting farmers used to leave the harvested crop in their fields itself for five days to dry and make it ready for threshing.
Threshing and separating pods	Machine threshing. Around 100 machines were available in the area.	Farmers were using local threshing machine on rental basis @Rs.4000 per acre and completes in three hours. After separation, pods allowed to dry in the field itself for one day.
Bagging	Plastic sheet bags of 40 kg of pods.	Farmers take the portion of the produce for storing in gunny bags for the seed purpose for next season and remaining produce was bagged for sale in plastic bags.
Yield range	45-55 bags per acre	Ranged from 1800 -2200 kg pods per acre. Some farmers harvesting 2600 - 2800 kg pods per acre.
Haulms	Left in the field for sheep feeding.	After threshing, the haulms, were left in the field itself. Sheep herds (about 20-25 herds with 400-500 sheep in each herd) from the nearby areas visit the harvested fieldsto feed on the haulms by staying around 45-60 days. The farmers were being benefited by sheep penning for enriching their soil.
Farm Mechanization	Adopting mechanization for many farm operations	Due to intensive cultivation and for taking timely operations on a common crop calendar basis farmer opted for more mechanization and using machines for field preparation, sowing operations, spraying of agrochemicals, irrigation and threshing operations. During the study, farmers expressed their need to have a combined harvester and thresher to harvest the produce in less time and also to overcome the labour shortage during the harvesting time.

Table 1 Contd...

Table 1 Contd...

Aspects	Practices followed by the farmers	Observations
Marketing	Buyers come to fields during harvesting season. Other area farmers also buy for seed purpose.	As the entire area of around 4000 acres was in one locationand availability of large quantity of produce, the buyers came to the fields to purchase the produce. These farmers are supplying majority of seed required by the other farmers in the district for sowing Khairf season crop from the Rabiseason crop produce. There is huge potential for groundnut seed production in the study area.

Table 2. Major constraints perceived by the farmers in the study area with regards to groundnut cultivation in coastal sandy soils

S. No.	Perceived Constraint	Priority Rank
1	Lack of improved short duration varieties suitable for coastal sandy soils	I
2	Lack of recommended package of practices for coastal sandy soils	II
3	Lack of combine harvester and threshers to overcome labour problem	III
4	Labour shortage during peak season	IV
5	Water shortage during drought years leading to reduced area under cultivation	V
6	Lack of facility for storage of the produce for better market price or for storing it forseed purpose	VI

The constraints perceived by the farmers were prime importance to consider and work out the strategies for reducing losses and address them by developing cost reduction cultivation technologies. Few constraints such as 'lack of improved short duration varieties' and 'research based recommended package of practices' can be taken up as future researchable issues (Table 2).The constraint of lack of storage facility can be addressed by establishing seed godowns so that intensive seed production activity can be taken up.

SWOT Analysis of groundnut cultivation in Coastal sandy soils

SWOT analysis results (Fig. 3.) reveal that the strengths identified during SWOT analysis include high suitability of the soil for groundnut cultivation, no alternative suitable and remunerative crop other than groundnut and more irrigation water availability and good livelihood for the farmers. When opportunities were examined, there was a possibility of complete seed to seed mechanisation of groundnut cultivation, promotion of Custom Hiring Centres (CHCs) for farm machinery, initiating Farmers Producers Organisation (FPO) especially for seed production, instead of selling the pods in the field as bulk to the traders, farmers can start processing and value

addition activities As area is under intensive cultivation of groundnut,the entire area or a significant part of the area can be promoted as seed production hub by the competent seed agencies.

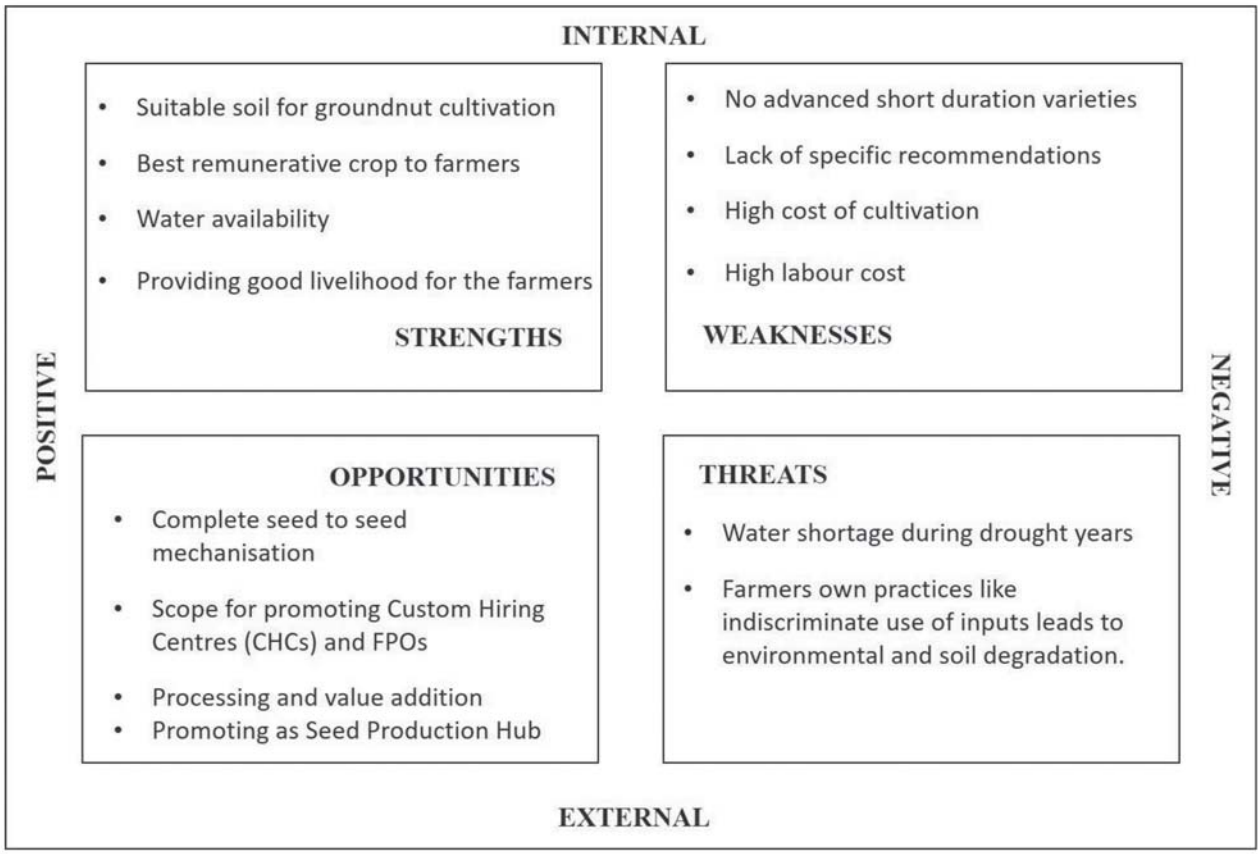

Fig. 3. SWOT analysis of groundnut cultivation in coastal sandy soils in SPS Nellore District

The major weaknesses were non-availability of suitable short duration varieties, lack of specific package of practices / recommendations suitable for coastal sandy soils, high cost of cultivation due to heavy application of inputs and more labour cost. On the other hand, the perceived threats include water shortage in the tube wells during the drought years leading to the reduction in the area of cultivation. Due to lack of recommend package of practices, farmers own practice and desire to take more yield led to indiscriminate use of inputs and there by leading to soil and environmentdegradation.

CONCLUSION

The case study documented the groundnut crop cultivation practices being followed by the farmers as a groupin coastal sandy soils of SPS Nellore district. Even without standard location specific recommended package of practices coastal sandy soils in the study area, farmers were intensively cultivating the groundnut crop since decades. The documented practices will become a source for formulating researchable issues for development of suitable package of practices in these ecosystems. The research-able issues as detailed in this case study will

help to conduct the On-farm research in the study area in Participatory Technology Development (PTD) approach to develop interventions and suitable location specific technologies which may also be useful for similar coastal sandy soils ecosystems where groundnut is being cultivated.There isa huge potential in this district to promote Custom Hiring Centres (CHCs) mechanisation, development of Farmers Producers Organisations (FPOs), promotion of processing centres, and seed production hub.

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CAREER PREFERENCE ASSESSMENT OF AGRICULTURAL STUDENTS USING PAIRED COMPARISION METHOD

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ABSTRACT

The study was conducted among 300 agricultural graduates of Kerala state to find their most preferred job among the five options selected by the judges, *viz.,* Assistant Professor, Agricultural Officer, Banker, Farmer and Agripreneur. Paired comparision method, established by L.L. Thurston, based on the law of comparative judgement was used for the study. From the scale values obtained it was found that the most preferred job was that of an agricultural officer and least preferred job was of that of a farmer. The reluctance of agricultural students to take up farming and agripreneurship calls for attention to the fact that they should be given proper orientation regarding the emerging opportunities in these arenas during their undergraduate education periods. This is essential to channelize the skilled and knowledgeable manpower into the farming and agribusiness sector and to contribute to the sustainable entrepreneurship scenario of this agricultural country.

INTRODUCTION

India in this 21st century is still an agriculture based economy.With the development in technology, research, and innovation agricultural students have immense career scopes in diverse occupational areas.Food being the basic necessity that sustains existence, feeding the mouths will never face a recession or a slowdown. Hence, unlike other courses, agriculture courses have great potential and they never face downsizing.

Career preferences are free opportunity to select a desired career which ultimately forms the foundation for job satisfaction.Human feelings are non linear. Paired comparision method, established by L.L. Thurston, gives interval data based on the law of comparative judgement.Paired comparision method is applicable when the jobs are significantly different from one another and requires different skill sets, knowledge, qualification and expertise. It is best used when the range of options is small and the most preferred choice is to be determined.

MATERIAL AND METHODS

Career options

The matrix of career options for the individual agricultural graduates, based on the recent trends, was prepared by eighteen experts.This matrix of 16 career options were presented to ten judges to score them from one (least relevant) to five (most relevant). The mean scores obtained are presented in Table 1.

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Table 1. Mean Scores obtained for 16 career options

Sl No	Career option	Score obtained (mean score=30)
1	Assistant Professor	40
2	Agricultural Officer	40
3	Banking	43
4	Agripreneur(Any agribusiness)	35
5	Consultancy Services	21
6	Input seller/dealer	10
7	Plant Protection Officer	17
8	Farm/Nursery Manager	13
9	Entomologist/Pathologist	0
10	Farmer	38
11	Breeder	26
12	Farm News Journalist /Reporter	17
13	Environmental specialist	13
14	Microbiologist	14
15	Civil Services	17
16	ARS Scientist	29

The final matrix of career options used for the study is as shown in the Table 2. It included the careers that got a mean score of 30 and above.

Table 2. Final matrix of career options

S. No	Career option& Letter assigned	Mean score
1	Assistant Professor (C)	40
2	Agricultural Officer (A)	40
3	Agripreneur (D)	35
4	Banking (B)	43
5	Farmer (E)	38

Respondents

Agricultural students from Kerala (n=300) studying at different agricultural universities in India constituted the sample.All of them were undergoing the irgraduate level education. About 95 percent of them were females and the rest, males. Eighty-six percent of the students accepted the agricultural course as per the allotment, seven percent because of their inherent interest in agriculture and the rest opted the course due to peer pressure.

Administration of the questionnaire

The questionnaires were administered via e-mail and the data obtained was tabulated as below. Career preference judgements of these graduate agricultural students were based on their feeling of preference towards options. As there were five job choices (n=5), the total number of pairs, as obtained by the formula [n(n-1)]/2, equals to 10. The Table 3 shows the frequencies of preferences of 300 respondents in preferring job over the other option in a pair for all 10 pairs. Here *i>j* indicates the number of respondents who found *i* more preferable than *j*; *i* indicates a column entry and *j* indicates a row entry.

Table 3. Frequencies of preferences of jobs (N=300)

A > B = 165	C > E = 254
B > C = 172	D > E = 184
C > D = 92	A > D = 283
A > C = 170	B > E = 281
B > D = 268	A > E = 294

THE PAIRED COMPARISION METHOD

The law of comparative judgement helps to order the stimuli along a psychological continuum (Edwards, 1957). The stimulus *i* is associated with the most frequently aroused or modal discrimination process over the psychological continuum. The paired comparision data obtained in this study is represented as F (frequency) matrix, P(proportion) matrix and Z (normal deviate) matrix, in the Tables shown as followed.

RESULTS AND DISCUSSION

F matrix

Table 4 shows the cell entry where column A and row B meet is indicated as f_{AB}(A>B).It means the frequency with which A was judged more favourable than A. From the data obtained in this study, f_{AB} (A>B) = 165, which indicates f_{BA} is automatically N- $f_{AB.}$300-150=150. Similarly, frequency of all other items was found out.

Table 4. F matrix (N=300)

X	A	B	C	D	E
A	X	135	130	17	6
B	165	X	128	32	19
C	170	172	X	208	46
D	283	268	92	X	116
E	294	281	254	184	X

P matrix

The cell entries of F matrix divided by N gives the P matrix as shown in table 5. The cell entries give the proportion of times that the column stimulus is judged more favourable than the row stimulus. P_{AB}=1-$P_{BA.}$ The sums of each column are found out.

Table 5. P matrix (N=300)

X	A	B	C	D	E
A	X	0.45	0.43	0.06	0.02
B	0.55	X	0.43	0.11	0.06
C	0.57	0.57	X	0.69	0.15
D	0.94	0.89	0.31	X	0.39
E	0.98	0.94	0.85	0.61	X
Sum	**3.04**	**2.85**	**2.02**	**1.47**	**0.62**

Rearranged P matrix

The P matrix is rearranged as per the ascending order of the sums obtained as shown in Table 6.

Table 6. Rearranged P matrix (N=300)

X	E	D	C	B	A
E	X	0.61	0.85	0.94	0.98
D	0.39	X	0.31	0.89	0.94
C	0.15	0.69	X	0.57	0.57
B	0.06	0.11	0.43	X	0.55
A	0.02	0.06	0.43	0.45	X

Z matrix

The Z matrix (Table 7) is obtained from the Table of normal deviates *z* corresponding to proportions *p* of a dichotomised unit normal distribution.Here Z_{AB} is a function of scale separations S_A-S_B and standard deviations S_A and S_B and the correlation coefficient $r_{AB.}$

The mean of z values under column E expresses the scale values of stimulus E in terms of its deviation from the mean of all the scale values. The scale values are obtained by adding the largest negative number to the means. The sum of the scale values in deviation form may be obtained and this sum should be equal to zero. Z values of 1 and 0 are indeterminate, but considered here as the number of respondents is more than 200.

Table 7. Z matrix

X	E	D	C	B	A
E	X	0.279	1.036	1.555	2.054
D	-0.279	X	-0.496	1.227	1.555
C	-1.036	0.496	X	0.176	0.176
B	-1.555	-1.227	-0.176	X	0.126
A	-2.054	-1.555	-0.176	-0.126	X
Sum	-4.924	-2.007	0.188	2.832	3.911
Mean	-0.9848	-0.4014	0.0376	0.5664	0.7822
Scale values	**0**	**0.5834**	**1.0224**	**1.5512**	**1.767**

Table 8 elaborates the matrix of successive differences of column entries shows how scale values are computed.

Table 8. Matrix of successive differences of column entries

X	D-E	C-D	B-C	A-B
E	0.279	0.757	0.519	0.499
D	0.279	-0.496	1.723	0.328
C	1.532	-0.496	0.176	0
B	0.328	1.051	0.176	0.126
A	0.499	1.379	0.050	0.126
Sum	2.917	2.195	2.644	1.079
n	5	5	5	5
Mean(Sum/n)	0.5834	0.4390	0.5288	0.2158

Scale value of E= 0.000 (Lowest);
Scale value of D= 0.000+0.5834=0.5834;
Scale value of C=0.5834+0.4390=1.0224;
Scale value of B= 1.0224+0.5288=1.5512;
Scale value of A=1.5512+0.2158=1.767 (Highest)

Internal Consistency Check

An internal consistency check is applied to determine how well the observed or empirical proportions P_{ij} agree with those to be expected in terms of the derived scale values. The first step is to obtain Z' matrix (Table 9). For each stimulus we obtain Z_{ij} by subtracting the entries at the left of the Table from the scale values at the top of the columns and only for n (n-1)/2 entries below the diagonal. The corresponding theoreticalpro portions P_{ij}'are obtained from the table of normal deviates(Table 10). If we subtract and the entries in the P'matrix from the corresponding independent entries in P matrix,(P-P'matrix Table 11), the discrepancies between the empirical with which we started, the theoretical proportions will be obtained. Absolute Average Discrepancy (AAD) was obtained by dividing the sum of the absolute values of P-P' matrix with n(n-1)/2.

$$AAD=\frac{\sum \left| P_{ij}-P_{ij}' \right|}{[n(n-1)/2]}$$

Table 9. Z' matrix

X	0.000	0.5834	1.0224	1.5512	1.767
0.000	X				
0.5834	-0.5834	X			
1.0224	-1.0224	-0.439	X		
1.5512	-1.5512	-0.9678	-0.5288	X	
1.767	-1.767	-2.3504	-0.7446	-0.2158	X

Table 10. P' matrix

X	E	D	C	B	A
E	X				
D	0.280	X			
C	0.153	0.330	X		
B	0.061	0.169	0.298	X	
A	0.038	0.010	0.228	0.414	X

Table 11. P-P' matrix

X	E	D	C	B	A
E	X	-0.11	0.003	0.001	0.018
D	0.11	X	-0.360	0.059	-0.050
C	-0.003	0.360	X	-0.132	-0.202
B	-0.001	-0.059	0.132	X	-0.036
A	-0.018	0.050	0.202	0.036	X
Sum	**0.088**	**0.241**	**0.023**	**0.036**	**0.270**

AAD=(0.658)/10= 0.0658 ~ 0.066**.** The absolute average discrepancy of 0.066 for the 5 stimuli is slightly larger.

This study which analysed the career preferences of the agricultural graduates presented the interesting finding that the most preferred job was that of an agricultural officer and the least preferred job was that of a farmer. This supports the finding of Ramesh *et al.* (2018).

Sixty-two percent of the respondents reported in their remarks that the job of an agricultural officer was a good option that could be achieved with the graduate level of education. It offers them a respectable social status, a decent pay scale with an opportunity to contribute to the agricultural sector. At the same time, 18 percent mentioned about the huge responsibilities of an agricultural officer as an unfavourable aspect. The banking job, which was the second most preferred job, also provides the same possibilities, chances to work with prestigious banks and can even open opportunities to contribute to agricultural sector.

The risk and insecurity attached with the farming might be the reasons for the disinterest in pursuing it as a career. This data too is in tune with the observations of Ramesh et *al* (2018). Moreover, 95 percent of the respondents were females. This strengthens the

conclusion of Hasan *et al.* (2019) that female students scored less for risk-taking behaviour in comparision to their male counterpart. Additionally, 43 percent of the respondents reported that they were reluctant to pursue higher studies and other academic pursuits which enable them for an academic job. It is a notable result that eighty-nine percent informed that the career choice after graduation will solely be based on their own interest, whereas, the rest were ready to consider the career options their parents or peers would suggest. However, almost all the respondents agreed that career choice is based on professional experience (97%) and good salary (96%). Good working environment and career advancement opportunities were other important factors in deciding careers,as reported by 87% and 83% of the respondents, respectively. This result supports the findings of Mcgraw *et al.*(2012).

CONCLUSION

Paired comparision method is a useful tool for weighing up the relative importance of different options when the prime concerns aren't clear, where the options are completely different, where evaluation criteria are subjective, or where they're competing in importance. The finding of the study using this tool was a promising one indicating that the agricultural officer was the most preferred job among the agricultural graduates. On the other hand, the graduate students were reluctant to take up agripreneurship or farming. This calls for attention to the fact that agricultural students should be given proper orientation regarding the scope and immense possibilities in agri-business, farming and related activities during their undergraduate education period. This is essential to channelize the skilled and knowledgeable manpower into the farming and agribusiness sector and to build entrepreneurial culture in our society.

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INTEGRATED NUTRIENT MANGEMENT OF SAFFLOWER CROP IN PROBLEM SOILS

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India has a total total geographical area 329 mha.Out of the 329 mha, the arid and semi-arid zones occupy more than one-third of the area (127.4 mha). The salt affected soils occurring in these zones occupy 12 mha area spread over in 15 states of the country, out of which 4.12 mha are alkali, 3.26 mha are saline soils and 4.62 mha saline alkali soils. Among these salt affected soils, alkali soils are found to be highly problematic for crop production because of very poor physical and chemical environment particularly in irrigated areas. Sodicity problem in irrigated agriculture is becoming more serious because of faulty methods of irrigation, intensive cultivation of high water requirement crops, use of poor quality water, lack of adequate knowledge about soils and poor management practices. The amelioration of these alkali soils is not only expensive but also time consuming and laborious. (Gupta *et al*., 1995). Management practices which can be adopted to reduce negative effects of salts on plant growth includes leaching out salts from the soil profile, use of amendments such as gypsum, use of farmyard manure. Addition of organic amendments to soil improves soil properties and it is highly accepted by the farmers (Prapagar *et al*., 2012). Gypsum is the most commonly used amendment due to its availability at low cost. Joachim *et al*. (2007) attributed the beneficial effect of combined use of farm yard manure and gypsum on the reclamation of sodic soils.

Safflower (*Carthamus tinctorius* L.) is considered to be a moderately salt-tolerant crop. There are very few reports about safflower resistance to salt stress or alkali stress (Liu & Baird, 2003). Salt content of 7 dSm^{-1} reduced safflower yield by 10-15% (Francois and Berstein, 1964). Safflower is a versatile crop that can be grown on a range of soil types, but comes up well on deep and well drained neutral to alkaline soils. Extensive deep root system combined with a long duration can break hard-pans and create channels in the soil profile, thus, facilitating air and water movement and benefit the management of soils prone to salinity (Houmanat, 2016). The study was carried out to evaluate the performance of safflower crop in alkali soil under different agronomic management practices.

The field experiment was conducted during *rabi,*2017 at Bhavanamvaripalem farmer's fields on sandy clay loam soil in randomized block design with five treatments and four replications (Table 1). Recommended

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agronomic management practices and plant protection measures were followed during crop growth period.

Plant height (cm) and number of branches plant^{-1}

Plant height was significantly affected by different treatments. Maximum plant height (95.3 cm) was recorded with gypsum + FYM + 25% extra nitrogen applied treatment (T_5) and found superior to farmers practice (Table 1) but on par with the application of gypsum+25% extra nitrogen (94.3 cm). The increase in plant height due to application of increased level of nitrogen might be due to stimulating effect of nitrogen on various physiological processes including cell division and cell elongation of the plant (Alim, 2012). The lowest plant height (70.8 cm) was recorded in farmers practice similarly highest number of branches were recorded in (10.5) followed by gypsum application + 25% extra recommended dose of nitrogen fertilizer (T_4) lowest number of branches were recorded in farmers practice (4.3). Sipai *et al*. (2015) reported that application of sulphur @ 60 kg ha^{-1} as gypsum resulted in significantly higher plant height, number of primary and secondary branches, number of siliqua per plant and test weight of mustard.

Number of heads plant^{-1} and number of seeds plant^{-1}

Significantly maximum number of heads per plant^{-1} (24.3) were recorded in T_5, whereas lowest (8) heads were observed in control treatment. Better availability of nutrients may result in better crop growth rate and ultimately more number of heads in safflower. Gypsum is the cheapest source of S which is known to significantly improve crop biometric parameters and yield (Mandal *et al*., 2005) and also used as amendment in salt affected soils (Rathod *et al*., 2005). There were significant differences among the treatments in respect of number of seeds per head (Table 1). The maximum (42) seeds were recorded with FYM+ gypsum application + 25% additional dose of recommended nitrogen fertilizer (T5), whereas, the minimum (24) seeds per head were observed in T_1 (control).

Seed Yield

The maximum seed yield (434 kg ha^{-1}) was recorded by T_5 treatment *i.e* FYM+ gypsum application + 25% additional dose of recommended nitrogen fertilizer, followed by T_4 (326 kg ha^{-1}) *i.e.* gypsum application + 25% additional recommended dose of nitrogen fertilizer. Lowest seed yield (177 kg ha^{-1}) seed yield was observed in T_1 (control). Gypsum although relatively less soluble, is a good source of S to oilseed crops. Gypsum as sulphur source significantly improved grain and stover yield of mustard compared to that of other S sources similar to elemental S and iron pyrite (Kumar *et al*., 1997). Gypsum applications (250 kg ha^{-1}) reflected in significant improvement in yield attributes and seed yield of Indian mustard (Rao and Shaktawat, 2002).

Biological Yield

Biological yield is a combination of seed yield and straw yield and is direct index of photosynthetic machinery. It becomes more important for multipurpose crop like safflower in terms of seed yield and more drymatter used

Table 1. Influence of different management practices on growth and yield attributes of Safflower in alkali soils

Treatments	Plant height (cm)	No. of branches plant^{-1}	No. of heads plant^{-1}	No. of seeds head^{-1}
T_1- Farmers practice	70.8	4.3	8.0	24
T_2- Gypsum application	75.8	6.5	17.5	25
T_3- FYM + Gypsum application	83.3	8.0	17.8	30
T_4- Gypsum application + 25% extra recommended dose of nitrogen fertilizer	94.3	8.3	20.5	38
T_5-FYM+Gypsum application + 25% extra recommended dose of nitrogen fertilizer	95.3	10.5	24.3	42
SEm+	2.9	0.7	0.9	0.4
CD(0.05)	8.8	2.2	3.1	1.4
CV (%)	6.9	19.7	13.5	14.1

Table 2. Influence of different management practices on yield of safflower in alkali soils

Treatments	Seed yield (kg ha^{-1})	Biological yield (kg ha^{-1})
T_1- Farmers practice	177	989
T_2- Gypsum application	208	1126
T_3- FYM + Gypsum application	232	1208
T_4- Gypsum application + 25% extra recommended dose of nitrogen fertilizer	326	1515
T_5- FYM+ Gypsum application + 25% extra recommended dose of nitrogen fertilizer	434	1984
SEm+	54	62
CD(0.05)	163	190
CV (%)	12.3	9.8

for fodder purpose. Maximum biological yield (1984 kg ha^{-1}) was recorded in T_5which was at par with T_4.Application of gypsum with organic manures is a less expensive alternative not only to improve soil condition but also to enhance crop yields. The addition of gypsum and organic manure to the saline and sodic soils has a synergistic effect between the two antagonists especially for monovalent cations such as Na+ (Mahmoodabadi *et al*., 2012). In a study by Hosmath *et al*. (2014), 20 kg S ha^{-1} applied in the form of gypsum improved the yield of soybean by 12%. The oil content and quality also improved with application of S along with other nutrients.

This study indicated that there is a scope of increasing crop yields through use of integrated nutrient management. Application of g**y**psum + FYM + 25% additional nitrogen resulted in better yield attributing characters and yield followed by gypsum+25% additional nitrogen treatment while, the lowest yield was recorded in farmers practice.

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COST ANALYSIS OF MEDICINAL AND AROMATIC PLANTS IN ANDHRA PRADESH AND TELANGANA STATES

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Medicinal and aromatic plants are receiving substantial amount of attention across the worldas the products made with these plants offer a wide range of safe, cost effective, preventive and curative therapies. Though, there exists cultivation of different species of number of medicinal and aromatic plants, this study was limited to most cultivated two plants *viz.*,Coleus (*Coleus forskolii*), and Palmarosa (*Cymbopogan martini*). Coleus is considered as one of the most potential medicinal plants for its pharmaceutical properties.

In India, medicinal and aromatic plants are grown in an area of 720 thousand ha, with total production of 866 thousand tones and total productivity 1.2 MT per hectare. (Indiastat, 2018). In Andhra Pradesh, the total area under medicinal and aromatic plants is 6000 ha with a total production of 9000 MT (Indiastat, 2018). In Telangana state, the total cultivated area is 2538 ha with a production of 4410 MT (Indiastat, 2018). Keeping this in view, the study was conducted to estimate the cost analysis of the selected two medicinal and aromatic plants Coleus and Palmarosa.

The study was conducted in Mahabub-nagar and Chittoor districts of Telangana and Andhra Pradesh, respectively. The lists of farmers cultivating the two crops were collected from the (Department of Agriculture offices from both districts) selected villages. All the mandals in Chittoor district with their coleus cultivated area were listed in descending order and top one mandal was selected *i.e.* Nagari for this study. Similarly, Bijinapally mandal In Mahabub-nagar district was selected for studying Palmarosa crop. For each crop 30 farmers were selected randomly, thus, making a total of 60 farmers. The primary data was collected through personal interview using a pre-tested scheduleduring the year 2015-2016.For the computation of costs, cost concepts as suggested by the Commission for Agricultural Costs and Prices (CACP, 2020) were included.

On an average, the total cost of cultivation of coleus was Rs.90452. It was found that the

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Table 1. Cost of cultivation of Coleus(component-wise per ha)

S.No.	Item	Amount (Rs.)
I.	**Operational Costs**	
1	**Human labour**	47968 (53.03)
	Owned	3436 (3.80)
	Hired	44532 (49.23)
2	**Cattle labour**	2084 (2.31)
	Owned	282 (0.31)
	Hired	1802 (2.00)
3	**Machine power**	3848 (4.25)
	Owned	1190 (1.31)
	Hired	2658 (2.94)
4	Seed	4997(5.52)
5	Manures and fertilizers	11702 (12.94)
	a. Manures	6000 (6.64)
	b. Fertilizers	5702 (6.30)
6	Plant protection chemicals	1369 (1.51)
	Irrigation charger's	876 (0.97)
	Interest on working capital	1912 (2.11)
	Total Operational Costs	**74756 (82.64)**
II	**Fixed costs**	
1	Land revenue	150(0.17)
2	Rental value of owned land	10000(11.06)
3	Depreciation	3865(4.27)
4	Interest on fixed capital	1682(1.86)
	Total fixed costs	**15696 (17.36)**
	Total costs	**90452 (100)**

Note:Figures in parentheses indicate percentages to total

operational costs accounted for a major share in the total cost of cultivation. The total operational costs were Rs.74756 (Table 1).In case of Coleus, the costs of both owned, hired human labour was the major cost component among operational costs with an amount of Rs.47968/- accounting for 53%.The next important operational cost was manures and fertilizers with an amount of Rs.11702 (12.94%). The other items of expenditure in the order of importance were seed (5.52%), machine power (4.25%), cattle labour (2.31%), interest on working capital (2.11%) plant protection chemicals (1.51%), and, irrigation chargers (0.97%).

Fixed costs per hectare were estimated at Rs.15696/-accounting for 17.36% of total cost of cultivation.The rental value of owned land was the major cost item among the fixed costs which accounted for 11.06%. Depreciation, interest on fixed capital and land revenue were other fixed cost items accounting for 4.27%, 1.86 % and 0.17 %, respectively.

Palmarosa

The cost of both owned and hired human labour was the major cost components among the operational costs with an amount of Rs.43348/- accounting for 57.66% of cultivation of Palmarosa for the main crop (Table 2). The next important operational cost was manures and fertilizers with an amount of Rs.13687/- (18.20 %)main crop.The other items of expenditure in main crop in the order of importance were seed (6.46 %), machine power (5.59 %), cattle labour (3.09 %), irrigation charges (1.50), interest on working capital (1.23 %) and plant protection chemicals (0.97 %).

Fixed costs for main crop stood at Rs.3687 accounting for 4.90 % of total cost of cultivation. The rental value of owned land was the major cost item among the fixed costs which accounted for 3.32 %. Depreciation, interest on fixed capital and land revenue were other fixed cost items accounting for 1.00%, 0.53 % and 0.05%, respectively.

In case of ratoon –I, the cost of labour both owned and hired human labour was the major cost components among the operational costs with an amount of Rs.29442/-(69.16%) of cultivation costs of Palmarosa. The next important operational cost was fertilizers with an amount of Rs.7200/- (16.91%) of Palmarosa. The other items of expenditure were irrigation charges (2.42%), protection chemicals (1.65%), and interest on working capital (1.20%) plant.Fixed costs per hectare for Palmarosa were at Rs.3687 accounting for 8.66 % of the total cost of cultivation. The rental value of owned land was the major cost item among the fixed costs which accounted for 5.87% of Palmarosa cultivation. Depreciation, interest on fixed capital and land revenue were the other minor fixed cost components accounting for 1.770%, 0.93% and 0.09%, respectively.

In case of ratoon – II, the cost of both owned, hired human labour was the major cost

Table 2. Cost of cultivation of Palmarosa (component-wise per ha)

(Rs. per ha)

S.No.	Particulars	Main crop	Ratoon - I	Ratoon – II	Ratoon - III
I.	**Operational Costs**				
1	Human labour	43348 (57.66)	29442 (69.16)	26144 (68.10)	23092 (66.41)
	Owned	2328 (3.10)	1928 (4.53)	1528 (3.98)	1402 (4.03)
	Hired labour	41020 (54.56)	27514 (64.63)	24616 (64.12)	21690 (62.38)
2	Cattle labour	2324 (3.09)	-	-	-
	Owned	286 (0.38)	-	-	-
	Hired	2038 (2.71)	-	-	-
3	Machine power	4502 (5.99)	-	-	-
	Owned	1746 (2.32)	-	-	-
	Hired	2756 (3.67)	-	-	-
4	Seed	4853 (6.46)	-	-	-
5	Manures andFertilizers	13687 (18.20)	-	-	-
	a. Manures	5824 (7.75)	-	-	-
	b. Fertilizers	7863 (10.45)	7200 (16.91)	6501 (16.93)	5987 (17.22)
6	Plant protection chemicals	728 (0.97)	699 (1.65)	631 (1.64)	598 (1.72)
7	Irrigation charger's	1129 (1.50)	1029 (2.42)	973 (2.53)	946 (2.38)
8	Interest on working capital	926 (1.23)	576 (1.20)	516 (1.17)	467 (1.33)
	Total Operational Costs	71497 (95.10)	38881 (91.34)	34698 (90.40)	31085 (89.65)
II	**Fixed Costs**				
1	Land revenue	38 (0.05)	38 (0.09)	38 (0.09)	38 (0.10)
2	Rental value of owned land	2500 (3.32)	2500 (5.87)	2500 (6.50)	2500 (7.19)
3	Depreciation	755 (1.00)	755 (1.77)	755 (1.97)	755 (2.17)

Table 2 contd.

S.No.	Particulars	Main crop	Ratoon - I	Ratoon – II	Ratoon - III
4	Interest on fixed capital	395 (0.53)	395 (0.93)	395 (1.03)	395 (1.14)
	Total Fixed Costs	3687 (4.90)	3687 (8.66)	3687 (9.60)	3687 (10.35)
	Total Costs	75184 (100)	42569 (100)	38385 (100)	34772 (100)

Note: Figures in parentheses indicate percentages to total

component among operational costs with an amount of Rs.26144/- accounting for 68.10% of cost of cultivation in Palmarosa.The next important operational cost was fertilizers with an amount of Rs.6500 (16.93 %).The other items of expenditure were irrigation chargers (2.53 %), protection chemicals (1.64 %), and interest on working capital (1.17 %) plant.Fixed costs per hectare were estimated for palmarosa at Rs.3687/- accounting for 9.60 % of total cost of cultivation. The rental value of owned land (which accounted for 6.50%) was the major cost item among the fixed costs.Land revenue, interest on fixed capital and depreciation were the other minor fixed cost items accounting for 0.09%, 1.03%, and 1.97%, respectively.

In case of ratoon – III, the cost of (both hired and owned), hired human labour was the major cost component among operational costs with an amount of Rs.23092/-(66.41%). The next important operational cost was manures and fertilizers with an amount of Rs.5987/-(17.22%). The other items of expenditure in the order of importance were irrigation chargers (2.38%), protection chemicals (2.38 %), and interest on working capital (1.33%) plant. Fixed costs were estimated at Rs.3687 accounting for 10.35% of total cost of cultivation. The rental value of owned land was the major cost item among the fixed costs which accounted for 7.19%.Land revenue, Interest on fixed capital, depreciation, and land revenue were the other minor fixed cost items accounting for 0.10%,1.14%, and 2.17%, on Palmarosa, respectively.

Cost Concepts

The cost of cultivation of Palmarosa andColeus was estimated by adopting the cost concepts used in farm management studies *viz.,* Cost A_1, Cost A_2, Cost B_1, Cost B_2, Cost C_1, Cost C_2 and Cost C_3. Out of all the cost concepts, Cost C_2 is the most comprehensive cost as it covers both operational costs and fixed costs (Cost B_2 + imputed value of family labour).

Coleus

There was no lease-in activity among the farmers and hence there was no difference in cost A_1 and cost A_2values. On an average, the total cost of cultivation (Cost C_2) of coleus per hectare was Rs.90452 (Table 3).

Table 3. Cost concepts in Coleus cultivation

S.No.	Costs	Coleus (Rs. per ha)
1	Cost A_1/A_2	75334
3	Cost B_1	77016
4	Cost B_2	87016
5	Cost C_1	80452
6	Cost C_2	90452
7	Cost C_3	99497

Palmarosa

It is recorded that there was no lease-in activity among the farmers and hence cost A_1 and cost A_2 calculated values were equal. On an average, the total cost of cultivation (Cost C_2) of was Rs. 75184/- in main crop and for ratoon I, II, and III; it was Rs. 42568/-, Rs. 35385/-, and Rs. 34772/-, respectively (Table 4).

Output and Returns

Coleus

It is recorded that the coleus fields recorded a yield of 1800 q/ha. The gross returns obtained were Rs.2,52,000/- and the total costswere Rs.90452. The net returns obtained were Rs.1,61,548/-and returns per rupee of expenditure were Rs.1.78 (Table 5).

Table 4. Cost concepts in Palmarosa cultivation (Rs. / ha)

S.No.	Costs	Main crop	Ratoon - I	Ratoon - II	Ratoon – III
1	Cost A_1/A_2	69961	37745	33962	30475
3	Cost B_1	70356	38141	34357	30870
4	Cost B_2	72856	40069	36857	33370
5	Cost C_1	72684	40641	35885	32272
6	Cost C_2	75184	42569	35385	34772
7	Cost C_3	82703	46825	39224	38249

Table 5.Economics of Coleus cultivation per hectare (Rs./ha)

S.No.	Particulars	Coleus
1	Yield (in q)	1800
2	Gross returns (Rs.)	252000
3	Total costs (Rs.)	90452
4	Net returns (Rs.)	161548
5	Returns per rupee of expenditure	1.78

Palmarosa

It is recorded that the Palmarosa farm recorded a yield of 700 q of crop per hectare for main crop and for subsequent- ratoons as well. In ratoon crop no need to spend on operational cost for some activities so the returns of rupee expenditure is high compare to main crop.The average gross returns obtained were Rs. 1,54,000/- in main crop and the same for ratoons were Rs.1,40,000, Rs.1,19,000, Rs. 1,05,000, respectively. The net returns obtained in were Rs. 78816/-, Rs. 97431/-, Rs. 83615/-, and Rs. 70,228/- and returns per rupee of expenditure were Rs.1.04, Rs. 2.28, Rs. 2.36, and Rs. 2.02, respectively (Table 6).

In case of Coleus, Cost A_1/A_2, Cost B_1, Cost B_2, CostC_1, Cost C_2, and Cost C_3 were Rs.75334/-, Rs.77,016/-, Rs.87,016/-, Rs.80,452/-, Rs.90,452/- and Rs.99,497/-, respectively. The coleus yield per ha was1800q and the gross returns were Rs. 2,52,000/-. The returns per rupee of expenditure were Rs.1.78.

In case of Palmarosa, Cost A_1/A_2, Cost B_1, CostB_2, Cost C_1, Cost C_2, and Cost C_3 were Rs.69961, Rs.70,356, Rs.72,856, Rs.72,684, Rs.75,184, and Rs.82,703 for main crop, respectively. The yield per hectare was same for main crop, ratoon I, II and III *i.e.,* 700 q. Furthermore, the returns per rupee of expenditure were Rs.1.04, Rs.2.28, Rs.2.36 and Rs.2.02 for main crop, ratoon I, II and III, respectively. It could be observed that second ratoon crop is giving higher return per rupee spent which is Rs.2.36, when compared with the main crop, ratoon I and III.

Table 6. Economics of Palmarosa cultivation (Rs./ ha)

S.No.	Particulars	Main crop	Ratoon - I	Ratoon - II	Ratoon – III
1	Yield (q)	700	700	700	700
2	Gross returns	154000	140000	119000	105000
3	Total cost	75184	42569	35385	34772
4	Net returns	78816	97431	83615	70228
5	Returns of rupee expenditure	1.04	2.28	2.36	2.02

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ASSOCIATION OF MATERNAL HEALTH FACTORS WITH BIRTH WEIGHT OF NEWBORNS

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Healthy women are the foundation of a strong community and healthy newborns are the future. Maternal health is closely associated with newborns health and survival(Ray *et al.,* 2015). Pregnancy is the crucial and most intensive period for fetal development. The diagnosis of any risk factor during pregnancy affects the fetal outcome negatively. Low birth weight is a single most predictor that is closely related to mortality, morbidity, physical development, and survival of newborns (Sathenahalli *et al.,*2015).The most influencing multi-factors for the prevalence of low birth weight among newborns are maternal age, gestational age, weight,weight gained during pregnancy, parity, lack of antenatal care, low body mass index, and low hemoglobin level. (Kader *et al.,*2014).

According to the UNICEF report, every year 20 lakh babies die globally within the neonatal period. Out of this 6.4 lakh deaths alone occur in India. Moreover, the neonatal mortality rate in India is 25.4. India is ranked 12th among 52 lower-middle-income nations in newborn mortality (UNICEF, 2018). The report mentioned that India is the only major country in the world, which has higher mortality among girls children than boys. Kerala and Goa have 10% of neonatal mortality rate, whereas, Bihar and Uttarakhand have 44%. Uttar Pradesh, Madhya Pradesh, Rajasthan stands at 57% of the neonatal mortality rate. The infant mortality rate is 41 in Odisha (GoI, 2019). It is recognised that about 61% of the infant death occurs during the first 28 days of life due to asphyxia, prematurity, low birth weight, respiratory infections, diarrhea, and malnutrition(Govt. of Odisha, 2019).

The sustainable development goals (SDGs) aim to end child mortality by the year 2030 because the deaths of newborns are preventable. Despite remarkable development in maternal and newborn health due to the implementation of several programmes and interventions worldwide, there is a gap between reality and practice. There is also paucity of data on the birth weight of newborns with maternal health factors in remote areas of Odisha. Therefore, the research is designed to study the risk factors associated with maternal health parameters and the birth weight of newborns.The objective of the research was to study the association of maternal health parameters with the birth weight of the new-borns.

For this study,Lakhanpur and Jharsuguda Block of Jharsuguda district of Odisha were selected. There are 957 Anganwadi centers in total in Jharsuguda District of Odisha. Out of these 16 Anganwadi centers of Lakanpur block

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and 12 Anganwadi centers of Jharsuguda block were selected randomly. The study was conducted for a period of 9 months *i.e.* from May, 2018 to February, 2019. Considering the objectives in view, exploratory-cum-descriptive research was adopted.A total of 300 pregnant women in the third trimester of pregnancy till their delivery were selected by purposive sampling method from the total population who were willing to participate in the investigation.The data was collected with the help of the pre-tested personal interview schedule. The pre-designed questionnaire was finalized with the help of the pilot study.For the assessment of the nutritional status of pregnant women, weight was taken with the help of a weighing machine with minimum clothing. Height of the subject was measured witha wooden scale by standing erect with heels together after removing his shoes, looking straight, holding head comfortably, and back of the head was in the same line and touching the rod. The body mass index (BMI) was calculated with the help of formula weight in kg/ height in mt^2. The assessments of nutritional status by classifying the BMI values were carried out as per the following table. For the calculation of BMI,the pre-pregnancy weight was taken into consideration. The BMI classification is as follows:Underweight - <18.5; Normal - 18.5-22.9; Overweight - 23.0-24.9; Obese-25.0-29.9 and Morbidity Obese - >30. The hemoglobin level of mothers was recorded from themother and child protection card and classified into different categories of anemia as per WHO classification: Normal -Above 10.9 gm/dl; Mildly Anaemic -10-10.9 gm/dl; Moderately Anaemic-9.9-7 gm/dl; Severely Anaemic-Below 7 gm/dl.

Birth weight of newborns

Table 1. Distribution of newborns on the basis of their birth weight (n=300)

Birth weight	Frequency	Percentage
Below 1.5 kg (VLBW)	3	1.00
1.5 to 2 kg (LBW)	16	5.33
2 to 2.5 kg (LBW)	103	34.33
2.5 t0 3 kg (NBW)	97	32.33
3 to 3.5 kg (NBW)	70	23.33
Above 3.5 kg (NBW)	11	3.68
Total	**300**	**100**

Results (Table1) revealed the distribution of newborns according to their birth weight and the prevalence of low birth weight among newborns was 40.66%. On further analysis, it was observed that the majority (59.34%) newborns had normal birth weight (NBW) followed by 39.66% newborns belonged to low birth weight (LBW)category whereas only 1% newborns found under very low birth weight (VLBW) category.According to NFHS-3 prevalence of low birth weight in rural India is 22.1% but in the study, the percentage of LBW was found to be more by 17.56% which is a matter of concern. Agrawal and Sharma (2017) investigated the incidence of LBW and found that the majority of 41% newborns had 2.5 to 3.49 kg birth weight.

Maternal weight and Birth weight of newborns

Table 2. Distribution of respondents on the basis of maternal weight in relation to birth weight of newborns

Maternal Weight	Below 1.5 kg (VLBW)	1.5 kg to 2 kg (LBW)	2 kg to 2.5 kg (LBW)	2.5 kg to 3 kg (NBW)	3 kg to 3.5 kg (NBW)	Above 3.5 kg (NBW)	Total	Chi-Square Value
Below 50 kg	3 (2.56)	15 (12.82)	73 (62.39)	25 (21.37)	1 (0.85)	0 (0.00)	117 (100)	χ^2 = 124.54 *
Above 50 kg	0 (0.00)	1 (0.55)	30 (16.39)	72 (39.34)	69 (37.70)	11 (6.01)	183 (100)	
Total	3 (1.00)	16 (5.33)	103 (34.33)	97 (32.33)	70 (23.33)	11 (3.68)	300 (100)	

* **Significant**

The results (Table 2) depict that the majority of the mother's had above 50 kg body weight in the third trimester of pregnancy who delivered morenormal birth weight (NBW) newborns (83.06%). It is interesting to note that 2.56% of very low birth weight (VLBW) and 75.21% of low birth weight(LBW) newborns born to mothers who hadbelow 50 kg body weight in the trimester of pregnancy. Cent percent of very low birth weight (VLBW) newborns were found to be delivered by mothers who hada below 50 kg body weight. Statistically, it was also observed that there was a strong association between the weight of pregnant mothers and the birth weight of newborns. Agarwal and Sharma (2017), Sanghvi *et al.* (2016) also found that maternal weight was statistically associated with low birth weight babies. Thus, it can be concluded that the birth weight of newborns depends on the weight of mothers.

Maternal height and Birth weight of newborns

Table 3. Distribution of respondents on the basis of maternal height in relation to birth weight of newborns

Maternal Height	Below 1.5 kg (VLBW)	1.5 kg to 2 kg (LBW)	2 kg to 2.5 kg (LBW)	2.5 kg to 3 kg (NBW)	3 kg to 3.5 kg (NBW)	Above 3.5 kg (NBW)	Total	Chi-Square Value
Below 145 Cms.	1 (14.29)	3 (42.86)	2 (28.57)	1 (14.29)	0 (0.00)	0 (0.00)	7 (100)	χ^2 = 39.74*
145 Cms.-154 Cms.	1 (0.93)	9 (8.33)	37 (34.26)	33 (30.56)	24 (22.22)	4 (3.70)	108 (100)	
Above 155 Cms.	1 (0.54)	4 (2.16)	64 (34.59)	63 (34.05)	46 (24.86)	7 (3.78)	185 (100)	

***Significant**

Results delineates (Table 3) that the percentage of very low birth weight (VLBW) and low birth weight (LBW) newborns were more *i.e.*14.29% and 71.43%, respectively among the mothers that had below 145 cm height (short stature) in comparision to their counterparts. It was also observed that the percentage of normal birth weight newborns increased with the increase in height of the mothers *i.e.* 56.48% and 62.69% for 145-154cms and above 155 cm height of mothers respectively. However, a significant statistical association between the maternal height and the birth weight of newborns was found in this study. Similar findings were also observed by Agarwal and Sharma (2017) andSanghvi*et al.,*(2016)who reported that the majority of low birth weight babies belonged to pregnant women having below 145 cms of height.Thus, it can be concluded that the incidence of low birth weight newborns was more prevalent among short stature mothers.

Maternal weight gain and Birth weight of newborns

Table 4. Distribution of respondents on the basis of weight gain of mothers in relation to birth weight of newborns

Weight gain (kg)	Below 1.5 kg (VLBW)	1.5 kg To 2 kg (LBW)	2 kg to 2.5 kg (LBW)	2.5 kg to 3 kg (NBW)	3 kg to 3.5 kg (NBW)	Above 3.5 kg (NBW)	Total	Chi-Square Value
2-5	2 (1.39)	15 (10.42)	79 (54.86)	42 (29.17)	6 (4.17)	6 0(0.00)	144 (100)	
5-8	1 (1.22)	1 (1.22)	20 (24.39)	31 (37.80)	26 (31.71)	3 (3.66)	82 (100)	χ^2 = 119.41*
8-12	0 (0.00)	0 (0.00)	4 (5.41)	24 (32.43)	38 (51.35)	8 (10.81)	74 (100)	

***Significant**

The results (Table 4) showed that more percentage of normal birth weight newborns(94.59%) were born to the mothers who hada weight gain of 8-12 kg during pregnancy. It was interesting to note that none of theVLBW babies born to mothers who hada weight gain of 8-12 kg. Similarly, 65.28% and 1.39% LBW and VLBW babies born to mothers who hada weight gain of 2-5 kg, respectively. It was noted that the percentage of VLBW and LBW babies decrease with the increase in weight gain of mothers during pregnancy such as 1.22% VLBW babies born to mothers who had 5-8 kg weight gain and nil VLBW newborns born to mothers who had 8-12 kg weight gain. However, a strong statistical association was observed between the birth weight of newborns with weight gain of mothers during pregnancy. Thus, it can be concluded that the weight gain of mothers during pregnancy plays a significant role in the birth weight of newborns. Konapur *et al.,* (2017)also found a similar significant association between weight gain during the third trimester of pregnancy and the birth weight of newborns.

Maternal Body Mass Index and Birth weight of newborns

Table 5. Distribution of respondents on the basis of maternal BMI in relation to birth weight of newborns

Maternal BMI	Below 1.5 kg (VLBW)	1.5 kg to 2 kg (LBW)	2 kg to 2.5 kg (LBW)	2.5 kg to 3 kg (NBW)	3 kg to 3.5 kg (NBW)	Above 3.5 kg (NBW)	Total	Chi-Square Value
Under weight	2 (3.57)	2 (3.57)	43 (76.79)	9 (16.07)	0 (0.00)	0 (0.00)	56 (100)	χ^2 = 98.42*
Normal	1 (0.46)	14 (6.39)	60 (27.40)	83 (37.90)	52 (23.74)	9 (4.11)	219 (100)	
Over weight	0 (0.00)	0 (0.00)	0 (0.00)	4 (19.05)	15 (71.43)	2 (9.52)	21 (100)	
Obesity	0 (0.00)	0 (0.00)	0 (0.00)	1 (25.00)	3 (75.00)	0 (0.00)	4 (100)	

*Significant

Table 5 reveals that more percentage of very low birth weight (VLBW) and low birth weight newborns (LBW) born to underweight mothers *i.e.*3.57% and 80.36%, respectively. The majority of the mothers were belonged to the normal BMI category, out of them only 0.46% of mothers given birth to very low birth weight (VLBW) newborns. It is interesting to found that none of the overweight and obese mothers had VLBW and LBW newborns and their cent percent of babies born with normal birth weight(NBW). Singh *et al.*(2018) found in their study that maternal BMI status was significantly related tothe birth weight of newborns which was similar to the results of the study. The results revealed that there was a significant association between Body Mass Index of mothers and birth weight of newborns.

Maternal hemoglobin and Birth weight of newborns

Table 6. Distribution of respondents on the basis of maternal hemoglobin in relation to birth weight of newborns

Maternal Haemo-globin	Below 1.5 kg (VLBW)	1.5 kg to 2 kg (LBW)	2 kg to 2.5 kg (LBW)	2.5 kg to 3 kg (NBW)	3 kg to 3.5 kg (NBW)	Above 3.5 kg (NBW)	Total	Chi-Square Value
Severely anaemic	3 (9.09)	9 (27.27)	16 (48.48)	5 (15.15)	0 (0.00)	0 (0.00)	33 (100)	χ^2 = 148.4*
Moderately anaemic	0 (0.00)	7 (3.13)	86 (38.39)	86 (38.39)	39 (17.41)	6 (2.68)	224 (100)	
Normal haemoglobin	0 (0.00)	0 (0.00)	1 (2.33)	6 (13.95)	31 (72.09)	5 (11.63)	43 (100)	

*Significant

Results (Table 6) showed that the mothers who were severely anemic delivered more percentage of VLBW(very low birth weight)and LBW(low birth weight) newborns *i.e.* 9.09% and 63.75% respectively in comparison to mothers from moderate anemic and normal hemoglobin level. It was also interesting to note that the percentage of VLBW(very low birth weight)newborn was nil among the mothers from moderate anemic or normal hemoglobin levels.However,41.52% of low birth weight newborns were born to mothers from moderate anemic and only 2.33% LBW(low birth weight)newborns were born to mothers who had a normal level of hemoglobin.None of the mothers found to be mildly anemic in this study. Statistically,a strong significant association was also found with maternal hemoglobin levels during pregnancy and birth weight of newborns.A similar statistical association wasalso observed by Dayanithi*et al.*(2018).

Association of some significant maternal health factors in relation to the birth weight of newborns is established in this study. Mothers who havebelow 50 kg bodyweight during the third trimester of pregnancy found to delivered more percentage(75.21%) of low birth weight newborns. The incidenceof low birth weight newborns was found to be highest (85.71%) among the short stature mothers in comparison to their counterparts. The study indicated that with an increase in weight gain during pregnancy the percentage of low birth weight newborns decreases. It was found that 80.36% of low birth weight newborns born to the motherswhose weight gain was 2-5kg duringthe third trimester of pregnancy. It was also interesting to note that none of the overweight and obese mothers had VLBW and LBW newborns.Mothers suffered from severe anemia found to delivered75.75% low birth weightnewborns.Thus, it can be concluded that the prevalence of low birth weight among newborns decreases with an increase in maternal body weight, height, level of hemoglobin, and BMI of mothers,weight gain during pregnancy.

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