THE JOURNAL OF RESEARCH ANGRAU

ACHARYA N.G. RANGA AGRICULTURAL UNIVERSITY

Lam, Guntur - 522 034

The J. Res. ANGRAU, Vol. XLV No. (1), pp 1-92, Jan.-March, 2017

Indexed by CAB International (CABI)

www.cabi.org and www.angrau.ac.in

The Journal of Research ANGRAU

(Published quarterly in March, June, September and December)

SUBSCRIPTION TARIFF

Individual (Annual)	:	Rs 300/-	Institutional (Annual)	:	Rs. 1200/-
Individual (Life)	:	Rs. 1200/-	Printing Chagres	:	Rs. 100/- per page

DD drawn in favour of **COMPTROLLER, ANGRAU, GUNTUR** may be sent to the Principal Agricultural Information Officer, Agricultural Information & Communication Centre, E.S.R. Enclave, Balaji Nagar, M.G. Inner Ring Road, Guntur - 522 509, A.P.

CONTENTS

PART I: PLANT SCIENCES

PART II: AGRICULTURAL ENGINEERING

PART III: SOCIAL SCIENCES

J.Res. ANGRAU 45(1) 1-6, 2017

IDENTIFICATION OF SUITABLE FOXTAIL MILLET VARIETY FOR RAINFED ALFISOLS OF SCARCE RAINFALL ZONE

C. RADHA KUMARI, P. SHANTHI, M. NIVEDITHA, K.V.S. SUDHEER,
Y. PAVAN KUMAR REDDY and B. SAHADEVA REDDY
Agricultural Research Station, Acharya N. G. Ranga Agricultural University, Ananthapuramu -515 001

Date of Receipt: 28.11.2016 Date of Acceptance: 09.1.2017

ABSTRACT

A field experiment was conducted to study the suitability of foxtail millet varieties for alfisols of scarce rainfall zone under rainfed conditions for two consecutive years during *kharif*, 2014-15 and 2015-16 at Agricultural Research Station, Ananthapuramu of Andhra Pradesh. The treatments consisted of six varieties *viz.,* Narasimharaya, Krishnadevaraya, Srilakshmi, SiA 3085, Prasad and Suryanandi. The results revealed that the varieties SiA 3085 followed by Narasimharaya and Srilakshmi produced significantly higher grain yield as compared to the other tested varieties. Narasimharaya and Krishnadevaraya can be recommended for dual purpose both for grain and straw followed by Srilakshmi variety. The variety SiA 3085 can be recommended for grain production on commercial basis as its potential for production of straw is low.

INTRODUCTION

India is having nearly 108 million hectares of rainfed area, which accounts for nearly 75 per cent of the total arable land of 143 million hectares. Out of 108 million hectares of total rainfed area, dry lands constitute about 47 million hectares and contribute 42 per cent of the total food grain production of the country. In India, for the four decades since 1961, the area under millets was declined by nearly 50% from about 18 million hectares to about 9 million hectares. During this period of time, production of millets declined from about 8.8 million tons to about 7.2 million tons with a decline of 18 per cent. These figures indicate that millions of households are unable to access affordable nutritious food anymore (Stanly Joseph Michaelraj and Shanmugam, 2013). Harvested area and the consumption of millets in India is gradually decreased in alternative years of 2005-2008 and from the year of 2009 onwards, the area harvested gradually increased and then 2011, it has come down to falling. On the other hand, the availabe quantity for consumption of millets was decreased in 2009 and from the year 2009, its level goes on increasing and in the year of 2012 onwards comes to a falling rate of -20.0 per cent (Stanly Joseph Michaelraj and Shanmugam, 2013).

Foxtail millet is one of the oldest small millets cultivated for food and fodder in India. It is known for its drought tolerance and can withstand severe moisture stress and also suited to wide range of soil conditions. It is of shortest duration and can be grown with low cost consumptive crop, nutritionally superior, providing protein, minerals and vitamins and forms staple food for the poorer sections of the society (Mallesh, 1986). In India, Andhra Pradesh (4,79,000 ha), Karnataka (2,32,000 ha) and Tamilnadu (20,000 ha) are the major foxtail millet growing states contributing to about 90 % of the total area under cultivation. Andhra Pradesh is a major foxtail millet growing state with an area contributing to about 79 % of the total area. However, the yields per unit area are very low since the crop is mainly grown by small and marginal farmers on poor, shallow and marginal soils under rainfed conditions besides lack of high yielding varieties.

In Ananthapuramu district of Andhra Pradesh except sorghum, pearlmillet and fingermillet, no other millet showed any improvement in their cultivable area. Ananthapuramu district is the second most drought affected districts of India. It receives around 550 mm rainfall annually. The agriculture is predominantly dependent on rainfall which is very

E-mail: radhaagronomy@gmail.com

erratic and uncertain. Being located in the scarce rainfall zone of Andhra Pradesh, it does not get the full benefit of either the southwest or northeast monsoon. In this region, local varieties of foxtail millet often are being cultivated under unmanured and unfertilized conditions which has resulted in reduced returns. Hence, by keeping all the above points in view, the present study was carried out to study the performance of newly developed foxtail millet varieties in rainfed alfisols of Ananthapuramu district.

MATERIAL AND METHODS

A field experiment was conducted to study the suitability of foxtail millet varieties for alfisols of scarce rainfall zone under rainfed conditions for two consecutive years during *kharif*, 2014-15 and 2015-16 at Agricultural Research Station, Ananthapuramu of Andhra Pradesh. The soil of the experimental site was red sandy loam with shallow depth, low in organic carbon (0.36%) and low in available nitrogen (143 kg ha^{-1}), medium in available phosphorous (28 kg ha^{-1}) and potassium (215 kg ha^{-1}). The experiment was laid out in randomized block design with three replications. The treatments consisted of six varieties *viz.,* T_1: Narasimharaya, T_2: Krishnadevaraya, T_3: Srilakshmi, T_4: SiA 3085, T_5: Prasad and T_6: Suryanandi. The experimental field was prepared by working with a tractor drawn disc plough and then tractor drawn cultivator was drawn along the field. Healthy seeds of foxtail millet varieties with good germination percent (95%) used for sowing purpose. Sowing was taken up as per the treatments. The seeds were sown by dibbling in furrows at a depth of 5 cm. The furrows were covered immediately after sowing and compacted sufficiently for better germination. Thinning was done at 15 DAS by retaining one healthy seedling $hill^{-1}$. The recommended dose of 16 and 8 kg N and P_2O_5 ha^{-1} was applied through urea and single super phosphate, respectively. Thinning and gap filling was done wherever necessary, weeding and hoeing were taken up depending on the intensity of weeds at critical stages of crop weed competition. Two hand weedings were done with the help of star weeder in interrows and with hand hoes in the intrarows and all other cultural practices were kept normal and uniform for all treatments. At harvest, five plants were randomly selected from each treatment for recording growth parameters such as plant height, number of tillers and $panicles^{-1}$ plant, panicle length, panicle weight $plant^{-1}$, threshing percent and test weight. At harvest, in each treatment grain and straw yield from the net plot (5 m x 5 m) was recorded and expressed in kg ha^{-1}.

RESULTS AND DISCUSSION

Rainfall and crop performance

In 2014-15, annual rainfall received (375.2 mm in 26 rainy days) was 65.8% of normal annual rainfall (570 mm). All varieties were sown on 15.07.2014. Tested varieties were harvested at different dates depending on maturity (Table 1) with varying crop duration. Crop duration of varieties was ranged from 84 to 107 days, rainfall during crop period ranged from 150.4 to 224.1 mm in 9 to 14 rainy days. In 2015-16, annual rainfall received (641 mm in 44 rainy days) was 108% of normal annual rainfall (590.6 mm). All varieties were sown on 18.06.2015. Tested varieties harvested at different dates depending on maturity (Table 2) with varying crop duration. Crop duration of varieties was ranged from 94 to 115 days, rainfall during crop period ranged from 238.4 to 328.0 mm in 17 to 24 rainy days.

Growth and yield attributes

The plant height was significantly influenced by the tested varieties. Among the six varieties evaluated, Narasimharaya, Srilakshmi and Prasad varieties produced significantly taller plants compared to other varieties while shorter plants were produced by Suryanandi (Table 3). These results were contradictory to Karanam Navya Jyothi *et al*. (2016) who reported that the taller plants were produced by the variety SiA 3156 followed by SiA 3085, while, the shorter plants were produced by SiA 3088.

Table 1. Rainfall and rainy days during crop growth period, 2014-15

Parameter	SiA 3085	Surya-nandi	Prasad	Narasim-haraya	Sri-lakshmi	Krishna-devaraya
Date of sowing	15.7.2014	15.7.2014	15.7.2014	15.7.2014	15.7.2014	15.7.2014
Date of harvesting	8.10.2014	6.10.2014	12.10.2014	20.10.2014	17.10.2014	29.10.2014
Crop duration	86	84	90	98	95	107
Rainfall during crop period (mm)	160.4	150.4	163.4	165.2	164.8	224.1
Number of rainy days during the crop period	10	9	11	11	11	14
Normal annual rainfall (mm)	570					
Actual annual rainfall (mm)	375.2					
Number of rainy days during the year	26					

Table 2. Rainfall and rainy days during crop growth period, 2015-16

Parameter	SiA 3085	Surya-nandi	Prasad	Narasim-haraya	Sri-lakshmi	Krishna-devaraya
Date of sowing	18.6.2015	18.6.2015	18.6.2015	18.6.2015	18.6.2015	18.6.2015
Date of harvesting	19.9.2015	19.9.2015	23.9.2015	28.9.2015	28.9.2015	1.10.2015
Crop duration	94	94	98	103	106	115
Rainfall during crop period (mm)	238.4	238.4	238.4	264.8	264.8	328.0
Number of rainy days during the crop period	17	17	17	20	20	24
Normal annual rainfall (mm)	590.6					
Actual annual rainfall (mm)	641					
Number of rainy days during the year	44					

Different tested varieties have exerted significant influence on number of tillers plant^{-1}, among them Suryanandi variety recorded higher number of tillers plant^{-1} plant which in turn on par with Prasad variety and found to be significantly superior to remaining varieties. Less number of tillers plant^{-1} was produced by Srilakshmi. These results were contradictory to Karanam Navya Jyothi *et al*. (2016) who reported that the total number of tillers m^{-2} was not significantly influenced by different varieties. The difference in the growth characters may be attributed to the genetic constitution of the varieties. The variation in number of panicles per plant was not significantly influenced by tested varieties. However, higher number of panicles plant^{-1} was recorded with Suryanandi and lesser panicles plant^{-1} was noticed with Srilakshmi and SiA 3085.

Panicle length and panicle weight plant^{-1} was significantly influenced by different varieties. Srilakshmi and SiA 3085 recorded maximum panicle length which inturn were comparable to each other and significantly superior over other varieties. SiA 3085 produced significantly higher panicle weight compared to other varieties. Variation in threshing percent was inconsistent among the varieties during

Table 3. Growth and yield components as influenced by foxtail millet varieties (Mean of 2 years data)

Treatments	Plant height (cm)	Number of tillers plant^{-1}	Number of panicles plant^{-1}	Panicle length (cm)	Panicle weight plant^{-1} (g)
Narasimharaya	78.5	3.9	3.1	9.7	7.9
Krishnadevaraya	70.6	4.3	3.6	9.9	7.7
Srilakshmi	78.1	3.5	2.7	12.7	8.6
SiA 3085	69.9	3.8	2.7	11.7	12.2
Prasad	75.0	5.0	4.0	10.4	10.5
Suryanandi	68.6	5.8	4.6	8.0	6.7
S.Em ±	1.32	0.38	0.47	0.59	0.18
C.D. at 5%	4.21	1.21	NS	1.90	0.59

NS : Non-Significant

Table 4. Threshing %, test weight and yield of foxtail millet varieties (Mean of 2 years data)

Treatments	Threshing %	Test weight (g)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest Index
Narasimharaya	61.4	2.38	554	2130	0.21
Krishnadevaraya	58.8	2.62	482	2099	0.21
Srilakshmi	56.7	2.50	557	1764	0.26
SiA 3085	63.9	2.91	591	1279	0.32
Prasad	60.8	2.28	421	1423	0.23
Suryanandi	56.8	2.47	512	1490	0.27
S.Em ±	2.6	0.25	31.5	75.0	0.02
C.D. at 5%	NS	NS	100	241.0	0.07

NS : Non-Significant

the period of investigation. However, higher threshing percent was noticed with SiA 3085 and lower threshing percent was recorded with Srilakshmi and Suryanandi. The test weight was not influenced by the varieties tested. However, SiA 3085 produced higher test weight and lesser test weight was recorded with Prasad variety.

Grain and straw yield

Grain and straw yields were remarkably influenced by the tested varieties (Table 4). Among the varieties tested SiA 3085, Narasimharaya and Srilakshmi produced significantly higher grain yield as compared to the other tested varieties. Difference in yields among the varieties can be attributed to

Table 5. Correlation coefficient between yield components and yield of foxtail millet varieties in rainfed alfisols (mean of 2 years data)

Parameter	Plant height (cm)	Number of tillers plant^{-1}	No. panicles plant^{-1}	Panicle length (cm)	Panicle weight per plant (g)	Threshing%	Test weight (g)	Straw yield (kg ha^{-1})	Grain yield (kg ha^{-1})	Harvest Index
Plant height (cm)	1.00									
Number of tillers plant^{-1}	0.35	1.00								
No. of panicles plant^{-1}	0.23	0.96**	1.00							
Panicle length (cm)	0.63*	-0.26	-0.38	1.00						
Panicle weight plant^{-1} (g)	0.45	0.09	-0.07	0.73**	1.00					
Threshing %	0.25	0.11	-0.03	0.28	0.64*	1.00				
Test weight (g)	-0.40	-0.26	-0.37	-0.07	0.03	0.23	1.00			
Straw yield (kg ha^{-1})	0.60	0.10	0.07	0.08	-0.27	0.02	-0.22	1.00		
Grain yield (kg ha^{-1})	-0.38	-0.27	-0.27	-0.03	0.10	0.41	0.16	-0.29	1.00	
Harvest Index	-0.62	-0.26	-0.23	-0.06	0.22	0.24	0.28	-0.80	0.79**	1.00

**= Significant at 1 % level   *=Significant at 5 % level

their genetic potentiality to utilize and translocate photosynthates from source to sink. The results were in conformity with the findings of Saini and Negi (1996) and Karanam Navya Jyothi *et al*. (2016). Narasimharaya and Krishnadevaraya have produced significantly higher straw yield compared to the other tested varieties. SiA 3085 recorded higher harvest index which was at par with Suryanandi variety and proved to be significantly superior to other varieties. Present investigation confirms the results reported by Karanam Navya Jyothi *et al*. (2016).

Correlation between yield components and yield of foxtail millet varieties

There was significant positive correlation between number of panicles plant^{-1} plant and number of tillers plant^{-1} (Table 5). Panicle weight plant^{-1} has significant positive correlation with panicle length. Panicle length was significantly and positively correlated to plant height. Threshing per cent has positive relation with panicle weight plant^{-1}. Straw yield has significant positive correlation with plant height. Grain yield was not significantly influenced by any factor. Harvest index was significantly and negatively influenced by plant height and straw yield. However, it has significant positive relation with grain yield.

CONCLUSION

Keeping in view the demand for fodder and grain, the foxtail millet varieties, Narasimharaya and Krishnadevaraya can be recommended for dual purpose followed by Srilakshmi. SiA 3085 variety can be recommended for grain production on commercial basis as its potential for production of straw is poor.

REFERENCES

Karanam Navya Jyothi, Sumathi, V and Sunitha, N. 2016. Productivity, nutrient balance and profitability of foxtail millet (*Setaria italica* L.) varieties as influenced by levels of nitrogen. Journal of Agriculture and Veterinary Science. 9(4):18-22.

Mallesh, N.G. 1986. Small millets in global agriculture. In: Proceedings of the First International Small Millets Workshop, Bangalore, India.[Sitharam, A., Riley, K.W and Harinarayana, G. (Eds.)]. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi, India. pp. 305 -339.

Saini, J.P and Negi, S.C. 1996. Response of foxtail millet (*Setaria italica* L.) genotypes to nitrogen fertilization under dry-temperate conditions. Indian Journal of Agronomy. 41(2): 261-264.

Stanly Joseph Michaelraj and Shanmugam. 2013. A study on millets based cultivation and consumption in India. International Journal of Marketing, Financial Services and Management Research. 2 (4): 49-58.

J.Res. ANGRAU 45(1) 7-10, 2017

REACTION OF BT COTTON HYBRIDS AGAINST MAJOR DISEASES

S. L. BHATTIPROLU and V. CHENGA REDDY

Regional Agricultural Research Station, Acharya N. G. Ranga Agricultural University,

Lam, Guntur – 522 034

Date of Receipt: 03.12.2016 Date of Acceptance: 07.1.2017

ABSTRACT

One hundred and twelve(112) Bt cotton hybrids were evaluated during *kharif* 2013 and 2014, in randomized block design with two replications, each composed of four rows, at a spacing of 105 cm x 60 cm. Infector row technique was employed to supplement the natural disease pressure and intensity of Alternaria leaf spot, grey mildew and rust was recorded by adopting 0 to 4 scale. Bt hybrid, Ankur 2224 was free from grey mildew and moderately resistant to Alternaria leaf spot (ALS) while Ankur Shreyash was resistant to grey mildew (GM) and moderately resistant to ALS and rust. Bt hybrid, ACH 152-2 showed resistant reaction to both ALS and GM. *Bt* hybrid, Ankur 8120 exhibited resistance to rust and moderate resistance to GM. Two Bt hybrids *viz*., Bio 7213-2 and RJHH 10 were moderately resistant to ALS, GM as well as rust. Sixteen Bt hybrids were moderately resistant to ALS and GM, whereas, nine Bt hybrids were moderately resistant to ALS and rust. Seven Bt hybrids expressed moderately resistant reaction to both GM and rust. These studies help cotton farmers, in particular, small and marginal as well as tenant farmers to choose best Bt hybrids with multiple disease resistance for ecofriendly and economic production.

INTRODUCTION

Cotton is an important commercial crop in India with a production of 352 lakh bales (170 kg lint each) in 2015-2016 from an area of 118.81 lakh ha with a productivity of 503kg ha^{-1}, which is far behind the leading countries. Andhra Pradesh stood 3rd in area (6.63 lakh ha) but 4th in production (19.10 lakh bales) and 2nd in productivity (641 kg ha^{-1}) during 2015 – 2016 (Annual Report of AICCIP, 2016). During the surveys conducted in Andhra Pradesh, it was observed that popular *Bt* cotton hybrids were affected by fungal diseases. Leaf spot/blight caused by *Alternaria macrospora* Zimm. is the most commonly occurring disease in Andhra Pradesh causing losses to the tune of 38.23 per cent in cotton variety LRA 5166 (Bhattiprolu and Prasada Rao, 2009). Grey mildew, under congenial weather caused losses 38.38 per cent losses in Bunny BG II (Bhattiprolu, 2012). Avoidable loss due to rust disease was estimated to be 34.05 per cent in RCH 2 BG II while the loss was to the tune of 21.7 per cent in Bunny Bt (Bhattiprolu, 2015; Monga *et al*., 2013). Cultivation of resistant varieties/hybrids is an important component of Integrated disease management. Identification of resistant sources is a pre-requisite for development of resistant varieties and/or hybrids. Hence, present studies were taken up to evaluate and identify Bt cotton hybrids resistant to major diseases.

MATERIAL AND METHODS

A field experiment was conducted at Regional Agricultural Research Station, Lam, Guntur during *kharif* seasons of 2013 and 2014. One hundred and twelve Bt cotton hybrids were sown in randomized block design with two replications, each composed of four rows, at a spacing of 105 cm x 60 cm. Infector row technique was employed to supplement the natural disease pressure. Each entry was sandwiched between infector rows of susceptible variety LRA 5166. In addition, two border rows of LRA 5166 were raised around the field. The crop was protected from sucking pests using recommended insecticides and these hybrids were evaluated against foliar diseases under unprotected conditions. Five plants, at random, of each test hybrid were tagged and 10 leaves, three leaves at bottom, four in the middle and three at the top of each plant were scored by adopting 0 to 4 scale at peak intensity of leaf spots, grey mildew and rust (0 = No disease; 1 = <5%; 2 = 6-20%; 3 = 21-40% and 4 = >40% leaf area is diseased) (Sheo Raj, 1988). Depending on the scores collected, per cent disease intensity (PDI)

E-mail: bhattiprolu2023@gmail.com

was calculated by using Wheeler's formula (1969) as given below:

$$\text{PDI} = \frac{\text{Sum of all the numerical ratings}}{\text{Total number of leaves scored} \times \text{Maximum disease grade}} \times 100$$

Depending upon the grade of infection the hybrids were categorized into immune, resistant, moderately resistant or susceptible and susceptible groups.

RESULTS AND DISCUSSION

One Bt hybrid, Ankur 2224 was free from grey mildew and moderately resistant to Alternaria leaf spot while Ankur Shreyash was resistant to grey mildew and moderately resistant to Alternaria leaf spot and rust (Table 1). One Bt hybrid, ACH 152-2 showed resistant reaction to both Alternaria leaf spot and grey mildew. Bt hybrid, Ankur 8120 exhibited resistance to rust and moderate resistance to grey mildew. Two Bt hybrids *viz*., Bio 7213-2 and RJHH 10 were moderately resistant to Alternaria leaf spot,

Table 1. Reaction of Bt Cotton hybrids to major diseases (Pooled data of 2013-14 and 2014-15)

Scale	Grade	Disease reaction of hybrids		
		Alternaria leaf spot	**Grey mildew**	**Rust**
0	Immune	Nil	Ankur 2224	Nil
1	Resistant	ACH 152-2	ACH 152-2, Ankur Shreyash	Ankur 8120
2	Moderately resistant	ACH-4, SCH-505, KCH-3011, SCH-311, Ankur 2595, Western Niogi-51, JKCH 8905, KSCH-232, IAHH 4202, DPC 9104 (Aravind), 81 SS 33, KCH-3041, KSCH-209, 741 SS 66, Ankur 5464, Ankur 2224, SCH-234, KCH 3001, NCH 1311, DPC-7102 (Arind), NCH 1049, RCH 779, DPC 9105 (Arind), Surpass (First days), SP 7618, MRC 7399, NAMCOT 639, NAMCOT 640, ACHH 57, ACHH 55, Tulasi 315, JKCH 8935, JKCH 12124, PCHH -4, KCH 3061, CKH 3071, KCH 3081, KCH 3091, ACH 151-2, ACH 104-2, Ankur Shreyash, DPC 9114, DPC 7115, DPC 7102, Bio 7213-2, RCH 812, NBC-10, NCS 2122, NCS 4567, NCS 3133, NCS 3456, NCS 8899, NCS 6566, PCH 549, PRCH 777, RJHH 113, RJHH 13, RJHH 10, KSCH 212, KSCH 208, KSCH 211, SCH 745, SCH 844	NCH 2108, PCHH-4 (Saraswathi), Western Niogi-51, ACHH-2, KCH-3021, First class, 60 SS 66, Ankur 5464, SP 7585, KSCH-229, Surpass Asha, 63 88 33, NBC 102, DPC 9105 (Arind), KSCH 234, SCH 333 , SP 7592, MRC 7355, Tulasi 315, JKCH 12124, PCHH -4, KCH 3091, ACH 151-2, Ankur Narayan, Ankur Pushkar, Ankur 8120, DPC 7112, DPC 5111, DPC 9113, Bio 7213-2, NBC-11, NCS 3456, NCS 234, PCH 9619, PCH 549, JKCH 8906, JKCH 8905, RJHH 113, RJHH 10, KSCH 212, KSCH 208, KSCH 211, SCH 745, SCH 844	ACHH-2, SP 7618, Ankur Shreyash, Ankur Narayan, Ankur Pushkar, DPC 7112, DPC 9114, DPC 7115, DPC 5111, DPC 9113, DPC 7102, Bio 7213-2, RCH 812, NBC-10, NBC-11, NCS 2122, RJHH 13, RJHH 10

Contd.......

Scale	Grade	Disease reaction of hybrids		
		Alternaria leaf spot	Grey mildew	Rust
3	Moderately Susceptible	Western Nirogi-108 BG II, NCH 2108, KSCH-207, Bunny, ACH-2, SWCH-4823, PCHH-4 (Saraswathi), ACH-1, NBC-101, Mallika, ACHH-2, KCH-3021, Jaadoo, DPC 5102 (Aravind), First class, ACH 104-2, KSCH-233, PCHH-5073 (Meenakshi), 60 SS 66, Ankur 3818, SP 7585, KSCH-229, KCH 3031, RCH 797, IAHH 178, Surpass Asha, Ankur-4858, 63 88 33, NBC 102, SP 7517, KSCH 234, SCH 777, SCH 333, SP 7517, SP 7592, MRC 7355, Tulasi 414, KCH 3051, Ankur Narayan, Ankur Pushkar, Ankur 8120, DPC 7112, DPC 5111, DPC 9113, NBC-11, NCS 234, PCH 222, PCH 9619, JKCH 8906	Western Nirogi-108 BG II, SCH-505, KSCH-207, ACH-2, SWCH-4823, SCH-311, Ankur 2595, KSCH-232, DPC 5102 (Aravind), DPC 9104 (Aravind), ACH 104-2, KSCH-233, PCHH-5073 (Meenakshi), KCH-3041, 741 SS 66, SCH-234, KCH 3031, IAHH 178, NCH 1311, Ankur-4858, DPC-7102 (Arind), NCH 1049, RCH 779, SCH 777, SP 7517, Surpass (First days), SP 7618, MRC 7399, NAMCOT 639, NAMCOT 640, ACHH 57, ACHH 55, Tulasi 414, JKCH 8935, KCH 3051, KCH 3061, CKH 3071, KCH 3081, ACH 104-2, DPC 9114, DPC 7115, DPC 7102, RCH 812, NBC-10, NCS 2122, NCS 4567, NCS 3133, NCS 8899, NCS 6566, PCH 222, PRCH 777, RJHH 13	Western Nirogi-108 BG II, NCH 2108, ACH-4, SCH-505, KSCH-207, SWCH-4823, PCHH-4 (Saraswathi), ACH-1, SCH-311, Ankur 2595, JKCH 8905, KCH-3021, DPC 5102 (Aravind), First class, IAHH 4202, DPC 9104 (Aravind), ACH 104-2, PCHH-5073 (Meenakshi), 60 SS 66, Ankur 3818, KCH-3041, 741 SS 66, Ankur 2224, KSCH-229, KCH 3031, IAHH 178, KCH 3001, Surpass Asha, DPC-7102 (Arind), 63 88 33, NCH 1049, NBC 102, SP 7517, DPC 9105 (Arind), KSCH 234, SCH 777, SCH 333, SP 7592, Surpass (First days), MRC 7355, MRC 7399, NAMCOT 639, NAMCOT 640, ACHH 57, ACHH 55, Tulasi 315, Tulasi 414, JKCH 8935, JKCH 12124, PCHH -4, KCH 3061, KCH 3091, ACH 151-2, ACH 152-2, ACH 104-2, NCS 4567, NCS 3133, NCS 3456, NCS 8899, NCS 6566, NCS 234, PCH 222, PCH 9619, PCH 549, PRCH 777, JKCH 8906, RJHH 113, KSCH 212, KSCH 208, KSCH 211, SCH 745, SCH 844
4	Susceptible	Nil	ACH-4, Bunny, KCH-3011, ACH-1, NBC-101, Mallika, Jaadoo, IAHH 4202, 81 SS 33, Ankur 3818, KSCH-209, RCH 797, KCH 3001	Bunny, ACH-2, KCH-3011, NBC-101, Mallika, Jaadoo, Western Niogi-51, KSCH-232, KSCH-233, 81 SS 33, KSCH-209, Ankur 5464, SCH-234, RCH 797, NCH 1311, Ankur-4858, RCH 779, KCH 3051, CKH 3071, KCH 3081

grey mildew as well as rust. Sixteen Bt hybrids were moderately resistant to Alternaria leaf spot and grey mildew, whereas, nine Bt hybrids were moderately resistant to Alternaria leaf spot and rust. Seven Bt hybrids expressed moderately resistant reaction to both grey mildew and rust. Sixty-three Bt cotton hybrids were moderately resistant to Alternaria leaf spot while 44 and 18 hybrids were moderately resistant to grey mildew and rust, respectively. Hosagoudar *et al*. (2008) observed that Bt hybrids *viz*., JKCH-2 Bt, JKCH-3 Bt, JKCH-4 Bt, JKCH-5 Bt, JKCH- 6 Bt, Bunny Bt, JKCH-7 Bt, RCH-2 were moderately susceptible and JKCH-1 Bt was highly susceptible to grey mildew while all nine Bt hybrids were highly susceptible to Alternaria leaf spot. Ganesh BG II was resistant while Brahma, Dr Brent BG II, Neeraja BG II, SWCH 4746 BG I, Bullet BG II, Indra Vajra, and Mallika BG II showed moderately resistant reaction to Alternaria leaf spot (Gurava Reddy *et al*., 2015). Bhattiprolu and Prasad (2011) reported resistant nature of MRC – 7201 BG II (Neeraja BG II) to Alternaria leaf spot while Mallika Gold Bt 2, Mallika Bt 2 and Mallika Bt were moderately resistant. Bt cotton hybrids *viz*., Tulasi-4 Bt, RCH-2 BG II, Bunny Bt, Bunny BG II and Tulasi-9 BG II were moderately susceptible to rust (Shridhar Shetty *et al*., 2011).

CONCLUSION

Cotton farmers, in particular, small and marginal as well as tenant farmers may choose best Bt hybrids with multiple disease resistance for ecofriendly and economic production.

REFERENCES

AICCIP. 2016. Annual report of All India Coordinated Cotton Improvement Project(AICCIP), Coimbatore. pp.36-45.

Bhattiprolu, S.L. 2012. Estimation of crop losses due to grey mildew (*Ramularia areola* Atk.) disease in Bt cotton hybrid. Journal of Cotton Research and Development. 26 (1): 109-112.

Bhattiprolu, S.L. 2015. Estimation of crop losses due to rust *Phakopsora gossypii* (Arth.) Hirat.f disease in Bt cotton hybrid. Journal of Cotton Research and Development. 29 (2): 301-304.

Bhattiprolu, S.L and Prasada Rao, M.P. 2009. Estimation of crop losses due to Alternaria leaf spot in cotton. Journal of the Indian Society for Cotton Improvement. 34 (3): 151-154.

Bhattiprolu, S.L and Prasad, N.V.V.S.D. 2011. Field evaluation of Bt cotton hybrids against major diseases. Journal of Cotton Research and Development. 25 (1): 112-114.

Gurava Reddy, K., Sree Lakshmi, B., Reddy, M.C.S and Chenga Reddy, V. 2015. Field evaluation of Bt cotton hybrids against certain sucking pests and foliar diseases. The Journal of Research ANGRAU. 43 (3&4): 42-47.

Hosagoudar, G.N., Chattannavar, S.N and Srikanth Kulkarni. 2008. Screening of Bt and Non-Bt cotton genotypes for foliar diseases. Karnataka Journal of Agricultural Sciences. 21(1): 141-143.

Monga, D., Sree Lakshmi, B and Prakash, A.H. 2013. Crop losses due to important cotton diseases. Central Institute for Cotton Research (CICR) Technical Bulletin, Nagpur. No. 1. pp. 23.

Sheo Raj. 1988. Grading system for cotton diseases. Central Institute for Cotton research (CICR) Technical Bulletin, Nagpur. pp.1-7.

Shridhar Shetty, P., Gururaj Sankad, Naik, M.K and Amaresh, Y. S. 2011. Sources of field resistance to rust of cotton caused by *Phakopsora gossypii*. Karnataka Journal of Agricultural Sciences. 24 (3): 406 -407.

Wheeler, B.E.J. 1969. An Introduction to Plant Diseases. John Wiley and Sons Limited, London, pp. 301.

J.Res. ANGRAU 45(1) 11-15, 2017

EVOLVING SUITABLE SELECTION INDEX BY ASSIGNING EQUAL ECONOMIC WEIGHTS IN FINGER MILLET [*Eleusine coracana* (L.) Gaertn]

P. SRILAKSHMI, D. RATNA BABU, P.V. RAMA KUMAR AND P. ANIL KUMAR

Department of Genetics and Plant Breeding, Agricultural College, Acharya N.G. Ranga Agricultural University, Bapatla -522 101

Date of Receipt: 08.11.2016 Date of Acceptance: 03.1.2017

ABSTRACT

The present investigation on forty- three finger millet genotypes was carried out to arrive at a suitable selection index for selecting superior genotypes for seed yield plant^{-1}(g). In the process of developing suitable index equal economic weights were assigned to all the eleven traits *viz.,* plant height(cm), days to 50% flowering, days to maturity, number of productive tillers plant^{-1}, fingers ear^{-1}, finger length(cm), ear weight plant^{-1}, 1000-seed weight, and seed yield plant^{-1}(g), seed calcium content(mg/100g), seed protein content(%). It was observed that addition of characters one by one in the construction of selection index resulted in the increased estimates of genetic advance. Finally, the index constructed using all the eleven characters, recorded maximum expected genetic advance and per cent gain over seed yield plant^{-1} compared to that of all 2047 possible combinations.

INTRODUCTION

In any breeding programme for improvement of a particular character which is of quantitative nature like yield, breeder is faced with the problem of arriving at an appropriate index to be employed in taking up selection in different kinds of plant material. This commonly faced problem can be solved to a greater extent by formulating a selection index. Such an index was first proposed by Smith (1936) utilizing the concept of discriminant function developed by Fisher (1936). Since, the seed yield levels in finger millet are far below the actual potential the present investigation was planned to develop a suitable selection index, which can be utilized for performing selection in different finger millet genotypes for high yield genotypes and some nutritional quality.

MATERIAL AND METHODS

The experimental material consists of forty-three diverse finger millet germplasm obtained from Agricultural Research Station, Vizianagaram. These lines were evaluated in Randomized Complete Block Design with three replications, each entry consisting of five rows of three metre length with 30 cm x 10 cm spacing at Agricultural College Farm, Bapatla, located at an altitude of 5.4 m from MSL, 15^0 54' N latitude and $80^0$90' E longitude, during *kharif,* 2012-13. Eleven different nutritional and yield components *viz.,* Seed calcium content (mg 100 g^{-1}), seed protein content (%), plant height (cm), days to 50% flowering, days to maturity, number of productive tillers plant^{-1}, fingers ear^{-1}, finger length (cm), ear weight plant^{-1}(g), 1000-seed weight (g), and seed yield plant^{-1} were taken up for construction of suitable index. Observations were recorded on ten randomly selected plants per treatment per replication and their means were used for statistical analysis. However, days to 50% flowering, days to maturity, 1000-seed weight and seed protein and seed calcium contents were recorded on plot basis. Seed calcium content (mg 100g^{-1}), in each sample was estimated by Versenate titration method (Jackson, 1967) and the protein content (%) was estimated as described by Sadasivam and Manickam (1996).

The restricted selection indices were computed as per Kempthorne and Nordskog (1959), which enables us to restrict change in only some characters without affecting the development in other characters. A series of constructs to the tune of 2047 were constructed using all the eleven traits considered for this study to evolve a suitable selection index using restricted and classical

E-mail: didlaratnababu@gmail.com

selection index as per the procedure given by Singh and Chaudhary (1977) for making easy and accurate selection to select superior genotypes particularly for seed yield plant^{-1}. In this process of constructing and identifying suitable construct, equal economic weights were assigned for all the eleven characters (one of the three possible ways of assigning weights to each trait) and 2047 constructs were developed.

RESULTS AND DISCUSSION

Those indices which gave higher estimates of genetic advance compared to the direct selection were discussed hereunder (Table 1). Among the selection indices constructed by allotting equal economic weights, 2022 constructs out of 2047 possible indices resulted in higher genetic advance than the direct selection on yield alone. When independent characters were considered for construction of index, the indices having seed calcium content (106.24 g/plant, 2112.31%), days to 50% flowering (15.43 g/plant, 306.78%) and days to maturity (14.32 g/plant, 284.68%) recorded higher genetic advance and relative gain over seed yield plant^{-1}, respectively.

Among two character combinations, 45 out of 55 possible combinations recorded higher genetic advance and relative gain over seed yield plant^{-1}, out of which, days to maturity + seed calcium content (111.72 g/plant, 2221.38%), days to 50% flowering + seed calcium content (110.43 g/plant, 2195.71%) and plant height + seed calcium content (109.88 g/ plant, 2184.77%) recorded maximum values of genetic advance and relative gain over seed yield plant^{-1}, respectively. In case of selection indices constructed using three character, 157 out of 165 possible indices recorded higher genetic advance and relative gain over seed yield plant^{-1}. Among them, the combinations *viz.,* days to 50% flowering + days to maturity + seed calcium content (117.11 g/plant, 2328.55%), plant height + days to maturity + seed calcium content (115.74 g/plant, 2301.21%) and days to maturity + ear weight plant^{-1} + seed calcium content (115.18 g/plant, 2290.08%) recorded higher genetic advance and percent gain over seed yield plant^{-1}, respectively.

Among four character combinations, 329 out of 330 possible indices recorded higher genetic advance and relative gain over seed yield plant^{-1}. Among them, the combinations *viz.,* plant height + days to 50% flowering + days to maturity + seed calcium content (121.16 g/plant, 2409.00%), days to 50% flowering + days to maturity + ear weight plant^{-1} + seed calcium content (120.73 g/plant, 2400.51%) and plant height + days to maturity + ear weight plant^{-1} + seed calcium content (119.23 g/ plant, 2370.70%) recorded higher genetic advance and relative gain over seed yield plant^{-1}, respectively.

In case of five character combinations, all the 462 possible indices recorded higher genetic advance and relative gain over seed yield plant^{-1}. Among them, the constructs *viz.,* plant height + days to 50% flowering + days to maturity + ear weight plant^{-1} + seed calcium content (124.81 g/plant, 2481.55%), seed yield plant^{-1} + plant height + days to 50% flowering + days to maturity + seed calcium content (122.28 g/plant, 2431.25%) and plant height + days to 50% flowering + days to maturity + seed protein content + seed calcium content (122.09 g/ plant, 2427.29%) recorded higher genetic advance and percent gain over seed yield plant^{-1}, respectively.

When six characters are involved, all the possible 462 combinations recorded higher genetic advance and relative gain over seed yield plant^{-1}. Among them, the combinations *viz.,* seed yield plant^{-1} + plant height + days to 50% flowering + days to maturity + ear weight plant^{-1} + seed calcium content (126.09 g/plant, 2507.10%), plant height + days to 50% flowering + days to maturity + ear weight plant^{-1} + seed protein content + seed calcium content (125.72 g/plant, 2499.77%) and plant height + days to 50% flowering + days to maturity + finger length + ear weight plant^{-1} + seed calcium content (125.36 g/ plant, 2492.61%) recorded higher genetic advance and relative gain over seed yield plant^{-1}, respectively.

Table 1. Expected genetic advance and Relative efficiency over seed yield plant^{-1} of different constructs formulated using equal economic weights

Sl. No.	Selection index	Expected genetic advance (g/plant)	Relative efficiency over X_1 (%)
1	Seed yield plant^{-1} (X_1)	5.03	100.00
2	Days to maturity (X_4)	14.32	284.68
3	Days to 50% flowering (X_3)	15.43	306.78
4	Seed calcium content (X_{11})	106.24	2112.31
5	X_2+X_{11}	109.88	2184.77
6	X_3+X_{11}	110.43	2195.71
7	X_4+X_{11}	111.72	2221.38
8	$X_4+X_8+X_{11}$	115.18	2290.08
9	$X_2+X_4+X_{11}$	115.74	2301.21
10	$X_3+X_4+X_{11}$	117.11	2328.55
11	$X_2+X_4+X_8+X_{11}$	119.23	2370.70
12	$X_3+X_4+X_8+X_{11}$	120.73	2400.51
13	$X_2+X_3+X_4+X_{11}$	121.16	2409.00
14	$X_2+X_3+X_4+X_{10}+X_{11}$	122.09	2427.59
15	$X_1+X_2+X_3+X_4+X_{11}$	122.28	2431.25
16	$X_2+X_3+X_4+X_8+X_{11}$	124.81	2481.55
17	$X_2+X_3+X_4+X_7+X_8+X_{11}$	125.36	2492.61
18	$X_2+X_3+X_4+X_8+X_{10}+X_{11}$	125.72	2499.77
19	$X_1+X_2+X_3+X_4+X_8+X_{11}$	126.09	2507.10
20	$X_1+X_2+X_3+X_4+X_5+X_8+X_{11}$	126.61	2517.37
21	$X_1+X_2+X_3+X_4+X_7+X_8+X_{11}$	126.70	2519.14
22	$X_1+X_2+X_3+X_4+X_8+X_{10}+X_{11}$	126.98	2524.70
23	$X_1+X_2+X_3+X_4+X_6+X_8+X_{10}+X_{11}$	127.47	2534.60
24	$X_1+X_2+X_3+X_4+X_5+X_8+X_{10}+X_{11}$	127.50	2535.05
25	$X_1+X_2+X_3+X_4+X_7+X_8+X_{10}+X_{11}$	127.59	2536.94
26	$X_1+X_2+X_3+X_4+X_5+X_6+X_8+X_{10}+X_{11}$	128.00	2545.12
27	$X_1+X_2+X_3+X_4+X_6+X_7+X_8+X_{10}+X_{11}$	128.10	2546.97
28	$X_1+X_2+X_3+X_4+X_5+X_7+X_8+X_{10}+X_{11}$	128.12	2547.45
29	$X_1+X_2+X_3+X_4+X_6+X_7+X_8+X_9+X_{10}+X_{11}$	128.26	2550.16
30	$X_1+X_2+X_3+X_4+X_5+X_7+X_8+X_9+X_{10}+X_{11}$	128.27	2550.43
31	$X_1+X_2+X_3+X_4+X_5+X_6+X_7+X_8+X_{10}+X_{11}$	128.63	2557.66
32	$X_1+X_2+X_3+X_4+X_5+X_6+X_7+X_8+X_9+X_{10}+X_{11}$	128.80	2560.91

Where, X_1=Seed yield plant^{-1}, X_2=Plant height, X_3=Days to 50% flowering, X_4=Days to maturity, X_5=Productive tillers plant^{-1}, X_6= Fingers ear^{-1}, X_7= Finger length, X_8= Ear weight plant^{-1}, X_9=1000-seed weight, X_{10}= Seed protein content & X_{11}= Seed calcium content.

In case of selection indices constructed using seven character combinations, all the possible 330 indices recorded higher genetic advance and relative gain over seed yield plant^{-1}. Among them, the combinations *viz.,* seed yield plant^{-1} + plant height + days to 50% flowering + days to maturity + ear weight plant^{-1} + seed protein content + seed calcium content (126.98 g/plant, 2524.70%), seed yield plant^{-1} + plant height + days to 50% flowering + days to maturity + finger length + ear weight plant^{-1} + seed calcium content (126.70 g/plant, 2519.14%) and seed yield plant^{-1} + plant height + days to 50% flowering + days to maturity + productive tillers plant^{-1} + ear weight plant^{-1} + seed calcium content (126.61 g/plant, 2517.37%) recorded higher genetic advance and percent gain over seed yield plant^{-1}, respectively.

All the possible 165 indices constructed using eight character combinations recorded higher genetic advance and relative gain over seed yield plant^{-1}. Among them, the combinations, without productive tillers plant^{-1}, fingers ear^{-1} and 1000-seed weight (127.59 g/plant, 2536.94%), without fingers ear^{-1}, finger length and 1000-seed weight (127.50 g/plant, 2535.05%) and the one without productive tillers plant^{-1}, finger length, 1000-seed weight (127.47 g/plant, 2534.60%) recorded higher genetic advance and relative gain over seed yield plant^{-1}, respectively.

When nine characters are included, all the possible 55 combinations recorded higher genetic advance and relative gain over seed yield plant^{-1}. Among them, the combinations without fingers ear^{-1} and 1000-seed weight (128.12 g/plant, 2547.45%), without productive tillers plant^{-1}, 1000-seed weight (128.10 g/plant, 2546.97%) and the one without finger length and 1000-seed weight (128.00 g/plant, 2545.12%) recorded higher genetic advance and per cent gain over seed yield plant^{-1}, respectively.

Among the selection indices constructed using the ten characters, 11 out of 11 possible indices recorded higher genetic advance and relative gain over seed yield plant^{-1}. Among them, the combinations which do not include the 1000-seed weight (128.63 g/plant, 2557.66%), fingers ear^{-1} (128.27 g/plant, 2550.43%), productive tillers plant^{-1} (128.26 g/plant, 2550.16%) registered higher estimate of genetic advance and relative gain over seed yield plant^{-1}, respectively.

The index constructed using all the eleven characters, recorded maximum expected genetic advance (128.80 g/plant) and per cent gain over seed yield plant^{-1} (2560.91%) compared to all 2047 possible combinations. Such results were also reported by Bhat and Shariff (1994), Padmaja *et al.,* (2006), Padmaja *et al.,* (2007) and Ammu (2011). Further, it is observed that addition of characters one by one in the construction of selection index resulted in the increased estimates of genetic advance. These findings are in tune with the results of Basavaraja and Sheriff (1992), Bhat and Shariff (1994) and Padmaja *et al.* (2007).

CONCLUSION

In conclusion, the index constructed using all the eleven characters, recorded maximum expected genetic advance and per cent gain over seed yield plant^{-1} compared to that of all 2047 possible combinations.

REFERENCES

Ammu, M. 2011. Character association and selection indices in rice (*Oryza sativa* L.). M.Sc. Thesis submitted to Acharya N. G. Ranga Agricultural University, Hyderabad.

Basavaraja, G.T and Sheriff, R.A. 1992. Formulation of selection indices in finger millet (*Eleusine coracana* Gaertn.). Indian Journal of Genetics and Plant Breeding. 52 (2): 199-202.

Bhat, B.V and Shariff, R.A. 1994. Selection criterion in finger millet (*Eleusine coracana* Gaertn.). Mysore Journal of Agricultural Sciences. 28 (1): 5-7.

Fisher, R.A. 1936. The use of multiple measurements in taxonomic problems. Annals of Eugenics. 7: 179-188.

Jackson, M.L. 1967. Soil Chemical Analysis. Prentice Hall of India Private Limited, New Delhi. pp. 282-289.

Kempthorne, O and Nordskog, A.W. 1959. Restricted selection indices. Biometrics. 15: 10-15.

Padmaja, G., Rao, C.P., Kumar, P.V.R and Rao, V.S. 2006. Classical and restriction selection indices in AICSMIP group of genotypes of finger millet [*Eleusine coracana* (L.) Gaertn.]. The Andhra Agricultural Journal. 53 (3): 61-65.

Padmaja, G., Rao, C.P., Kumar, P.V.R and Rao, V.S. 2007. Path analysis and selection indices in VMEC group of genotypes of finger millet [*Eleusine coracana* (L.) Gaertn.]. The Andhra Agricultural Journal. 54 (3&4): 128-133.

Sadasivam, S and Manickam, A. 1996. Biochemical Methods. Second Edition, New Age International (P) Limited, Publishers. New Delhi. pp. 12-34.

Singh, R.K and Chaudhary, B.D. 1977. Biometrical Methods in Quantitative Genetic Analysis. Kalyani Publishers, New Delhi. pp. 215-218.

Smith, H.G. 1936. A discriminant function for plant selection. Annals of Eugenics. 7: 240-250.

J.Res. ANGRAU 45(1) 16-21, 2017

SOIL TEST BASED NUTRIENT MANAGEMENT FOR RABI SUNFLOWER (*Helianthus annuus* L.)

K. PRABHAKAR, P. MUNIRATHNAM, S. BALAJI NAYAK, K. VENKATARAMANAMMA, T. RAGHAVENDRA, P. PULLI BAI AND B. GOPAL REDDY

Regional Agricultural Research Station, Acharya NG Ranga Agricultural University, Nandyala - 518 502

Date of Receipt: 30.11.2016 Date of Acceptance: 28.12.2016

ABSTRACT

A field experiment was conducted for two *rabi* seasons (2014-15 and 2015-16) at Regional Agricultural Research Station, Nandyala, Andhra Pradesh to study the influence of different levels of soil test based nutrient management on yield attributes, seed yield, plant nutrient uptake and available soil nutrient status of sunflower. The results revealed that the maximum plant height (cm), capitulum diameter (cm), capitulum weight(g), single plant yield (g), stalk yield kg ha^{-1} and seed yield (2683 kg ha^{-1}) were obtained with STCR approach + VC @ 2 t ha^{-1}. While the minimum values of yield attributes and seed yield (1015 kg ha^{-1}) and yield attributes were recorded with farmers practice. The study indicated that nutrient management based on soil tested data lead to positive nutrient balance.

INTRODUCTION

Sunflower *(Helianthus annuus* L.) is an important oilseed crop of the world and it ranks third in production next to groundnut and soybean. Nutrient management studies in sunflower focus on available nutrient sources, production practices and other management practices that influence nutrient availability and crop productivity. For over 40 years, soil testing has been a recommended means of predicting the kind and amount of fertilizers needed.

Yet many farmers still do not use this relatively simple tool but apply fertilizers as per their will. Farmers still apply fertilizer where none is required or at lower rates than required or at higher rates than required to optimize yields. Farmers also apply inadequate rates or use ineffective application methods. While soil test recommendations for nutrient requirements and optimum rates needed for maximum profit are not always totally correct, they are superior to no soil testing program at all. Soil test-based nutrient application also allows judicious and efficient use of nutrient inputs at the local and regional levels (Sahrawat *et al*., 2010). Sharma and Singh (2005) reported existence of operational range of soil test values after fertility gradient experiment with preliminary crop pearl millet for development of soil test based fertilizer recommendation to obtain economic yield of wheat crop. The objective of the study is to demonstrate the effect of soil test based fertilization on the soil nutrient status and seed yield of the sunflower so that farmers of the region would be benefitted by the judicious use of the fertilizers after testing their soil.

MATERIAL AND METHODS

A field experiment was conducted at Regional Agricultural Research Station, Nandyala under Irrigated Dry (ID) conditions during *rabi* 2014-15 and 2015-16. The soil of experimental site was medium deep black, low in organic carbon (0.36%), high in available P_2O_5 (45 kg ha^{-1}) and available K_2O (536 kg ha^{-1}). Treatments comprised of ten nutrient management practices, wherein, recommended NPK (75:90:30 N, P_2O_5, K_2O kg ha^{-1}), soil test based NPK (Soil Test Based Fertilizer method), Soil Test Crop Response Co relation (STCR) approach (Yield target: 25 q ha^{-1}) with vermicompost 2 t ha^{-1} and micronutrients Zn, B, S combinations and farmer adopting dose. The experiment was carried out in randomized block design (RBD) with three replications. The sunflower hybrid NDSH -1 was used with a seed rate of 5 kg ha^{-1} at a spacing of 60 cm x

E-mail: kprabhakar7714@gmail.com

Table 1. Plant growth and yield attributes and seed yield of sunflower as influenced by different soil test based nutrient management

Treatments	Plant height (cm)	Capitulam diameter (cm)	Capitulam weight (g)	Yield plant^{-1} (g)	Seed yield (kg ha^{-1})	Stalk yield (kg ha^{-1})	Test weight (g) 1000 seeds
T_1- Recommended NPK (75:90:30 N, P_2O_5, K_2O kg ha^{-1})	176.2	11.5	47.7	30.6	1545	3777	45.2
T_2 - T_1+ Vermicompost 2 t ha^{-1}	188.3	12.1	46.5	32.9	1686	3970	47.1
T_3- T_1+ Zn + B + S (50- 10- 10 kg ha^{-1})	176.4	12.0	48.4	33.5	1609	3829	54.3
T_4 - Soil test based NPK (STBF method) (98:63:20 N, P_2O_5, K_2O kg ha^{-1})	177.4	12.2	48.6	34.5	1739	3972	48.0
T_5- T_4 + Vermicompost 2 t ha^{-1}	188.3	11.6	51.4	39.8	1777	4024	55.1
T_6 - T_4 + Zn + B + S (50- 10- 10 kg ha^{-1})	175.1	11.8	50.3	38.4	1700	3931	49.4
T_7- STCR approach (Yield target: 25 q ha^{-1}) (140:80:53 N, P_2O_5, K_2O kg ha^{-1})	174.6	14.0	57.2	46.5	2478	4717	41.7
T_8 - T_7 + Vermicompost 2 t ha^{-1}	186.6	15.4	61.6	48.1	2683	4803	48.4
T_9 - T_7 + Zn + B + S (50- 10- 10 kg ha^{-1})	177.2	15.1	58.3	46.2	2566	4672	45.5
T_{10}- Farmers practice (50:60:0 N, P_2O_5, K_2O kg ha^{-1})	163.2	10.2	39.3	17.7	1015	2878	41.4
S. Em +	1.8	0.6	2.5	1.8	93	147	9.1
C. D. @ 5%	5.4	1.8	7.4	5.3	274	441	NS

NS : Non-Significant

30 cm. The crop was raised under ID condition and received four irrigations during the crop growth period in both the years. Vermicompost was incorporated in furrows as per the treatments one month before sowing and entire quantity of P_2O_5 and K_2O were applied as basal dose, 33.5% of nitrogen applied as basal dose and remaining 66.5% nitrogen applied as topdressing through urea as per the treatments at 30 and 50 days after sowing. Phosphorus was applied in form single superphosphate whereas potassium was applied in the form of muriate of potash for all the treatments. The data related to plant height and yield attributes was recorded on ten randomly selected plants in each plot. Net seed and stalk yield were recorded for net plot and computed as kg ha^{-1}. Soil and plant samples were collected in each treatment and analysed by following standard procedures. All the data was subjected to statistical analysis.

RESULTS AND DISCUSSION

Plant growth and yield attributes and economic yield

Data presented in Table 1 indicates a significant influence of application of vermicompost @ 2 t ha^{-1} along with RDF, STBF and STCR over all other treatments. The higher plant height (188.3, 188.3 and 186.6 cm, respectively) was noticed with application of vermicompost @ 2 t ha^{-1} along with Recommended dose of fertilizers (RDF), STBF and STCR approach. The results also indicated application of micro nutrients zinc, boron and sulphur with RDF, STBF and STCR approach did not recorded significant influence on plant growth, yield and nutrient uptake. This may be due to sufficient availability of micro nutrients in soil. However, farmers practice (163.2 cm) was significantly inferior to rest of soil test based nutrient management practices. This clearly indicates the need for adding organic manures to the soil in conjunction with inorganic fertilizers, which increases the availability of nutrient considerably, resulting in positive effect on growth parameters. Similar findings were noticed by Imayavarmboni *et al.* (2002) who reported increased plant height in sunflower due to application of FYM (12.5 t ha^{-1}) along with recommended dose of NPK fertilizers. The present findings are also in conformity with the findings of Byra Reddy *et al.* (2008), who obtained higher plant height with the application of FYM (8 t ha^{-1}) along with recommended dose of NPK fertilizers as compared to NPK alone in sunflower.

The yield parameters differed significantly due to treatments (Table 1). The higher capitulum diameter (15.4 cm) was noticed in STCR approach + vermicompost @ 2 t ha^{-1}(T_8), which was on par with STCR approach + Zn + B + S (T_9) and STCR approach (T_7), whereas, lowest capitulum diameter noticed with farmers practice (T_{10}) (10.2 cm). The increase in capitulum diameter might be mainly due to the higher nutrient availability which enhanced the size of the capitulum. The capitulum weight and seed yield $plant^{-1}$ were also higher in T_8 (61.6g and 48.1g, respectively) which was on par with T_7 and T_9. However, treatments T_1, T_2, T_3, T_4, T_5 and T_6 were significantly superior to T_{10} (farmers practice).Test weight was not influenced by nutrient management practices. The seed yield $plant^{-1}$, seed yield ha^{-1} and stalk yield were significantly influenced by the nutrient management based on soil test based results, which directly increasing crop yields by increasing supply of major and minor nutrients. Significantly maximum seed yield (2683 kg ha^{-1}) was recorded with STCR approach + vermicompost @ 2 t ha^{-1} treatment (T_8) but significantly lower seed yield (1015 kg ha^{-1}) was recorded with farmers practice (T_{10}) which is inferior compared with other nutrient management practices. The results are in accordance with the findings obtained of Rajan Bhatt (2013) who obtained yield increase of about 8-12% in sunflower and 10-15% in *gobhi-sarson* crops when fertilization is followed on soil test basis results.

Table 2. Nutrient uptake and available nutrient status of soil after crop harvest as influenced by different soil test based nutrient management

Treatments	Plant nutrient uptake (kg ha^{-1})			Available nutrient status of soil (kg ha^{-1})		
	Nitrogen	Phosphorus	Potassium	Nitrogen	Phosphorus	Potassium
T_1 - Recommended NPK (75:90:30 N, P_2O_5, K_2O kg ha^{-1})	81.77	29.0	79.87	134.5	55.3	341.7
T_2 - T_1 + Vermicompost 2 t ha^{-1}	82.63	30.87	77.53	137.8	54.0	374.8
T_3 - T_1 + Zn + B + S (50- 10- 10 kg ha^{-1})	80.52	28.93	76.55	125.4	49.8	350.1
T_4 - Soil test based NPK (STBF method) (98:63:20 N, P_2O_5, K_2O kg ha^{-1})	87.33	30.40	80.93	140.9	57.6	350.8
T_5 - T_4 + Vermicompost 2 t ha^{-1}	90.14	31.05	81.22	146.1	55.8	347.7
T_6 - T_4 + Zn + B + S (50- 10- 10 kg ha^{-1})	88.66	30.88	80.55	130.3	56.7	356.8
T_7 - STCR approach (Yield target: 25 q ha^{-1}) (140:80:53 N, P_2O_5, K_2O kg ha^{-1})	104.22	34.67	88.55	156.2	65.2	453.8
T_8 - T_7 + Vermicompost 2 t ha^{-1}	106.63	35.13	90.32	168.8	68.3	439.6
T_9 - T_7 + Zn + B + S (50- 10- 10 kg ha^{-1})	103.52	35.83	89.17	160.9	67.3	448.2
T_{10} - Farmers practice (50:60:0 N, P_2O_5, K_2O kg ha^{-1})	68.67	18.53	63.15	92.0	42.3	255.4
S. Em +	4.18	1.04	2.09	10.8	2.6	12.8
C. D. @ 5%	12.54	3.12	6.26	NS	7.8	37.9

NS : Non-Significant

Nutrient uptake and soil nutrient status after crop harvest

Data from Table 2 reveals that different nutrient management practices had highly significant effect on the nutrient uptake and soil nutrient status. The maximum uptake of nitrogen (106.63 kg ha^{-1}), phosphorous (35.13 kg ha^{-1}) and potassium uptake (90.32 kg ha^{-1}) was recorded in STCR approach + vermicompost @ 2 t ha^{-1} (T_8). This treatment was statistically on par with T_7 and T_9 treatments. The lowest level of N, P and K nutrient uptake was found with T_{10} with uptake of 68.67 kg ha^{-1}, 18.53 kg ha^{-1} and 63.10 kg ha^{-1}, respectively. The available nitrogen status has not differed with nutrient management practices but maximum nitrogen uptake (168.8 kg ha^{-1}), phosphorous uptake (68.3 kg ha^{-1}) and potassium uptake (429.6 kg ha^{-1}) after harvest was recorded in T_8, wherein (STCR approach + vermicompost 2 t ha^{-1}), was used. In general, the higher uptake and the availability of these nutrients were due to higher availability and high dry matter production. The results are in accordance with the findings of Vandhana (2003).

The increased nutrient application through site specific nutrient management (SSNM) approach resulted in greater absorption of nutrients from soil and this in turn led to higher NPK content in seed and stalk. The results are in line with the findings of Mishra *et al.* (1995) and Thavaprakash (2002). A significant and positive relation was observed between applied fertilizer levels of N, P and K and their available forms in the soil. Similar results were also reported by Gebremedhin *et al*, (2015).

CONCLUSIONS

From the results of the study, it could be concluded that the STCR approach with vermicompost @ 2 t ha^{-1} was found superior in increasing the seed yield, total nutrient uptake and available nutrient status in soil. Application of higher doses of nitrogen, phosphorus and potassium leads to higher availability of nutrients in soil that resulted in higher nutrient uptake by plants. Soil nutrient status after crop harvest is also maintained by adopting soil test based nutrient management techniques.

REFERENCES

Byra Reddy, K., Uppar, D.S., Vyakaranahal, B. S., Hiremath, S.M., Ravi Hunje and Nadaf, H. L. 2008. Effect of integrated nutrient management on Sunflower hybrid (KBSH-I) seed production. Karnataka Journal Agricultural Sciences. 21(2): 171-175.

Imayavarambani, V., Thanunathan, K., Singaravel, R and Manickam, G. 2002. Studies on the influence of integrated nutrient management on growth, yield parameters and seed yield of sesame. Crop Research. 24: 309-313.

Mishra, A., Dash, P and Palkaray, R. K. 1995. Yield and nutrient uptake by winter sunflower (*Helianthus annuus* L.) as influenced by nitrogen and phosphorous. Indian Journal of Agronomy. 40(1): 137-138.

Rajan Bhatt.2013. Soil test based fertilization to improve production of oil seed crops in Kapurthala district of Punjab. International Journal of Science, Environment and Technology. 2(3): 521 –526.

Sahrawat, K. L., Wani, S. P., Pardhasaradhi, G and Murthy, K.V. 2010. Diagnosis of secondary and micronutrient deficiencies and their management in rainfed agro-ecosystems: Case study from Indian semi-arid tropics. Communications in Soil Science and Plant Analysis. 41: 346-360.

Sharma, B. M and Singh, R. V. 2005. Soil test based fertilizer use in wheat for economic yield. Journal of the Indian Society of Soil Science. 53: 356-359.

Gebremedhin, T., Shanwad U. K, Desai, B. K., Shankergoud, I and Gebremedhin, W. 2015. Soil test based nutrient management for sunflower (*Helianthus annuus* L.): Analysis of growth, biomass, nutrient uptake and soil nutrient status. Journal of Biology, Agriculture and Healthcare. 5(15): 2224-3208.

Thavaprakash, N., Sivakumar, S. D., Raja, K and Senthil Kumar, G. 2002. Effect of nitrogen and phosphorus levels and ratios on seed yield and nutrient uptake of sunflower hybrid DSH-1. Helia. 25. Nr. 37. pp. 59-68.

Vandhana, P. 2003. Response of green chilli (*Capsicum annuum* L.) to irrigation schedule and fertility levels in Vertisols. M.Sc. Thesis submitted to University of Agricultural Science, Dharwad, India.

J.Res. ANGRAU 45(1) 22-31, 2017

STUDY OF COMBINING ABILITY ANALYSIS AND GENE ACTION FOR SEED COTTON YIELD AND FIBRE CHARACTERS IN UPLAND COTTON (*Gossypium hirsutum* L.)

K. BAYYAPU REDDY, V. CHENGA REDDY, M. LAL AHMED and K.V. SIVA REDDY
Department of Genetics and Plant Breeding, Agricultural College,
Acharya N.G. Ranga Agricultural University, Bapatla- 522101

Date of Receipt: 26.12.2016 Date of Acceptance: 13.03.2017

ABSTRACT

Combining ability was studied with ten parents in a diallel crossing design excluding reciprocals along with their parents for seventeen characters in order to identify suitable parents/crosses, which could be utilized in upland cotton *(Gossypium hirsutum* L.) for further improvement programme. The analysis of variance for combining ability revealed that, the SCA variances were higher than GCA variances for all the characters except for days to 50 % flowering indicating the predominance of non-additive gene action. The estimates of *gca* effects revealed that the parents NDLH 1938, L 788 and MCU 5 were found to be best general combiners for yield and fibre quality traits in desired direction. The crosses, NDLH 1938 × L 770, L 604 × RAH 1004 and L 788 × G COT 16 recorded high *per se* performance (111.98, 105.13 and 122.6 g) and significant positive *sca* effects (51.49, 24.71 and 21.35) for seed cotton yield plant^{-1} respectively. These hybrids were also recorded high *per se* performance and significant positive *sca* effects for number of bolls plant^{-1}, boll weight and lint yield plant^{-1}.

INTRODUCTION

Cotton is a major crop of global importance and has high commercial value. In India, cotton is being grown over an area of 118.81 lakh ha with an annual production of 352 lakh bales (1 bale=170 kg of lint) and a productivity of 503 kg ha^{-1} (AICCIP Annual Report, 2015). As combining ability (CA) forms the basis for Selection of parents for hybridization mainly depends on CA and expression of heterosis in the combination in desired direction, therefore, the present study was undertaken to estimate heterosis as well as to have an idea about nature of combining ability for yield and other characters, with a view to identify good combiners. Diallel analysis is a useful procedure for preliminary evaluation of genotypes for use in hybridization programme.

MATERIAL AND METHODS

The present investigation was carried out by crossing ten parents *viz.,* NDLH 1938, L 788, L 770, NA 1325, L604, SURABHI, RAH 1004, HYPS 152, MCU 5 and G COT 16 in a diallel fashion without reciprocals and forty five intra-specific cross combinations were generated and the evaluation of hybrids along with parents was done at Agricultural Research Station, Darsi, Prakasam district, Andhra Pradesh during *kharif*, 2013-14. Each entry was represented by following 120 cm x 60 cm spacing with 3 rows for each entry with a row length of 6m. Recommended doses of fertilizers 120 N, 60 P_2O_5 and 40 K_2O kg ha^{-1} were applied in split doses. Observations were recorded on five randomly selected competetive plants from each genotype per replication for the characters *viz.,* plant height (cm), number of monopodia plant^{-1}, number of sympodia plant^{-1}, number of bolls plant^{-1}, boll weight (g), chlorophyll content (mg g^{-1} fresh weight), seed index (g), lint index (g), seed cotton yield plant^{-1} (g) and lint yield plant^{-1} (g). The data on days to 50% flowering, ginning out turn (%), 2.5% span length (mm), micronaire value (10^{-6}g inch^{-1}), bundle strength (g tex^{-1}), uniformity ratio and elongation (%) were recorded on plot basis. The fibre quality parameters were studied at Central Institute for Research on Cotton Technology (CIRCOT), RARS, Lam, Guntur, Andhra Pradesh by using HVT Expert 1201 high volume fibre tester instrument. The data was statistically analysed by following method 2 and model II of Griffing (1956).

E-mail: drkaipu3@gmail.com

Table 1. Analysis of variance of combining ability for different characters in cotton during *kharif*, 2013-14

Source of variation	d f	Days to 50 % flowering	Plant height (cm)	No. of monopodia plant^{-1}	No. of sympodia plant^{-1}	No. of bolls plant^{-1}	Boll weight (g)	Chlorophyll content (mg g^{-1} fresh weight)	Seed index (g)	Lint index (g)
Replications	2	4.10	101.96	0.05	0.53	2.60	0.01	0.01	0.25	0.09
Treatments	54	25.20**	180.84**	0.03*	9.08**	15.02**	0.30**	0.01**	14.97**	2.68**
Parents	9	32.40**	122.38**	0.04	8.91**	25.58**	0.13**	0.01	4.44**	1.06**
Hybrids	44	20.93**	188.66**	0.03*	7.97**	13.16**	0.34**	0.01**	17.31**	3.02**
Parent Vs.Hybrids	1	148.00**	362.78**	0.01	59.14**	1.89	0.00	0.00	6.67**	2.07**
Error	108	1.89	35.70	0.02	1.43	1.45	0.04	0.01	0.17	0.03
Total	164	9.59	84.29	0.025	3.93	5.93	0.12	0.008	5.04	0.90
GCA	9	38.21**	135.58**	0.013	4.04**	5.36**	0.07**	0.003	5.89**	0.75**
SCA	45	2.43**	45.21**	0.010*	2.82**	4.93**	0.10**	0.004*	4.81**	0.92**
Error	108	0.62	11.90	0.007	0.47	0.48	0.01	0.002	0.05	0.01

Contd...

Source of variation	d f	Ginning out turn (%)	2.5% span length (mm)	Micronaire value (10^{-6} g/inch)	Bundle strength (g/tex)	Uniformity ratio	Elongation (%)	Seed cotton yield plant^{-1} (g)	Lint yield plant^{-1} (g)
Replications	2	0.60	0.80	0.05	3.05	4.19	0.01	20.01	1.30
Treatments	54	40.27**	9.21**	0.92**	4.30**	4.22**	0.06**	537.60**	124.98**
Parents	9	41.15**	8.39**	0.45**	3.65**	3.21	0.09**	389.92*	116.35**
Hybrids	44	40.44**	9.31**	1.02**	4.45**	4.47**	0.06*	579.48***	128.72**
Parent Vs.Hybrids	1	24.85**	12.16*	0.68**	3.85	2.30	0.00	24.13	38.24
Error	108	2.52	2.59	0.03	1.23	1.70	0.03	159.29	9.79
Total	164	14.92	4.75	0.32	2.26	2.56	0.04	282.15	47.61
GCA	9	12.94**	1.24	0.13**	0.71	1.22*	0.03**	56.87	31.61**
SCA	45	13.51**	3.43**	0.33**	1.57**	1.44**	0.01*	203.66**	43.67**
Error	108	0.84	0.86	0.01	0.41	0.56	0.01	53.09	3.26

**significant at 1% level * significant at 5% level df - degrees of freedom

Table 2. General combining ability (GCA) effects of ten parents for yield and yield components in cotton during *kharif*, 2013-14

Parent	Days to 50% flowering	Plant height (cm)	No. of monopodia $plant^{-1}$	No. of sympodia $plant^{-1}$	No. of bolls $plant^{-1}$	Boll weight (g)	Chlorophyll content (mg g^{-1} fresh weight)	Seed index (g)	Lint index (g)
NDLH 1938	0.15	-3.66**	-0.02	0.37*	1.42**	-0.03	-0.02	-0.41**	0.02
L 788	0.43	3.18**	0.06*	0.75**	-0.19	0.07*	0.02	-0.20**	-0.16**
L 770	-1.77**	4.60**	0	0.34	-0.64**	0.06	0.02	1.53**	0.60**
NA 1325	-2.13**	2.45*	0	0.46*	-0.68**	0.06	-0.02	0.50**	0.16**
L 604	-2.13**	-3.51**	0.01	-0.78**	-0.21	-0.01	-0.01	-0.85**	-0.22**
SURABHI	-0.96**	-3.06**	0	0.15	0.71**	-0.11**	-0.01	-0.08	0.16**
RAH 1004	0.62**	-3.80**	-0.04	-0.94**	-0.64**	-0.02	0.01	0.34**	-0.10**
HYPS 152	0.37	-1.32	0.01	-0.21	0.36	-0.07*	0	-0.66**	-0.15**
MCU 5	3.01**	2.67**	-0.06*	0.39*	-0.18	0.12**	-0.02	-0.49**	-0.17**
G COT 16	2.40**	2.45*	0.03	-0.54**	0.05	-0.07*	0.02	0.32**	-0.14**
S E (gi)	0.217	0.944	0.022	0.188	0.190	0.032	0.012	0.064	0.027

Contd...

Parent	Ginning out turn (%)	2.5% span length (mm)	Micronaire value (10^{-6}g $inch^{-1}$)	Bundle strength (g tex^{-1})	Uniformity ratio	Elongation (%)	Seed cotton yield $plant^{-1}$ (g)	Lint yield $plant^{-1}$ (g)
NDLH 1938	0.72**	0.25	0.11**	0.04	-0.23	0.08**	3.91	2.51**
L 788	0.68**	0.28	0.16**	0.2	0.12	-0.04	1.5	1.22*
L 770	-1.07**	0.2	0.11**	-0.07	-0.18	0.02	-0.01	-0.97
NA 1325	-0.83**	0.41	0.05	-0.03	-0.25	-0.09**	-0.56	-1.24*
L 604	-0.16	0.08	0	-0.1	-0.07	-0.07*	0.07	-0.32
SURABHI	1.28**	0.03	-0.12**	0.18	0.01	0.02	-1.61	0.99*
RAH 1004	-1.18**	-0.48	0	0.42*	0.35	0.05	-2.69	-2.13**
HYPS 152	1.09**	-0.18	-0.13**	-0.51**	0.3	0.01	-1.61	0.47
MCU 5	0.86**	-0.02	-0.03	-0.11	-0.54**	0.01	2.94	1.66**
G COT 16	-1.39**	-0.56*	-0.15**	-0.02	0.49*	0	-1.93	-2.21**
S E (gi)	0.250	0.254	0.027	0.175	0.206	0.028	1.995	0.494

**Significant at 1% level   *Significant at 5% level

RESULTS AND DISCUSSION

The analysis of variance for combining ability recorded significant differences for most of the characters (Table 1). The differences among the parents and hybrids were significant for all the characters except for number of monopodia plant^{-1}, chlorophyll content and uniformity ratio for parents. Whereas, the differences among the parents vs hybrids were significant for 8 characters *i.e.* days to 50% flowering, plant height, number of sympodia plant^{-1}, seed index, lint index, ginning out turn, 2.5% span length and micronaire value. The analysis of variance for combining ability revealed that, the variance due to SCA variances were higher than GCA variances for all the characters except for days to 50 % flowering, indicating the prepoundence predominance of non-additive gene action for all characters and additive gene action for days to 50 % flowering. General combining ability effects of parents and specific combining ability effects of crosses were estimated and presented in Tables 2 and 3, respectively. The estimates of GCA and SCA variances were presented in Table 4.

The GCA effects revealed that none of the parent recorded significant GCA effects for all the characters studied. Among the parents, NDLH 1938 showed significant positive GCA effects for number of sympodia plant^{-1}, number of bolls plant^{-1}, Ginning out turn, micronaire value, elongation and lint yield plant^{-1}. The parent L 788 showed significant positive *gca* effects for plant height, number of monopodia plant^{-1}, number of sympodia plant^{-1}, boll weight, Ginning out turn, micronaire value and lint yield plant^{-1}. The parent MCU 5 showed significant positive GCA effects for days to 50% flowering, plant height, number of sympodia plant^{-1}, boll weight, Ginning out turn and lint yield plant^{-1}. These results are in confirmity with those of Tuteja and Manju Banga (2013) and Deosarkar *et al*. (2014).

The hybrids which showed the highest significant positive *sca* effects for various characters were HYPS 152 × MCU 5 (2.33) and L 770 × G COT 16 for days to 50 % flowering, L 770 × NA 1325 (21.38) for plant height, NDLH 1938 × L 604 (0.17) for number of monopodia plant^{-1}, NDLH 1938 × SURABHI (3.17) for number of sympodia plant^{-1}, NDLH 1938 × L 770 (7.63) for number of bolls plant^{-1}, NDLH 1938 × L 770 (0.70) for boll weight, L 770 × SURABHI and L 770 × G COT 16 (0.09) for chlorophyll content, L 770 × RAH 1004 (3.72) for seed index, L 788 × RAH 1004 (2.00) for lint index, SURABHI × RAH 1004 (6.07) for ginning out turn, RAH 1004 × G COT 16 (3.35) for 2.5% span length, L 770 × MCU 5 (1.08) for micronaire value, L 770 × G COT 16 (3.21) for bundle strength, L 788 × NA 1325 (3.17) for uniformity ratio, L 788 × NA 1325 (0.27) for elongation, NDLH 1938 × L 770 (51.49) for seed cotton yield plant^{-1} and NDLH 1938 × L 770 (22.42) for lint yield plant^{-1}. The crosses between high × low or low×high general combiners resulted in superior cross combinations due to complementary gene action which has arisen out of both additive and non-additive gene action. These crosses may likely throw superior trangressive segregants. These components may be exploited by adopting breeding procedures such as cyclic hybridization, biparental mating and diallel selective mating system. The highest significantly positive SCA effect for seed cotton yield plant^{-1} was recorded by cross, NDLH 1938 × L 770 (51.49) followed by L 604 × RAH 1004 (24.71) and L 788 × G COT 16 (21.35).

The hybrid NDLH 1938 × L 770 also showed significant SCA effects for number of sympodia plant^{-1} (1.45), number of bolls plant^{-1} (7.63), boll weight (0.70), ginning out turn (4.5) and lint yield plant^{-1} (22.42). The high seed cotton yield combination (high x low) might be attributed to interaction between positive alleles in the two parents. The cross L 604 × RAH 1004 showed significant positive SCA effects also for number of bolls plant^{-1}(2.39), boll weight (0.59), micronaire value (1.07), uniformity ratio (1.87) and seed cotton yield plant^{-1} (24.71).The

Table 3. Specific combining ability (GCA) effects of 45 hybrids of cotton for yield and yield components in cotton during *kharif*, 2013-14

HYBRIDS	Days to 50 % flowering	Plant height (cm)	No. of monopodia $plant^{-1}$	No. of sympodia $plant^{-1}$	No. of bolls $plant^{-1}$	Boll weight (g)	Chlorophyll content (mg g^{-1} fresh weight)	Seed index (g)	Lint index (g)
NDLH 1938 × L 788	0.46	-10.23**	-0.24**	-0.24	-3.15**	-0.42**	0.08*	1.80**	-0.61**
NDLH 1938 × L 770	-0.01	2.06	0.04	1.45*	7.63**	0.70**	-0.03	-2.40**	-0.50**
NDLH 1938 × NA 1325	-0.98	0.77	0.04	0.86	0.07	0.06	0.01	0.19	0.27**
NDLH 1938 × L 604	-2.65**	-7.98*	0.17*	-0.97	1.86**	0.1	0.05	0.56*	0.49**
NDLH 1938 × SURABHI	-1.48*	7.46*	-0.03	3.17**	1.42*	-0.29*	0.05	-1.40**	0.26**
NDLH 1938 × RAH 1004	0.27	3.93	-0.02	0.46	1.23	-0.2	-0.01	0.03	0.31**
NDLH 1938 × HYPS 152	-0.81	-0.66	0.06	2.19**	0.69	-0.23*	-0.01	-0.74**	-0.85**
NDLH 1938 × MCU 5	-0.45	7.66*	-0.02	-0.4	-1.50*	0.11	0.04	-0.91**	-0.08
NDLH 1938 × G COT 16	0.16	-4.4	0.16*	0.66	0.08	0.23*	-0.09*	-0.81**	-0.33**
L 788 × L 770	-1.62*	-3.62	0.08	-0.9	1.77**	0.01	-0.03	-1.50**	0.06
L 788 × NA 1325	-2.26**	-4.13	-0.06	-0.26	2.48**	-0.1	0.01	-0.98**	-0.46**
L 788 × L 604	-0.92	3.76	0.13	0.31	-1.73**	0.05	0	-3.03**	-2.16**
L 788 × SURABHI	-2.42**	6.84*	-0.08	3.06**	-2.71**	-0.22	0.06	1.23**	0.61**
L 788 × RAH 1004	-0.34	6.65*	0	-0.45	1.17	0.57**	0.01	2.10**	2.00**
L 788 × HYPS 152	0.91	-3.5	0	-0.05	0.57	-0.21	0.04	1.87**	0.64**
L 788 × MCU 5	0.94	-3.82	0	-1.51*	-0.29	0.21	-0.10*	-1.29**	0.56**
L 788 × G COT 16	2.21**	8.00*	0.11	-0.19	2.76**	0.39**	-0.01	-1.13**	0.22*
L 770 × NA 1325	0.27	21.38**	0.14	1.83**	0.66	-0.69**	0.04	-1.01**	-0.27**
L 770 × L 604	-0.06	0.67	-0.14	1.53*	-0.61	-0.33**	0.05	0.52*	0.99**
L 770 × SURABHI	0.77	2.82	0	-0.53	-0.59	0.03	0.09*	3.46**	0.16
L 770 × RAH 1004	0.19	1.92	0.11	2.36**	-1.05	0	-0.07	3.72**	0.25*
L 770 × HYPS 152	-2.56**	0.45	-0.21**	-3.10**	-2.98**	0.44**	0	3.17**	1.06**
L 770 × MCU 5	-1.54*	1.85	-0.07	1.50*	-1.51*	-0.08	0.05	-0.11	0.05

**Significant at 1% level *Significant at 5% level

Table 3 (contd…)

Table 3 (contd…)

HYBRIDS	Days to 50 % flowering	Plant height (cm)	No. of monopodia plant^{-1}	No. of sympodia plant^{-1}	No. of bolls plant^{-1}	Boll weight (g)	Chlorophyll content (mg g^{-1} fresh weight)	Seed index (g)	Lint index (g)
L 770 × G COT 16	-0.59	-3.69	0.17*	1.56*	-0.8	0.02	0.09*	0.48*	0.23*
NA 1325 × L 604	1.63*	-10.31**	0.12	-0.53	0.36	-0.16	-0.07	-5.49**	-2.89**
NA 1325 × SURABHI	-0.2	-7.55*	0.01	-0.38	0.58	0.57**	-0.02	3.41**	1.13**
NA 1325 × RAH 1004	0.21	9.12**	0.02	2.11**	-0.68	-0.1	-0.09*	0.03	0.03
NA 1325 × HYPS 152	-1.54*	4.2	0.05	-0.09	-1.68*	0.14	-0.06	1.70**	1.03**
NA 1325 × MCU 5	-0.84	4.91	0.06	1.04	1	0.41**	-0.12**	0.78**	0.03
NA 1325 × G COT 16	-0.9	2.74	-0.1	1.50*	0.97	0.07	0.07	1.56**	0.04
L 604 × SURABHI	0.46	0.2	-0.02	0.52	-1.86**	0.35**	-0.12**	1.88**	1.00**
L 604 × RAH 1004	-0.45	3.47	0.03	0.34	2.39**	0.59**	0.06	-0.04	-0.96**
L 604 × HYPS 152	0.46	3.19	-0.09	1.28	-1.15	0.16	0.03	1.97**	0.01
L 604 × MCU 5	-0.84	3.27	0.04	-0.92	0.46	-0.56**	0.04	-0.76**	-0.59**
L 604 × G COT 16	-0.9	2.03	-0.18*	-1.53*	-0.56	-0.76**	0.01	0.06	0.56**
SURABHI × RAH 1004	-0.62	-5.04	-0.03	-1.84**	1.94**	0	0.04	-5.57**	-2.09**
SURABHI × HYPS 152	-1.70*	6.94*	0.05	-1.11	0.01	0.2	-0.02	-2.02**	-0.35**
SURABHI × MCU 5	0.66	-4.18	-0.01	-1.51*	-2.09**	-0.12	0.01	1.40**	0.38**
SURABHI × G COT 16	-0.06	-9.35**	-0.1	-0.72	-0.21	-0.23*	-0.09*	-1.06**	-0.74**
RAH 1004 × HYPS 152	-1.29	3.01	0.03	2.38**	-1.72*	-0.35**	0.01	-0.43	-0.24*
RAH 1004 × MCU 5	-0.92	-10.04**	0.1	0.32	-1.38*	-0.05	-0.06	0.16	0.34**
RAH 1004 × G COT 16	-1.31	-0.62	0.01	-0.83	0	-0.15	-0.02	-1.76**	-0.41**
HYPS 152 × MCU 5	2.33**	-4.52	-0.07	0.65	-1.51*	-0.11	0.08	-2.18**	-1.01**
HYPS 152 × G COT 16	-0.4	-0.9	0.02	-1.69*	-2.13**	0.05	-0.03	-3.40**	-1.15**
MCU 5 × G COT 16	-1.37	6.71*	-0.11	1.38*	-0.46	0.03	0.07	1.66**	0.61**
S E (Sij)	0.730	3.177	0.076	0.635	0.639	0.110	0.040	0.218	0.093

**Significant at 1% level   *Significant at 5% level

Table 3 (contd…)

Table 3 (contd…)

HYBRIDS	Ginning out turn (%)	2.5% span length (mm)	Micronaire value (10^{-6} g/inch)	Bundle strength (g/tex)	Uniformity ratio	Elongation (%)	Seed cotton yield plant^{-1} (g)	Lint yield plant^{-1} (g)
NDLH 1938 × L 788	-8.71**	1.76*	-0.59**	1.64**	-0.61	-0.04	-22.47**	-15.33**
NDLH 1938 × L 770	4.50**	-0.02	-0.55**	0.07	0.2	-0.15	51.49**	22.42**
NDLH 1938 × NA 1325	1.51	1.36	-0.68**	0.17	-1.49*	-0.11	1.81	1.64
NDLH 1938 × L 604	2.74**	3.17**	-0.37**	1.88**	-0.31	0.14	8.14	5.10**
NDLH 1938 × SURABHI	1.2	1.12	0.52**	0.72	0.96	0.14	-5.51	3.02
NDLH 1938 × RAH 1004	1.54	-1.19	0.83**	-0.34	1.31	0.12	-2.7	0
NDLH 1938 × HYPS 152	-2.75**	-0.59	0.19	-0.48	1.71*	0.04	-4.98	-4.86**
NDLH 1938 × MCU 5	2.39**	-1.41	0.39**	-1.35*	-0.88	-0.11	-2.12	1.14
NDLH 1938 × G COT 16	0.27	0.27	-0.09	0.51	0.05	0.1	6.81	1.86
L 788 × L 770	3.55**	-1.93*	0.36**	-1.71**	1.23	0.06	6.11	5.35**
L 788 × NA 1325	-0.9	-3.16**	0.66**	-1.52*	3.17**	0.27**	5.27	0.83
L 788 × L 604	-8.69**	-2.28*	-0.21*	-1.26*	0.66	-0.01	-5.76	-10.16**
L 788 × SURABHI	-1.32	1.54	0.47**	1.31*	-2.09**	-0.21*	-14.85*	-6.71**
L 788 × RAH 1004	3.21**	2.13*	-0.42**	1.77**	-1.82*	-0.07	20.77**	10.11**
L 788 × HYPS 152	-2.69**	2.66**	-0.40**	0.65	0.88	-0.07	-4.15	-4.16*
L 788 × MCU 5	5.84**	1.21	0.30**	-0.03	-1.44*	-0.01	4.98	7.76**
L 788 × G COT 16	2.94**	-1.28	0.31**	0.1	0.86	0.13	21.35**	10.16**
L 770 × NA 1325	1.7	-1.23	0.03	-0.42	0.81	-0.15	-18.21**	-4.21*
L 770 × L 604	4.71**	1.68	-0.03	0.48	-0.44	0.12	-12.95	-0.13
L 770 × SURABHI	-5.62**	-0.63	0.35**	-1.39*	1.15	-0.17	-0.85	-6.26**
L 770 × RAH 1004	-4.88**	0.23	0.04	-1.14	-1.87**	-0.12	-4.15	-5.82**
L 770 × HYPS 152	-1.75*	-0.49	0.07	-0.06	-0.73	0.12	1.88	-1.32
L 770 × MCU 5	0.26	-1.41	1.08**	-1.39*	-0.45	0.18	-7.98	-2.47

**Significant at 1% level *Significant at 5% level

Table 3 (contd…)

Table 3 (contd…)

HYBRIDS	Ginning out turn (%)	2.5% span length (mm)	Micronaire value (10^{-6} g/inch)	Bundle strength (g/tex)	Uniformity ratio	Elongation (%)	Seed cotton yield plant^{-1} (g)	Lint yield plant^{-1} (g)
L 770 × G COT 16	0.42	-0.15	-0.59**	3.21**	-0.22	0.07	-2.5	-0.37
NA 1325 × L 604	-3.48**	0.47	-0.01	0.08	-0.75	0	-4.66	-4.37*
NA 1325 × SURABHI	-2.03*	0.94	0.63**	-0.33	-1.66*	0.06	19.49**	3.77*
NA 1325 × RAH 1004	0.11	-0.66	0.72**	-1.48*	0.25	-0.02	-5	-1.16
NA 1325 × HYPS 152	0.96	0.31	0.14	0.72	0.33	0.04	-1.07	0.59
NA 1325 × MCU 5	-2.08*	0.34	0.19*	1.05	0.29	0.03	15.54*	2.72
NA 1325 × G COT 16	-2.93**	-1.22	0.26**	0.42	-0.17	0.06	5.31	-1.06
L 604 × SURABHI	1.05	-0.83	0.82**	-0.25	0.37	0.1	3.31	1.88
L 604 × RAH 1004	-5.68**	-2.51**	1.07**	-0.68	1.87**	0.04	24.71**	0.92
L 604 × HYPS 152	-4.42**	0.04	0.26**	1.82**	0.8	0.16	0.03	-4.24*
L 604 × MCU 5	-0.89	-1.64	-1.27**	-0.31	0.99	-0.29**	-16.44*	-5.99**
L 604 × G COT 16	3.70**	-1.77*	0.39**	-0.68	-0.49	0.08	-25.27**	-4.87**
SURABHI × RAH 1004	6.07**	-0.09	-0.60**	0.17	-0.94	0.09	6.68	8.14**
SURABHI × HYPS 152	4.52**	-0.53	-0.79**	0.22	-0.96	-0.11	6.6	6.44**
SURABHI × MCU 5	-2.46**	1.07	-0.56**	0.43	0.88	-0.01	-9.95	-5.82**
SURABHI × G COT 16	-2.21*	0.6	-0.65**	-0.29	-1.18	-0.20*	-7.53	-4.52**
RAH 1004 × HYPS 152	-1.02	2.11*	-0.37**	-0.29	0.24	0.05	-14.95*	-5.59**
RAH 1004 × MCU 5	0.43	-3.29**	0.22*	-1.04	0.58	0.09	-6.25	-1.51
RAH 1004 × G COT 16	1.4	3.35**	-0.72**	0.34	0.53	-0.06	-4.42	0.12
HYPS 152 × MCU 5	-0.13	0.89	-0.69**	0.17	-1.04	-0.18	-7.72	-2.7
HYPS 152 × G COT 16	2.99**	-4.20**	0.14	-3.45**	-0.26	-0.24*	-5.3	1.1
MCU 5 × G COT 16	-1.61	-0.53	0.51**	-1.27*	2.20**	0.03	-0.64	-1.68
S E (Sij)	0.844	0.856	0.093	0.590	0.694	0.097	6.712	1.663

**Significant at 1% level   *Significant at 5% level

Table 4. Estimates of *gca* and *sca* variances for yield and yield components in cotton during *kharif*, 2013-14

Source	Location	Days to 50 % flowering	Plant height (cm)	No. of monopodia plant^{-1}	No. of sympodia plant^{-1}	No. of bolls plant^{-1}	Boll weight (g)	Chlorophyll content (mg g^{-1} fresh weight)	Seed index (g)	Lint index (g)
σ^2GCA	ARS, Darsi	3.13	10.31	0.00	0.30	0.41	0.00	0.00	0.49	0.06
σ^2SCA	ARS, Darsi	1.81	33.32	0.00	2.35	4.45	0.09	0.00	4.75	0.91
σ^2GCA/σ^2SCA	ARS, Darsi	1.73	0.31	0.14	0.13	0.09	0.05	0.04	0.10	0.07
Source	**Location**	**Ginning out turn (%)**	**2.5% span length (mm)**	**Micronaire value (10^{-6} g inch^{-1})**	**Bundle strength (g tex^{-1})**	**Uniformity ratio**	**Elongation (%)**	**Seed cotton yield plant^{-1} (g)**	**Lint yield plant^{-1}(g)**	
σ^2GCA	ARS, Darsi	1.01	0.03	0.01	0.03	0.05	0.00	0.31	2.36	
σ^2SCA	ARS, Darsi	12.68	2.57	0.33	1.17	0.87	0.01	150.57	40.41	
σ^2GCA/σ^2SCA	ARS, Darsi	0.08	0.01	0.03	0.02	0.06	0.27	0.00	0.06	

hybrid L 788 × G COT 16 also showed significant SCA effects for days to 50% flowering (2.21), plant height (8.00), number of bolls plant^{-1}(2.76), boll weight (0.39), lint index (0.22), ginning out turn (2.94), micronaire value (0.31), lint yield plant^{-1} (10.16) and seed cotton yield plant^{-1} (21.35). Similar results were earlier reported by Rajanna (2010), Imran *et al.* (2012), Senthil Kumar *et al.* (2013), Tuteja and Manju Banga (2013) and Rajamani *et al*. (2014).

Hybrids with positive and significant SCA effects for all characters including seed cotton yield were produced by parents (good, average and poor) in almost all types of parental combinations (good x good, good x average, good x poor, average x good, average x average, average x poor, poor x good, poor x average and poor x poor). The crosses with high SCA effects were in general the combinations of parents with good x good and good x poor or good x average GCA effects. It was observed that the cross combinations involving high × high general combiners produced crosses with significant SCA effect indicating the role of additive and additive × additive genetic component of variance which could be easily improved through simple selection procedures.

CONCLUSIONS

It could be inferred that the choice of parents for crossing programme should be based not only on the *per se* performance and GCA effects but also on SCA effects of the cross combinations. Parents with good individual performance and good GCA effects may not nick well, on the other hand parents with poor GCA effects may nick well in combination due to complementary gene action. Hence, in breeding programme, low GCA parents could also be included.

REFERENCES

AICCIP.2015. Annual Report. All India Coordinated Cotton Improvement Project. Coimbatore, Tamilnadu, India.

Deosarkar, D.B., Deshmukh, J.D and Deshmukh, V.D. 2014. Combining ability analysis for yield and fibre quality traits in upland cotton (*Gossypium hirsutum* L.). Journal of Cotton Research and Development. 28(1):18-23.

Griffing, B. 1956. Concept of general and specific combining ability in relation to diallel crossing systems. Australian Journal of Biological Science. 9: 463-493.

Imran, M., Shakeel, A., Azhar, F.M., Farooq, J., Saleem, M.F., Saeed, A., Nazeer, W., Riaz, M., Naeem, M and Javaid, A. 2012. Combining ability analysis for within boll yield components in upland cotton (*Gossypium hirsutum* L.). Genetics and Molecular Research. 11(3): 2790-2803.

Rajamani, S., Gopinath, M and Reddy, K. H. P. 2014. Combining ability for seed cotton yield and fibre characters in upland cotton (*Gossypium hirsutum* L.). Journal of Cotton Research and Development. 28(2): 207-210.

Rajanna, B. 2010. Combining ability studies involving new hirsutum lines in cotton (*Gossypium hirsutum* L.). M.Sc. Thesis submitted to Acharya N. G. Ranga Agricultural University, Hyderabad, India.

Senthil Kumar, K., Ashok Kumar, K and Ravikesavan, R. 2013. Genetic effects of combining ability studies for yield and fibre quality traits in diallele crosses of upland cotton (*Gossypium hirsutum* L.). African Journal of Bio-technology. 13 (1):119-126.

Tuteja, O. P and Manju Banga. 2013. Combining ability estimates for yield and quality characters of parents and crosses based on genetic male sterility in cotton (*Gossypium hirsutum* L.). Indian Journal of Agricultural Sciences. 83(9): 987-991.

J.Res. ANGRAU 45(1) 32-38, 2017

INTEGRATED WEED MANGEMENT PRACTICES FOR IMPROVED PRODUCTIVITY AND ECONOMICS IN MUNGBEAN (*Vigna radiata* (L.)

P. VENKATA RAO, A. SUBBARAMI REDDY, J.SATEESH BABU and M.V. RAMANA

Regional Agricultural Research Station, Acharya N.G. Ranga Agricultural University, Guntur- 522 034

Date of Receipt: 05.1.2017 Date of Acceptance: 28.2.2017

ABSTRACT

A field experiment was conducted during *kharif* seasons of 2013 and 2014 at RARS, Guntur on deep black clay loam soil to study the effect of integrated weed management practices for improved productivity and economics of mungbean. The experiment was laid out with nine weed control treatments. The maximum yield attributes, grain yield, gross returns, net returns and effective weed control in mungbean were recorded with pre-emergence application of Pendimethalin 30EC+Imazethapyr 2EC @1.0 kg ha^{-1} followed by manual hand weeding at 25-30 days after sowing which was closely followed by hand weeding twice at 20 and 40 days after sowing.

INTRODUCTION

Pulses are major constituent of Indian agriculture on account of their ability to provide protein rich food to vegetarian masses, and high quality feed and fodder to livestock besides enriching soil fertility. India is the largest producer and consumer of pulses in the world contributing around 25-28 % of the global production. Mungbean (*Vigna radiata* (L.) Wilczek**)** because of its ecological versatility, it is widely cultivated in various climate and geographical regions of India (Tripathi *et al.*, 2012), covers an area of 3.55 mha with production of 1.71 mt (Anonymous, 2012), plays an important role in local economy and sustainable agriculture. Almost two third of total mungbean production in the country is taken up during *kharif* season, but its productivity is low as compared to its potential yield. A number of factors are responsible for low mungbean productivity. One of the major factor is heavy infestation of weed comprises grasses, sedges and broadleaf weeds. Life cycle of most of them coincide with that of crop they invade, thus ensuring mixing of their seed with those of the crops. Weeds spread easily, because of their enormous seed production and once established are not easily eradicated. Weeds not only compete for natural resources (moisture, nutrients, light and space) during crop growth but also serve as alternate host to several insect-pest and diseases. The timing of weed seed emergence flushes in crop fields is mostly depend on air and soil temperature and relative humidity. Mechanical practices such as hand weeding and intercultural operation are quite effective but it is expensive, tedious, time consuming and causes root injury.

Moreover, unavailability of labour and continuous rainfall in rainy season does not permit it to operate timely. Yield losses in mungbean due to weeds have been estimated to range between 30-50% (Kumar *et al*., 2004). The current trends and further development of intensive agriculture likely to seek the help of herbicide as an effective tool for weed control. Keeping these in view, the present investigation was undertaken to find out the effect of integrated weed management practices on productivity of *kharif* mungbean.

MATERIAL AND METHODS

A field experiment was conducted during *kharif* season of 2013 and 2014 at Regional Agricultural Research Station, Lam, Guntur. The farm is situated at 25°18´ N latitude, 83°36´ E longitude and at an altitude of 128.93 m above mean sea level (MSL). The experiment plot was black clay loam in texture with low in organic carbon (0.34%) and available N(192.3 kg ha^{-1}), medium in available

E-mail: venkatraoptn@gmail.com

Table 1. Effect of IWM practices on plant growth and weeds in mungbean

Treatments	Plant height (cm)			Weed counts (No.m^{-2})			Weed dry wt.(g m^{-2})			WCE (%)		
	2013	2014	Mean	2013	2014	Mean	2013	2014	Mean	2013	2014	Mean
T_1. Pendimethalin 30EC@ 1.0 kg ha^{-1} (PE)	53	69	61	183	121	152	145.7	71.3	108.5	16.3	39.8	25.8
T_2 -Pendimethalin 30 EC + Imazethapyr 2 EC @ 1.0 kg ha^{-1} (PE)	57	75	66	64	83	74	92.3	39.5	65.9	47..0	66.7	55.0
T_3 -T_1 + Quizalofop-ethyl @ 50 g *a.i* ha^{-1} (POE at 15-20 DAS)	59	73	66	75	94	84	72.7	42.2	57.5	58.2	64.4	60.7
T_4 -T_2 + Quizalofop-ethyl @ 50 g *a.i* ha^{-1} (POE at 15-20 DAS)	60	72	66	111	109	110	60.3	41.0	50.7	65.3	65.4	65.3
T_5 -T_1 + Imazethapyr @ 50 g *a.i* ha^{-1} – (POE at 15-20 DAS)	52	71	61	66	72	69	46.7	37.1	41.9	73.2	68.7	71.4
T_6- T_1 + Manual weeding at 25-30 DAS	58	72	65	85	53	69	42.0	34.4	38.2	75.9	71.0	73.9
T_7 -T_2 + Manual weeding at 25-30 DAS	61	73	67	87	63	75	37.6	32.4	35.0	78.4	72.7	76.1
T_8- Two Manual weedings each at 20 and 40 DAS	52	75	64	73	80	76	33.3	34.1	33.7	80.9	71.2	76.9
T_9 - Weedy check	48	60	54	193	209	201	174.0	118.5	146.3	-	-	-
SEM$\pm$	2.7	2.70	1.88	7.7	8.4	-	5.0	2.79	-	-	-	-
C D (5%)	8.2	8.1	5.6	23.0	25.3	-	15.1	8.4	-	-	-	-
C V (%)	8.5	6.6	5.1	12.8	14.9	-	11.5	9.6	-	-	-	-

PE - Pre Emergence, POE - Post Emergence, DAS - Days after Sowing

P (23.3 kg ha^{-1}) and K (212 kg ha^{-1}) with pH 7.4. The treatments comprised of nine applications *viz*., T_1: Pendimethalin 30EC @ 1.0 kg ha^{-1} (pre-emergence, PE); T_2: Pendimethalin 30 EC + Imazethapyr 2 EC @ 1.0 kg ha^{-1} (PE); T_3: Pendimethalin30EC @ 1.0 kg ha^{-1} + Quizalofop-p-ethyl @50 g *a.i*.ha^{-1} (post emergence, POE); T_4: Pendimethalin 30 EC + Imazethapyr 2 EC @ 1.0 kg ha^{-1} (PE) + Quizalofop-p-ethyl @ 50 g *a.i*. ha^{-1} (POE); T_5: Pendimethalin 30 EC @ 1.0 kg *a.i*. ha^{-1} (PE) + Imazethapyr 2 EC @ 50g *a.i*. ha^{-1} (POE at 15-20 DAS); T_6: Pendimethalin 30 EC @ 1.0 kg *a.i*.ha^{-1} PE +manual weeding at 25-30 DAS; T_7: Pendimethalin 30 EC + Imazethapyr 2 EC (Vallore32) @ 1.0 kg ha^{-1} (PE) + manual weeding at 25-30 DAS; T_8: Two manual hand weeding at 20 and 40 DAS and 9. Weedy check laid out in RBD and replicated thrice. Recommended dose of N (20 kg ha^{-1}) and P_2O_5 (50 kg ha^{-1}) were applied as basal through Urea (46% N) and single super phosphate (16% P_2O_5), respectively. The seed of mungbean variety LGG-460 was sown @ 20 kg ha^{-1} on July 15, 2013 and July14, 2014, respectively, with 30 cm x10 cm spacing. All agronomic operations except those under study were kept normal and uniform for all the treatments. A total of 599 mm and 507.4 mm rainfall was received during crop growing season in 2013 and 2014, respectively.

Weed population and weed dry weight was recorded at 50 DAS. The weed population was taken with the help of iron frame of 1 m^2 from 2 places of each plot and then averaged. Weed dry weights recorded by placing them in hot air oven and weed control efficiency (WCE) was calculated.

$$WCE = \frac{\text{(Dry weight of weeds in weedy check - Dry weight of weeds in treatment)}}{\text{Dry weight of weeds in weedy check}} \times 100$$

Gross returns were calculated by taking sale price of mungbean Rs.65/- and Rs.70/-per kg in 2013 and 2014, respectively. Net returns were calculated by subtracting cost of cultivation including the cost of individual treatments from Gross returns. Benefit-cost ratio was calculated after dividing net returns with the cost of cultivation. The plant height, branches plant^{-1}, number of pods plant^{-1}, test weight and grain yield was recorded. Data collected was statistically analyzed by using standard statistical procedures. The comparision of treatment means was made by critical difference (CD) at $P<0.05$.

RESULTS AND DISCUSSION

Effect on weeds

Weed flora emerged during the period of experimentation were grasses such as *Cynodon dactylon*, *Dactyloctenium aegyptium*, *Echinichloa colona*, *Brachiaria* sp., sedges *viz., Cypurus rotundus* and broad leaved weeds such as *Amaranthus viridis*, *Digera arvensis*, *Parthenium hysterophorus*, *Phyllanthus niruri*, *Trianthema portulacastrum* and wild bhendi.

Among the herbicides and cultural methods of weed management practices, application of pendimethalin+Imazethapyr @1.0 kg ha^{-1} (PE) followed by hand weeding at 25-30 DAS and hand weeding twice at 20 and 40 DAS were registered the lowest dry weight of weeds (Table 1). However, there was no significant difference was noticed among these two treatments in both the years of the study. However, Imazethapyr was more effective against annual broad leaved weeds, grasses and sedges. This highest weed dry matter production was recorded in weedy check treatment (146.3 g m^{-2}) where as the lowest was noticed in hand weeding twice at 20 and 40 DAS (33.7 g m^{-2}) which was closely followed by application of Pendimethalin 30 EC+ Imazethapyr 2 EC @1.0 kg ha^{-1} as PE followed by hand weeding at 25-30 DAS (35.0 g m^{-2}). Similarly, WCE was the highest under two hand weedings (76.9%) treatment, followed by pre-emergence application of Pendimethalin 30EC+Imazethapyr 2EC @1.0 kg ha^{-1} in combination with one hand weeding at 25-30 DAS (76.1%). Greater reduction in weed biomass might have increased the WCE under these treatments.

Table 2. Effect of IWM practices on yield attributes and grain yield of mungbean

Treatments	No.of Branches plant^{-1}			No. of Pods plant^{-1}			100 seed weight (g)			Grain Yield (kg ha^{-1})		
	2013	2014	Mean	2013	2014	Mean	2013	2014	Mean	2013	2014	Mean
T_1 . Pendimethalin 30EC @ 1.0 kg ha^{-1} (PE)	2.7	2.1	2.4	25.2	20.7	23.0	3.0	2.8	2.9	570	527	549
T_2 -Pendimethalin 30 EC + Imazethapyr 2 EC @ 1.0 kg ha^{-1} (PE)	2.8	2.3	2.6	39.3	25.4	32.4	3.2	2.9	3.1	692	658	675
T_3 -T_1 + Quizalofop-ethyl @ 50 g *a.i* ha^{-1} (POE at 15-20 DAS)	2.7	2.2	2.5	23.2	22.5	22.9	3.2	2.8	3.0	662	600	631
T_4 -T_2 + Quizalofop-ethyl @ 50 g *a.i* ha^{-1} (POE at 15-20 DAS)	2.6	2.2	2.4	27.5	21.8	24.7	2.9	2.8	2.9	713	625	669
T_5 -T_1 + Imazethapyr @ 50 g *a.i* ha^{-1} – (POE at 15-20 DAS)	2.8	2.1	2.4	29.7	22.6	26.2	3.2	2.9	3.1	668	647	658
T_6- T_1 + Manual weeding at 25-30 DAS	3.2	2.2	2.7	31.3	22.7	27.0	2.9	2.9	2.9	693	700	697
T_7 -T_2 + Manual weeding at 25-30 DAS	3.3	2.2	2.8	39.5	23.9	31.7	3.3	3.1	3.2	727	713	720
T_8- Two Manual weedings each at 20 and 40 DAS	2.7	2.5	2.6	30.0	26.6	28.3	3.0	3.1	3.1	634	775	705
T_9- Weedy check	2.3	1.4	1.9	17.7	18.5	18.1	2.8	2.7	2.8	443	425	434
SEM**+**	0.3	0.1	0.16	2.96	1.26	1.79	1.4	0.07	0.10	42	31.7	32.77
C D (5%)	NS	0.3	0.5	8.9	3.8	5.4	NS	0.2	NS	126	95	98
C V (%)	18.6	8.3	11.0	17.5	9.6	11.9	8.2	4.2	5.7	11.3	8.7	8.9

PE - Pre Emergence, POE - Post Emergence, DAS - Days after Sowing, NS - Non Significant

Table 3. Effect of IWM practices on economics of mungbean

Treatments	Gross Income (Rs.)			Cost of cultivation (Rs.)			Net Returns (Rs.)			B:C Ratio		
	2013	2014	Mean	2013	2014	Mean	2013	2014	Mean	2013	2014	Mean
T_1 - Pendimethalin 30EC @ 1.0 kg ha^{-1} (PE)	37050	36890	36970	23950	27840	25895	13100	9050	11075	0.55	0.33	0.44
T_2 - Pendimethalin 30 EC + Imazethapyr 2 EC @ 1.0 kg ha^{-1} (PE)	44980	46060	45520	24450	28340	26395	20530	17720	19125	0.84	0.63	0.74
T_3 - T_1 + Quizalofop-ethyl @ 50 g *a.i* ha^{-1} (POE at 15-20 DAS)	43030	42000	42515	25200	29090	27145	17830	12910	15370	0.71	0.44	0.58
T_4 - T_2 + Quizalofop-ethyl @ 50 g *a.i* ha^{-1} (POE at 15-20 DAS)	46345	43750	45048	25700	29590	27645	20645	14160	17403	0.80	0.48	0.64
T_5 - T_1 + Imazethapyr @ 50 g *a.i* ha^{-1} – (POE at 15-20 DAS)	43420	45290	44355	24450	28340	26395	18970	16950	17960	0.78	0.60	0.69
T_6 - T_1 + Manual weeding at 25-30 DAS	45045	49000	47023	25950	29840	27895	19095	19160	19128	0.74	0.64	0.69
T_7 - T_2 + Manual weeding at 25-30 DAS	47255	49910	48583	26450	30340	28395	20805	19570	20188	0.79	0.65	0.72
T_8 - Two Manual weedings each at 20 and 40 DAS	41210	54250	47730	26800	30690	28745	14410	23560	18985	0.54	0.77	0.66
T_9 - Weedy check	28795	29750	29273	22800	26690	24745	5995	3060	4528	0.26	0.12	0.19

PE - Pre Emergence, POE - Post Emergence, DAS -Days after Sowing

Higher weed control efficiency (WCE) and long lasting effects of pre-emergence application of Pendimethalin 30 EC+ Imazethapyr 2 EC @ 1.0 kg ha^{-1} provided effective control of all the grassy weeds and created weed free conditions till first 40 days of sowing and single hand weeding at 25-30 DAS improved the tilth by making the soil more vulnerable for the plants to utilize water and air. These results are in close conformity with those of Khairnar *et al*.(2014) and Jakhar *et al*.(2015).

Effect on growth and yield

Different weed control treatments significantly influenced plant height, branches $plant^{-1}$, pods $plant^{-1}$, seeds pod^{-1} and 100-seed weight (Table 2) over weedy check. These plant growth and yield attributes were superior in case of pre-emergence (PE) application of Pendimethalin 30EC +Imazethapyr 2EC @1.0 kg ha^{-1} followed by hand weeding at 30 DAS, hand weeding twice at 20 and 40 DAS and Pendimethalin 30EC +Imazethapyr 2EC @1.0 kg ha^{-1} PE. The test weight did not differed significantly with weed control treatments. A Significant increase in plant height (67.0 cm) and branches $plant^{-1}$ (2.8) were recorded with application of Pendimethalin 30 EC +Imazethapyr 2 EC @1.0 kg ha^{-1} (PE) followed by hand weeding at 30 DAS over weedy check (54 cm and 1.9). This was due to better control of both grassy as well as broad leaved weeds during early crop growth period. These results are in close agreement with those of Yadav *et al*. (2015) in blackgram and Khairnar *et al*. (2014) in *kharif* mungbean. The highest number of pods $plant^{-1}$ (32.4) was registered under Pendimethalin 30EC +Imazethapyr 2 EC @1.0 kg ha^{-1} (PE) treatment and it was closely followed by T_7 (31.7) and hand weeding twice at 20 and 40 DAS (28.3). Among these three treatments the differences were not statistically comparable. The lowest number of pods $plant^{-1}$ was recorded in weedy check (18.1).

The seed yield was significantly influenced by all the weed management practices over weedy check (Table 2). The maximum mungbean grain yield (720 kg ha^{-1}) was registered with Pendimethalin 30 EC +Imazethapyr 2 EC @1.0 kg ha^{-1} (PE) followed by hand weeding at 30 DAS which was closely followed by two hand weedings at 20 and 40 DAS (705 kg ha^{-1}) and it was significantly superior over Pendimethalin 30EC@1.0 kg ha^{-1} (549 kg ha^{-1}) and weedy check (434 kg ha^{-1}). Unchecked weed growth decreased the yield to the extent of 62.44% compared to two hand weedings at 20 and 40 DAS. However, the treatments T_2-T_8 did not influence the grain yield. Higher seed yield obtained in these treatments might be due to the maintenance of weed free environment especially during critical crop growth stages as evident from increase in the values of yield components. In addition, the least weed population and dry weight of weeds were registered under these treatments are also responsible for better seed yield. These findings are in line with those reported by Mirjha *et al*. (2013) and Simeerjeet *et al*. (2016).

Economics

All the weed management practices boosted profitably over weedy check. Economics of different weed control treatments (Table 3) showed that pre-emergence application of Pendimethalin 30 EC +Imazethapyr 2 EC @1.0 kg ha^{-1} followed by hand weeding at 25-30 DAS recorded the highest gross returns (Rs.48,583/-) and net returns (Rs.20,188/-) though B:C ratio was lower (0.72) because of higher costs incurred in weeding, however, B:C ratio was higher with pre-emergence application of Pendimethalin+Imazethapyr @1.0 kg ha^{-1} (0.74) alone without integration of hand weeding. Because of higher costs incurred on hand weeding, weedy check treatment recorded the lowest net returns (Rs.4,528/-) and B:C ratio (0.19) due to its lower productivity.

CONCLUSIONS

Based on the results it can be concluded from the two years study that maximum grain yield, gross returns, net returns and effective weed control in mungbean were obtained with pre-emergence application of Pendimethalin 30EC +Imazethapyr 2EC @1.0 kg ha^{-1} followed by integration of one manual hand weeding at 25-30 DAS.

REFERENCES

Jakhar, P., Yadav, S.S and Choudhary, R.2015. Response of weed management practices on the productivity of urdbean (V*igna mungo* L.Hepper). Journal of Applied and Natural Sciences. 7(1):348-352.

Khairnar, C.B., Goud, V.V and Sethi, H.N. 2014. Pre- and post-emergence herbicides for weed management in mungbean. Indian Journal of Weed Science. 46(4):392-395.

Kumar, A and Tewari, A. N. 2004. Crop weed competition studies on summer sown blackgram (*Vigna mungo* L.). Indian Journal of Weed Science. 36(1/2):76-78.

Mirjha, P.M., Prasad, S.K., Singh, M.K., Pragati Baghel and Ram Hari Paikra. 2013. Productivity and economics of mungbean as influenced by chemical weed control. Annals of Agricultural Research(New Series). 34 (2):185-188.

Simeerjeet Kaur, Tarundeep Kaur and Makhan, S. Bhullar. 2016. Imidazolinone herbicides for weed control in greengram. Indian Journal of Weed Science. 48(1):37-39.

Tripathi, P., Singh, M.K., Singh, J.P and Singh, O.N.2012.Effect of rhizobial strains and sulphur nutrition on mungbean (*Vigna radiata* (L.) Wilczek) cultivars under dryland agro-eco system of Indo-Gangetic plain. African Journal of Agricultural Research.7 (1):34-42.

Yadav, K.S., Dixit, J.P and Prajapati, B.L. 2015. Weed management effects on yield and economics of blackgram. Indian Journal of Weed Science. 47(2):136-138.

J.Res. ANGRAU 45(1) 39-45, 2017

DESIGN AND DEVELOPMENT OF LOW HP TRACTOR DRAWN INCLINED PLATE GROUNDNUT PLANTER

K.MADHUSUDHANA REDDY, D.VIJAY KUMAR, B.SAHADEVA REDDY and M.V.RAMANA

Agricultural Research Station, Acharya N.G. Ranga Agricultural University,

Anantapuramu – 515 001

Date of Receipt: 15.12.2016 Date of Acceptance : 17.2.2017

ABSTRACT

In Andhra Pradesh, groundnut is one of the major oil seed crop grown in an area of 9.0 lakh ha annually under rainfed conditions in red soils. High HP tractor drawn groundnut planters can be used for sowing of groundnut but large initial investment of high HP tractors may not permit for using by small and medium farmers. As a consequence, the small and medium farmers are turning towards low HP tractors, which are less expensive, compared to high HP tractors. However, the planting the implements are not widely available that are suitable to low HP tractors and local soil conditions. Keeping this in-view, a low HP tractor drawn 4-row groundnut planter was developed and evaluated its performance. Row to row spacing of groundnut planter is 30cm. The seed metering in the planter is of inclined plate type. Power is transmitted from ground wheel to metering system through chain and sprockets with power transmission ratio of 1.41. A double point shovel type furrow opener was provided for opening the furrows. The seed is placed in the furrows at desired depth of 4.5 cm and sees to seed spacing of 10.1 cm. The implement can operated by a 18 - 24 HP tractor. During evaluation the field capacity of the planter was found to be 0.24 ha h^{-1} at the average speed of operation of 2.88 km h^{-1} with field efficiency of 69.44%. It was found that, the cost of sowing with low HP tractor drawn groundnut planter was Rs.1,085/- per ha.

INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is an important source of edible oil in India and ranks second in the world in groundnut production and cultivated in an area of 5.8 mha with a productivity of 948 kg ha^{-1}. Three southern states namely Andhra Pradesh, Tamil Nadu, Karnataka and the western state *viz*., Gujarat together account for close to 80% of the annual output in India. In Andhra Pradesh groundnut is mostly sown under rainfed conditions in red and sandy loam soils.

Traditionally groundnut is sown by hand dropping of seed using funnel and tube attached to 4-row bullock drawn cultivator frame. This method of sowing is very laborious and time consuming operation. However, both time and labour can be saved by high HP tractor drawn 8-row groundnut planter but

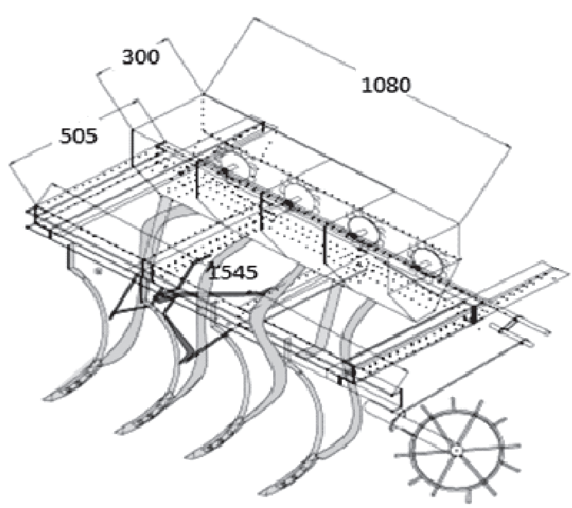

Fig.1. Isometric view of the low HP tractor drawn groundnut planter

E-mail: madhu.karakala@gmail.com

high initial cost of high HP tractormay not permit for using small and medium farmers.Also diminishing population of bullocks and un-availability labour now a days, the farmers may not be able sow the groundnut within recommended period of sowing by using bullock drawn implements. As a consequence, the small and medium farmers are turning towards low HP tractors which are less expensive when compared to high HP tractors. However, the planting implements are not widely available that are suitable to low HP tractors. Keeping this in view, a low HP groundnut planter was designed, developed and evaluated for its performance.

Table 1. Constructional specifications of functional components of low HP tractor drawn 4 row groundnut planter having row to row spacing of 30 cm

Component	Specifications	
Main frame	Length (mm)	1345
	Width (mm)	505
	Height (mm)	600
	Material of construction	MS-U,L and flat sections
Hopper	Number	4
	Volumetric capacity (cm^3)	3165
	Slope of hopper wall Shape	62^0 Semi-circular
	Overall dimensions (length, mm × width, mm × height, mm)	241 × 265 × 300
	Material of construction(2 mm)	MS sheet
Metering unit	Type	Inclined plate
	Diameter of cell plate	150
	No. of cells	15
	Cell size (mm)	10 × 9
	Material	Plastic
Seed tube	Diameter (mm)	31.75
	Material	Plastic
Furrow opener	Type	Double point shovel type
	Dimensions (mm)	260 × 60 × 5
	Material	MS flat
Ground wheel	Diameter (mm)	320
	No. of spokes/lugs	12
	Material (mm)	MS flat (50 ×10)
	Lug length (mm)	55
Furrow covering device	Dimensions (length × \width × thickness) (mm)	1250 × 75 ×10
	Material of construction	MS flat

MATERIAL AND METHODS

A four row low hp tractor drawn groundnut planter having row to row spacing of 30cm was developed at Agricultural Research Station, Anantapuramu. The major components are mainframe with hitching unit, hopper, metering unit, seed tube cum furrow opener, ground wheel and power transmitting unit. The isometric view of the low hp tractor drawn groundnut planter is shown in Fig.1 and the detailed specifications of the functional components of groundnut planter is presented in Table 1.

Main frame with hitching unit

The main frame was made from 5 mm thick mild steel U-channel section of 40 mm × 72 mm dimensions. The main frame had 12.7 mm diameter holes at every 9.5 mm interval throughout its length to facilitate the fixing of all other components. A three point hitching unit was fabricated. It was made up of mild steel flat having dimensions of 50 mm ×10 mm. The hitching pins 150 mm length were fabricated from mild steel rod of 16 mm diameter. The hitching unit was fixed rigidly to the main frame by nuts and bolts.

Hopper

The groundnut planter consisted of eight hoppers each of 3165 cm^3 volumetric capacity. The hoppers were made of 2 mm thick mild steel sheet. It was fabricated taking into consideration the volumetric capacity required, angle of repose and bulk density groundnut seed. The length of hopper was 240 mm with the diameter of curvature 210 mm. The cross section was kept semi-circular. A sliding plate was provided to maintain the depth of seed layer in pickup chamber irrespective of the filling of main chamber. The slope of the hopper was kept as 62^o.

Seed Metering unit

An inclined plate type metering unit was designed and developed for groundnut seed. It consists of a seed plate and picking chamber. The seed plate made of plastic was mounted over a set of bevel gear. It had 15 cells around its periphery. The cells were L-shaped having length 9 mm and height and width each 10 and 8 mm, respectively. The seed plate was mounted at an angle of 600 with horizontal so that the extra seed dragged along were dropped before reaching the seed outlet of the picking chamber.

Seed-tube cum-furrow opener

Four seed tubes of each diameter 31.75 mm made of plastic were used for passing of seed from metering device to furrow. A double point shovel type furrow opener was selected by taking into consideration the local soil condition (red stony loam).

Ground wheel

The ground wheel is required to drive the metering system and it was designed by taking into consideration the recommended seed spacing of 10 cm in a row for groundnut. The ground wheel was made of 50 mm × 10 mm mild steel flat. The diameter of the ground wheel was 320 mm and lugs of 50 mm length were provided on the outside of the wheel rim for better traction. The lugs were also made with 10 mm diameter mild steel rod.

Power transmitting unit

Transmission system was developed for proper power transmission from ground drive wheel to main shaft of seed metering device through a set of chain and sprocket arrangement. The ground wheel was arranged at the side of the planter. The power transmission is provided with three mild steel sprockets of 17 teeth, four bevel gears of 17 teeth and four bevel gears of 24 teeth. Two chains of 12 mm pitch were used for power transfer from drive sprocket of ground wheel to seed metering shaft. The speed ratio of 1.41:1 was provided between the ground wheel and seed plate to get the recommended seed spacing in row.The planter was evaluated in the laboratory and in the field condition for its performance. In the laboratory calibration row-to-row variation in seed metering and uniformity in seed delivery over sand bed method were evaluated (IS: 6316-1971).

Laboratory Calibration

i) Row to row variation in seed metering

Groundnut seed of variety Kadiri-6 was filled in 4 seed hoppers. The ground wheel was jacked up and 100 revolutions were given to the ground wheel. The seed discharged from each of the seed tube were collected separately and weighed. Ten replications were done. Series of tests at full,3/4 th and 1/2 capacity of the hopper were conducted and changes in the seed rates were observed.

ii) Uniformity of seed distribution

The uniformity of seed distribution within the rows was determined using the sand-bed test. A sand bed was prepared with fine sand and spread uniformly over a leveled surface. The covering blade was removed and the planter was pulled over the sand bed. The number of seed dropped for 3 m length and seed to seed distance was noted for each row. Ten replications were done.

Field Evaluation

The field experiments for the performance evaluation of the low hp tractor drawn groundnut planter were conducted. The field was prepared into fine tilth by twice with spring tyne cultivator followed by leveling for the operation of sowing. The test plot was subdivided into three plots of size 20 m × 30 m. All hoppers were filled with groundnut seed and operated in straight rows. The operation was replicated in three plots. The performance was compared with local seed drill for groundnut seed. A separate test plot was used for local practice of groundnut sowing and field condition was kept similar as per the requirement. The following observations were taken to evaluate the performance of planter.

i) Time taken to cover the area
ii) Actual depth of placement of seed
iii) Speed of operation
iv) Man-h/ha for sowing
v) Seed rate
vi) Draft required to operate the planter

The following indicators of performance were calculated using the observed data in the field (Mehta *et al*., 2005)

i) Draft: By double tractor method the draft was recorded by spring type digital dynamometer.
ii) Field capacity

The theoretical field capacity is the rate of field coverage that would be obtained if the planter was operated continuously without any interruptions like turning at the ends and filling of hopper. The effective field capacity is the actual average rate of coverage including the time lost in filling hopper and turning at the end of rows.

The theoretical field capacity was determined by using the following relationship

$$TFC = WS/10 \ \text{ha h}^{-1}$$

Where,

TFC = Theoretical field capacity, ha h^{-1}

W = Width of operation, m

S = Speed of operation, km/h

Effective field capacity,ha/h=(Total area covered,ha)/(Total time taken,h) X 100

iii) Field efficiency

Field efficiency is the ratio of effective field capacity and theoretical field capacity as shown below:

Field efficiency= (Effective field capacity,ha/h)/(Theoretical field capacity,ha/h) X 100 (%)

iv) Field machine index

It indicates the influence of field geometry on working capacity of a machine. Field machine index was worked out by the following formula (Renoll, 1970):

$$FMI,\% = Tp/(Tp+Tt) \times 100$$

Where,

FMI = Field Machine Index,%

Tp = Total productive time, s

Tt = Turning time loss, s

Table 2. Seed distribution in a row with different hopper capacities

Hopper capacity		Average weight of seed discharged in 100 revolutions of ground wheel (g)				
		R 1	R 2	R 3	R 4	Average
Half hopper or ½ hopper						
(i)	Average	364.37	351.19	371.28	354.07	360.22
(ii)	Maximum deviation from average	1.15	2.50	3.07		1.73
Three-fourth hopper or ¾ th hopper						
(i)	Average	379.22	357.19	362.13	370.11	367.34
(ii)	Maximum deviation from average	3.23	2.56	1.41		0.75
Full hopper						
(i)	Average	373.26	350.48	365.79	369.62	364.78
(ii)	Maximum deviation from average	2.32	3.92	0.27		1.32

Note:R - row

Cost economics

The total cost of sowing for both the methods was determined based on the fixed cost and variable cost (IS: 1964-1979). The following variables were considered in determining the cost of operation of the planter.

1. Fixed cost
   i) Depreciation
   ii) Interest
   iii) Insurance and taxes
   iv) Shelter
2. Variable cost
   i) Repair and maintenance

The total cost of operation was determined as the sum of the fixed and variable cost. The total cost of operation per hour of the machine was computed. The cost of operation of the tractor was also calculated following the same procedure. The cost of fuel, lubrication and operator was added to the variable cost. The total cost of operation was determined by adding the hourly cost of operation of the machine and tractor and expressed in Rs. per hour. It was converted into area basis by multiplying it with the effective field capacity of the machine and expressed in Rs per ha.

RESULTS AND DISCUSSION

Laboratory calibration

In the laboratory condition, the row-to-row variation in seed metering and uniformity of seed delivery were studied. The tests were conducted with full, ¾ and ½ filled hopper. The results indicated that variation of seed discharged from the average of eight rows was less than standard limit.

An overall average of 364.11g of seed was delivered in 100 revolutions of the ground wheel (Table 2). The maximum deviation of seed discharge of any row from the average was observed to be less than

4 %. All the deviations were within the range of 7% set by the Indian standards. No difference in metering was observed with different hopper capacity. This was due to the partition of hopper by sliding plate. The depth of seed layer was same for all the hopper capacity in the pickup chamber, hence no difference was observed for different hopper capacity.

Sand-bed test

The seeding uniformity was also evaluated by using the sand-bed test. An average of 11 seeds were placed per meter length. The maximum deviation of seed of any of the rows from the average was less than 7% set by Indian standards. Average seed to seed spacing observed was 10.2 cm and this was almost equal to recommended seed to seed spacing for groundnut *i.e.* 10 cm. Hence, it could be concluded that the prototype planter performed satisfactorily in metering groundnut seeds (Table 3).

Table 3. Sand bed test for seeding uniformity

Parameter	**Number of seed per metre length of bed**				
	R 1	R 2	R 3	R 4	Average
Mean	10.32	11.65	11.13	10.95	11.0
Maximum deviation from average, %	6.18	5.91	1.18	0.45	
Parameter	Seed to seed spacing obtained (cm)				
	R 1	R 2	R 3	R 4	Average
Mean	9.8	10.2	10.5	10.3	10.2
Maximum from average, %	3.92	0	2.94	0.98	

Field performance test

Field performance tests were carried out to obtain actual data on overall performance of the low HP tractor drawn groundnut planter. The field tests were conducted and the performance data of the planter is presented in Table 4.

Table 4. Field performance data of low HP tractor drawn groundnut planter

Performance parameters	**Values**
Average draft (kgf)	262
Average speed (km h^{-1})	2.88
Average depth of placement (cm)	4.8
Average field capacity (ha h^{-1})	0.24
Average field efficiency (%)	69.44
Field machine index (%)	86.54
Labour requirement (man-h ha^{-1})	5.6
Seed spacing (cm)	10.1
Number of seeds per m^2	37
Seed rate (kg ha^{-1})	109

Note: Soil moisture content = 18% and Bulk density = 1.12 g cc^{-1}

The average draft requirement of 262 kgf was recorded for the low H.P tractor drawn groundnut planter. Hence, a low H.P tractor (15 – 22 H.P) could easily operate the planter. An average field capacity of 0.24 ha h^{-1} was obtained for continues operation of groundnut planter at an average speed of 2.88 km h^{-1}. A field efficiency of 69.44% was observed which was in the prescribed range of 65 – 75% for row crop planter (Kepner *et al*., 1987). The major loss in field efficiency was due to the turns at headland and adjustment of planter position before run so that the ridges formed in the previous pass were not disturbed. No break down, repairs and adjustment of components during the observation was observed. The average depth of placement of seed of ten observations randomly selected was 4.8 cm. The field machine index was recorded at an average of 86.54 %. This was due to the rectangular size of the test plot and less turning time at the head land. The average seed rate observed in the field was 109 kg ha^{-1} over recommended seed rate of 90 to 110 kg ha^{-1}. The average number of seeds per m^2 was found to be 37 and it was nearer to recommended seeds of 33 per m^2. The cost of the prototype planter was worked and it was found to be Rs.35,000/- and hourly cost of operation was found to be Rs.374/-.The cost of planting by planter was Rs.1,085/- per ha.

CONCLUSION

The planter worked satisfactorily with a field capacity of 0.24 ha h^{-1} and it can be operated by a low HP tractor (15 – 22 HP). The operation of groundnut planter, cost of sowing and the performance were quite substantial and justified the use of planter.

REFERENCES

Indian Standard. 1971. Test code for seed-cum-fertilizer drill. IS: 6316-1971. Bureau of Indian Standards, New Delhi.pp.22-24.

Indian Standard. 1979. Test code for calculation of cost of operation of Agricultural machines. IS: 1964-1979. Bureau of Indian Standards, New Delhi. pp.28-31.

Kepner, R.A., Roy Bainer and Barger, E.L. 1987. Principles of Farm Machinery. CBS Publishers and Distributers, New Delhi. pp.42-48.

Mehta, M.L., Verma, S.R., Misra, S.K and Sharma, V.K. 2005. Testing and Evaluation of Agricultural Machinery. Daya Publishing House, Delhi. pp.68-74.

J.Res. ANGRAU 45(1) 46-57, 2017

SPATIO-TEMPORAL VARIABILITY OF CLIMATE CHANGE AND ITS IMPACT ON YIELD: A CASE FROM NAGARJUNA SAGAR PROJECT, KRISHNA RIVER BASIN

M. CHANDRASEKHAR REDDY, D.VISHNU SANKAR RAO, K.GURAVA REDDY, G.RAGHUNADHA REDDY AND V.SREENIVASA RAO

Department of Agricultural Economics, Agricultural College,
Acharya N.G Ranga Agricultural University, Bapatla -522 101

Date of Receipt: 15.11.2016 Date of Acceptance: 27.12.2016

ABSTRACT

The present paper reviews the current state of understanding of the climate change impacts on irrigation water on the crop yield and relevant adaptations in Andhra Pradesh (2013-14). The Just and Pope Production function was used to estimate the mean yield of crops and the variance associated with the mean yield for five districts under Nagarjuna Sagar Project of Krishna River basin. The results indicated that rice production will reduce during mid-century and end-century periods and there is a need to adopt water saving interventions.

INTRODUCTION

Climate Change is a reality now. Agriculture is the most affected sector due to climate change because of two of its primary inputs, precipitation and temperature. The inter-annual and long-term variability of monsoon rainfall have indicated that variation in rainfall for the subcontinent is statistically significant. Hence, monsoon rainfall is considered as the important climatic phenomenon in the Indian subcontinent and the adjoining Asian and African regions. On the other hand, several authors have also acknowledged that there is an increasing trend in surface temperature, with decreasing trends in rainfall (Palanisami *et al*., 2009). It has been recognised that such climate change affects not only yield, but also its variability (Barnwal and Kotani, 2010; Ranganathan, 2009). Hence, while quantifying the impact of climate change it is necessary that these two parameter quantities are jointly considered. Many previous studies on quantifying impact of climate change employed regression techniques and concentrated on the estimation of average productivity only. Little attention was given to optimal land allocation to competing crops with climate change induced productivities. The problem becomes more important in the context of gradual decline in available land area for agriculture due to urbanization.

This paper focuses on estimating average yield and variability in yield of four important crops namely rice, cotton, chillies and groundnut grown in five districts of Nagajuna Sagar Project in Krishna River Basin, by applying an econometric technique.

Review on understanding the climate change impacts

South Asia is the home for one-fifth of the world's population and is the most disaster-prone region in the World (UNEP, 2003). Climate change is affecting a large number of people across South Asia in different ways, which include variability in the monsoons, increase in average temperature, warm winters, increased salinity in coastal areas, reduced discharges from rivers, etc. The Intergovernmental Panel on Climate Change (IPCC) has also projected that the mean annual temperatures of South Asia will increase by 0.5 to 1.2^{0}C by 2020, 0.88 to 3.16^{0}C by 2050 and 1.56 to 5.44^{0}C by the end of the century (IPCC, 2007). High temperatures are likely to reduce the yields of different crops, increase the proliferation of weeds and pests, thus providing new challenges for agricultural scientists (Nelson *et al*., 2009; Cruz *et al*., 2007). In tropical parts of South Asia, rise of temperature will negatively impact rice and wheat yields as they are already being grown close to their threshold (Kelkar and

E-mail: csreddy9315@gmail.com

Bhadwal, 2007). In sub-humid, semi-arid and arid regions wheat yields are predicted to decline by 6-9% with a 1^0C rise in temperature (Sultana and Ali, 2006). Cash crops such as cotton, mango and sugarcane will be severely impacted with a decadal rise of 0.3^0C. Thus, the overall impacts of temperatures on agriculture are expected to be negative and threatening global food security.

Droughts or floods are destructive but when they last for longer periods, then the effects can be devastating or irreversible (Conway, 2009). Widespread flooding is seen in many small island and delta regions, for example the Mekong delta. The floods in Myanmar during 2008 devastated 1.75 million ha of rice land while in Bangladesh it caused a production loss of about 0.8 million metric tons of rice during 2007 (Craufurd *et al*., 2011). In India, 70% of the arable land is prone to drought and 20% to floods and cyclones. Of the total precipitation of around 4000 mm^3 in the country, availability of surface water and replenishable groundwater is estimated at 1893 mm^3. But due to the variations of topography and uneven distribution of rain over space and time, only about 1123 mm^3, including surface water and groundwater resources can be put to beneficial use (Aggarwal *et al*., 2012).

As a result, water scarcity is expected to become an ever-increasing problem due to the changing climate in India. The water balance will also change due to the accelerated rate of evaporation from soil and water bodies and transpiration from plants. Several studies have shown that unless we adopt to the changing situations there is a probability of a 10-40% loss in crop production in India by the end of the century owing to global warming (Knox *et al*., 2011).

Among other things, the river basins are going to be highly affected by sedimentation, reducing water storage, water availability (due to poor monsoon) and area under production. The per-capita water resource availability of the basins in India also varies from a low of 240 m^3 (Sabarmati Basin) to a high of 17,000 m^3 (Brahmaputra Basin) (Amarasingh *et al*., 2005). Authors also reported that many river basins record significantly lower per-capita water availability in terms of total renewable water resources, thus increasing the demand for water resources. There are several factors influencing water supply and demand in the basins such as population growth, urbanization and income, changes in dietary preferences, irrigation expansion and environmental flow requirements.

Though there is much concern on reduced water supplies and substantial impact of climate change in crop production in South Asia, still there is limited understanding on the adaptation strategies used. Adaptations are adjustments or interventions which take place in order to manage the losses or take advantage of the opportunities presented by a changing climate. Adaptation occurs at two levels: i) farm-level adaptation which mainly focuses on farming-related interventions or adjustments and are related to short-term periods and influenced by seasonal climate variations and local agricultural cycles, and ii) the regional- or national-level adaptation which focuses on the agricultural production at macro level linking domestic and international policies.

MATERIAL AND METHODS

Palanisami *et al.* (2011) have estimated production functions focusing on the relation between yield and its variability in the context of climate change. The authors have estimated the Just-Pope production function using maximum likelihood method by assuming the relation between yield of a crop and climate variables (temperature and precipitation) for different districts (Just and Pope, 1978). In the present study, functions developed by the authors were fitted for an irrigation project in Godavari, Krishna and Cauvery river basins. A quadratic form was assumed for the mean function (Ranganathan, 2009), which ensures positive output variance. In addition, the riskiness of an input variable was also derived from the sign of the coefficient. The mean function was used to study the maximum and minimum possible yields and also the impact of climate change on the crop yield. The first and second order conditions were derived by assuming that precipitation and temperature will vary and technology will be held at the current level. Nonetheless, accurate region-specific predictions for changes in temperature and rainfall are needed to capture the impact of climate change. Gosain and Sandhya Rao (2012) have predicted the season-wise changes under Godavari River Basin for baseline period (1960-90) mid-century period (2021-50) and end-century period (2071-98).

Two scenarios were formulated based on the mid-century and end-century periods (Table 2). The mid-century scenario for *kharif* season showed an increase of 1.93^{0}C and an overall increase of 13.6% in precipitation. This scenario is denoted by 1.93^{0}C/ 13.6% and for e rabi season the scenario is 2.22^{0}C/ 13.6%. Similarly, the end-century scenarios for *kharif* and *rabi* are respectively 4.03^{0}C/17.8% and 4.28^{0}C/ 17.8%. In all these scenarios, only the annual change in precipitation (and not seasonal changes) is considered, as the annual precipitation reflects inter-seasonal water accumulation. These predicted changes were used in the mean and variance functions to predict the average yield and variability in yield induced by climate change. The precipitation is increasing in both scenarios but the climate models do not have information on the rainfall distribution pattern. There can be a sudden pour where the present storage reservoirs are not sufficient to meet the demand. The Assessment Report 4 (AR4) by IPCC noted that the frequency of more intense rainfall events in many parts of Asia has increased, causing severe floods, landslides and mud flows. At the same time, the number of rainy days has decreased. Analysis of rainfall data for India highlights the increase in the frequency of severe rainstorms over the last 50 years. The number of storms with more than 100 mm rainfall in a day is reported to have increased by 10% per decade (UNEP, 2007). However, due to storage-related issues, the actual irrigation water availability can be decreased in contrast with the projected increased rainfall, which would increase the demand for food grain production.

Table 1. Projected changes in climatic variables during *kharif* and *rabi* seasons in Nagarjuna Sagar Project , Krishna River Basin of A.P.

Change in mean daily average temperature (^{0}C)		
	Kharif (June to November)	Rabi (December to April)
Change from baseline to mid-century	1.93	2.22
Change from baseline to end-century	4.03	4.28

Change in mean precipitation (%)			
	Kharif (June to November)	Rabi (December to April)	Overall
Change from baseline to mid-century	12.5	17.6	13.6
Change from baseline to end-century	13.0	53.4	17.8
Source: Calculations based on figures from Gosain and Sandhya Rao (2012).			

The projected changes from Table 1 were assumed to be same for the Krishna river basin for modelling purposes as the estimates for Krishna basins are not available and it is adjacent to the Godavari basin.The parameters were estimated by using the following equation with the assumption that $\omega_{it} \sim N(0,1)$, the likelihood function is given by

$$L = \left[\frac{1}{2\pi}\right]^{N/2} \prod_{t=1}^{T}\prod_{i=1}^{R}\left[\frac{1}{h(x_{it};\delta)}\right]^{1/2} \exp\left[-\{y_{it} - f(x_{it};\beta)\}^2 / 2h(x_{it};\delta)\right]$$

where, R is the number of districts and T is the number of time periods and N=RT. So the log likelihood function is given by

$$\ln L = -\frac{1}{2}\left[N\ln(2\pi) + \sum_{t=1}^{T}\sum_{i=1}^{R}\ln(h(x_{it};\delta)) + \sum_{t=1}^{T}\sum_{i=1}^{R}\frac{\{y_{it} - f(x_{it};\beta)\}^2}{h(x_{it};\delta)}\right]$$

It was then maximized to estimate the parameter vectors ß and d. STATA software package has inbuilt ml command and it was used to maximize the log likelihood function.

Nagarjuna Sagar Project, Krishna River Basin

The Nagarjuna Sagar Project (NSP) is one of the largest and highest masonry dams (125 m) in the world. It is situated downstream of the Srisailam Reservoir on the main Krishna River covering Telangana and Andhra Pradesh states. It is a multi-purpose project with irrigation, hydropower, and flood control components. The catchments area of the dam is 215,193 km^2; the annual rainfall in the catchments is 889 mm, the maximum observed flood is 30,050 cubic meter per second (cumec), and the design flood (return period 1,000 year) is 58,340 cumec. NSP complex has a substantial capacity for hydropower generation. It has one conventional and seven reversible units, each with a 110 MW capacity. The right bank canal powerhouse has three units of 30 MW each and the left canal powerhouse has two units of 20 MW each.

The NSP annually provides 7,465 Mm^3 water on average to a command of 0.89 Mha. The project was completed in 1974 and comprises a dam with two canals taking off on either side. The Nagarjuna Sagar Right Canal (NSRC) is 203 km long and creates irrigation potential for 0.47 Mha in Guntur and Praksam districts, while the Nagarjuna Sagar Left Canal (NSLC) is 179 km and creates irrigation potential for 0.42 Mha in Nalgonda, Khammam, and Krishna districts. Of the five districts under NSRC and NSLC, Guntur District has the highest command area of 284,000 ha covering 39 mandals in the district.

The command area under NSP is designed for a mixed cropping pattern, that is, one-third wet and two-third irrigated dry (ID). The areas close to the head reaches were localized as ID *rabi* (December to April) and the command in the lower reaches were localized as *kharif* wet (June to November). Water is supplied for a single crop, either only for *kharif* wet or *rabi* ID. Rice is the major crop grown in the *kharif* season and ID crops are sown after October in *rabi*. The important ID crops grown in the project area are chilli, cotton, pulses and groundnut. The cropping pattern observed from 1995-96 to 2004-05 had not much variation (I&CAD-GoAP, 2009). Whatever changes that have occurred in the cropping pattern are due to the availability of water in the reservoir, coupled with the seasonal rainfall pattern. Most of the cropping takes place during the *kharif* season. Though the upper reaches are designed for ID crops, wet crops are generally sown, resulting in excess use of water compared to its original design, depriving tail-end users. The tail-end users are thus compelled to cultivate ID crops or supplement irrigation of wet crops with groundwater. The water in the canal flows continuously in *kharif* and on and off during the *rabi* season. The crops grown also depend on the soils, climatic conditions, irrigation facilities, and market price conditions. Rice is the most favourite crop for the farmers and is also a staple food. In the rabi season, farmers cultivate pulses or vegetables and irrigated- dry (ID) crops such as groundnut and maize.

In NSP, problems regarding availability of water at the tail end exist due to excess use of water at the head regions. The average on-farm efficiency is working out to 39% and the project efficiency to 21.8% (I&CAD-GoAP, 2009). The roles and responsibilities of the water user associations are not clearly known and defined. Water management options are also poorly disseminated to the farming community. Hence, there is a need to address some of these challenges by adapting to water management practices to improve water use efficiency at the farm and project level.

RESULTS AND DISCUSSION

Climate change affects both the mean yield and yield variability, so it is important to estimate both measures simultaneously. The Just Pope production function was used for the purpose for each major crop from the five districts. The results of crop with analysis are discussed below.

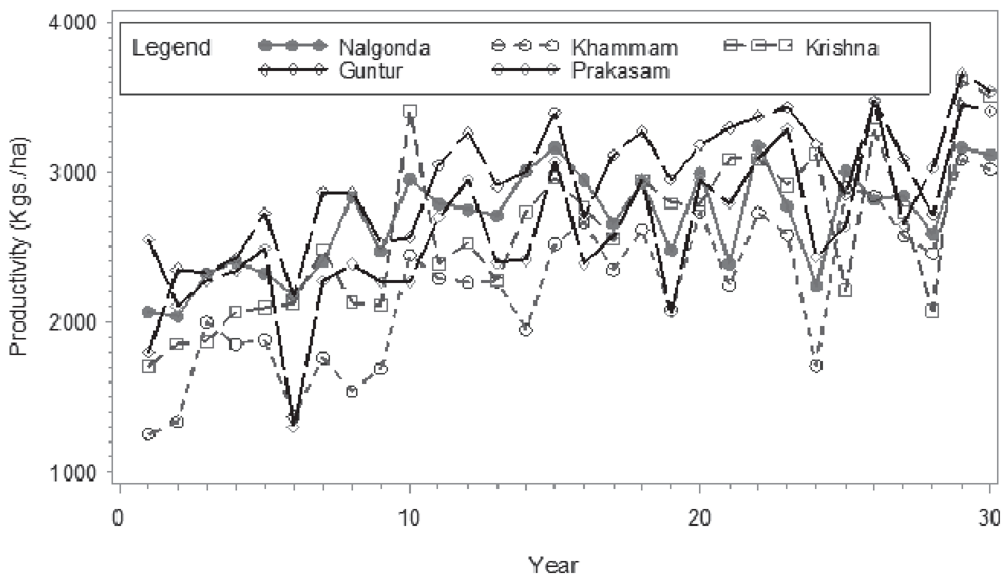

Fig. 1. Trend in yield of *kharif* rice in five districts (1984–2014)

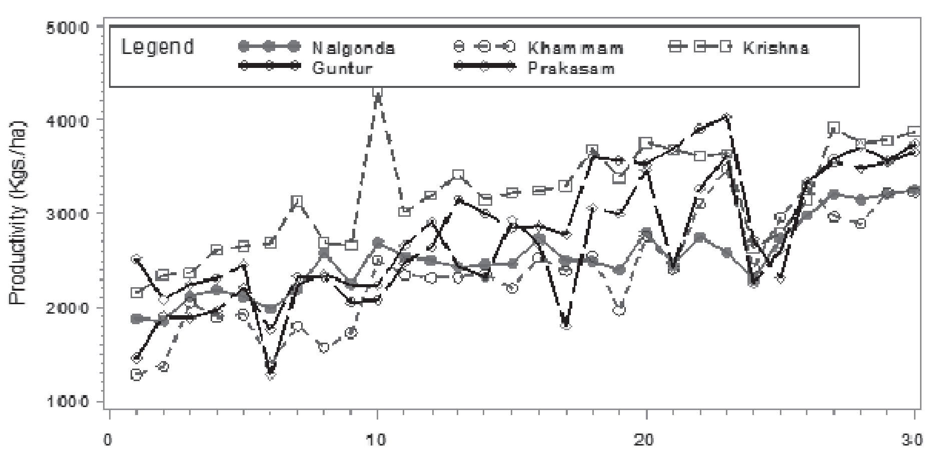

Fig.2. Trend in yield of *rabi* rice in five districts (1984–2014)

Rice is the most important food crop for people in South India. Andhra Pradesh and Telangana states account for 12.75 per cent of the country's rice production as it is grown in most of the districts during both *kharif* (June to November) and *rabi* season (December to April). Fig. 1 and 2 give an overview of the rice yield trend for the two seasons. The yields have an increasing trend in both seasons. During kharif season, the yield of Guntur district is higher than the other four districts. Productivity trends in Nalgonda and Krishna districts are similar, whereas Khammam district has the lowest productivity on the other hand during *rabi* season, Krishna district performs far better than the other districts.

Table 2 provides a summary statistics of average rice yield (kg ha $^{-1}$), precipitation (mm) and temperature (^{0}C) for the five districts for 30years (1984-2014). The major share of annual precipitation comes during *kharif* season (or the Southwest monsoon season) in all the districts. The temperature during the *kharif* season is slightly higher than that of *rabi* season.

Table 2. Summary statistics of rice yield and climate variables during 1984-2014

District	Kharif season (June to November)			Rabi season (December to April)		
	Yield (kg ha $^{-1}$)	Precipitation (mm)	Temperature (^{0}C)	Yield (kg ha $^{-1}$)	Precipitation (mm)	Temperature (^{0}C)
Nalgonda	2,686	114.4	27.7	2,529	8.7	26.7
Khammam	2,234	156.2	28.4	2,376	9.1	26.8
Krishna	2,608	141.8	28.7	3,197	10.6	26.7
Guntur	2,925	124.8	28.8	2,824	9.7	27.0
Prakasam	2,644	111.9	29.0	2,713	9.7	27.6

Table 3 provides the estimated coefficients for the mean function, variance function, standard errors of the coefficients, and log-likelihood function for rice. Most of the climate variable coefficients and their square terms are significant for both mean and variance functions. The trend coefficient is positive and strongly significant for the two seasons for both functions. This suggests technological advancement in rice production in all the districts covering under NSP.Based on the climate change projections/ scenarios only the annual change in precipitation was considered, because annual precipitation reflects inter-seasonal water accumulation. These predicted changes are used in the mean and variance functions to predict the climate change induced average yield and variability in yield. Table 4 shows the impact of climate change on rice production during two seasons under two climate change scenarios. Percentage losses are calculated based on normal yield, which is the average yield during the last five years, ending 2008 - 09. For the first scenario, the expected loss in yield during Kharif season varies from -1.5 per cent to 11.4 per cent.

Table 3. Just- Pope production function for rice, parameter estimates

Mean Yield	*Kharif*		*Rabi*	
	Coefficient	Std.Error	Coefficient	Std.Error
Precipitation (R) (in mm)	7.13	6.03	-5.71	7.14
Temperature (T) (in ^{0}C)	517.56***	225.37	1147.89***	486.36
Trend(year)	38.67***	3.31	36.74***	2.93
R^2	-0.001***	0.0004	-0.0004	0.000
T^2	-9.40***	3.90	-28.52***	9.51
R x T	-0.16	0.20	0.20	0.25
Nalgonda	-138.39	107.16	4230.13***	368.95
Khammam	-563.7501***	85.86	2664.96***	290.26
Krishna	-155.25	92.38	2055.13***	209.86
Guntur	206.04***	77.01	1203.98***	128.11
Constant	-6141.21	32079.72	-13809.61	45671.94
Variability in Yield				
Precipitation (R)	-0.002**	0.001	-0.001*	0.001
Temperature (T)	0.42	0.28	-0.17	0.26
Trend	0.02**	0.01	0.026*	0.01
Nalgonda	0.03	0.56	1.72	1.90
Khammam	0.28	0.45	1.90	1.45
Krishna	0.76*	0.44	1.71	1.03
Guntur	- 0.05	0.39	0.51	0.67
Constant	0.50	8.31	14.08	10.85
Likelihood Function	-1059.3		-1056.2	

Note: *Significant at 10 percent level; ** Significant at 5 percent level; ***Significant at 1 percent level

The highest loss was predicted for Khammam district and the lowest for Nalgonda. For Nalgonda district, the loss is -6.4, which means a marginal gain. The standard deviation in yield ranges from 370 kg to 586 kg. The second scenario produces greater percentage of losses and variability in yield. The percentage loss varies from 7.8 percent to 31.1 percent and Khammam, Prakasam and Krishna districts are expected to suffer substantial yield losses. At the end of the century, the overall loss percentages will be about 17 percent. The predicted variability in yield in all the districts at end-century is higher than that predicted for the mid-century. The losses predicted for the *rabi* season are much higher than the corresponding figures for both scenarios (mid-and end-centuries) in all five districts. At mid-century, the highest loss during *rabi* season is likely to be in Nalgonda and the lowest is likely to be in Khammam, with losses of 40.2 percent and 20.3 percent, respectively. The variability in yield is likely to range from 88 kg to 326 kg.

Table 4. Climate change impact on rice yield and variability in yield in *Kharif* and *Rabi*

Season	CC-Scenario		Nalgonda	Khammam	Krishna	Guntur	Prakasam	Overall
	Normal yield		2,883	2,773	2,814	3,111	3,139	2,944
Kharif	Mid-Century 1.93^{0}C/13.6%	MC-Predicted yield)	3,068	2,458	2,855	3,174	2,980	2,923
		%Loss (base/normal yield)	-6.4	11.4	-1.5	-2.0	5.1	0.7
		Standard deviation	370	420	586	446	474	452
	Mid-Century 1.93^{0}C/13.6%	EC-Predicted yield	2,658	1,912	2,335	2,687	2,520	2,439
		%Loss (base/normal yield)	7.8	31.1	17.0	13.6	19.7	17.1
		Standard deviation	558	628	879	671	715	680
		Normal yield	3,074	3,060	3,440	3,368	3,346	3,258
Rabi	Mid-Century 2.22^{0}C/13.6%	MC-Predicted yield	1,837	2,437	2,634	2,053	2,159	1,472
		%Loss (base/normal yield)	40.2	20.3	23.4	39.0	35.5	34.8
		Standard deviation	326	269	237	174	88	201
	End-Century 4.28^{0}C/17.8%	EC-Predicted yield	1,289	1,983	2,180	1,483	1,987	935
		%Loss (base/normal yield)	58.1	35.2	36.6	56.0	40.6	45.3
		Standard deviation	434	358	317	232	117	268

Note: Yield and Standard Deviations are in kg ha^{-1}

Again, Nalgonda district is likely to suffer a loss of 58.1 percent at mid-century followed by Guntur, with a loss of 56 percent. The variability in yield may range between 117 kg and 434 kg. Thus, it can be concluded that climate will induce both yield loss and greater variability in rice yield. This conclusion confirms with the results of Ranganathan (2009) and Barnwal and Kotani (2010).

Similarly, Just - Pope production functions for the cotton, chilli and groundnut crops are given in Table 5. As in the case of rice, most of the climate variable coefficients are significant for these three crops also in mean function as well as in variance function. Coefficients of temperature and temperature-square are significant for chillies. In the variance function, the coefficients of both climate variables are negative, implying that these are risk-decreasing variables for chillies. This implies that higher the values of these variables, lower will be the variability. For cotton, temperature has positive significant effect and precipitation square is significant. Both precipitation and temperature are risk-increasing factors as their coefficients in the variance function are positive and significant. In the case of groundnut crop, temperature and temperature-square have significant coefficients. Since the coefficient of precipitation in the variance function is negative, it is a risk-decreasing factor. However, temperature is a risk-increasing variable for groundnut. For all three crops, trend has a positive significant effect, implying technological advancements. Interaction between precipitation and temperature is not significant for any of the three crops. Out of the two climatic variables, temperature has been significantly contributing towards mean and variance for all the three crops.

Table 5. Just-Pope function parameters for chillies, cotton and groundnut

	Chillies		Cotton		Groundnut	
Mean Yield	Coefficient	Std. Error	Coefficient	Std.Error	Coefficient	Std. Error
Precipitation(R)	1.26	16.43	-0.31	2.48	-11.76	8.11
Temperature (T)	-4550.5190***	1595.18	1642.90**	814.41	2685.46**	1461.20
Trend(year)	77.02***	7.16	7.19***	1.30	25.13***	2.27
R^2	0.0002	0.001	0.006**	0.000	-0.0001	0.000
T^2	80.03***	32.32	-30.08	15.43	-53.97***	15.32
R x T	-0.065	0.54	0.01	0.08	0.42	0.27
Nalgonda	183.36	246.84	-161.0456***	43.12	-284.91**	109.62
Khammam	958.67***	155.63	-99.83**	40.39	-74.35	70.05
Krishna	925.11***	154.65	-9.51	40.83	-16.53	79.72
Guntur	1607.05***	177.57	107.54***	42.59	83.63	70.40
Constant	65400.22	109211.80	-22254.53	20296.92	-31988.28	78422.93
Variability in Yield						
Precipitation (R)	- 0.002***	0.001	0.0016***	0.001	-0.0009	0.001
Temperature (T)	- 0.76	0.47	0.95***	0.46	0.15	0.45
Trend	0.03*	0.02	-0.05**	0.01	0.12	0.02
Nalgonda	0.39	0.64	-0.79	0.66	-0.64	0.55
Khammam	0.45	0.53	-1.08**	0.52	-2.49***	0.43
Krishna	0.47	0.52	-0.43	0.44	-1.399**	0.47
Guntur	1.22***	0.43	0.25	0.38	-1.25***	0.40
Constant	35.11	13.84	-17.84	13.36	6.49	12.95
Likelihood Function	-1167.2	- 907.2	-1026.3			

Table 6 presents the climate change impact on the three crops. The percentage of loss in chilli yield is smaller for the first scenario in all the districts. During the mid-century, the maximum loss is likely to be about 24 percent for Khammam followed by 18.8 percent for Guntur. Overall, the variability in yield of chilli will be around 335 kg. Surprisingly, for the scenario 4.1°C/17.8 per cent, variability in yield seems to decrease while the increase in percentage loss is only marginal. For cotton crop, Khammam and Guntur will suffer equally, with a percentage loss in yield of around 36 percent during mid-century.

Table 6. Climate change impact on chillies, cotton and groundnut crops

Crop	Climate Change-Scenario		Nalgonda	Khammam	Krishna	Guntur	Prakasam	Overall
	Normal yield		2,415	4,145	3,696	4,845	2,739	3,568
Chillies	Mid-century 2.05^{0}C/13.6 percent	MC-Predicted yield	2,272	3,163	3,170	3,933	2,314	2,947
		% Loss *	5.9	23.7	14.2	18.8	15.5	17.4
		SD	484	272	285	426	253	335
	End-century 4.1^{0}C/17.8 percent	EC-Predicted yield	1,901	3,098	3,148	3,991	2,345	2,867
		% Loss	21.3	25.2	14.8	17.6	14.4	19.7
		SD	210	117	123	185	110	145
		Normal Yield	302	419	490	625	377	442
Cotton	Mid-century 2.05^{0}C/13.6 percent	MC-Predicted yield	315	266	330	397	301	332
		% Loss	-4.2	36.4	32.7	36.4	20.2	25.1
		SD	93	153	210	301	243	183
	End-century 4.1^{0}C/17.8 percent	EC-Predicted yield	208	155	217	283	187	220
		% Loss	31.3	63.0	55.6	54.6	50.4	50.3
		SD	100	166	226	325	261	198
Groundnut	Mid-century 2.05^{0}C/13.6 percent	Normal Yield	923	1,471	2,357	2,325	2,080	1,831
		MC-Predicted yield	1,341	1,570	1,545	1,507	1,393	1,483
		% Loss	-45.2	-6.7	34.4	35.2	33.1	19.1
		SD	808	315	566	646	1229	647
	End-century 4.1^{0}C/17.8 percent	EC-Predicted yield	892	1,104	992	822	679	913
		% Loss	3.4	25.0	57.9	64.7	67.4	50.2
		SD	935	364	654	748	1423	749

Note: Yield and Standard Deviations are in kg ha^{-1}

* % loss in base/normal yield; MC-Mid-Century;EC-End-Century;SD-Std.Deviation

The variability in cotton yield will average around 183 kg during this period. The percentage loss at end-century is likely to be much higher in all the districts, with the highest loss of 63 percent for Khammam district. For groundnut crop also, the predictions are similar. Nalgonda and Khammam may experience an increase in productivity during the mid-century, while other districts will experience losses of around 35 percent in yield. Variability in yield will most likely be highest for Prakasam with an overall variability of around 647 kg. The percentage loss is likely to be much higher at the end of the century, varying from 3.4 to 67.4. Nalgonda district may experience the least loss and Prakasam district the maximum loss. The variability in yield is likely to increase considerably during this period. The average variability in yield is predicted to be 749kg. In summary, it may be concluded that climate change will have considerable impact on all three major crops in the selected five districts. The predicted losses at the end-century scenario are higher than those at mid-century. Variability in yield may also increase during the latter period.

CONCLUSIONS

Climate change impacts will, in the long run, reduce rice production in the Nagarjuna Sagar Project districts by 11-30% in *kharif* and 20-40% in *rabi* seasons. The expected losses could be also high for chilli, cotton and groundnut during mid and end-centuries. Water is the key long-term constraint in rice production and land currently under fallow due to water scarcity will be a key issue to address in the future. By implementing various water- and labour-saving technologies in rice and commercial crops, one can minimize the reduction in yield by 20% to 25% during the mid- and end-century periods, and these technologies will also help to minimize water use as well.

REFERENCES

Aggarwal, P.K., Palanisami, K., Khanna, M and Kakumanu, K.R. 2012. Climate change and food security of India: Adaptation strategies for the irrigation sector. World Agriculture. 3(1):pp.20-26.

Bahadur, J and Ranganathan, C.R. 2009. Quantifying the impact of climatic change on yields and yield variability of major crops and optimal land allocation for maximizing food production in different agro-climatic zones of Tamil Nadu, India: An econometric approach. Working Paper. Research Institute for Humanity and Nature. Kyoto, Japan.

Barnwal, P and Kotani, K. 2010. Impact of variation in climatic factors on crop yield: A case of rice crop in Andhra Pradesh, India. Economics and Management Series. 17. Minamiuonuma: International University of Japan.

Conway, G. 2009. The science of climate change in Africa: Impacts and adaptation. Discussion Paper No. 1. London, UK: Imperial College.

Cruz R.V., Harasawa, H., Lal, M., Wu, S., Anokhin, Y., Punsalma, B., Honda, Y., Jafari M., Li, C and Huu, N. 2007. Asia climate change 2007, impacts, adaptation and vulnerability. In: Contribution of working group II to the fourth assessment report of the Intergovernmental Panel on Climate Change. Parry, M.L., Canziani, O.F., Palutikof, J.P., Van der Linden and Hanson, C.E. (Eds.), Cambridge: Cambridge University Press. pp. 469-506.

Gosain, A.K and Rao, Sandhya. 2012. Analysis of climate scenarios in the Godavari river basin. In: Water and climate change: An integrated approach to address adaptation challenges. Nagothu, U.S., Gosain, A.K and Palanisami, K. (Eds.). Macmillan Publishers India Ltd, New Delhi. pp.59-79.

Irrigation and Command Area Development Department, Government of Andhra Pradesh (I&CAD, GoAP). 2009. Water use efficiency studies - Nagarjuna Sagar Project. In: Edition by Irrigation and Command Area Development Department, Government of Andhra Pradesh. pp.36.

Intergovernmental Panel on Climate Change(IPCC). 2007. Climate change 2007- The physical science basis. Solomon, S., D. Qin, M., Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (Eds.), Contribution of working Group I to the fourth assessment report of the Intergovernmental Panel on Climate Change. Cambridge, United Kingdom and New York, USA. Cambridge University Press.Vol(4):102.

Kelkar, U and Bhadwal, S. 2007. South Asian regional study on climate change impacts and adaptation: Implications for human development. Occasional Paper. Human Development Report Office. New Delhi: United Nations Development Programme. pp:48-62.

Knox, J.W., Hess, T.M., Daccache, A and Perez Ortola, M. 2011. What are the projected impacts of climate change on food crop productivity in Africa and South Asia? DFID Systematic Review, Final Report. Cranfield, UK: Cranfield University.pp:66-68.

Nelson, G., Rosegrant, M., Koo, J., Robertson, R., Sulser, T., Zhu, T., Ringler, C., Msangi, S., Palazzo, A., Batka, M., Magalhaes, M., Valmonte-Santos, R., Ewing, M and Lee, D. 2009. Climate change: Impact on agriculture and costs of adaptation. International Food Policy Research Institute, Washington, DC.

Palanisami, K., Ranganathan, C.R., Kakumanu, K.R and Udaya, S.N. 2011. A hybrid model to quantify the impact of climate change on agriculture in Godavari river basin. Energy and Environment Research.1(1): 32–52.

Palanisami, K., Ranganathan, C. R., Senthinathan, S and Aggarwal, P. K. 2009. Impact of climate change on crop production in Tamilnadu using Ricardian Approach. In: Global Climate Change and Indian Agriculture. Indian Council of Agricultural Research, New Delhi. pp. 19-23.

Sultana, H and Ali, N. 2006. Vulnerabiltiy of wheat production in different climatic zones of Pakistan under climate change scenarios using CSM-CERES-Wheat model. Paper presented in The Second International Young Scientists Global Change Conference. Beijing, 7-9 November, 2006.

United Nations Environment Programme(UNEP). 2007. GEO yearbook 2007. An overview of our changing environment. Nairobi: UNEP. pp.86.

J.Res. ANGRAU 45(1) 58-63, 2017

IMPACT OF FARMER FIELD SCHOOLS ON PROFITABILITY OF THE PARTICIPANT AND NON-PARTICIPANT RICE FARMERS

G.K. SIDDESWARI, V. SAILAJA, P.V. SATYA GOPAL AND S.V. PRASAD

Department of Agricultural Extension, S.V. Agricultural College,

Acharya N.G. Ranga Agricultural University, Tirupati-517 502

Date of Receipt: 24.11.2016 Date of Acceptance: 02.1.2017

ABSTRACT

The present study was carried out in Nellore district of Andhra Pradesh state during 2014-15 to study the profitability levels and factors influencing the profitability levels of the participant and non-participant farmers of rice FFS. A total of 150 respondents were selected for the study out of which 75 farmers were participant farmers of rice FFS and the other 75 were non-participants. The results of the study revealed that 57.33 per cent of the participant farmers were having medium level of profitability followed by high (38.67%) and low (4.00%) levels. In case of non-participant farmers 41.33 per cent of the respondents were having medium level of profitability, followed by low (30.67%) and high (28.00%) levels. The profile of the respondents *viz.*, education, social participation, mass media exposure, extension contact, innovativeness, scientific orientation, achievement motivation and management orientation were found to be positively significant with the level of profitability of participant and non-participants. Further, all the selected 12 independent variables put together explained about 77.20 per cent variation in the profitability levels of the participant farmers of rice FFSs and, whereas, in case of non-participant farmers it was found 69.40 per cent. The independent sample't' test showed that there is significant (p value < 0.01) difference between participant and non-participant farmers with regard to their profitability levels. The results of Chi square test revealed that there is significantassociation (p value<0.01) between the 'participation in FFS' and the 'levels of profitability' on recommended ICM practices.

INTRODUCTION

Agriculture in India plays a major role in the economic development. It provides livelihood to the majority of the population in India. The scenario of Indian agriculture has changed drastically after first green revolution in 1960 and Indian farmer is using wide ranges of chemical pesticides to limit the losses from pests and diseases. The crop yields are not increasing as expected even though the cost of cultivation is increased many folds due to indiscriminate use of inputs resulting in poor quality of produce leading to poor returns.

Use of chemical pesticides for control pests and diseases have been increasing day by day leading to increasing the cost of cultivation and poor quality of produce, resulting less market price and less returns. Declining productivity and increasing production costs are affecting the economic sustain¬ability of farming community thereby compromising the only source of income for millions of people.

A necessary step to improving profitability is to cut the costs of production. To overcome these problems Indian government has been introduced innovative extension systems, which conceptualizes the transfer of technology as a social process based on adaptation and innovation by the users. The best example of participatory research and extension that engages researchers, extensionists and as well as farmers in the field for on-site experimentation is the Farmer Field School (FFS), as it involves Integrated Crop Management (ICM) and Integrated Pest Management (IPM) practices for achieving profitable yields with low cost of cultivation. So far a limited research was done on FFS programme and also the Department of Agriculture organized more number of Farmer Field Schools on rice in Nellore district, an attempt was made to study the impact of FFS programme in terms of profitability of the participant and non- participant farmers of rice FFS.

MATERIAL AND METHODS

Based on the objective of the study, *ex-post-facto* research was followed in the present study. Nellore district of Andhra Pradesh was purposively selected as rice is extensively cultivated and Farmer Field School on Integrated Crop Management (ICM)

E-mail: siddu.gk18@gmail.com

was also being successfully implemented in this district. Out of 46 mandals, three mandals were purposively selected based on the highest number of FFS on rice were conducted. Two villages *i.e.* one FFS village and another non-FFS village were selected randomly from each selected mandal, thus, making a total of six villages of which three were FFS and three non-FFS villages. From each FFS and non-FFS selected villages, 25 respondents were selected by using simple random sampling procedure, thus making a total of 150 respondents for the study of which 75 farmers were FFS rice farmers and the other 75 were non-FFS rice farmers.

Table 1. Selection of mandals, villages and respondents from Nellore district

S.No.	Mandal	FFS		Non-FFS	
		Village	No. of respondents	Village	No. of respondents
1.	Kovur	Jammipalem	25	Leguntapadu	25
2.	Kodavalur	Reddipalem	25	Kodavalur	25
3.	Buchireddypalem	Vavveru	25	Nagamambapuram	25
		Total	**75**		**75**
		Grand Total	**150**		

Profitability was operationally defined as net income obtained by the respondent from the unit area in the rice crop. Operations which were taken in production of rice were listed from field preparation to harvest and cost involved in each operation was taken from each of the respondent. The sum of all these operations costs constitutes the cost of cultivation. To obtain profitability, the cost of cultivation was subtracted from gross returns.

Gross returns (Rs.) = Per ha yield of rice (in kgs) X Market price (Rs.)

Net returns (Rs.) = Gross returns (Rs.ha^{-1}) – Total operational cost (Rs. ha^{-1})

The respondents were categorized as low, medium and high profitability category based on mean (X) and standard deviation (SD).

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

RESULTS AND DISCUSSION

A perusal of Table 2 reveals that more than half (57.33%) of the participant farmers had medium level of profitability, followed by high (38.67%) and low (4.00%) levels. In case of non- participant farmers, 41.33 per cent of the respondents had medium level of profitability followed by low (30.67%) and high (28.00%) levels.

Table 2. Distribution of respondents according to their profitability levels

S. No.	Category	Participant farmers (N_1=75)		Non-Participant farmers (N_2=75)	
		Frequency	Percentage	Frequency	Percentage
1.	Low profitability	3	4.00	23	30.67
2.	Medium profitability	43	57.33	31	41.33
3.	High profitability	29	38.67	21	28.00
	Total	75	100.00	75	100.00
	Mean	56,151.67 (Rs.ha^{-1})		40,168.12 (Rs.ha^{-1})	
	SD	5004.00		10,405.07	

From the above results it could be inferred that the profits obtained by the participant farmers of rice FFS were substantially higher than that of non-participant farmers. Adoption of recommended cultivation practices of rice including Integrated Nutrient Management (INM) and Integrated Pest Management (IPM) by the participant farmers results in low cost of cultivation with higher yields. Hence, the above trend of medium to high economic returns by the majority of participant farmers of rice FFS was observed. These results were in line with the findings of Vandenberg (2002), Mankar (2003), Kumar (2004) and Yeshwanth (2008).

Relationship between the selected profile with the profitability of the participant and non-participant farmers of rice FFSs

In order to study the nature of relationship between the selected profile with the profitability of recommended ICM practices by the participant and non-participant farmers of rice FFSs, correlation co-efficient ('r' value) was computed and the values were presented in Table 3.

Table 3. Correlation coefficient between the selected profile with the profitability levels of the participant and non-participant farmers

S.No.	Variable	Participant farmers (N_1=75)	Non-participant farmers (N_2=75)
		Correlation co-efficient('r' value)	Correlation co-efficient ('r' value)
X_1	Age	0.095 NS	-0.349**
X_2	Education	0.680**	0.579**
X_3	Land holding	0.051 NS	-0.040 NS
X_4	Farming experience	0.018 NS	-0.338**
X_5	Social participation	0.420**	0.338**
X_6	Mass media exposure	0.547**	0.497**
X_7	Extension contact	0.721**	0.534**
X_8	Innovativeness	0.678**	0.468**
X_9	Scientific orientation	0.715**	0.645**
X_{10}	Achievement motivation	0.506**	0.349**
X_{11}	Management orientation	0.586**	0.426**
X_{12}	Economic orientation	0.535**	0.223 NS

* Significant at 0.05 level of probability ** Significant at 0.01 level of probability NS-Non-significant

The r values in the Table 3 indicated that education (0.680**), social participation (0.420**), mass media exposure (0.547**), extension contact (0.721**), innovativeness (0.678**), scientific orientation (0.715**), achievement motivation (0.506**), management orientation (0.586**) and economic orientation (0.535**) were found significant at 1 per cent level of significance. Whereas, age (0.095), land holding (0.051) and farming experience (0.018) were found non-significant with profitability of participant farmers of rice FFS.

In case of non-participant farmers the r values in Table 3 indicated that education (0.579**), social participation (0.338**), mass media exposure (0.492**), extension contact (0.534**), innovativeness (0.468**), scientific orientation (0.645**), achievement motivation (0.349**) and management orientation (0.426**) were found significant at 1 per cent level of significance. Whereas, age (-0.349**) and farming experience (-0.338**) were found negative and significant at 1 per cent level of significance, economic orientation was exhibited non- significant (0.223) and land holding was found negative and non-significant (-0.040) relationship with the profitability of ICM practices.

Further, in order to study the combined effect of all the independent variables in explaining variation in levels of profitability on recommended ICM practices by the participant and non-participant farmers of rice FFS, Multiple Linear Regression (MLR) analysis was carried out. The computed co-efficient of determination (R2) and partial regression co-efficient (b) values with their corresponding't' values were presented in Table 4. The R2 and 'b' values were tested statistically for their significance.

The 'R^2' value of 0.772 which depicted that all the selected thirteen independent variables put together explained about 77.20 per cent variation in the profitability of the participant farmers of rice FFSs.

Table 4. Multiple Linear Regression analysis of the selected independent variables with the profitability of the participant and non-participant farmers of rice FFSs

S.No.	Variable	Participant farmers (N_1=75)				Non-Participant farmers (N_2=75)			
		Std. error	'b' value	't' value	'P value'	Std. error	'b' value	't' value	'P' value
X_1	Age	17.419	4.519	0.259NS	0.796	64.859	-57.573	-0.888NS	0.378
X_2	Education	123.693	332.698	2.690**	0.009	207.746	356.447	1.716NS	0.091
X_3	Land holding	35.189	-32.914	-0.935NS	0.353	175.445	39.423	0.225NS	0.823
X_4	Farming experience	15.839	7.520	0.475NS	0.637	60.071	34.216	0.570NS	0.571
X_5	Social participation	73.789	88.061	1.193NS	0.237	189.085	144.353	0.763NS	0.448
X_6	Mass media exposure	85.764	3.563	0.042NS	0.967	121.292	237.253	1.956*	0.055
X_7	Extension contact	86.198	308.795	3.582**	0.001	97.893	155.455	1.588NS	0.117
X_8	Innovativeness	72.074	192.427	2.670**	0.010	85.621	146.204	1.708NS	0.093
X_9	Scientific orientation	86.012	130.208	1.514NS	0.135	132.614	550.569	4.152**	0.000
X_{10}	Achievement motivation	63.018	-103.588	-1.644NS	0.105	76.051	12.794	0.168NS	0.867
X_{11}	Management orientation	109.546	-174.011	-1.588NS	0.117	46.573	86.216	1.851NS	0.069
X_{12}	Economic orientation	72.915	2.034	0.028NS	0.978	95.778	150.131	1.567NS	0.122

R^2 = 0.772 ; R^2 = 0.694

* Significant at 5% level of probability ** Significant at 1% level of probability NS-Non-significant

The partial regression coefficients presented in Table 4 further revealed that the independent variables *viz.*, education, extension contact and innovativeness were found positively significant at as evident from their significant't' values. This implied that education, extension contact and innovativeness have contributed to most of the variation in the profitability of the participant farmers of rice FFSs.

The 'R^2' value of 0.694 which depicted that all the selected thirteen independent variables put together explained about 69.40 per cent variation in the profitability of the participant farmers of rice FFSs. The partial regression coefficients presented in Table 4 further reveals that the independent variables social participation and scientific orientation were found positively significant at as evident from their significant 't' values. This implied that mass media exposure and scientific orientation have contributed to most of the variation in the profitability of the non-participant farmers of rice FFSs.

Difference in profitability levels of participant and non-participant farmers

Independent sample't' test was carried out to assess the significant mean difference between the participant and non-participant farmers with regard to their profitability levels.

Table 5. Difference in profitability levels of participant and non-participant farmers

Dependent variable	Type of farmer	N	Mean (Rs. ha^{-1})	Std. Deviation	t value	P value
Profitability	Participant farmers	75	56,151.67	5004.00	11.989**	0.000
	Non-participant farmers	75	40,168.12	10405.07		

** Significant at 0.01 level of probability

It is clear from the Table 5 that the average profitability of participant farmers was Rs.56,151.67 ha^{-1} with standard deviation 5004.00 whereas the average profitability of non- participant farmers was Rs.40,168.12 ha^{-1} with standard deviation 10,405.07 and the 't' value was 11.989. The above results indicated that (p value < 0.01) there was significant mean difference between the participant and non-participant farmers with regard to their profitability at 1 per cent level.

Association between participation in FFS and the profitability levels

Chi square test was carried out to know the significant association between the profitability levels and participation of farmers in FFS.

Table 6. Association between participation in FFS and the profitability levels

Type of farmer	Profitability			Total	Chi – square value	P value
	Low	Medium	High			
Participant farmers	3 (4.0%)	43 (57.3%)	29 (38.7%)	75 (100.0%)	18.611**	0.000
Non-participant farmer	23 30.7%)	31 (41.3%)	21 (28.0%)	75 (100%)		
Total	26(17.3%)	74(49.3%)	50(33.33%)	150(100.0%)		

** Significant at 0.01 level of probability

The figures mentioned in parentheses indicate percentages

It is evident from Table 6 that there was significant association between the profitability level and participation of farmers in FFS at 1% level since p value (0.000<0.01) for the corresponding chi square value 18.611, which means that there is significant influence of ‘participation of farmers in FFS on profitability levels.

CONCLUSIONS

The results of the study showed that there is significant difference in the profitability levels of FFS participant farmers and non-participant farmers with respect to ICM practices in rice. The knowledge acquired during the learning process in Farmer Field School enables farmers to adapt the existing technologies which were more productive, profitable and responsive to changing conditions. Further, testing and adoption of new technologies developed their ability to make critical decisions that will render their crop production systems more productive, profitable and sustainable. The Department of Agriculture (DoA) has brought a positive change in the behaviour of the farmers of the study area through FFS approach. It has increased the profitability of the rice farmers. FFS methodology is an effective extension tool to enhance profitability of rice farmers by adopting the recommended Integrated Crop Management (ICM) practices.

REFERENCES

Kumar, R. 2004. Economics of integrated pest management in rice in Bihar. Proceedings on Integrated Pest Management in Indian Agriculture. National Centre for Agricultural Economics and Policy Research. New Delhi. 11:185-194.

Mankar, D.M. 2003. A study on knowledge of gram panchayat members about improved agricultural technologies and their role performance in Konkan Region of Maharastra. Ph.D Thesis submitted to University of Agricultural Sciences, Dharwad.

Vandenberg, H. 2002. The potential for farmer field research in Tropical Asia. International learning work shop on Farmer Field School: Emerging issues and challenges. Yogyakarta, Indonesia. pp.21-25.

Yeshwanth, L.G. 2008. A study on knowledge and adoption of Integrated Crop Management (ICM) practices by the participants of Farmer Field School (FFS) in Bellary district. M.Sc.Thesis submitted to University of Agricultural Sciences, Dharwad.

J.Res. ANGRAU 45(1) 64-70, 2017

KNOWLEDGE MAPPING ON COTTON (*Gossypium herbaceum* L.) PRODUCTION TECHNOLOGIES OF THE FARMERS OF KARIMNAGAR DISTRICT IN TELANGANA STATE

N. VENKATESHWAR RAO, P.K. JAIN, N. KISHORE KUMAR and M. JAGAN MOHAN REDDY

Krishi Vigyan Kendra, Jammikunta, Karimnagar District – 505 122

Date of Receipt: 29.11.2016 Date of Acceptance:27.12.2016

ABSTRACT

The present paper highlights the knowledge levels of farmers on cotton production technologies in Karimnagar district of Telangana State (Formerly Andhra Pradesh state). *Ex-post facto* research design was adopted for the study and the study was conducted during the year 2014.Total ninety (90) farmers were selected for the study of cotton crop knowledge mapping. High level of knowledge of cotton production technologies is observed among the adopted farmers of *KVK* compared to the non adopted farmers.

INTRODUCTION

Knowledge is key ingredient in application of any technology. It reflects an array of information possessed by an individual. It plays a pivotal role in understanding the intricacies involved in any given phenomena. The *Krishi Vigyan Kendra* (*KVK*)s are rendering a great help to the farmers in increasing the level of knowledge on various crops, these institutions conducting different programmes to enlighten the farmers on various crop production technologies. Being the cotton is one of the main crops of Karimnagar district the present paper focuses on knowledge mapping of the farmers on cotton production technologies in Karimnagar district.

MATERIAL AND METHODS

Ex-post facto research design combined with exploratory type of research design was used for the present study conducted during the year 2014 as the selected phenomena have already occurred and the researcher had no control over the same.15 adopted villages of *KVK*, Jammikunta were selected for the study. A sample of 60 cotton growing farmers who are adopting the *KVK* technologies and 30 cotton farmers who are not covered under *KVK* production technologies were selected from the adopted villages. A schedule was developed with 26 technologies to assess the knowledge levels of the cotton growing farmers which is measured on two point continuum *i.e.* yes and no, with the scores of 2,1 respectively.

Accordingly, the respondents were grouped on the basis of frequency and percentage.

RESULTS AND DISCUSSION

Level of knowledge on cotton production technologies of the farmers

Distribution of farmers in terms of level of knowledge of cotton production technologies

Table 1. Distribution of respondents according to their level of knowledge

Category	*KVK* adopted cotton farmers (N=60)			*KVK* non adopted cotton farmers (N=30)		
	Low (26- 34)	Medium(35–43)	High (44 -52)	Low (26- 34)	Medium(35–43)	High (44 -52)
Frequency	14	19	27	16	12	02
Percentage	23.33	31.67	45.00	53.33	40.00	6.67

E-mail: neelamrao2000@gmail.com

It was observed from Table 1 that majority (45.00%) of the *KVK* adopted cotton farmers had high level of knowledge followed by medium (31.67%) and low (23.33%) whereas, majority (40.00%) of the non-adopted farmers of *KVK* had medium level of knowledge followed by low (53.33%) and high (6.67%).These findings are in line with the results of Prashanth(2011) and Rao *et al.* (2012).

Table 2. Comparision between *KVK* adopted and non adopted cotton farmers in terms of level of knowledge

S. No.	Respondent category	Size of the sample(N)	Mean	S.D.	'Z' value
1.	*KVK* adopted farmers	60	51.25	1.00	5.32*
2.	Non adopted farmers	30	33.36	2.35	

* Significant at 0.01 level of probability

It is evident from the Table 2 that calculated 'Z' Value (5.32) was greater than table 'Z' value at 0.01 level of probability. Hence, the null hypothesis was rejected and it could be concluded that there exists a significant difference between mean scores of *KVK* adopted and non adopted farmers.

Table 3. Item wise analysis of adopted farmers on level of knowledge of cotton production technologies

N=60

S.No.	Cotton production technologies	Level of Knowledge				Total score	Mean score	Rank
		Yes		No				
		f	%	f	%			
1	Soil samples are collected up to 15-20cm depth in 'V' shape for soil testing	57	95.0	3	5.0	117	1.95	III
2	Soil test based fertilizer application is economical	57	95.0	3	5.0	117	1.95	III
3	Seed treatment with *Trichoderma viridi* @ 8 gm kg^{-1} reduces wilt incidence	54	90.0	6	10.0	114	1.90	IV
4	Closer spacing in Bt cotton increases the yields	60	100.0	0	0.0	120	2.00	I
5	Sowing of refugee crop around the main crop is essential to sustain the Bt technology	52	86.7	8	13.3	112	1.86	VI
6	Application of *Trichoderma viridi* culture (2 kg *Trichoderma viridi* in 100 Kg FYM) at the time of sowing under optimum moisture conditions will reduce wilt incidence	58	96.7	2	3.3	118	1.96	II
7	Recommended DAP fertilizer is applied as basal to improve the yields in Bt cotton	53	88.3	7	11.7	113	1.88	V
8	Recommended dose of urea and potash fertilizers applied with equal doses at 20,40,60 and 80 DAS increases the yields	53	88.3	7	11.7	113	1.88	V

Contd........

S.No.	Cotton production technologies	Level of Knowledge				Total score	Mean score	Rank
		Yes		No				
		f	%	f	%			
9	Stem application with monocrotophos @1:4 with water at 20,40 and 60 days effectively controls sucking pests and improves natural enemy population	60	100.0	0	0.0	120	2.00	I
10	Spraying of quizolofop ethyl 400 ml and pyrithiobac sodium 250 ml in 200 l of water reduces all the weeds	48	80.0	12	20.0	108	1.80	IX
11	Spraying 2% potassium nitrate at flowering and boll formation stages increases the yields	53	88.3	7	11.7	113	1.88	V
12	Bt cotton crop period is less. After Bt cotton cultivation of maize, sesamum and other pulses increases the net returns	58	96.7	2	3.3	118	1.96	II
13	Installation of yellow sticky traps reduces the white fly incidence	42	70.0	48	30.0	102	1.70	X
14	Use of micronutrients is as important as the use of NPK	50	83.3	10	16.7	110	1.83	VIII
15	Providing irrigation at critical stages is important for achieving higher yields.	55	91.6	5	8.4	115	1.90	IV
16	Installation of pheromone traps is good for monitoring of pests	50	83.3	10	16.7	110	1.83	VIII
17	Boll guard II is tolerant for both *Helicoverpa and Spodoptera*	60	100.0	0	0.0	120	2.00	I
18	Fertigation in drip increases yields with less water	50	83.3	10	16.7	110	1.83	VIII
19	Mono cropping of cotton increases the pest & diseases	51	85.0	9	15.0	111	1.85	VII
20	Application of pesticides based on ETL levels is economical	51	85.0	9	15.0	111	1.85	VII
21	Foliar spraying of urea 2%, 19:19:19 1% and potassium nitrate 1% facilitates early recovery of plants under stress conditions	58	96.7	2	3.3	118	1.96	II
22	Soil drenching with COC @ 3 gm l^{-1} of water or carbendezim @ 1 g l^{-1} of water reduces wilt incidence	58	96.7	2	3.3	118	1.96	II
23	Growing of trap crops is good for monitoring of pests	53	88.3	7	11.7	113	1.88	V
24	Spraying of 5% NSKE controls the hatching of insect eggs and 1st instar larvas	53	88.3	7	11.7	113	1.88	V
25	Poison bait is effective for spodoptera control	58	96.7	2	3.3	118	1.96	II
26	Drip irrigation reduces the water usage and facilitates good crop growth and higher yields	50	83.3	10	16.7	110	1.83	VIII

Table 4. Item wise analysis of non adopted farmers on level of knowledge of cotton production technologies **N=30**

S.No.	Cotton production technologies	Level of Knowledge				Total score	Mean score	Rank
		Yes		No				
		f	%	f	%			
1	Soil samples are collected up to 15-20cm depth in 'V' shape for soil testing	15	50.0	15	50.0	45	1.50	VI
2	Soil test based fertilizer application is economical	15	50.0	15	50.0	45	1.50	VI
3	Seed treatment with *Trichoderma viridi* @ 8 gm kg^{-1} reduces wilt incidence	20	66.6	10	33.3	50	1.66	V
4	Closer spacing in Bt cotton increases the yields	25	83.3	5	16.7	55	1.83	II
5	Sowing of refugee crop around the main crop is essential to sustain the Bt technology	20	66.6	10	33.3	50	1.66	V
6	Application of *Trichoderma viridi* culture (2 kg *Trichoderma viridi* in 100 Kg FYM) at the time of sowing under optimum moisture conditions will reduce wilt incidence	22	73.3	8	26.7	52	1.73	IV
7	Recommended DAP fertilizer is applied as basal to improve the yields in Bt cotton	20	66.6	10	33.4	50	1.66	V
8	Recommended dose of urea and potash fertilizers applied with equal doses at 20, 40,60 and 80 DAS increases the yields	22	73.3	8	26.7	52	1.73	IV
9	Stem application with monocrotophos @1:4 with water at 20,40 and 60 days effectively controls sucking pests and improves natural enemy population	25	83.3	5	16.7	55	1.83	II
10	Spraying of quizolofop ethyl 400 ml and pyrithiobac sodium 250 ml in 200 l of water reduces all the weeds	15	50.0	15	50.0	45	1.50	VI
11	Spraying 2% potassium nitrate at flowering and boll formation stages increases the yields	15	50.0	15	50.0	45	1.50	VI
12	Bt cotton crop period is less. After Bt cotton cultivation of maize, sesamum and other pulses increases the net returns	25	83.3	5	16.7	55	1.83	II
13	Installation of yellow sticky traps reduces the white fly incidence	15	50.0	15	50.0	45	1.50	VI

Contd........

S.No.	Cotton production technologies	Level of Knowledge				Total score	Mean score	Rank
		Yes		No				
		f	%	f	%			
14	Use of micronutrients is as important as the use of NPK	10	33.3	20	66.7	40	1.33	VII
15	Providing irrigation at critical stages is important for achieving higher yields.	24	80.0	6	20.0	54	1.80	III
16	Installation of pheromone traps is good for monitoring of pests	10	33.3	20	66.7	40	1.33	VII
17	Bollguard II is tolerant for both	27	90.0	3	10.0	54	1.88	I
18	Fertigation in drip increases yields with less water	20	66.6	10	33.4	50	1.66	V
19	Mono cropping of cotton increases the pests & diseases	27	90.0	3	10.0	54	1.88	I
20	Application of pesticides based on ETL levels is economical	20	66.6	10	33.4	50	1.66	V
21	Foliar spraying of urea 2%, 19:19:19 1% and potassium nitrate 1% facilitates early recovery of plants under stress conditions	22	73.3	8	26.7	52	1.73	IV
22	Soil drenching with COC @ 3 gm l^{-1} of water or carbendezim @1 gm l^{-1} of water reduces wilt incidence	20	66.6	10	33.4	50	1.66	V
23	Growing of trap crops is good for monitoring of pests	20	66.6	10	33.4	50	1.66	V
24	Spraying of 5% NSKE controls the hatching of insect eggs and 1st instar larvas	15	50.0	15	50.0	45	1.50	VI
25	Poison bait is effective for spodoptera control	20	66.6	10	33.4	50	1.66	V
26	Drip Irrigation reduces the water usage and facilitates good crop growth and higher yields	20	66.6	10	33.4	50	1.66	V

Table 3 shows the item analysis of the KVK adopted farmers on level of knowledge possessed by them on cotton technologies. It can be noted from the Table 3 that ranks were assigned to all the technologies based on the total score obtained on each technology. The technologies on which the respondents had high level of knowledge are closer spacing, stem application with monocrotophos to control sucking pests, bollguard II tolerant for both *Helicoverpa* and *Spodoptera* ranked 1st followed by application of Trichoderma viridi culture to reduce wilt incidence, growing of second crop after Bt cotton under irrigated conditions , foliar spray with water soluble fertilizers under stress conditions, soil drenching with COC to reduce wilt incidence and Poison bait is effective for spodoptera control (2nd), soil sample collection, soil test based fertilizer application (3rd), seed treatment, providing irrigation at critical stages(4th), usage of recommended fertilizers, growing of trap crops, spraying of NSKE(5th), sowing of refugee crop(6th), respectively. The *KVK* adopted farmers had lowest level of knowledge on installation of yellow sticky traps and pheromone traps. Whereas, non adopted farmers (Table 4) had high level of knowledge on practices like boll guard II tolerant for both Helicoverpa and Spodoptera and mono cropping increases pest and disease incidence ranked 1st followed by closer spacing, stem application with monocrotophos to reduce sucking pest complex, growing of second crop after Bt cotton under irrigated conditions (2nd), providing irrigation at critical stages (3rd), wilt management with *Trichoderma viridi*, usage of recommended fertilizers, (4th), seed treatment, sowing of refugee crop, fertigation, growing of trap crops, poison bait for spodoptera control (5th), soil test based fertilizer application, spraying of post emergence herbicides, installation of yellow sticky traps (6th), mono cropping of cotton increases the pest and diseases, application of pesticides based on ETL levels is more economical (7th), use of micronutrients is as much important as the use of NPK, installation of pheromone traps is good for monitoring of pests, fertigation in drip increases yields with less water, drip Irrigation reduces the water usage and facilitates good crop growth and higher yields (8th), spraying of quizolofop ethyl 400 ml and pyrithiobac sodium 250 ml in 200 lt of water reduces all the weeds (9th) and installation of yellow sticky traps reduces the white fly incidence (10th) rank, respectively.

The item wise analysis indicates that adopted cotton farmers had high level of knowledge on closer spacing, stem application with monocrotophos for sucking pest management, cultivation of boll guard II hybrid, practicing the application of *Trichoderma viridi* culture against the wilt incidence, taking up of second crop after Bt cotton under irrigated conditions, taking of foliar spray with water soluble fertilizers under stress conditions, soil drenching with C.O.C. for wilt control, poison bait against spodoptera, collecting the soil samples, soil test-based fertilizer application, etc. The reasons could be the existing technologies have been assessed and tried to refine and address the local problems and demonstrated and disseminated for best application by the farmers. This exercise has been evaluated by the *KVK* scientists for better adoption of the above technologies. Hence, the farmers had high knowledge on all these said technologies. Whereas, the adopted farmers had lowest level of knowledge on usage of yellow sticky traps and pheromone traps due to non availability of these inputs in local market.

Whereas, the non-adopted cotton farmers had high level of knowledge on cultivation of boll guard II hybrid, closer spacing, stem application against sucking pests, taking second crop under irrigated conditions, giving irrigation at critical stages, wilt management with *Trichoderma viridi*, etc. The high level of knowledge by non adopted farmers on the said technologies could be that these farmers were impressed with the performance of the technologies practiced by the *KVK* adopted farmers. This inquisitiveness might have derived the non adopted cotton farmers to have more knowledge on the said technologies for their upliftment.

CONCLUSION

High level of knowledge on cotton production technologies was seen among the adopted farmers compared to the non-adopted farmers. This could be due to the multiplicity of the transfer of technology(ToT) methods followed by the *KVK* scientists in the adopted villages.

REFERENCES

Devi, S. 2000. Behaviour of cotton farmers towards IPM Technologies - An empirical analysis. Ph.D Thesis submitted to Tamilnadu Agricultural University, Coimbatore.

Dharminder, S and Ravinder, K. 2004. Knowledge level of cotton growers regarding IPM practices. Journal of Extension Education: 15(2&3): 3611-3617.

Latha, S. M . 2002. A study on knowledge and adoption of integrated pest management (IPM) practices in cotton by farmers in Kurnool district of Andhra Pradesh. M.Sc. Thesis submitted to Acharya N. G. Ranga Agricultural University, Hyderabad.

Nimje, N. R., Sinha, R. R and Choudhari, D. P. 1990. Knowledge of farmers about dryland technologies of cotton crop. Maharashtra Journal of Extension Education. 9: 165-169.

Prashanth, P. 2011. A Study on adoption of organic farming in cotton in Karimnagar district of Andhra Pradesh. M.Sc. Thesis submitted to Acharya N. G. Ranga Agricultural University, Hyderabad.

Rao, N.V., Ratnakar, R and Jain, P.K., 2012. Impact of Farmer Field Schools in *KVK* adopted villages on improved practices of cotton. Journal of Communication Studies: XXX(1) : 11-17.

Rosaiah Yelun. 2002. An analysis of knowledge gap on integrated pest management (IPM) technologies of cotton – A system analysis. M.Sc. Thesis submitted to Tamilnadu Agricultural University, Coimbatore.

J.Res. ANGRAU 45(1) 71-74, 2017

ADOPTION OF HOMESTEAD TECHNOLOGIES OF RAJENDRA AGRICULTURAL UNIVERSITY (RAU) BY RURAL WOMEN OF BIHAR

VEENITA KUMARI AND R. VASANTHA

Department of Agriculture Extension, College of Agriculture,

Professor Jayashankar Telangana State Agricultural University, Hyderabad-500030

Date of Receipt:16.12.2016 Date of Acceptance: 12.1.2017

ABSTRACT

Research scientists are continuously engaged in generation of technologies to shape the life of rural women. However, whether the intended homestead technologies reach the target client and are adopted by them widely is a matter of concern. Hence, the study was conducted in three districts of Bihar *i.e*., Samastipur, Muzaffarpur and Vaishali with 225 rural women who were exposed to all the nine selected homestead technologies of Rajendra Agricultural University(At present Dr. Rajendra Prasad Central Agriculture University). Data was collected during April 2013 to October 2013 and personally interviewing the respondents to assess the extent of adoption of these technologies at four point continuum *i.e*., full adoption, partial adoption, discontinuance and non-adoption. The results of the study revealed that the extent of adoption of homestead technologies for a majority (53.33%) of the respondents was medium. Majority of them had fully adopted four technologies *i.e*., stitching and embroidery, value addition to cereals and pulses, mushroom cultivation and vermicompost while for the rest of the technologies majority of them fell under non-adoption category.

INTRODUCTION

Adoption is defined as the "decision to make full use of an innovation or practice" (Rogers and Shoemaker, 1971). Adoption here refers to the 'use' *i.e.* not only acceptance of improved technology or practices in principle but its actual application in farm and household life. It is a common observation that rural women do not adopt all the recommended technology. Adoption of technology at individual rural woman's level is believed to be the consequence of extent to which various factors responsible for adoption are gainfully exploited because when individual gets exposed to the existence of a technology, a number of factors directly or indirectly impinge upon the pace as well as the level and extent of adoption.

There is a wide gap between agricultural technologies developed at research institutions and its adoption by small-scale farmers and rural households (Kroma, 2003). Efforts need to be made to ensure that the technologies meant for the rural women gets disseminated at large scale throughout the length and width of the State leading to high rate of adoption of these technologies. However, there is paucity of data in this regard and no such study had been conducted so far to provide a baseline data for the functionaries to design action plan for them. Keeping these things in view, the research study was conducted with the objective to assess the extent of adoption of homestead technologies of Rajendra Agricultural University (RAU) by the rural women.

MATERIAL AND METHODS

The objective of the study was to study the extent of adoption of homestead technologies of RAU by rural women. Hence, a list of technologies or practices was prepared under each of the nine selected homestead technologies *viz*., fruit & vegetable preservation, stitching and embroidery, value addition to garments, arts and craft making, value added products from cereals and pulses, mushroom production, value added mushroom products, vermicompost technology and apiculture. The respondents were randomly selected from nine villages, covering three villages from each randomly selected block, from the three randomly selected districts *viz.*, Samastipur, Muzaffarpur and Vaishali. To study the extent of adoption of each technology or practice at various levels of adoption *i.e.,* full adoption, partial adoption, complete discontinuance and non-adoption, data was collected from 225 rural

E-mail: veen_chand2@yahoo.co.in

women who were exposed to all the nine selected homestead technologies.

Scoring pattern

Schedule comprising of 38 items (technologies) was prepared. The response continuum for each item ranged from full adoption, partial adoption (some aspects of the technologies were adopted and some were not adopted), discontinuance (adopting and discontinuing) and non-adoption. A score of 4, 3, 2 and 1 was assigned for full adoption, partial adoption, discontinuance and non-adoption, respectively. By adding up the scores obtained by a respondent on all the items, total score was obtained. Thus, total scores for all the respondents were computed. Mean and standard deviation of the total score was calculated and accordingly the respondents were categorised into the following three categories as given below:

S. No.	Category	Score
1	Low	Mean- S.D.
2	Medium	Mean ±S.D
3	High	Mean +S.D.

Further, information was also obtained for technology-wise percentage of adoption of the nine homestead technologies by the respondents on the four point continuum of adoption *i.e.*, full adoption, partial adoption, discontinuance and non-adoption.

RESULTS AND DISCUSSION

Overall extent of adoption of homestead technologies

The results of Table 1 revealed the extent of adoption of homestead technologies by the respondents. It can be inferred from the data of this table that the extent of adoption of homestead technologies for a majority (53.33%) of the respondents was medium. It was followed by high category and low category of respondents comprising 28.89 per cent and 17.78 percent, respectively.

Table 1. Distribution of respondents based on the extent of adoption

N=225

S. No.	Category	Frequency (f)	Percentage (%)
1	Low	40	17.78
2	Medium	120	53.33
3	High	65	28.89
	Total	225	100.00

Mean= 56.85 Standard Deviation=5.83

Technology – wise extent of adoption of homestead technologies

This section presents data on extent of adoption of the homestead technologies technology-wise which has been presented in tables and graph. It can be observed from the data of this table that the homestead technologies *i.e.*, vermicompost technology (62.67%), stitching and embroidery (55.55%) and mushroom production (52.89%) were fully adopted by a majority of the respondents. For the remaining six homestead technologies i.e., value addition to garments (94.67%), value added mushroom products (76.0%), art and craft making (65.33%), fruit and vegetable preservation (61.33%), apiculture (56.0%) and value addition to cereals and pulses (47.56%) majority of the respondents fell under non-adoption category. Out of them, a small percentage of the respondents were found to discontinue these technologies except value addition to garments and value added mushroom products. It is interesting to note that majority of the respondents were found not to adopt six technologies out of the nine selected homestead technologies.

The findings revealed that majority (53.33%) of the respondents had medium extent of adoption of homestead technologies. Majority of them had fully adopted four technologies *i.e.*, stitching and embroidery, value addition to cereals & pulses, mushroom cultivation and vermicompost while for the rest of the technologies majority of them fell under non-adoption category. The reason for this may be due to untimely supply of inputs, poor financial condition and lack of proper financial and marketing support from the institutions. As per the suggestions of the respondents, if efforts on improving input accessibility, exploring market channels, development of low cost technologies, trainings on proper storage and packaging, efforts in obtaining quality assurance certificates were intensified then definitely adoption level of these technologies will also improve. Waman *et al*. (2006) revealed that majority of the farmers had low to medium level of adoption of recommended IPM practices in cotton.

Table 2. Distribution of respondents (technology-wise) based on the extent of adoption (N=225)

S. No.	Homestead technology	Extent of Adoption			
		Full adoption f (%)	Partial adoption f (%)	Discontinuance f (%)	Non adoption f (%)
1	Fruit and Vegetable preservation	61(27.11)	0.00(0.00)	26(11.56)	138(61.33)
2	Stitching and embroidery	125(55.55)	0.00 (0.00)	04 (1.78)	96 (42.67)
3	Value addition to garments	12(5.33)	0.00 (0.00)	0.00 (0.00)	213 (94.67)
4	Art and craft making	51(22.67)	0.00(0.00)	27(12.00)	147 (65.33)
5	Value addition to cereals and pulses	100 (44.44)	0.00 (0.00)	18(8.00)	107 (47.56)
6	Mushroom production	119 (52.89)	0.00(0.00)	9(4.00)	97(43.11)
7	Value added mushroom products	54(24.00)	0.00(0.00)	0.00(0.00)	171(76.00)
8	Vermicompost technology	141(62.67)	0.00 (0.00)	1 (0.44)	83 (36.89)
9	Apiculture	78 (34.67)	0.00 (0.00)	21 (9.33)	126 (56.00)

* figures in parentheses indicate percentages

CONCLUSION

Adoption of a technology is the ultimate indicator of success or failure of the technology. Hence, it is not only imperative to generate technologies but also to ascertain that it gets assimilated among the end-users. The study highlighted that the extent of adoption of homestead technologies by the rural women of Bihar is not satisfactory. Hence, a lot needs to be done by the research scientists as well as the extension personnel to improve the extent and rate of adoption of these technologies so that it can bring a positive change in the life of rural women. Monitoring and follow-up action would greatly help in improving the adoption of these technologies.

REFERENCES

Kroma, M. 2003. Participation and social learning: Supporting farmers' innovation in Central Ghana. Journal of Internatational Agriculture and Extension Education. 10 (1): 43-49.

Rogers, E.M and Shoemaker,F.F.1971. Communication of innovations. The Free Press, New York. pp.108-112.

Waman, G. K., Girase, K. A and Wagh, B. R. 2006. Knowledge and adoption of integrated pest management practices by irrigated cotton growers. International Journal of Agricultural Sciences. 2(1): 100-103.

J.Res. ANGRAU 45(1) 75-80, 2017

MARKET POTENTIAL FOR AGRICULTURAL CONSULTANCY IN VIDARBHA REGION OF MAHARASHTRA STATE

PRIYANKA SHINDE, Y. PRABHAVATHI, N. VANI AND P. SUMATHI

Institute of Agribusiness Management, S. V. Agricultural College,

Acharya N G Ranga Agricultural University, Tirupati- 517 502

Date of Receipt: 20.1.2017 Date of Acceptance: 14.3.2017

ABSTRACT

Agriculture consultancy is the fast growing field in agriculture. The role of agriculture consultancy is becoming more and more critical as agriculture enters the fast paced era of consolidation, technology, specialization, mergers and reformation. The present study was mainly aimed to study the farmers' perception for private agricultural consultancy services, their expectations from private agricultural consultants and also to study the scope for private agricultural consultancy firms. A multistage purposive cum random sampling technique was adopted and the study was undertaken in Nagpur and Wardha districts of Maharashtra state. The data was analysed to attain the stated objectives by using percentage analysis, Garrett's ranking and logit model. The study inferred that willingness of farmers to consult a private agricultural consultancy service was seen in both the districts but majorly in Wardha district. Farmers of Nagpur and Wardha districts require information primarily for government schemes and subsidies followed by crop planning.

INTRODUCTION

India is an agrarian country where agriculture is not merely a source of livelihood but a way of life. Agriculture is the backbone of the Indian economy but there is severe state of crisis existing in Indian agriculture. Today's farmer is different from yesterday. Farmer is not depending on agriculture for food alone, but to produce more marketable surplus and to make more profit. Farmer is depending on agriculture to meet his diversified growing needs born out of modernization and his expectations from extension services are also changing (Daniel and Teferi, 2015). In order to achieve the objectives regarding the structural change in agriculture, it takes more than to meet the specific requirements of the agricultural population on certain well identified problems, they need guidance in identifying a direction of action, development and services of socio - economic guidance. With the emergence of importance of agriculture, the agricultural consultancy is gaining ground.

There is tremendous demand for agriculture consultancy in near future. Agricultural consultancies mostly concentrate on improved technology (Akinwumi and Joji, 1995) transfer a long with supply of required inputs (Govindasamy *et al*., 2001) for clientele. Clientele benefit is linked with the survival of private consultancies. Hence, they are taking responsibility for clientele success for better income. Further, consultancy also takes care of marketing facilitates and increased market price for the clientele produces. The farming situation in Vidarbha region of Maharashtra is dismal. It calls for targeted efforts and solutions from all fronts, from agricultural policies to irrigation benefits in addressing issues of climate change. The region occupies 31.6% of total area and holds 21.3% of total population of Maharashtra. Farm families in this region have to make a number of different types of decisions, because they face different kinds of problems. Each type requires its own kind of support from agricultural extension (John and Prabuddha, 2011) which the consultancy services can provide.With this background delineated above, emanates the need for an in depth study on willingness of farmers to consult private agricultural consultancy services in Vidharbha region of Maharashtra. The study was undertaken especially in Nagpur and Wardha districts of Vidharbha region with the following objectives - to assess farmers willingness to consult private agricultural consultancy services in study area and to find the major expectations of respondents from private agricultural consultancy services.

E-mail: prabhayanduri@gmail.com

MATERIAL AND METHODS

The study was undertaken in two districts *viz*., Nagpur and Wardha districts of Maharashtra state. To achieve the objectives of the study, a combination of suitable qualitative data was collected using a well-structured schedule and primary data was collected from sample respondents. Nagpur and Wardha districts of Maharashtra state were purposively selected because of the adverse condition of farm lands in these two districts. Five tehsils of Nagpur district and five tehsils of Wardha district were randomly selected and two villages were randomly selected from each tehsil. Thus, from identified twenty villages, five farmers from each village were selected randomly making the total sample size 100 (50 respondents from Nagpur district and 50 respondents from Wardha district). Information gathered from farmers include: Questions related to socioeconomic characteristics, farmers willingness to consult private agricultural consultancy services and major expectation of farmers from private agricultural consultancy services. In this particular study statistical analysis including percentage analysis, Garret ranking technique and econometric model *i.e*., Logit model were used to analyze the data obtained from the field. The survey work undertaken pertains to the period from January-April 2016.

(1) Percentage Analysis

Per cent increase and per cent decrease are measures of per cent change, which is the extent to which a variable gains or losses intensity, magnitude, extent, or value. The figures are arrived at by comparing the initial (or before) and final (or after) quantities according to a specific formula.

It is expressed as

D% = 100 (X2 - X1) / X1 Where,

D% - Percentage change

X1 - The initial value

X2 - The final value

(2) Garrett's ranking technique

To find out the most significant factor that influences the respondents, the Garrett's ranking technique was employed and respondents were asked to assign the rank for all factors and the outcomes of such ranking have been converted into score value with the help of the following formula:

Percent position = 100 (Rij – 0.5)/ Nj

Where

Rij = Rank given for the ith variable by j^{th} respondents

Nj = Number of variable ranked by j^{th} respondents

With the help of Garrett's table, the percent position estimated is converted into scores. Then for each factor, the scores of each individual are added and then total value of scores and mean values of score is calculated. The factors having highest mean value is considered to be the most important factor.

(3) Logistic regression

Logit model is a regression model where dependent variable (DV) is categorical. It was used to analyse farmers' willingness to consult private agricultural consultancy services.

The logistic function of any number is given by the inverse-logit:

$logit^{-1}$(á)= logistic(á)=1/1+exp(-á)=exp(á)/exp(á)+1

If p is a probability, then p/(1-p) is the corresponding odds, the logit of the probability is the logarithm of the odds.

Logistic regression model,

Ln[p/1-p] = â0 + â1÷1 +â2÷2 + – + ân÷n

The 'p' value in logit model infers that,

if p value is less than 0.05 then the variables used are significant at 5% level of significance.

if p value is less than 0.01 then the variables used are significant at 10% level of significance.

if p value is greater than 0.05 then the variables used are not significant.

RESULTS AND DISCUSSION

I. Farmers Willingness for Private Agricultural Consultancy Services

Six key characteristics *i.e.*, age, education, occupation, information regarding crop production, financial aspects and marketing aspects were considered as explanatory variables. The effect of these independent variable on willingness of farmers to consult private agricultural consultancy services in the study area was studied with the help of Logit Model. Age, education and occupation variables were further categorized into different categories. Age variable was categorized into three groups *i.e.*, farmers between the age group of 25-35 years, 36-45 years and more than 45 years. Education variable was categorized in to four groups *i.e.*, farmers who are illiterate, whose educational status is up to 10th standard, intermediate level and graduate and above. Occupation variable was categorized into three groups *i.e.*, farmers having occupations like farming, business and service. Age group of 25-35 years, education status of illiterate and occupation as farming were taken as references. Logit model was used to analyze the willingness of the farmers of Nagpur and Wardha districts to consult private agricultural consultancy services and results are presented in the Table 1 and Table 2 below.

Table1. Farmers willingness for private agricultural consultancy services-Nagpur district (N=100)

Variables	B	S.E.	Wald	df	P value	Odds ratio
Age - 25-35 years		1.036	2	0.596		
36-45 years	-0.623	1.177	0.280	1	0.597	0.536
More than 45 years	0.472	1.316	0.128	1	0.720	1.603
Literacy status - Illiterate		1.969	3	0.579		
Upto 10th std.	-2.943	2.546	1.336	1	0.248	0.053
Intermediate	-2.196	1.979	1.231	1	0.267	0.111
Graduation and Above	-2.877	2.067	1.938	1	0.164	0.056
Main Occupation - Farming		1.933	2	0.380		
Business	1.963	2.359	0.692	1	0.405	7.119
Service	-1.078	1.568	0.472	1	0.492	0.340
Crop production related information	0.372	0.344	1.170	1	0.279	1.451
Financial aspects related information	-1.527	0.845	3.266	1	0.071	0.217
Marketing aspects related information	0.599	0.383	2.445	1	0.118	1.821
Constant	0.931	3.880	0.058	1	0.810	2.538

Table 1 indicated that variables like age, literacy status, main occupation, information needed for crop production, financial aspects and marketing aspects were not statistically significant at 5% level of significance. Though information need on financial aspects was significant at 10% level of significance, but it has negative effect on willingness of farmers to take private agricultural consultancy services. This inferred that farmers have adequate information on availability of farm credit from different financial institutions. The co-efficient of multiple determination (R^2) value for the above model is 0.219.This indicated that 22% of farmers' willingness to consult private agricultural consultancy services was explained by above six independent variables taken under present study.

Table 2. Farmers willingness for private agricultural consultancy services- Wardha district (N=100)

Variables	B	S.E.	Wald	df	P value	Odds ratio
Age - 25-35 years		1.311	2	0.519		
36-45 years	-1.621	2.186	0.550	1	0.458	0.198
More than 45 years	0.768	2.972	0.067	1	0.796	2.156
Literacy status - Illiterate		2.216	3	0.529		
Upto 10th std.	0.686	17413.48	0.000	1	1.000	1.985
Intermediate	-21.284	12113.256	0.000	1	0.999	0.000
Graduation and Above	-3.006	2.019	2.216	1	0.137	0.049
Main Occupation - Farming	0.079	2	0.961			
Business	18.248	12113.256	0.000	1	0.999	84173370.58
Service	0.537	1.914	0.079	1	0.779	1.710
Crop production related information*	1.568	0.728	4.632	1	0.031	4.796
Financial aspects related information	0.005	0.962	0.000	1	0.996	1.005
Marketing aspects related information	-0.652	0.882	0.546	1	0.460	0.521
Constant	-2.658	5.380	0.244	1	0.621	0.070

*indicates the significance level of 5 %; df: degrees of freedom

Table 2 indicates that the variables *viz*., age, education, occupation, marketing aspects related information and financial aspects related information were not statistically significant. *i.e*., they are not contributing towards the farmers intention for taking private agricultural consultancy services. Advice on crop production related information was statistically significant at 5% level of significance. This indicated the farmers' readiness to consult private agricultural consultancy services for crop production related information.

The co-efficient and odds value for advice on crop production related information were 1.568 and 4.796, respectively. This indicated that for every one unit increase in the score the intentions to consult private agricultural consultancy services by the farmer for crop production related information will increase by 4.796 times. This evidently indicated that the selected area offers wide opportunities in the area of crop production related consultancy services. The co-efficient of multiple determination (R^2) value for the above model is 0.309. This indicated that 30.0 per cent of the farmers' willingness to consult private agricultural consultancy services was explained by above six variables taken for study.

II.Major Expectations of Respondents from Private Agricultural Consultancy Services

The results of Garret ranking technique employed to study the expectations of respondents for private agricultural consultancy services in Nagpur and Wardha districts of Maharashtra state were presented and discussed in Table 3 and Table 4.

Table 3. Major expectations of farmers from private agricultural consultancy services: Nagpur district (N=100)

Major expectations from private consultancy services	Total	Average	Rank
Service required on			
Crop planning	3226	64.5	2
Production technologies including pest management	2501	50	8
Organic farming	2015	40.3	9
Farming systems	2917	58.3	4
Input availability	1503	30.1	12
Market Prices	3026	60.5	3
Availability different markets to sell commodities	2563	51.3	7
Market demand	1793	35.9	10
Transport and storage facilities	1693	33.9	11
Government Schemes and subsidies	3472	69.4	1
Crop insurance	2579	51.6	6
Credit sources	2762	55.2	5

It is inferred from Table 3 that the respondents majorly expected information on government schemes and subsidies and holds first position followed by advice on crop planning in second position. Services like information on market prices, farming systems, availability of credit sources, crop insurance, availability of different markets for the commodities production technologies including pest management holds 3rd, 4th, 5th, 6th, 7th and 8th positions, respectively. Information on organic farming, market demand, transport and storage facilities and availability of inputs were least preferred.

Table 4. Major expectations of farmers from private agricultural consultancy services- Wardha district (N=100)

Major expectations from private consultancy services	Total	Average	Rank
Service required on			
Crop planning	3327	66.54	2
Production technologies including pest management	2831	56.62	4
Organic farming	2220	44.4	9
Farming systems	2762	55.24	5
Input availability	1800	36	11
Market Prices	2951	59.02	3
Availability of different markets to sell commodities	2352	47.04	8
Market demand	1458	29.16	12
Transport and storage facilities	1887	37.74	10
Government Schemes and subsidies	3391	67.82	1
Crop insurance	2563	51.26	6
Credit sources	2479	49.58	7

It is inferred from the Table 4 that respondents majorly expected information on government schemes and subsidies and holds first position followed by advice on crop planning in second position. Services such as information on market prices, production technologies including pest management, farming systems, crop insurance, availability of credit sources and availability of different markets for the commodities hold 3rd, 4th, 5th, 6th, 7th and 8th position and information on organic farming, transport and storage facilities, availability of inputs and market demand were least preferred.

CONCLUSIONS

In Nagpur district, information on financial aspects was significant at 10% level of significance, but it had negative effect on willingness of farmers to take private agricultural consultancy services. In Wardha district advice on crop production related information was statistically significant at 5% level of significance and indicated farmers readiness to consult private agricultural consultancy service for crop production related information. In Nagpur and Wardha districts, major expectations of farmers from private agricultural consultancy service was on information on government schemes and subsidies followed by crop planning and information on transport and storage facilities, input availability and market demand was least preferred.

REFERENCES

Akinwumi, A.A and Jojo, B.F. 1995. Farmers' perceptions and adoption of new agricultural technology: evidence from analysis in Burkina Faso and Guinea, West Africa. Agricultural Economics.13: 1-9.

Daniel, T and Teferi, T. 2015. Determinates of small holder farmers willingness to pay for agricultural extension services: A case study from Eastern Ethiopia. African Journal of Agricultural Research. 10(20): 2152-2158.

Govindasamy, R., John, I and Adesoji, A. 2001. Predicting willingness-to-pay a premium for integrated pest management produce: a logistic approach. Agricultural and Resource Economics Review. 30(2): 151-159

John, U and Prabuddha, S. 2011. Joint estimation of farmers' stated willingness to pay for agricultural services. International Food Policy Research Institute. Discussion Paper. 01070.

Research Note
J.Res. ANGRAU 45(1) 81-82, 2017

PERFORMANCE OF VEGETABLE CROPS IRRIGATED WITH POLLUTED WATER

D. SANATH RAJ, P. PRABHU PRASADINI AND M. YAKADRI
Department of Environmental Science and Technology,
College of Agriculture, Acharya N.G Ranga Agricultural University,
Rajendranagar, Hyderabad-500 030

Date of Receipt:17.11.2016 Date of Acceptance: 09.1.2017

Vegetables are often grown around urban areas, as they are more profitable because of the demand due to urbanisation. The crops are more prone for heavy metal contamination due to variety of urban and industrial activities and continuous use of waste water for irrigation. It is well known that plants absorb and accumulate metals from contaminated soil. Rapid urbanization and industrialization releases enormous volumes of water, which is increasingly utilised as a valuable resource for irrigation in urban and peri-urban agriculture. Waste water may contain various heavy metals namely Zn, Cu, Pb, Mn, Ni, Cr, Cd, etc. depending up on the type of activities it is associated with. Continuous irrigation of agricultural land with sewage and industrial waste water may cause heavy metal accumulation in the soil. Heavy metal concentrations of plants is directly associated with their concentrations in soils, but their threshold levels significantly differ with plant species, growth stages and environment. Thus, accumulation of heavy metals in the edible parts of vegetables represents a direct pathway for their incorporation into the human food chain. The excessive intake of these elements from the soil creates dual problems; first the harvested crops get contaminated, which serve as a source of heavy metal in our diet, and secondly the crop yield decline due to the inhibition of metabolic processes (Singh and Kumar, 2006). An attempt was made to study the performance of vegetable crops irrigated with polluted water in a peri-urban area of Hyderabad city.

Field experiment was taken up in the Student farm, College of Agriculture, Hyderabad during kharif, 2012. The farm is geographically situated at an altitude of 542.5 m above mean sea level at 170 19 N latitude and 78028 E longitude and falls under the Southern Telangana zone of state. The experiment was laid out in randomized block design and the treatments were replicated thrice.

Different vegetable crops selected for the study were: T_1 - Radish (*Raphanus sativus*), T_2-Carrot (*Daucus carota*), T_3 - Potato (*Solanum tuberosum*), T_4 -Tomato (*Solanum lycopersicum*), T_5 - Brinjal (*Solanum melongena*), T_6 -Bhendi (*Abelmoschus esculentus* L.), T_7 -Palak (*Spinacia oleracea*) and T_8 -Fenugreek (*Trigonella foenum-graecum*). The water used for irrigation from well no.5 of student farm contained Mn, Cu and Cd which were higher than the permissible limits prescribed by WHO (2004) and Indian Standards (Sharma *et al*., 2009); Pb and Cr were more than those suggested by Sharma *et al.* (2009) for irrigation. It was highly saline with electrical conductivity of 1.69 dSm-1. Data on dry matter production and yield of different crops at harvest was collected and is given in Table 1.

Perusal of the data indicates that dry matter production at harvest varied from 0.46 t ha^{-1} (bhendi) to 2.023 t ha^{-1} (radish). The dry matter production was higher in root vegetables followed by leafy and fruit vegetables. Edible yield on dry weight basis varied from 1.23 (fenugreek) to 4.50 t ha^{-1} (brinjal). The recorded fresh weight values of edible yield varied between 4.33 (bhendi) and 16.06 t ha^{-1} (brinjal). When compared to the normal yield, the edible yields were recorded lower in all vegetables studied. The percent

E-mail: prabhuprasadini@rediffmail.com

Table 1. Data on drymatter production and yield of vegetable crops as affected by polluted water

Treatment	Crop	Normal Yield* (t ha^{-1})	Edible Yield fresh wt (t ha^{-1})	Yield loss%	Edible Yield	Biomass
					Dry weight in (t ha-1)	
T_1	Radish	15.00	7.95	47	2.33	2.02
T_2	Carrot	20.00	10.43	48	1.95	1.83
T_3	Potato	27.50	13.72	50	3.48	1.88
T_4	Tomato	30.00	14.73	51	1.88	0.43
T_5	Brinjal	35.00	16.06	54	4.50	0.78
T_6	Bhendi	10.00	4.33	57	1.81	0.46
T_7	Palak	8.75	5.56	36	1.34	1.34
T_8	Fenugreek	8.00	4.88	39	1.23	1.23
SEd	-	-	1.90	-	0.90	0.48
CD at 5%	-	-	4.08	-	1.93	1.03

*Source: *Vyavasaya Panchangam* (2012)

reduction in the yield (fresh weight) was lowest in palak (36%) and highest in bhendi (57%). As far as the edible part or economic yields are concerned, leafy vegetables (palak and fenugreek) performed better in that soil when irrigated with polluted water followed by root vegetable crops radish, carrot and potato, and fruit vegetable crops (bhendi, tomato and brinjal). Among solanaceae fruit vegetable crops, tomato and brinjal recorded 51 % and 54% lesser yields, whereas, highest reduction (57% less) in yield was recorded in bhendi compared to normal yields as reported in agriculture almanac (*Vyavasaya Panchangam,* 2012). The data emphasises that leafy vegetables perform better in polluted soils.

REFERENCES

Sharma, R.K., Agarwal, M and Marshall, F. 2009. Heavy metals in vegetables collected from production and marketing sites of a tropical urban area of India. Food and Chemical Toxicology. 47:583-591.

Singh, S and Kumar, M. 2006. Heavy metal load of soil, water and vegetables in peri-urban Delhi. Environmental Monitoring and Assessment. 120: 79–91.

Vyavasaya Panchangam.2012. Vegetable crops. Published by Acharya N.G Ranga Agricultural University, Rajendranagar, Hyderabad.

WHO(World Health Organisation). 1996. Guide lines for drinking water quality. 3rd Edition. Published by World Health Organisation, Geneva. 1:145-196.

Research Note
J.Res. ANGRAU 45(1) 83-85, 2017

FACTORS INFLUENCING GROUP DYNAMICS OF FARMERS' INTEREST GROUPS UNDER AGRICULTURAL TECHNOLOGY MANAGEMENT AGENCY (ATMA)

N. HEMA SARAT CHANDRA, K.S. KADIAN AND R. VISHWATEJ
Dairy Extension Division, National Dairy Research Institute, Karnal-132 001

Date of Receipt: 16.1.2017 Date of Acceptance: 27.2.2017

The study of internal and external forces that operates with group of people is known as group dynamics. ATMA is a huge public extension system that works through bottom up approach and it accommodates group led extension in India. ATMA is an advisory body that operates at district level under the control of Ministry of Agriculture and Farmers welfare. To measure the group dynamics of Farmers interest groups (FIGs) under ATMA Group dynamics index was developed by the researcher. Normalized rank order method (Guilford, 1954) was used to assign specific weights to each dimension based on their perceived significance by thirty judges. This group dynamics of FIGs can be identified with ten indicators of it. The group dynamics score of the study area achieved is 0.65 out of 1, but to achieve better performance of the group and to implement enhanced group led extension there is a need to identify factors that influence group dynamics. In this paper an attempt was made to explain the procedure to identify factors influencing group dynamics of FIGs under ATMA.

The study was conducted in Andhra Pradesh due to its exposure to ATMA since pilot stage *i.e.* 1998 under NATP and it has highest number (49 out of 302 in India) of Farmers' organizations (SFAC, 2014). So this state has purposively selected for this study. ATMA has introduced in Andhra Pradesh state in three phases. One from each phase three districts have been randomly selected for this study. Two groups from each district (each phase) have been selected, by combining all members of the group the total sampling size has been constituted to 121. Interview schedule was developed from the statements of respective ten dimensions of GDI used for data collection. The data obtained from the 121 farmers of six FIGs under ATMA were provided for factor analysis. Prior to performing factor analysis, test of sample adequacy was done through Kaiser-Meyer Olkin (KMO) test and Bartlett's test of sphericity.

The KMO test is the measure of sampling adequacy (0.428 for this data), which varies between 0 and 1. If the KMO index value is nearer to zero, application of Principal component analysis won't be relevant. Further, Bartlett's test of sphericity confirms the adequacy of the sample population by testing the null hypothesis that the variables in the population correlation matrix are uncorrelated and inadequate.

Null Hypothesis (H_0): There is no statistically significant interrelationship between factors influencing group dynamics of FIGs under ATMA.

Alternate Hypothesis (H_1): There may be a statistically significant interrelationship between factors influencing group dynamics of FIGs under ATMA.

The Bartlett's test of sphericity had the p-value (Significant) of 0.000 < 0.01, which indicated that the sample population was adequate so the null hypothesis was rejected and accepted the alternate hypothesis (H1) that there may be statistically significant interrelationship between factors. The KMO and Bartlett's test measure of sampling adequacy was used to examine the appropriateness of Factor Analysis. The eigen values = 1 were considered for the number of components to be

E-mail: sarathchandra.neelam@gmail.com

generated. The eigen values associated with each component represent the variance explained by that particular linear component (Field, 2005). The eigen values of the first three components from the principal component analysis were greater than 1 *i.e.*, 5.886, 2.371 and 1.263, respectively. The variance explained by these three components was 38.809, 30.368 and 26.020 per cent, respectively. All the remaining components were not significant. The first component accounted for the highest variance (and hence had the highest eigen value) and the next component accounted for as much of the left over variance as it could, and so on. Thus, these three components accounted for 95.196 per cent of variance which is regarded as satisfactory in social sciences (Hair *et al*., 2006).The seventy- eight items belonging to the ten indicators of group dynamics index (GDI) were subjected to Varimax rotation to identify the factors along with the underlying variables.

The extracted factor loading by Varimax rotation: In order to obtain a meaningful representation of items and factor mapping along the principal axis, the resulted principal component was rotated using orthogonal transformation by varimax. The items with loadings equal to or greater than 0.4 were considered meaningful and extracted for factor analysis (Field, 2005). Table 1 reveals how the item analysis reduced original seventy eight items into three independent components (factors). The results show that the factor loadings ranging from 0.967 to 0.781 were substantially loaded on the component 1 subscale, from 0.944 to 0.888 on the component 2 subscale and from 0.986 to 6.99 on the component 3 subscale.

Table 1. Extracted factors along with their factor loadings

Rotated Component Matrix[a]			
Indicators of Group dynamics index (GDI)	**Component**		
	1	2	3
1. Goal achievement	.967	-.127	.131
2. Teamwork	.869	.415	.232
3. Decision making	.849	.370	-.346
4. Interpersonal trust	.811	.464	.231
5. Group cohesivness	.781	.522	
6. Participation in group activities	.220	.944	.212
7. Confirmation to norms	.287	.888	
8. Group communication			.986
9. Leadership	.185	.274	.918
10. Role function	.190	.684	.699
Extraction Method: Principal Component Analysis Rotation Method: Varimax with Kaiser Normalization			
a. Rotation converged in 5 iterations			

The behaviour of individual items in relation to others within the same subscale provides good evidence for content validity because the highest factor loading is central to the domains assessed by these subscales (Francis *et al.*, 2000).These three factors were named based on the variables included in respective components (factors) as team work for success, obey in rules and responsibility and communication among roles. The three factors found influencing the group dynamics of the FIGs under ATMA were important to draws attention to put in focus in implementation of group led extension. To achieve better group dynamics extension functionaries has to strengthen these three factors.

REFERENCES

Field, P. 2005. Discovering statistics using SPSS for Windows: Advanced techniques for the beginner. Sage, London, UK.pp.82-88.

Francis, L., Katz, Y and Jones, S. 2000. The reliability and validity of the Hebrew version of the Computer Attitude Scale. Computers and Education. 35 (2):149–159.

Guilford, J.P. 1954. Psychometric methods (2nd Edition.). McGraw-Hill, the University of Wisconsin – Madison, New York.pp.66-72.

Hair Jr., J. F., Black, W. C., Babin, B. J., Anderson, R.E and Tatham, R.L. 2006. Multivariate data analysis, 6th Edition. Pearson Education, Inc., Upper Saddle River, New Jersey.

Small Farmers Agribusiness Consortium (SFAC). 2014. State wise details of farmer producer organizations (FPOs) - as on 10th March, 2014. (http://sfacindia.com/PDFs/Statewise-List-of-FPOs2014.pdf on 6.1.2017).

GUIDELINES FOR THE PREPARATION OF MANUSCRIPT

1. Title of the article should be short, specific, phrased to identify the content and indicate the nature of study.

2. Names should be in Uppercase prefixed with initials and separated by commas. For more than two authors the names should be followed by 'and' in small letters before the end of last name. Full address of the place of research in small letters should be typed below the names. E-mail i.d of the author may be given as foot note.

3. The full length paper should have the sub heads ABSTRACT, INTRODUCTION, MATERIAL AND METHODS, RESULTS AND DISCUSSION, CONCLUSION(S) and REFERENCES-all typed in capitals and bold font - 12. The research note will have only one sub head *i.e.* REFERENCES.

4. **ABSTRACT**: The content should include the year, purpose, methodology and salient findings of the research in brief not exceeding 200 words. It should be so arranged that the reader need not refer to the article except for details.

5. **INTRODUCTION** : Should be with title and indicate the reasons which prompted the research, objectives and the likely implication. The review of recent literature should be pertinent to the problem. The content must be brief and precise.

6. **MATERIAL AND METHODS** : Should include very clearly the experimental techniques and the statistical methods adopted. Citation of standard work is sufficient for the well known methods.

7. **RESULTS AND DISCUSSION** : Great care should be taken to highlight the important findings with support of the data well distinguished by statistical measures like CD, r, Z test etc. Too descriptive explanation for the whole data is not desirable. The treatments should be briefly expressed instead of abbreviations like T_1, T_2 , etc. The discussion should be concise and relate to the limitations or advantages of the findings in comparision with the work of others.

8. **REFERENCES :** Literature cited should be latest. References dating back to more than 10 years are not desirable. **Names of authors, their spelling and year of publication should coincide both in the text and references**. The following examples should be followed while listing the references from different sources.

Journals and Bulletins

Abdul Salam, M and Mazrooe, S.A. 2007. Water requirement of maize (*Zea mays* L.) as influenced by planting dates in Kuwait. Journal of Agrometeorology. 9 (1) : 34-41.

Hu, J., Yue, B and Vick, B.A. 2007. Integration of trap makers onto a sunflower SSR marker linkage map constructed from 92 recombinant inbred lines. Helia. 30 (46) :25-36.

Books

AOAC. 1990. Official methods of analysis. Association of official analytical chemists. 15th Edition. Washington DC. USA. pp. 256.

Federer, W.T. 1993. Statistical design and analysis for intercropping experiments. Volume I : Two Crops. Springer – Verlag, Cornell University, Ithaca, New York, USA. pp. 298-305.

Thesis

Ibrahim, F. 2007. Genetic variability for resistance to sorghum aphid (*Melanaphis sacchari,* Zentner) in sorghum. Ph.D. Thesis submitted to Acharya N.G. Ranga Agricultural University, Hyderabad.

Seminars / Symposia / Workshops

Naveen Kumar, P.G and Shaik Mohammad. 2007. Farming Systems approach – A way towards organic farming. Paper presented at the National symposium on integrated farming systems and its role towards livelihood improvement. Jaipur, 26 – 28 October, 2007. pp.43-46.

Proceedings of Seminars / Symposia

Bind, M and Howden, M. 2004. Challenges and opportunities for cropping systems in a changing climate. Proceedings of International crop science congress. Brisbane –Australia. 26 September – 1 October 2004. pp. 52-54. (website : www.cropscience 2004.com on 03-11-2004).

Tables and Graphs : The data in tables should not be duplicated in graphs and vice versa. Mean data for main treatment effects should be presented with appropriate SE± and CD values wherever necessary.The 2 or 3 way tables should be furnished only if the results are consistent over years and aredistinguished to have consideration of significant practical value. SE± and CD values however,should be furnished in the tables for all interactions and should be explained in the results anddiscussion. The treatments should be mentioned atleast in short forms if they are lengthy, but not simply abbreviated as T_1, T_2 and $T_{3,}$ etc. The weights and measures should be given in the metric system following the latest units eg. kg ha^{-1}, kg ha^{-1} cm, mg g^{-1}, dS m^{-1}, g m^{-3}, C mol kg^{-1} etc.

Typing : The article should be typed in 12 pt font on A4 size paper leaving a margin of 2 cm on all sides. There should be a single line space between the rows in abstract and double line in rest. **Verify the manuscript thoroughly for errors before submitting it for publication.**

Note : Latest issue of the Journal may be consulted. Further details can be obtained from the book “Editors Style Manual**,** Edition 4. American Institute of Biological Sciences, Washington DC”.

URL : http://www.angrau.ac.in/Publications.aspx

THE JOURNAL OF RESEARCH ANGRAU

DECLARATION CERTIFICATE TO BE SUBMITTED BY THE AUTHOR(S)

Certified that the article entitled ____

____

1. is based on my / our original research work / M.Sc / Ph.D thesis (strike off whichever is not applicable)
2. The article has been seen by all the authors and the order of authorship is agreed.
3. The results presented have not been published or submitted for publication elsewhere in part or full under the same or other title
4. The names of the authors are those who made a notable contribution.
5. **No authorship is given to anyone who did not make a notable contribution.**

S.No.	Name/s	Present address	Permanent address	Signature
1.				
2.				
3.				

CERTIFICATE BY THE COMPETENT AUTHORITY

(Professor & Head of the Department/ Principal Scientist of the station/ Associate Director of Research).

Certified that the article ____

____

authored by ____

______________________________ is fit for publication. It fulfills all the requirements for publication in The Journal of Research ANGRAU.

Name :

Signature :

Office seal :

Note: In case it is not possible to obtain the signature of a particular author for reasons beyond his/her reach, the reasons thereof should be explained.

ESSENTIAL REQUIREMENTS FOR CONSIDERATION OF PUBLICATION OF ARTICLES

1. Research of not less than 2 years and of high standard will be considered as full length paper. If necessary, it will be considered as Research Note.

2. M.Sc. Research of one year should be submitted in the style and format of Research Note.

3. The total number of pages should not exceed 10 for full paper and 5 pages for Research Note including tables and figures.The figures should be legible.

4. Previous research of 5 years old before the date of submission will not be considered.

5. All the authors should subscribe for the Journal either as annual/life member.

6. The manuscript should be submitted (soft copy as e-mail) as per the guidelines of the Journal at **angraujournal@gmail.com**

7. The manuscript should accompany the declaration certificate and subscription enrolment form(scanned soft copy).

8. The authors should accept the editorial / reviwer comments until the quality of the paper is improved.

9. The revised manuscript should be submitted as a soft copy(e-mail) at **angraujournal@gmail.com**

10. Demand Draft may be drawn in favour of **COMPTROLLER, ANGRAU,** payable at Guntur.

SUBSCRIPTION TARIFF

ANNUAL

Individual : Rs. 300/- author

Institution : Rs. 1200/-

LIFE

Individual (till retirement) : Rs. 1200/-

1. **Publications :** Managing Editor - Journal of Research ANGRAU, Agricultural Information &Communication Centre,Guntur.The DD should be mailed to the Managing Editor,The Journal of Research ANGRAU, ESR ENCLAVE, BALAJI NAGAR, M.G. INNER RING ROAD, GUNTUR – 522 509.

Note : Latest issue of the Journal may be consulted. The weights and measures should be given in the metric system following the latest units eg. kg ha^{-1}, kg ha^{-1} cm, mg $g^{-1,}$ dSm^{-1}, g m^{-3}, C mol kg^{-1} , etc.

Typing : The article should be typed in 12pt font on A_4 size paper leaving a margin of 2 cm on all sides. There should be a single line space between the rows in abstract and double line in rest.The article shall be printed on only one side of paper.

URL : http://www.angrau.ac.in/Publications.aspx

SUBSCRIPTION ENROLLING FORM

I/we,herewith enclose D.D. No...
dated ....for Rs. .... drawn in favour of COMPTROLLER, ANGRAU payable at Guntur as individual annual/individual life/Institutional annual Membership for The Journal of Research ANGRAU for the calendar year (January - December) ....

S.No.	Name of the authors	Address for correspondence	Name of the article	Signature
1.				
2.				
3.				
4.				

Note: DDs shall be sent to Managing Editor, The Journal of Research ANGRAU, ESR Enclave, Balaji Nagar, M.G. Inner Ring Road, Guntur - 522 509.

Statement About The Ownership And Other Particulars About Newspaper
THE JOURNAL OF RESEARCH ANGRAU
Form IV (SEE RULE 8)

Place of Publication	:	Guntur
Periodicity of publication	:	Once in three months (Quarterly)
Printer's Name	:	Ritunestham Press, Guntur
Nationality	:	INDIAN
Address	:	Ritunestham Press D.No. 8-198, Kornepadu, Guntur - 522 017
Publisher's Name	:	Dr. R. Veeraraghavaiah
Address	:	Dean, P.G. Studies, Administrative Office, Acharya N.G. Ranga Agricultural University, Mahatma Gandhi Inner Ring Road, Guntur- 522 509, Andhra Pradesh
Editor's Name	:	Dr. R.Veeraraghavaiah
Nationality	:	INDIAN
Address	:	Dean, P.G. Studies, Administrative Office, Acharya N.G. Ranga Agricultural University, Mahatma Gandhi Inner Ring Road, Guntur, - 522 509, Andhra Pradesh
Name and address of the individuals who own the newspaper and partners or share holders holding more than one percent of the total capital	:	Acharya N.G.Ranga Agricultural University, Administrative Office, Mahatma Gandhi Inner Ring Road, Guntur- 522 509, Andhra Pradesh.

I, Dr.R.Veeraraghavaiah, hereby declare that the particulars given above are true to the best of my knowledge and belief

Date:04.4.2017

Sd./-R.Veeraraghavaiah
Signature of the Publisher

printed at Ritunestham Press, Guntur and Published by Dr. R. Veeraraghavaiah, Dean, P.G. Studies and Editor,
The Journal of Research ANGRAU, Acharya N.G. Ranga Agricultural University, Lam, Guntur - 522 034
E-mail : angraujournal@gmail.com, www.angrau.ac.in/publications