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ASSOCIATION OF WEATHER VARIABLES WITH YIELD AND YIELD COMPONENTS OF COTTON (*Gossypium hirsutun* L.) AT REPRODUCTIVE PHENOPHASE

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ABSTRACT

Growth and development of cotton is influenced by several environmental factors such as change in temperature, amount and distribution of rainfall and carbon dioxide concentration which are attributes of climate change. A field experiment was conducted to study the contribution of weather variables for the total variation in yield and yield components during reproductive phenophase of cotton during 2013-14 and 2014-15 *kharif* season located within 17°19'19.64" N latitude and 78° 24'29.89" E longitudes. The experiment was set out with three sowing time (24, 26 and 28 standard week) as main plot, three deficit irrigation schedules (0.8 IW/CPE, 0.6 IW/CPE, 0.4 IW/CPE) and rainfed as sub plot in split plot design. Data on yield and yield components and daily weather variables were recorded during the study seasons and mean of yield and yield components were subjected to pair wise step down regression analysis with weather variables. The regression analysis result showed that weather variables such as maximum temperature, mean temperature, relative humidity I and relative humidity II were found to be influential and accounted for over 90 percent of total variation in seed cotton yield and yield components during phenophase.

Optimum time of sowing plays a vital role in realizing potential crop growth and yields. The time of sowings for various crops differs with difference in climate, varieties and whether the rainfed or irrigated. Cotton experiences temperature fluctuations ranging from 5°C to 45°C during the season, which diversely influence growth and development (Reddy, 1994). Study reports indicated that the high temperatures combined with water stress result in boll shed, small boll size and leaf damage (Hake and Silvertooth, 1990). Reddy *et al*. (1999) reported a significant decrease in boll growth followed by fruit shed in 3-5 days after blossom when there was an increase in temperatures over 32 ºC. Sustained changes in temperature during the fibre thickening period will lead to differences in micronaire (Bange, 2010).

So far, many researches were undertaken under controlled environment conditions and dates at field conditions. However, these studies did not reveal the relations among the climatic factors under field situations with yield and yield components. Attributing changes in yields to a single factor such as temperature is not possible due to the confounding effects of rainfall, and radiation during crop growing period. Furthermore, controlled environment studies often underestimate yield losses from temperature effects on plant density that would occur under field conditions (Paulsen, 1994). Therefore, this study was designed to identify the critical weather parameters affecting the yield and yield components of cotton.

A field **e**xperiment was carried out for two consecutive *Kharif* seasons (2013/14 – 2014/15) at College Farm, PJTSAU, Rajendranagar, located at an elevation of 542.6 meter above sea level and lies within 17°19'19.64" N latitude and 78° 24'29.89" E longitudes. The experiment was designed with three time of sowing viz., D_1- June 17 (24 standard week), D_2- July 03 (27 standard week) and D_3- July 20 (29 standard week) during 2013-14 *kharif* season and D_1- June 14 (24 standard week), D_2- June 30 (26 SW) and D_3- July 14 (28 SW) during 2014-15 *kharif* season as main plot and three deficit irrigations schedule as 0.4 IW/CPE (I_1), 0.6 IW/CPE (I_2), 0.8 IW/CPE (I_3) with rainfed as subplot treatments. The treatments were laid out in split plot design in three replications. Irrigation water of 50mm was applied when the CPE reaches 125.0mm, 82.3mm, 62.3mm for 0.4, 0.6 and 0.8 IW/CPE treatments respectively. Cotton seeds (cultivar Neeraja) were dibbled at 60 x 90 cm spacing and thinned at first two leaf stage to maintain the population one plant per hill. Recommended fertilizer rate of 120: 60: 60 kg per ha of N, P_2O_5 and K_2O were applied to all plots. Harvesting was done manually from a net plot area of 6.48 square meter for four successive pickings. Daily weather data on maximum temperature, minimum temperature, mean temperature, relative humidity I, relative humidity II, rainfall, sunshine, wind speed and pan evaporation were collected from weather station, Agricultural Research Institute, Rajendranagar. Data on canopy temperature was recorded with infrared thermometer and solar radiation with photo-radiometer. After

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establishing the relationship between weather and yield and yield attributes step down regression analysis (Drapper and Smith, 1996) were calculated to study the influence of weather parameters on yield and yield attributes. By this analysis, the contribution of respective weather parameters in bringing out the change in yield parameters was known and prediction equation was worked out.

RESULTS AND DISCUSSION

Correlation of yield and yield components with weather variables

Mean of weather variables prevailed during the reproductive phase of the study seasons and correlation analysis result of weather variables with yield and yield component is presented in Table 1 and Table 2, respectively. Weather variables viz., maximum temperature (Tmax), minimum temperature (Tmin), mean temperature (Tmean), relative humidity I and II (RHI and RHII), rainfall (RF) and wind speed (WS) were showed similar significant effect on boll weight (Bwt), hundred seed weight (HSW) and seed cotton yield (SCY). Boll weight showed positive and significant correlation with Tmax (r = 0.941**), Tmin (r = 0.905*), Tmean (r = 0.985**) and WS (r = 0.936**) and significantly negative with RHI (r = -0.977**), RHII (r = -0.968**) and rainfall (r = -0.827*). Likewise, HSW and SCY showed positive and significant correlation with Tmax (r = 0.954** and 0.751), Tmin (r = 0.805 and 0.945**), Tmean (r = 0.961** and 0.862*) and WS (r = 0.886* and 0.926*). However, the correlation of Tmin with HSW and Tmax with SCY was not significant. Pettigrew (2008) reported that slight elevation in temperature under field conditions was not sufficient to cause a decline in seed weight.

Ginning per cent at picking two (GINNII) and four (GINNIV) was negatively and significantly correlated with pan evaporation (r = -0.864* and -0.874*), respectively. Ginning per cent at picking four (GINNIV) was also showed negative and significant correlation with stress degree day ($r_{=}$-0.822*). Low lint per cent with insufficient carbohydrate production due to high temperature was demonstrated by Oosterhuis (1999) and Onder *et al.* (2009), who stated that highest number of opened boll and maximum lint per cent resulted from plots under stress condition. Negative effects of relative humidity could be associated with low temperature and disease and pest occurrence which could affect yield and yield components (Blanc *et al.,* 2008).

Regression analysis of yield and yield components with weather variables

Weather variables that showed significant influence on yield and yield components during reproductive phenophase was subjected for step down regression analysis and an estimation model for yield and yield components is presented in Table 3.

A change in mean maximum temperature over a range of 28.99 to 33.19°C accounted for 89 and 91 per cent of total variation in boll weight and hundred seed weight, respectively, over different sowing times and seasons. The effect of regressor variable was significant and revealed positive regression coefficient. Similar results on boll weight were reported by Ratnam *et al*. (2014).

A change in mean minimum temperature over a range of 21.7 to 23.7°C accounted for 82 and 89 per cent of total variation in boll weight and seed cotton yield, respectively, over different sowing times and seasons. The effect of regressor variable was significant and revealed positive regression coefficient. Similar results were reported by Ratnam *et al*. (2014).

A change in mean temperature over a range of 25.4 to 28.4°C accounted for 97, 92 and 74 per cent of total variation in boll weight, hundred seed weight and seed cotton yield respectively, over different sowing times and seasons. The effect of regressor variable was significant and revealed positive regression coefficient. Similar results on boll weight were reported by Ratnam *et al*. (2014). Positive effects of increasing average temperatures, especially at the start and end of the cotton season, on growth, development and ultimately yield were reported by Bange (2007). Benefits of temperature under optimum range were also documented by Sankaranarayanan *et al*. (2010) and Reddy *et al*. (1991).

A change in mean maximum relative humidity over a range of 79.0 to 89.1% accounted for 95, 96 and 73 per cent of total variation in boll weight, hundred seed weight and seed cotton yield, respectively over different sowing times and seasons. The effect of regressor variable was significant and revealed negative regression coefficient. Similar research

Table 1. Mean of weather variables prevailed for sowing times during reproductive phenophase of the study seasons.

Year	Sowing time	Tmax	Tmin	Tmean	RHI	RHII	RF	SShr	WS	Epan	GDD	Tc	SDD	InSR	ItSR
2013-14	24 SW	29.37	23.27	26.32	85.65	70.12	387.20	234.60	10.33	301.00	746.85	28.00	80.00	146.30	121.80
	26 SW	28.99	22.56	25.78	88.19	74.21	355.30	223.00	8.04	290.30	698.75	28.00	113.60	146.70	122.30
	28 SW	29.19	21.68	25.44	89.10	72.87	313.00	231.70	6.13	270.70	625.95	28.80	84.70	158.00	133.90
2014-15	24 SW	33.19	23.69	28.44	78.98	55.27	118.00	236.50	12.25	269.60	672.85	29.80	60.40	145.10	123.40
	26 SW	32.17	23.51	27.84	82.78	60.09	154.30	232.80	10.52	201.00	678.75	28.70	55.40	154.20	131.30
	28 SW	31.10	23.17	27.14	85.06	64.50	239.50	223.90	9.27	159.20	628.45	28.80	35.80	168.20	129.10

Table 2. Correlation coefficients (r) of weather variables with yield and yield components during flowering.

Weather variables	Yield and yield components						
	NSPP	NBPP	Bwt	HSW	SCY	GINNII	GINNIV
Tmax	-0.096	0.448	0.941**	0.954**	0.751	0.542	0.801
Tmin	-0.340	0.796	0.905*	0.805	0.945**	0.661	0.614
Tmean	-0.170	0.594	0.985**	0.961**	0.862*	0.611	0.788
RHI	0.302	-0.575	-0.977**	-0.982**	-0.854*	-0.435	-0.627
RHII	0.192	-0.453	-0.968**	-0.980**	-0.767	-0.538	-0.768
RF	-0.106	-0.302	-0.827*	-0.862*	-0.601	-0.479	-0.810
SShr	-0.434	-0.143	0.520	0.633	0.180	-0.266	-0.088
WS	-0.419	0.728	0.936**	0.886*	0.926*	0.473	0.508
Epan	-0.174	-0.090	-0.355	-0.282	-0.206	-0.864*	-0.874*
GDD	-0.262	0.462	0.102	0.005	0.342	-0.143	-0.399
Tc	-0.189	0.035	0.635	0.765	0.356	0.115	0.500
SDD	0.320	-0.105	-0.685	-0.671	-0.392	-0.768	-0.822*
ISRad	0.094	-0.379	-0.141	-0.154	-0.330	0.504	0.469
ASRad	0.404	-0.711	-0.154	-0.079	-0.542	0.102	0.290

* denotes significantly different at P < 0.05; Tmax – Maximum Temperature; ** denotes significantly different at P < 50.05 and strong correlation; SShr – Sunshine hours; Tmin – Minimum Temperature; WS – Wind speed; Tmean – Mean Temperature; Epan – Pan evaporation; RHI – Relative humidity I; GDD – Growing Degree Days; RHII – Relative humidity II; Tc – Canopy temperature; RF – Rainfall; SDD – Stress Degree days; InSR- incoming solar radiation; ItSR- intercepted solar radiation; NSPP- number of squares per plant; NBPP- number of bolls per plant; Bwt- boll weight; HSW- hundred seed weight; SCY- seed cotton yield; GINNII- ginning percent at picking two; GINNIV- ginning percent at picking four; SW- standard week.

Table 3. Estimation of yield and yield components by linear regression functions of weather variables at square initiation and first flower phenophases.

Regressor vs Response Variable	Model of estimated parameters	R^2	Probability	Regressor vs Response Variable	Model of estimated parameters	R^2	Probability
Tmax vs Bwt	Bwt = -3.4 + 0.23Tmax	0.89	0.0051	RHII vs Bwt	Bwt = 7.5 – 0.06RHII	0.94	0.0015
Tmax vs HSW	HSW = -2.9 + 0.4Tmax	0.91	0.0032	RHII vs HSW	HSW = 15.7 – 0.1RHII	0.96	0.0006
Tmin vs Bwt	Bwt = -8.5 + 0.5Tmin	0.82	0.0130	RF vs Bwt	Bwt = 4.6 – 0.003RF	0.68	0.0421
Tmin vs SCY	SCY = -10790 + 544Tmin	0.89	0.0044	RF vs HSW	HSW = 10.8 – 0.006RF	0.74	0.0272
Tmean vs Bwt	Bwt = -6.0 + 0.36Tmean	0.97	0.0004	WS vs Bwt	Bwt = 2.0 + 0.2WS	0.88	0.0060
Tmean vs HSW	HSW = -6.8 + 0.6Tmean	0.92	0.0023	WS vs HSW	HSW = 6.5 + 0.3WS	0.78	0.0188
Tmean vs SCY	SCY = -6650.1 + 312.4Tmean	0.74	0.0273	WS vs SCY	SCY = 7.1 + 182.2WS	0.86	0.0079
RHI vs Bwt	Bwt = 13.5 – 0.11RHI	0.95	0.0008	Epan vs GINNII	GINNII = 37.3 + 0.02Epan	0.75	0.0267
RHI vs HSW	HSW = 25.9 – 0.2RHI	0.96	0.0005	Epan vs GINNIV	GINNIV= 37.9 – 0.02Epan	0.76	0.0227
RHI vs SCY	SCY = 10053 – 98.02RHI	0.73	0.0305	SDD vs GINNIV	GINNIV = 35.4 – 0.04SDD	0.68	0.0449

Tmax – maximum temperature; SShr – sunshine hours; Tmin – minimum temperature; WS – wind speed; Tmean – mean temperature; Epan – pan evaporation; RHI – relative humidity I (Maximum); RHII – relative humidity II (Minimum); GDD – growing degree days; Tc – canopy temperature; RF – rainfall; SDD – stress degree days; InSR- incoming solar radiation; ItSR- intercepted solar radiation; NSPP- number of squares per plant; NBPP- number of bolls per plant; Bwt- boll weight; HSW- hundred seed weight; SCY- seed cotton yield; GINNII- ginning percent at picking two; GINNIV- ginning percent at picking four.

reports were documented by Oosterhuis (1999), Oosterhuis (1997) and Ratnam *et al*. (2014).

A change in mean minimum relative humidity over a range of 55.3 to 74.2% accounted for 94 and 96 per cent of total variation in boll weight and hundred seed weight, respectively over different sowing times and seasons. The effect of regressor variable was significant and revealed negative regression coefficient. The present result did not agree with the reports of Ratnam *et al.* (2014). However, increase in minimum relative humidity could favour the incidence of pest and disease (Sharma and Razdan, 2013) which could adversely affect yield and yield components.

A change in total rainfall over a range of 118.0 to 387.2mm accounted for 68 and 74 per cent of total variation in boll weight and hundred seed weight, respectively over different sowing times and seasons. The effect of regressor variable was significant and revealed negative regression coefficient. A large the amount of rainfall could result in over saturation and water lodging which had adverse effect on cotton growth and development. Similar reports were documented by Bange *et al.* (2004), who stated that plant dry matter reduced due to flooding that resulted in reduction in solar radiation use efficiency.

A change in mean wind speed over a range of 6.1 to 12.3km hr^{-1} accounted for 88, 78 and 86 per cent of total variation in boll weight, hundred seed weight and seed cotton yield, respectively over different sowing times and seasons. The effect of regressor variable was significant and revealed positive regression coefficient which could be expected in relation to turbulence effect of wind on atmospheric CO_2, moisture and leaf temperature favouring rate of photosynthesis in cotton. However, Barker *et al.* (1985a) reported plants grown under partial shelter condition shelter resulted in increased plant height, earlier squaring, earlier boll set and more bolls and biomass.

A change in total pan evaporation over a range of 159.3 to 301.0mm accounted for 75 and 76 per cent of total variation in ginning per cent at picking two and four, respectively over different sowing times and seasons. The effect of regressor variable was significant and recorded positive regression coefficient with ginning per cent at picking two and negative with ginning per cent at picking four. Similarly, a change in stress degree day over a range of 35.5 to 113.6^{o}C accounted for 68 per cent of total variation in ginning per cent at picking four over different sowing times and seasons. The effect of regressor variable was significant and revealed negative regression coefficient. Crop growth and development could be benefited from increasing pan evaporation provided that the soil moisture content maintained during critical crop growth periods, however, excess loss of moisture could result in desiccation which adversely affected ginning percent. Similar findings in relation to deficit irrigation were documented by Onder *et al.* (2009).

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EVALUATION AND UPSCALING OF ZERO TILLAGE MAIZE (*Zea mays* L.) – A RESOURCE CONSERVATION TECHNOLOGY IN ANDHRA PRADESH

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ABSTRACT

In Andhra Pradesh *rabi* maize yields in *kharif* rice fallows were affected due to late sowing under traditional practice of sowing after preparatory tillage. The crop was also subjected to terminal moisture stress due to late sowing in command areas particularly in tail end areas. To overcome the above situation zero tillage maize technology was introduced in Andhra Pradesh through KVKs. On farm trials and front line demonstrations were organized by KVKs in Andhra Pradesh to test and promote zero tillage maize technology during 2007-08 to 2011-12. The results revealed that there was a decrease in the cost of cultivation to an extent of Rs.3969/ha and an additional net returns of Rs.4119/ha was obtained by adopting zero tillage maize technology besides about 9 percent increase in yield as compared to conventional method. Due to the efforts made by the KVKs in convergence with other departments about 19000 ha of *rabi* maize was brought under this technology.

Maize (*Zea mays* L.) *is* an important cereal crop grown commercially in many states of India. It is grown in 8.7 kgha^{-1} with a production of 22.23 million tonnes. The productivity of the crop is 2476 kgha^{-1}. Andhra Pradesh is one of the important maize producing states with a production of 4.44 m. tonnes from an area of 0.78 million ha with a productivity of 5150 kgha^{-1}. Maize is used not only for human consumption but also as animal & poultry feed, fodder and in other industries. Therefore the cultivation of maize in A.P. has increased from 0 .45 kgha^{-1} to 0.78 kgha^{-1} during 1999-2000 to 2011-12 (57.69%). The important maize growing districts in A.P. are Medak, Mahaboobnagar, Karimnagar, Nizamabad, Warangal, Ranga Reddy, West Godavari and Krishna. In *rabi*, maize is grown in rice fallows and sowing of *Rabi* maize is delayed due to late harvesting of paddy.

The late sown maize was also affected due to non availability of canal water at terminal stage of the crop resulting in low yields particularly in tail-end areas. It is also difficult to prepare land in rice fallows which needs considerable energy, labour and time. Due to these reasons maize area is limited in *rabi* season. Low yields, increased cost of cultivation and shortage of labour necessitated the search for alternative methods of maize cultivation. Zero tillage maize technology was found to be an appropriate solution for the above situation.

Research studies (Singh *et al*. (2013), Rajwee Kumar *et al*, Rajkumara *etal* (2014), and Negi *etal*. (2013) and Amagain (2013) },indicated that Zero tillage practice in rabi for wheat, bajra, maize cultivation gave higher net returns, benefit cost ratio and reduced diesel consumption by 50-60 lit ha^{-1}. Therefore the Zero tillage maize technology was evaluated through On-farm trials (OFTs) and Frontline Demonstrations (FLDs) by few KVKs in Andhra Pradesh to validate its performance vis-à-vis conventional maize cultivation.

MATERIAL AND METHODS

Initially, in 2007-08 and 2008-09, On-farm trials on Zero Tillage Maize cultivation were conducted at 12 locations in the farmers' fields by KVK, Jammikunta in three villages, Keshavapoor, Gopalpoor and Ippala narsingapur of Karimnagar district. Encouraged by the results of these trials in Karimnagar District, the technology was demonstrated through Front Line Demonstrations (FLD) in other districts by KVKs in Andhra Pradesh. Before organizing these demonstrations skill oriented training programmes were conducted to the farmers. Few identified farmers were trained to become master trainers in each district. District Collector and other line department functionaries visited the demonstrations and were convinced about the efficacy of the technology and render their support for large

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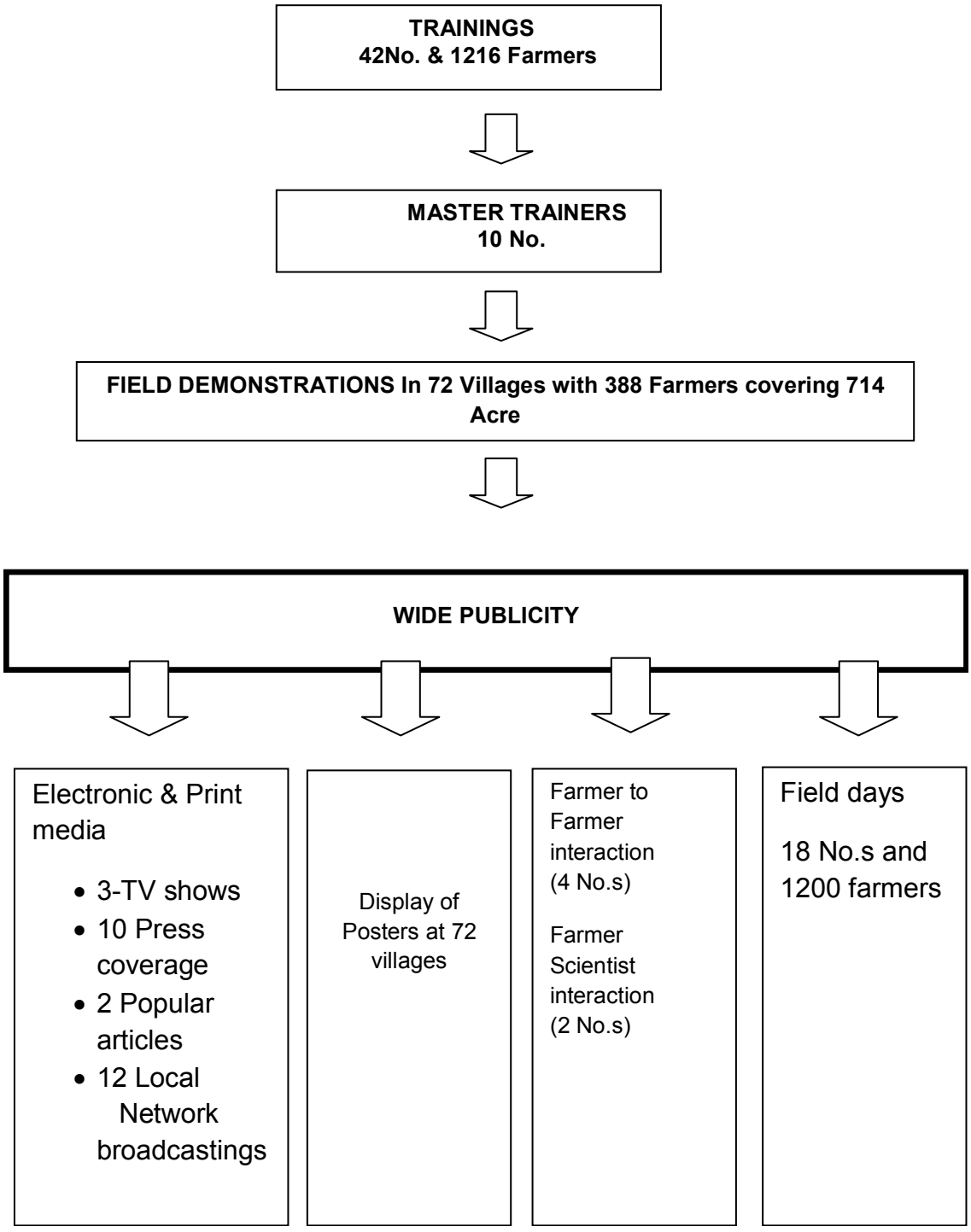
scale adoption. A total of 312 demonstrations (282 ha) were organized during 2009-10 to 2012-13, by six KVKs i.e. Karimnagar, Kurnool, Srikakulam, East Godavari, Ranga Reddy and Warangal. The demonstrations were conducted under irrigated situation in rice fallows with medium black soils / sandy loams. The sowing of crop was taken up in December/ January. The soils were low to medium in nitrogen (N), medium to high in phosphorus (P) and

Fig -1: Extension methodology followed by KVK Karimnagar to upscale the technology



medium to high in potassium (K). Each demonstration was organized in 0.4 ha comparing with farmers practice. The recommended package of practices was followed in both the methods. The present study was undertaken to know the performance of Zero tillage technology under front line demonstrations organized by Krishi Vigyan Kendra and its impact through adoption of the technology. The data on yield and extent of adoption of area were collected with the help of KVK staff and extension agencies. The data were computed through weighted averages and percentages.

RESULT and DISCUSSIONS

Results of the On-farm trials conducted in Karimnagar district are presented in table -1. The results showed that there is a reduction in cost of cultivation (' 3969/ha) in zero tillage maize cultivation due to reduction in cost of tillage and land preparation. Further there was an increase in the yield of maize up to 11 per cent due to timely sowing. There was an increase in net income from ' 23644 (traditional practice) to ' 27763 in zero tillage maize.

Table1. Results of on-farm trials on maize in Karimnagar District during 2007-08 to 2008-09.

Particulars	Zero Tillage Maize	Conventional Maize	Additional
Average Yield (kg/ha)	6375	5737	638
Cost of cultivation (Rs/ha)	18437	22406	3969
Gross Returns (Rs /ha)	46200	46050	150
Net Returns (Rs /ha)	27763	23644	4119
B.C. Ratio	2.50	2.05	

Performance of Zero Tillage Maize under FLDs

The performance of Front Line Demonstrations on Zero Tillage Maize conducted in six districts of Andhra Pradesh was given in Table 2. The analysis of pooled data showed that an average yield of 7356 $kgha^{-1}$ was obtained in the demonstrations compared to 6935 $kgha^{-1}$ recorded in traditional method with an increase of 8.66 per cent in for Zero Tillage maize.

Table 2. Performance of Demonstration with Zero Tillage Maize Technology in AP during 2009-10 to 2011-12

District	Demonstration (No.)	Area (ha)	Average Yield kg/ha		Increase in yield (%)
			Demonstration	Farmers practice	
Karimnagar	210	238	7647	6989	9.41
Kurnool	30	12	6372	6226	2.34
RangaReddy	8	3.2	4790	4456	7.5
Warangal	40	19	6989	6570	6.38
Srikakulam	9	3.7	5705	5500	4.54
East Godavari	15	6	9800	9600	4.16
Total	**312**	**281.9**	**7536**	**6935**	**8.66**

Economic analysis of the FLDs indicated that there was a reduction of ‘ 3828 / ha in the cost of cultivation in zero tillage maize Technology (Table 3). On an average, cost of cultivation in zero tillage maize amounted to ‘ 26334 per ha where as in conventional practice it was ‘ 30163 per ha. The net income in the zero tillage maize was ‘ 53308 per ha which was ‘ 14670 more than the net income with conventional maize cultivation.

Table 3. Economics of FLDs on Zero Tillage Cultivation in Andhra Pradesh

District	Karim Nagar	Kurnool	Ranga Reddy	Warangal	East Godavari	Srikakulam	Total/ Wt. Avg.
Demonstration (No.)	210	30	8	40	15	9	312
Area (ha)	238	12	3.2	19	6	3.7	281.9
Cost of Cultivation (`/ha)							
Demonstration	20069	30640	17825	23225	41000	25250	26334
Farmers practice	24433	38444	19825	25627	41150	31500	30163
Reduction in Cost (Rs/ha)	4364	7804	2000	2402	150	6250	3828
Gross Returns (`/ha)							
Demonstration	75522	84037	50770	60784	94874	109375	79227
Farmers practice	70774	82406	47081	56865	69181	86500	68801
Net returns (`/ha)							
Demonstration	55449	53398	32945	40059	53874	84125	53308
Farmers practice	46340	43963	27256	31238	28031	55000	38638
BC ratio							
Demonstrations	3.74	3	2.85	2.36	2.31	4.33	
Farmers practices	2.86	2	2.39	1.89	1.68	2.74	2.28

Up scaling of Zero Tillage Technology

After successful demonstration of zero tillage maize by KVKs, up scaling activities were taken up in collaboration with Agricultural Technology Management Agency, State Department of Agriculture and other agencies. Activities like training of farmers, master trainers, adarsha rythus and extension personnel, wide publicity through electronic and print media, organization of field days, interactions with farmers etc., were taken up by KVKs. (Fig.1). Due to all these efforts large number of farmers have adopted the technology in different districts of Andhra Pradesh and about 19000 ha of maize area was brought under the zero tillage maize technology in demonstrated villages and districts (Table 4). Karimnagar district ranked first in terms of adoption of highest area (12012 ha) under zero tillage maize cultivation followed by Warangal.

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EFFECT OF STORAGE TEMPERATURE ON PHYSICO-CHEMICAL CHARACTERISTIC AND ORGANOLEPTIC EVALUATION OF RAISINS PREPARED FROM SEEDLESS VARIETIES OF GRAPES (*Vitis vinifera* L.)

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ABSTRACT

The investigation was planned and executed in the Grape Research Station, Rajendranagar, Dr.Y.S.R. Horticultural University, to know the effect of storage temperature (5±1°C, 18±1°C and ambient) on physico-chemical characteristic and organoleptic evaluation of raisins prepared from five seedless varieties of grapes *viz*., Thompson Seedless, 2A Clone, Sonaka, Manik Chaman and Merbein Seedless. Observations were recorded on physico-chemical characteristic like green color retention, weight loss, molds damage, moisture content, brix-acid ratio, ascorbic acid content and organoleptic evaluation *viz*., color and appearance, texture, flavour, taste and overall acceptability of raisins at an interval of 30 days. The raisins stored at 5±1°C in 400 gauge low density polythene bags were superior in terms of studied parameters. Raisins stored at 5±1°C retained greenness upto 93.68 days, whereas at ambient condition the greenness retained only for 35.09 days. Regarding varieties, raisins prepared from Thompson Seedless were good for retention of greenness (77.46 days) and also for other studied characteristics. The physico-chemical characteristic and organoleptic evaluation of raisins was decreased with advancement of storage temperature and storage period in the present study. From this study, it can be concluded that the raisins prepared from variety Thompson Seedless and then stored at 5±1°C were superior for studied parameters.

Grape (*Vitis vinifera* L.) is an important commercial fruit crop in India, which grows in a wide range of climatic conditions. In India, about 78% of grape production is used for table purpose, nearly 17 to 20% is dried for raisin production, while 1.5% is used for juice and only 0.5% is used in manufacturing wine. Raisin is mostly produced from the variety Thompson Seedless and its clones *viz*., Tas-A-Ganesh, Sonaka and Manik Chaman (Adsule *et al*., 2008). The largest producer of dried grapes in the world is USA and Turkey. The raisin production in India is about 1, 60,000 tonnes (DFTS, 2013). Telangana State falls under semi-arid tropical region wherein the major grape cultivation is confined to Ranga Reddy, Mahabubnagar and parts of Nalgonda district. The different varieties of seedless grapes grown here are vigorous and highly productive. The physico-chemical qualities of these grapes are also highly suitable for raisin making.

Raisins are a good source of fiber, K, Fe, Ca and vitamin B and are free from fat and cholesterol. They contain only natural sugars as a source of energy. Green raisins are highly valued for their fresh, attractive green color, sweet flavour and sold for two to three times the price of sun-dried raisins. The technique of raisin production in India is mostly based on the dipping of the grape bunches in emulsion having 2.5% potassium carbonate and 1.5% ethyl oleate for a duration of 2 to 4 minutes, and subsequent shade drying in open tier system (Adsule *et al*., 2012). The dipping oil treatment alone induced soft texture, but it led to the development of brown rather greenish color. Application of antioxidants like ascorbic acid and benzyl adenine effectively reduced browning and increased the storage period of many fruits. Green color is one of the major concerns in raisin production; hence, extensive research is necessary to find the effect of storage temperature on green color retention, physico-chemical characteristic and organoleptic evaluation of raisins prepared from seedless varieties of grapes.

MATERIAL AND METHODS

The experiment was conducted at Grape Research Station, Rajendranagar, Hyderabad in Ranga Reddy district during 2012–14. The Grape Research Station is located at 77°85' East longitude and 18°45' North latitude and at an altitude of 542.6 m above mean sea level. Selected grape bunches of five varieties (Thompson Seedless, 2A Clone, Sonaka, Manik Chaman and Merbein Seedless) were manually harvested, cleaned, washed in soap water followed by washing in pure water and dipped in solution containing 2.4% potassium carbonate, 1.5% ethyl oleate and ascorbic acid 1000 ppm for 3 minutes, and then kept for shade drying in trays. Under shade drying, the trays of pre-treated bunches were placed in well ventilated room at ambient condition. Moisture

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testing was done frequently for a preserved level (approximately 15%).

Dried grapes were manually separated from the rachis and pedicels by twisting and gentle rubbing against the slotted surface of the trays. The prepared raisins were graded based on color. The color classes applied for grading was pale green (consider as green in the entire experiment), brown and mixed (the mixture in which the percentage of dominant color did not exceed 60%). 100 g of raisins were weighed and the separation was done according to the mentioned color classes (Arzani *et al.*, 2009). The moisture was checked to 15% approximately while in drying. Only the graded green color raisins of (V_1) Thompson Seedless (TS), (V_2) 2A Clone (2AC), (V_3) Sonaka (SO), (V_4) Manik Chaman (MC) and (V_5) Merbein Seedless (MS) were packed in 400 gauge low density polyethylene film bags and stored in corrugated boxes at the respective temperatures i.e. (T_1) 5±1°C, (T_2) 18±1°C and (T_3) ambient temperature in triplicate for a period of four months. The changes in physico-chemical properties and organoleptic evaluation of stored raisins were evaluated at monthly intervals (Doreyappa Gowda, 2000).

The green color retention in raisins was determined by recording the number of days as the raisins remained green in storage. The stage wherein more than 25% of the stored raisins showed color change was considered as end of green color retention in that particular replication and expressed as mean number of days. The moisture content of raisins was estimated by oven drying method (Gawade *et al.*, 2003). The weight of the raisins was recorded every month and subtracted from the initial weight of raisins. The loss of weight in relation to initial weight was calculated and expressed as percentage. The total soluble solids (TSS) of raisins was determined by using digital hand Refractometer and the values were corrected at 20°C with the help of temperature correction table (Mazumdar and Majumder, 2003). Acidity of raisins was estimated adopting the procedure given by Ranganna (1977). Brix-acid ratio was calculated by dividing the TSS value by the acid value. Ascorbic acid content of raisins was determined by 2,6-dichlorophenolindophenol visual titration method as suggested by Ranganna (1977). Organoleptic attributes *viz.*, color and appearance, flavour, texture, taste and overall acceptability was done by panel of 15 personnel of both the genders including students and staff using the 5 point hedonic scale (Adsule and Banerjee, 2003).

The experimental data were subjected to analysis of variance (ANOVA) using factorial completely randomized design as per the procedure out lined by Panse and Sukhatme (1985). Least significant differences (Fisher's protected LSD) were calculated following significant F-test (p=0.05).

RESULTS AND DISCUSSION

Green color retention (days)

Significant difference was observed on green color retention of raisins among storage temperature and varieties (Figure 1). Significantly maximum number of days (93.68 days) of green color retention was recorded in raisins stored at 5±1°C followed by 18±1°C (78.38 days) and lowest in ambient condition (35.09 days). With respect to varieties, it was significantly highest (74.46 days) recorded in raisins prepared from Thompson Seedless, which was comparable with Manik Chaman (71.67 days) and lowest in Sonaka (64.47 days) which was on par with Merbein Seedless (66.60 days) and 2A Clone (68.07 days). The interaction between storage temperature and varieties was not significant. The greenness of raisins gradually decreased with progress of storage period and increase of storage temperature. Raisins stored at 5±1°C retained green color for maximum period, which may be due to less activity of polyphenol oxidase at low temperature as reported by Ranveer *et al.* (2010). The raisin color was modified by storage time, temperature and storage atmosphere, where a low temperature and O_2 atmosphere (packaging in low density polyethylene film bags) retarded the color change (Tarr and Clingeleffer, 2005 and Adsule *et al.*, 2008). Thompson Seedless raisins retained green color for maximum days compared to others, which may be due to varied level of polyphenol oxidase enzymes responsible for browning (Serratosa *et al.*, 2012).

Weight loss (%)

The weight loss of raisins was not observed upto 90 days of storage but it was significantly lowest recorded at 5±1°C followed by 18±1°C and highest in ambient condition on 120 days of storage (Figure 2). There was no significant difference among the varieties as well as the interaction between storage temperature and varieties. The weight loss in these raisins gradually increased with increase of storage

temperature which may be due to rapid moisture loss causing shrinkage and loss of turgidity (Mane *et al.*, 2003). A gradual decrease in moisture at 30 to 120 days was evident from the data (Table 1).

Mold damage (%)

Mold damage of raisins prepared from seedless varieties of grape during the study of the experiment was not observed which may be due to alkaline emulsion of ethyloleate with ascorbic acid as a pre-drying treatment because the ascorbic acid, an antioxidant that keeps fruit from darkening and enhances destruction of bacteria during drying (Kendall and Safos, 2012).

Moisture content (%)

It was evident from data that the moisture content recorded highest (15.47%) in raisins stored at 5±1°C followed by 18±1°C (15.36%) whereas lowest recorded in ambient condition (15.25%) at 30 days after storage. Similar trend of moisture content in raisins was also observed at 60, 90 and 120 days after storage. Significantly lowest moisture content of raisins was recorded in Merbein Seedless (15.18%) followed by 2A Clone (15.33%) and highest in Sonaka (15.45%) which was comparable with Manik Chaman (15.44%) and Thompson seedless (15.39%) at 30 days after storage. Similar trend was observed at 60 and 90 days after storage. The interaction effect on moisture content of raisins between storage temperature and varieties was not significant on 30, 60, 90 and 120 days after storage. The weight loss in these raisins gradually increased with increase of storage temperature which may be due to decrease in moisture content (Mane *et al.*, 2003). A gradual decrease in moisture at 30 to 120 days is evident from the data (Table 1).

Brix-acid ratio

Significant difference was observed among the storage temperature with respect to brix-acid ratio (Table 1). Significantly highest brix-acid ratio was recorded in raisins stored at 5±1°C (78.13, 88.14, 98.12 and 103.30 respectively) followed by 18±1°C whereas it was minimum in ambient condition (67.16, 79.10, 87.27 and 91.40 respectively) on 30, 60, 90 and 120 days after storage, respectively. On 30 days after storage, it was significantly highest recorded in Thompson Seedless (81.09) followed by Manik Chaman (78.43) and 2A Clone (72.37) whereas it was lowest observed in Sonaka (63.90) which was on par with Merbein Seedless (66.24). On 60 days after storage, it was recorded maximum in Thompson Seedless (95.15) and lowest in Sonaka (72.60). Similar trend was also observed on 90 and 120 days after storage. The interaction between storage temperature and varieties was not significant on all the days of observation. The brix-acid ratio of raisins increased during storage from 30 to 120 days. A gradual increase of brix-acid ratio was observed during storage as increase of storage temperature and the highest was recorded in Thompson Seedless whereas minimum was noted in Sonaka. The increase in brix-acid ratio of raisins during the storage is due to increased total soluble solids and decreased acidity which ultimately leads to high brix-acid ratio, similar observations were also made by Mahmutoglu *et al.* (1996) and Jadhav *et al.* (2010).

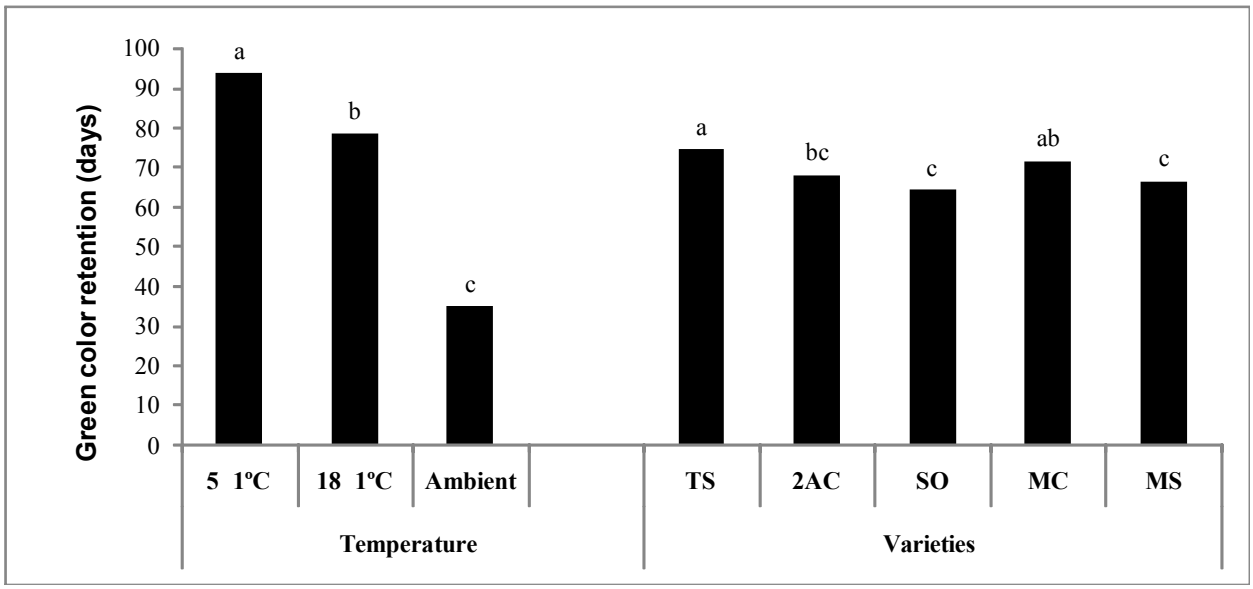
Ascorbic acid content (mg 100 g^{-1})

There was significant difference among the storage temperature with respect to ascorbic acid content of raisins (Table 1). It was a maximum of 19.93 and 19.78 mg 100 g^{-1} recorded in raisins stored at 5±1°C which was comparable with 18±1°C (19.90 and 19.74 mg 100 g^{-1}) whereas it was lowest in ambient condition (19.83 and 19.68 mg 100 g^{-1}) on 30 and 120 days after storage. After 60 and 90 days of storage, significantly maximum ascorbic acid content was noted in raisins stored at 5±1°C (19.86 and 19.80 mg 100 g^{-1}) and lowest in ambient condition (19.76 and 19.68 mg 100 g^{-1}). It was evident from data that significantly highest ascorbic acid content of raisins was recorded in Thompson Seedless (20.40 mg 100 g^{-1}) and lowest in Sonaka (19.44 mg 100 g^{-1}) on 30 days after storage. Similar trend was also observed on 60, 90 and 120 days after storage. The interaction between storage temperature and varieties was not significant with on all the days of observation. It was found to decrease with increase in storage temperature and raisins stored at 5±1°C recorded higher values, which may be lower loss of nutrient at low temperature (Mahmutoglu *et al.*, 1996). The ascorbic acid content of raisins decreased during storage from 30 to 120 days during storage. A gradual but continuous reduction in ascorbic acid may be attributed to its degradation in various metabolic processes of the stored raisins. The reduction in ascorbic acid content of raisins may be due to higher rate of oxidation. Similar observations were also reported by Simal *et al.* (1996).

Table 1. Effect of storage temperature on moisture content (%), Brix-acid ratio and ascorbic acid content (mg/100g) of raisins prepared from seedless grape varieties.

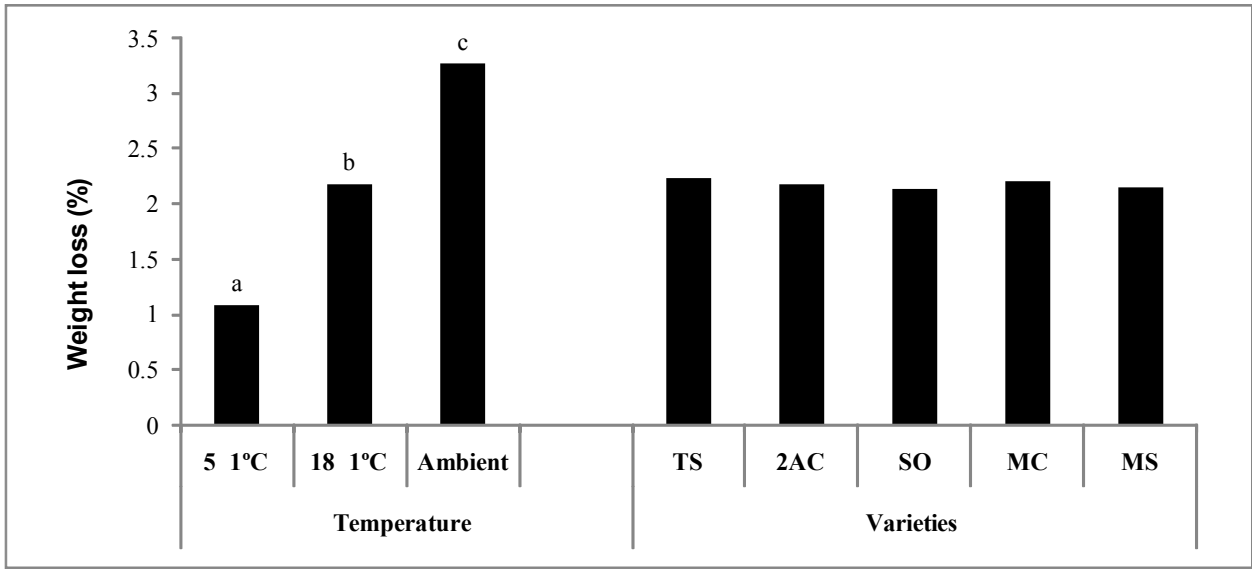
Temperature (T)	Moisture content (%)				Brix-acid ratio				Ascorbic acid content (mg/100g)			
	Days after storage				Days after storage				Days after storage			
	30	60	90	120	30	60	90	120	30	60	90	120
T_1 – 5±1ºC	15.47^{a}	15.45^{a}	15.40^{a}	14.30^{a}	78.13^{a}	88.14^{a}	98.12^{a}	103.30^{a}	19.93^{a}	19.86^{a}	19.80^{a}	19.78^{a}
T_2 – 18±1ºC	15.36^{b}	15.34^{b}	15.29^{b}	14.19^{b}	71.92^{b}	83.83^{b}	92.93^{b}	97.60^{b}	19.90^{a}	19.82^{b}	19.76^{b}	19.74^{a}
T_3 – Ambient	15.25^{c}	15.23^{c}	15.17^{c}	14.07^{c}	67.16^{c}	79.10^{c}	87.27^{c}	91.40^{c}	19.83^{b}	19.76^{c}	19.68^{c}	19.68^{b}
S.Em±	0.02	0.02	0.02	0.01	0.63	0.67	0.75	0.85	0.01	0.01	0.01	0.01
CD at 5%	0.05	0.05	0.05	0.04	1.83	1.94	2.18	2.45	0.04	0.02	0.02	0.04
Varieties (V)												
V_1 – Thompson Seedless	15.39^{bc}	15.37^{bc}	15.32^{c}	14.22^{c}	81.09^{a}	95.15^{a}	106.61^{a}	112.66^{a}	20.40^{a}	20.33^{a}	20.27^{a}	20.25^{a}
V_2 – 2A Clone	15.33^{b}	15.31^{b}	15.26^{b}	14.16^{b}	72.37^{c}	83.52^{c}	92.46^{c}	97.03^{c}	19.89^{c}	19.82^{c}	19.76^{c}	19.74^{c}
V_3 – Sonaka	15.45^{c}	15.43^{c}	15.37^{c}	14.28^{d}	63.90^{d}	72.60^{e}	79.51^{e}	82.91^{e}	19.44^{e}	19.37^{e}	19.31^{e}	19.29^{e}
V_4 – Manik Chaman	15.44^{c}	15.42^{c}	15.37^{c}	14.27^{d}	78.43^{b}	91.58^{b}	102.24^{b}	107.82^{b}	20.00^{b}	19.93^{b}	19.87^{b}	19.85^{b}
V_5 – Merbein Seedless	15.18^{a}	15.16^{a}	15.11^{a}	14.01^{a}	66.24^{d}	75.60^{d}	83.05^{d}	86.75^{d}	19.66^{d}	19.59^{d}	19.53^{d}	19.51^{d}
S.Em±	0.02	0.02	0.02	0.02	0.82	0.87	0.97	1.09	0.02	0.01	0.01	0.02
CD at 5%	0.06	0.06	0.07	0.05	2.36	2.50	2.82	3.16	0.05	0.03	0.03	0.05
Interaction (T x V)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Figures with different alphabet within temperature and varieties on each day after storage are significantly different at pd ≤ 0.05; NS–Not significant.



Bars labelled with the same alphabets within temperature and varieties were not significantly different at p≤0.05.

Figure 1. Green color retention (days) of raisins prepared from seedless varieties of grapes as influenced by storage temperature.



Bars labelled with the same alphabets within temperature were not significantly different at p≤0.05.

Figure 2. Weight loss (%) of raisins prepared from seedless varieties of grapes as influenced by storage temperature at 120 days after storage.

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PROBLEMS IDENTIFIED IN ADOPTED VILLAGE OF KRISHI VIGYAN KENDRA, DARSI WITH PROBLEM IDENTIFICATION TECHNIQUE (PIT)

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ABSTRACT

Problem Identification Technique (PIT) was used to identify the problems of Batchalakurapadu village during the year 2013-14. Fifty key informants and farmers were selected for PIT analysis. Problems were identified by using Magnitude value, Average Extent of Damage (AED) and area under the crop. The major problems identified were *Maruca* in redgram, Blast in paddy, pod borer damage in cowpea, chaffy grains in paddy, Yellow Mosaic Virus in blackgram, Bacterial Leaf Blight (BLB) in paddy, Flower and bud drop in cotton, fruit rot and die back in chilly, increased cost of cultivation in cotton and price fluctuations in chilly.

The basic purpose of Research and Extension in Agriculture is to develop technologies or prepare programmes for development based on the needs of the farmers and the problems faced by the farmers in actual field situation. Extension is often pictured as intermediary between the research system and the farmer. Information from research is passed on to extension for transfer to the farmers and farmers' problems are fed back by extension to help shape research priorities. In practice, the first linkage is usually not well developed and the second is almost non-existent. Although on-farm research offers an opportunity for rectifying this situation, there is much that remains to be done (Byerlee and Tripp, 1988).

Most of the research and extension programmes if claimed carefully will be found not wholly relevant to the farmers' needs (Cernea *et al.*, 1985). Classifying the problems and defining the needs of the farmers is an important step in programme planning in extension.

But, this step was not at all followed while planning agricultural production programmes at village level (Sabarathnam and Acharjee, 1975)

The research stations are not generally geared to produce technologies applicable to very specific and quite different agro- climatic conditions. Peasants have not been given much opportunity to actively participate in the identification of their agricultural problems. Less involvement of farmers in problem identification has greatly contributed towards the inapplicability of most of the research and research findings. Identification of major problems in a representative technological zone is the first step in any research and extension strategy and innovation development process. Keeping in view of this, an attempt has been made in this paper to identify the problems of adopted village of Krishi Vigyan Kendra (KVK) to plan relevant, need based and appropriate extension programmes.

MATERIAL AND METHODS

The present study was undertaken in Batchalakurapadu village, Konakanamitla mandal of Prakasam district in Andhra Pradesh. A set of steps suggested by Sabarathnam (2002) for identification of problems from farmers were adopted in the study and the steps were as fallows.

1. Identification of Key informants in village: Fifty key informants who know the in and outs of the various aspects of the village and practicing farmers were selected by using snow ball sampling technique.

2. Ranking the problems: Key informants identified were asked separately to list the general problems in agriculture faced by the farmers of the village. Further, they have been asked to rank the problems based on urgency, importance and magnitude.

3. Estimating the economic importance: The Key informants were asked to indicate the extent of loss incurred by the farmer due to the problem or extent of damage caused by the problem.

4. Contacting the required number of farmers and key informants: From all 50 key informants selected by snow ball sampling technique, Information was collected on problems, ranked the problems expressed and loss or extent damage caused due to each problem in percentage.

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5. Entering the ranks: For each problem the ranks given by the key informants were entered

6. Quantifying the data in terms of RBQ estimation: The RBQ formula given by Sabarathnam (1988) was used to find out the importance of the problems as perceived by the farmers and key informants.

$$RBQ = \frac{\sum (Fi)(n+1-i)}{Nn} \times 100$$

Where **RBQ =** Rank Based Quotient

Fi = Frequency of the farmers for ith rank of the problem

N= Number of farmers contacted for problem identification

n= The maximum number of ranks given for the various problems by a farmer among all the farmers contacted

" It directs to sum the multiplication factors

7. Collection of data for area for the crops grown: Information on the area of each crop grown in the village was collected by base line survey

8. Estimation of the magnitude value of the problem: Magnitude value of the problem is calculated by the following formula given by Sabarathnam (1988)

Village Magnitude Value (VMV) = RBQ ´ AEOD or AYLP ´ AC

RBQ = Rank Based Quotient

AEOD = Average Extent of Damage

AYLP = Average Yield Loss in percentage

AC = Area under the crop in the village

RESULTS AND DISCUSSION

Problems identified from the farmers of Batchalakurapadu village

Perusal of the Table 1 indicates that great majority of the key informants and farmers of Batchalakurapadu village identified Yellow Mosaic Virus in blackgram and pod borer damage in cowpea as major problems in agriculture (96.00 %), followed by *Maruca* in redgram (92.00%), flower and fruit drop in cotton (90.00%), increased cost of cultivation in cotton (88.00%), fruit rot and die back in chilly (84.00%), blast in paddy (82.00%), chaffy grains in paddy (72.00%), Bacterial Leaf Blight (BLB) in paddy (66.00%) and price fluctuations in chilly (58.00%).

Rank Based Quotient (RBQ) values for the problems identified in Batchalakurapadu village

RBQ values for all identified problems were calculated using the formula given by Sabarathnam (1988) and presented in Table 2. It is evident from the table that highest RBQ value was observed for the problem Yellow Mosaic Virus in blackgram (72.96) followed by pod borer damage in cowpea (70.86), flower and bud drop in cotton (66.33), blast in paddy (65.42), chaffy grains in paddy (64.81), *Maruca* in redgram (52.50), BLB in paddy (41.48%), fruit rot and die back in chilly (33.14), increased cost of cultivation in cotton (29.36) and price fluctuation in chilly (21.75).

Average yield loss in percentage for the problems identified in Batchalakurapadu Village

Data with respect to average yield loss caused by each problem was calculated and presented in Table 3. It is clear from the table that on an average great loss was evinced with Yellow Vein Mosaic disease in blackgram (68.20%), followed by pod borer damage in cowpea (59.50%), flower and bud drop in cotton (52.67%), *Maruca* in redgram (47.33%), fruit rot and die back in chilly (46.24%), blast in paddy (42.75%), chaffy grains in paddy (32.50%), BLB in paddy (28.67%), increased cost of cultivation in cotton (19.26%) and price fluctuations in chilly (15.67%).

Table 1. Problems identified by the farmers of Batchalakurapadu village

S.No	Problem expressed	Frequency	% farmers
1.	Yellow Mosaic Virus in blackgram	48	96.00
2.	Pod borer damage in cowpea	48	96.00
3.	*Maruca* in redgram	46	92.00
4.	Flower and bud drop in cotton	45	90.00
5.	Increased cost of cultivation in cotton	44	88.00
6.	Fruit rot and die back in chilly	42	84.00
7	Blast in paddy	41	82.00
8	Chaffy grains in paddy	36	72.00
9	BLB in paddy	33	66.00
10	Price fluctuations in chilly	29	58.00

Table 2. Rank Based Quotient (RBQ) values for the problems identified in Batchalakurapadu village

S.No	Problem expressed	RBQ value
1.	Yellow Mosaic Virus in blackgram	72.96
2.	Pod borer damage in cowpea	70.86
3.	Flower and bud drop in cotton	66.33
4.	Blast in paddy	65.42
5.	Chaffy grains in paddy	64.81
6.	*Maruca* in redgram	52.50
7	BLB in paddy	41.48
8	Fruit rot and die back in chilly	33.14
9	Increased cost of cultivation in cotton	29.36
10	Price fluctuations in chilly	21.75

Table 3. Average yield loss in percentage for the problems identified in Batchalakurapadu Village

S.No	Problem expressed	Average percent yield loss
1.	Yellow Mosaic Virus in blackgram	68.20
2.	Pod borer damage in cowpea	59.50
3.	Flower and bud drop in cotton	52.67
4.	*Maruca* in redgram	47.33
5.	Fruit rot and die back in chilly	46.24
6.	Blast in paddy	42.75
7	Chaffy grains in paddy	32.50
8	BLB in paddy	28.67
9	Increased cost of cultivation in cotton	19.26
10	Price fluctuations in chilly	15.67

Magnitude value for the problems identified in Batchalakurapadu village

Magnitude value for each identified problem was calculated by multiplying Rank Based Quotient value with Average Yield Loss (AYL) in percentage and Area under crop in the village. With the help of Magnitude Value the problems were prioritized by ranking. As the problem of *Maruca* in redgram has scored the maximum value it had been spotted as top most problem of the village by giving first rank.

The reason for this result was redgram is cultivated in huge area i.e., 260 ha, with 52.50 RBQ value and 47.33 per cent average yield loss. Hence this problem was given top most priority by KVK, Darsi by planning Front Line Demonstrations and training programmes on *Maruca* pod borer management in redgram in this village. To mitigate next prioritized problems viz., blast in paddy (Rank II), chaffy grains in paddy (Rank IV) and BLB in paddy (Rank VI) demonstrations on Integrated Disease Management in paddy were planned. Pod borer damage in cowpea (Rank III), Yellow Mosaic Virus in blackgram (Rank V), Fruit rot and die back in chilly (Rank VIII) were the problems which have been emphasized more in plant protection training programmes. Awareness programmes were organized to tackle Flower and fruit drop in cotton (Rank VII) and increased cost of cultivation in cotton (Rank IX). The problem of price fluctuations in chilly was mitigated by providing the farmers information on market forecast though Kisan Mobile Advisory services.

Table 4. Magnitude value for the problems identified in Batchalakurapadu village

S.No	Problem expressed	Area under crop in ha	Magnitude value	Rank
1.	*Maruca* in redgram	260	646055	I
2.	Blast in paddy	76	212550	II
3.	Pod borer damage in cowpea	40	168647	III
4.	Chaffy grains in paddy	76	160081	IV
5.	Yellow Mosaic Virus in blackgram	32	159228	V
6.	BLB in paddy	76	90382	VI
7	Flower and bud drop in cotton	22	69067	VII
8	Fruit rot and die back in chilly	25	38310	VIII
9	Increased cost of cultivation in cotton	22	12440	IX
10	Price fluctuations in chilly	25	8521	X

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ADOPTION OF IMPROVED FARM IMPLEMENTS RECOMMENDED BY VASANTRAO NAIK MARATHWADA KRISHI VIDYAPEETH

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ABSTRACT

The study was conducted in purposively selected three talukas *viz.,* Jintur, Parbhani and Purna of Parbhani District of Marathawada region of Maharashtra state during the year 2014-15. From each taluka, four villages selected purposively and from each village10 respondents were selected purposively, there by constituting a total sample size of 120 respondents. Data were collected by using personal interview method. The collected data were tabulated, analyzed and interpreted with the help of appropriate statistical tools. Majority of respondents were found having medium level of adoption of improved farm implements. It was observed that farming experience, social participation, extension contact, economic motivation and risk orientation had non-significant relationship with adoption of recommended improved farm implements whereas education, land holding, annual income and source of information had significant relationship with adoption of recommended improved farm implements by the respondents.

Agricultural Mechanization embraces the use of tools, implements and machines for agricultural land development, crop production, harvesting and preparation for storage, storage, and on-farm processing. It includes three main power sources: human, animal, and mechanical. The manufacture, distribution, repair, maintenance, management and utilization of agricultural tools, implements and machines is covered under this discipline with regard as to how to supply mechanization inputs to the farmer in an efficient and effective manner. Improved farm implements and machinery are rightly called as inputs of input. It has been recognized as an integral part of agricultural development for improving resource use efficiency and productivity in agriculture. Improved farm implements are used for primary and secondary tillage operations, and harvesting of the crops, post harvest operations like threshing can also carried out with the help of improved farm implements and machinery. Improved farm implements perform field operations speedily, efficiently, uniformly and relieving the farmers from drudgery of the physical work.

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The cropping systems like multiple and relay cropping can also possible with the help of improved farm implements. It means that, with proper use of improved farm implements farmers can produce more with minimum labour cost.

MATERIAL AND METHODS

The present study was purposively undertaken in the three talukas *viz.,* Jintur, Parbhani and Purna talukas of Parbhani district of Maharashtra state. Four villages were purposively selected from each taluka on the basis of higher number of respondents having farm implements. Thus, total twelve villages were purposively selected. From each selected village, 10 respondents were selected purposively by making a sample of 120 respondents. The present study was confined to ex-post-facto research design. The independent variables were measured by using suitable scales and procedures adopted by various researchers in past with due modification. The dependent variable taken up in this study was adoption of improved farm implements which was measured by developed structured schedule. An interview schedule was developed according to objectives of study and the data were collected by arranging personal interview with 120 respondents. The collected data were classified, tabulated and analyzed in order to make the findings meaningful.

RESULTS AND DISCUSSION

Socio-Personal characteristics of the farmers:

The personal, socio-economical, communicational, psychological and situational characteristics of the

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famers were studied and the data have been given in Table1.

Table 1. Distribution of the respondents according socio personal characteristics. (N=120)

Sr. No	Category	Frequency	Percentage
Education (standard classification)			
1.	Illiterate	13	10.84
2.	Primary (1-4 std)	27	22.50
3.	Secondary (5-7 std)	44	36.66
4.	Higher secondary (7-12 std)	30	25.00
5.	College level	06	5.00
Land holding (As per Govt. of Maharashtra)			
1.	Marginal (up to 1 ha)	13	10.83
2.	Small (1.1 to 2 ha)	41	34.17
3.	Semi-medium (2.1 to 4 ha)	47	39.17
4.	Medium (4.1 to 10 ha)	19	15.83
5.	Large (10.1 ha and above)	0	0.00
Annual income			
1.	Low(up to Rs.93638.59)	12	10.00
2.	Medium (Rs.93639-Rs.575111.39)	86	71.67
3.	High (Rs.575111.40 and above)	22	18.33
	Mean: Rs 334377.00 & SD: Rs 240736.00		
Farming experience			
1.	Experience up to 9 years	18	15.00
2.	Experience in between 10-22 years	77	64.17
3.	Experience above 23 years	25	20.83
	Mean: 15.76 yrs & SD: 6.40 yrs		
Social participation			
1.	Low (up to 2.46)	16	13.34
2.	Medium (2.47-4.14)	94	78.33
3.	High (4.15 and above)	10	8.33
	Mean: 3.3 & SD: 0.84		
Extension contact			
1.	Low (up to 1.59)	20	16.67
2.	Medium (1.60-4.64)	84	70.00
3.	High (4.65 and above)	16	13.33
	Mean: 3.12 & SD: 1.52		
Source of information			
1.	Low (up to 16.86)	19	15.83
2.	Medium (16.87-26.87)	84	70.00
3.	High (26.88 and above)	17	14.17
	Mean: 21.84 & SD: 5.00		
Economic motivation			
1.	Low (up to 17.36)	23	19.17
2.	Medium (17.37-23.14)	88	73.33
3.	High (23.15 and above)	9	7.50
	Mean: 20.85 & SD: 2.89		
Risk orientation			
1.	Low (up to 17.30)	21	17.50
2.	Medium (17.31-21.78)	73	60.83
3.	High (21.79 and above)	26	21.67
	Mean: 19.55 & SD: 2.24		

It was evident that more than one-third (36.66 %) of respondents were having secondary level of education followed by 25.00 per cent respondents in higher secondary level of education. Only 22.50 per cent respondents had education up to primary level whereas, 10.84 per cent respondents were illiterate and 5.00 per cent respondents had education up to college level. Most of the respondents (39.17 %) had semi- medium size of land followed by small (34.17 %), medium (15.83 %) and marginal (10.83 %). Whereas none of the respondents found in large land holding category. The majority (71.67 %) of the respondents had medium annual income, followed by 18.33 per cent and 10.00 per cent had high and low annual income, respectively. More than half of respondents (64 17.%) were having 9 to 22 years farming experience, whereas 20.83 per cent of the respondents were having farming experience of more than 23 years. While 50.00 per cent respondents were having farming experience less than 9 years. It was observed that most (78.33 %) of the respondents were in medium social participation group, followed by 13.34 per cent of the respondents having low level of social participation and 8.33 per cent of them had high social participation. As far as extension contact of the respondents was concerned, 70.00 per cent of them had medium extension contact followed by 16.67 per cent having low extension contact and only 13.33 per cent farmers were having high extension contact. Majority of the respondents (70.00 %) had medium level of utilization of sources of information, about 15.83 per cent of the respondents having low level of utilization of sources of information followed by 14.17 per cent of the respondents having high level of sources of information. It was noticed that most (73.33 %) of the respondents had medium economic motivation followed by low (19.17 %) economic motivation and high (7.50 %) economic motivation. It was observed that half of the (60.83 %) respondents had medium level of risk orientation followed by high (21.67 %) and low (17.50 %) risk orientation.

Implement wise adoption of improved farm implements:

Table 2. Distribution of respondents according to implement wise adoption of improved farm implements recommended by VNMKV. (N=120)

Sr No	Recommended implements	Frequency	Percentage	Rank
I	**Man operated implements**			
1	Cotton uprooting hipe	86	71.66	I
2	Ransawadi	46	38.33	II
3	Sugarcane knife	45	37.50	III
4	Paddy threshing machine	40	33.33	IV
5	MKV hand hoe	24	20.00	V
6	Seed treatment drum	17	14.16	VI
7	MKV sickle	16	13.33	VII
8	Gunny bag filling machine	04	3.33	VIII
9	Bhendi plucker	00	00	-
10	Fruit cutting machine	00	00	-
11	Maize shelling machine	00	00	-
12	Rotary maize shelling machine	00	00	-
13	Nalikadar maize shelling machine	00	00	-
14	Biba breaking machine	00	00	-
15	MKV dibbling machine	00	00	-
16	Bamboo machine	00	00	-
17	Seed and fertilizer spreading machine	00	00	-
18	Peg breaking machine	00	00	-
19	Sunflower threshing machine	00	00	-
II	**Bullock drawn improved farm implements**			
1	MKV tifan	82	68.33	I
2	Bullock drawn seed and fertilizer tifan	75	62.50	II
3	Sara yantra	74	61.66	III
4	Groundnut digging machine	60	50.00	IV
5	One row sowing machine	48	40.00	V

III	**Tractor drawn farm implements**			
1	Rotavater and plough	98	81.66	I
2	Banding machine	46	38.33	II
3	Spraying machine	00	00.00	-
IV	**Other university developed but VNMKV recommended implements**			
1	Knapsac spraying machine	118	98.33	I
2	Ridger	55	45.83	II
3	Electrical threshing machine	35	29.16	III
4	Rotavator	20	16.66	IV
5	Multipurpose sowing machine	0	00.00	-
V	**Traditional farm implement**			
1	Bullock cart	114	95.00	I
2	Deshi harrow	112	93.33	II
3	Deshi iron plough and wooden tifan	110	91.66	III
4	Wooden hoe	96	80.00	IV
5	Wooden plough	90	75.00	V
6	Keni	62	51.66	VI

The (table 2) indicates that implement wise adoption of improved farm implements

i) Man operated improved farm implements: The cotton uprooting hipe is adopted by most of the respondents in per cent 71.66 per cent which ranks first. The Ransawdi, sugarcane knife, paddy threshing machine were adopted by respondents in per cent 38.33, 37.50, 33.33 per cent respectively. Hand hoe, seed treatment drum, MKV sickle, gunny bag filling machine are having very less adoption in per cent 20.00, 14.16, 13.33, 3.33 per cent respectively. Other remaining improved farm implements were not adopted by respondents such as bhendi plucker, fruit cutting machine, maize shelling machine , rotary maize shelling machine, nalikadar maize shelling machine, biba breaking machine, MKV dibbling machine, bamboo machine, seed and fertilizer spreading machine, peg breaking machine, sunflower threshing machine.

Cotton uprooting hipe was adopted by most of the farmers because it is convenient and time saving. Other implements adopted very less may be due to inadequate knowledge about man operated improved farm implements. And also man operated implements more time and labours are required, due to which there was less adoption observed.

ii) Bullock drown improved farm implements: The majority (68.33 %) of the respondents had adoption of MKV tifan which ranks first, followed by bullock drawn seed and fertilizer tifan i.e. 62.50 per cent which ranks second. Sara yantra is having adoption about 61.66 per cent which ranks third, followed by groundnut digging machine i.e. 50.00 per cent. One row sowing machine is having very less adoption i.e. 40.00 per cent.

Indian farmers are still not ready for mechanized farming due to low economic condition and small land holding, so they make full use of bullock drawn implements. They are also economical affordable to them.

iii) Tractor drawn farm implements: In tractor drawn implements majority of respondents i.e. 81.66 per cent had adopted rotavator and plough which ranks first, while 38.33 per cent had adopted band forming machine. Whereas, none of the respondent adopted tractor drawn spraying machine.

For preparatory tillage operation adoption of rotavator and plough was high, because it is easy to operate, cost saving, time saving. Land holding of farmers was medium and cost of tractor drawn spraying machine is high, due to that non adoption of tractor drawn spraying machine.

iv) Other university developed but VNMKV recommended implements: The table 2 indicates that majority of respondents 98.33 per cent adopted knapsack spraying machine which ranks first, while 45.83 per cent had adopted ridger which ranks second. The electric threshing machine and rotavator had very less adoption i.e. 29.16 and 16.66 per cent respectively. None of the respondent adopted multipurpose sowing machine.

Knapsack sprayer was adopted by considerable number of farmers because it is very easy to use economically affordable to the farmers.

v) Traditional Farming implements: Majority (95.00 %) of the respondents are having bullock cart which ranks first, 93.33 per cent had adoption of deshi harrow which ranks second, while deshi iron plough and wooden tifan had equal adoption i.e. 91.66 per cent. Eighty per cent of the respondents adopted wooden hoe while wooden plough by 75.00 per cent and keni is adopted by 51.66 per cent respondents respectively.

Due to medium size of land holding and annual income farmers cannot afford improved farm implements and they don't go for mechanized farming. It is also not economical to purchase improved farm implements for limited size of land. Thus most of the farmers are still using traditional implements.

The above findings were similar with the findings of Salunkhe (1994), Jalak (2002), Mahanavar (2013) and Nagraj *et al.* (2013).

Extent of overall adoption of improved farm implements

Table 3. Distribution of the respondent according to their extent of adoption of farm implements (n=120)

Sr. No	Category	Frequency	Percentage
1	Low (up to 13.20)	22	18.33
2	Medium (13.21 to 24.10)	80	66.67
3	High (24.11 and above)	18	15.00
	Total	120	100.00
Mean=18.16 & SD=5.45			

Table 3 indicates that more than half of the (66.67 %) respondents had medium level of adoption, while (15.00 %) had high and only 18.33 per cent had low level of adoption of farm implements.

Majority of respondent adoption level was medium, may be due to medium education, medium land holding, medium annual income and medium knowledge. The similar results were observed by Akshaya Ghintala and Kishan Singh (2013).

Coefficient of correlation between profiles of respondents with adoption of recommended improved farm implements

Table 4. Relationship of profile of respondents with adoption of recommended improved farm implements

Sr. No	Independent variables	Adoption('r' value)
1.	Education	0.2658^{**}
2.	Land holding	0.4902^{**}
3.	Annual income	0.4811^{**}
4.	Farming experience	-0.0312^{NS}
5.	Social participation	0.1721^{NS}
6.	Extension contact	0.1776^{NS}
7.	Sources of information	0.4606^{**}
8.	Economic motivation	0.1809^{NS}
9.	Risk orientation	0.1567^{NS}

It was observed from table 4 that farming experience; social participation, extension contact, economic motivation and risk orientation had non-significant relationship with adoption of recommended improved farm implement of the respondents. Whereas education, land holding, annual income and source of information had significant relationship with adoption of recommended improved farm implement by the respondents. It indicates that the farmers having more education helps to increase knowledge and also increases their adoption of improved farm implements. Land holding is more farmers are interested to purchase improved farm implements for cultivation of land. Higher annual income leads to high investment on farming for use of cost intensive technologies and thus increases knowledge. More use source of information farmers get more knowledge about improved farm implements, he also came to know benefits of farm implements and thus adoption of improved farm implements recommended by Vasantrao Naik Marathwada Krishi Vidyapeeth increase. The similar results were observed by Ambavane (2014), Sawale (2011), Atar (2012), Lad (2013) .

CONCLUSIONS

The majority of the respondents having secondary and higher secondary education, semi medium size of land holding, having annual income between Rs. 93639 to Rs. 575111.39, having farming experience between 10-22 years, medium social participation, extension contact, source of information, economic motivation and risk orientation respectively. University has developed number of implements but traditional farm implements are more adopted by the farmers followed by bullock drawn farm implements developed by VNMKV, Parbhani. Majority of the respondents were found to have medium level of adoption of farm implements. It was observed that farming experience, social participation, extension contact, economic motivation and risk orientation had non-significant relationship with adoption of recommended improved farm implement of the respondents whereas education, land holding, annual income and source of information had significant relationship with adoption of recommended improved farm implement by the respondents.

Therefore it is suggested that the State Dept of Agril., SAUs, extension agencies should motivate the farmers for better participation in exhibition, krishi meala etc along with that they must trained by organizing group discussion and by organizing training programme on improved agricultural implements. It helps for increasing adoption of improved farm implement by the respondents.

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Research Note
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DETERMINATION OF TRICHOME DENSITY IN DIFFERENT DUAL TOXIN TRANSGENIC BT COTTON (*Gossypium Spp.*) HYBRIDS (BG-II) AND NON-BT

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Among the sucking pests attacking cotton, leafhoppers (*Amrasca biguttula biguttula*) are very important. Both nymphs and adults suck the sap from under surface of the leaf causing specking symptoms, crinkling, distortion of leaves and reddening all along the sides of leaves with downward curling. At present, most of the commonly used insecticides are not able to suppress its population below economic thresholds probably because of development of resistance. Alternately, host plant resistance vis-à-vis, morphological characters of plants like trichomes and allelochemical can be exploited against the leafhoppers.

Seven different BG-II hybrids and a non Bt hybrid were evaluated for trichome density on lower side of the leaves. Leaves were collected from unsprayed plots. For measuring trichome density, leaf segments (approximately 2 cm^2) were cleared in acetic acid; alcohol (2:1) and transferred to 90% lactic acid in small vials (Maiti *et al*., 1980). The leaf segments were then mounted on a slide in a drop of lactic acid and observed under stereo microscope at a magnification of 4x. The number of trichomes on lower surface was counted in three microscopic fields at random and expressed as trichome density.

The data on trichomes showed that significantly highest trichomes were present in Orugallu Krishna (84.80/4x microscopic area) and Neeraja (76.20) which were on par with each other but significantly superior over other hybrids evaluated (64.60 to 35.40 trichomes/4x microscopic area). Significantly lowest trichomes were registered in RCH-2 (35.60 / 4 x microscopic area)(Table-1).Studies on leaf hopper population revealed significantly low population in Orugallu Krishna (2.32) and Neeraja (2.41) during 2011-12 and 2012-13.While, RCH-2 had lower trichome density and significantly higher leafhopper population(5.15). Dwivedi *et al*. (1986) reported that genotype crosses with long trichomes on leaves and petioles showed high level of resistance to leafhopper as evidenced by very low per cent of yellowed foliage (hopper burn). Earlier, Butler *et al*.(1991) opined that leafhopper population decreased but the whitefly population increased as the number of trichomes increased. Similar reports by Kalpana *et al.* (2009) and Murugesan and Kavitha (2010) have confirmed that the leafhoppers population was negatively correlated with trichome density.

Table-1.Trichome density in different BG-II hybrids at 4x magnification microscopic area (lower side)

Treatments	Trichomes	Overall mean of leafhoppers
Bunny BG-II	63.20^{bc}	2.93^{abc} (1.97)
Mallika BG-II	64.60^{b}	2.88^{abc} (1.96)
Neeraja BG-II	76.20^{a}	2.41^{ab} (1.84)
Brahma BG-II	53.60^{c}	2.89^{abc} (1.97)
Tulasi-9 BG-II	62.13^{bc}	3.04^{bc} (2.00)
RCH-2 BG-II	35.60^{d}	5.15^{d} (2.47)
RCH-530 BG-II	59.33^{bc}	3.12^{c} (2.02)
Orugallu Krishna (Non Bt)	84.80^{a}	2.32^{a} (1.82)
CD at 5%	10.47	0.17
SE m±	3.46	0.05
CV %	9.61	4.96

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Research Note
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INCIDENCE PATTERN OF SUCKING INSECT PESTS WITHIN PLANT CANOPY OF SELECTED COTTON (*Gossypium Spp*.) BT AND NON-BT CULTIVARS

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In India, cotton (*Gossypium Spp.*) crop is damaged by several insect pests comprising of bollworms and sap sucking pests. The sucking pests include aphids, *Aphis gossypii* (Glover); leafhoppers, *Amrasca biguttula biguttula* (Ishida); whiteflies, *Bemisia tabaci* Genn.; and thrips, *Thrips tabaci* Lindeman that damage the crop with regular occurrence at different growth stages and reduce the growth and yield up to 21.20 per cent (Dhawan *et al*., 1988). Considering the importance of the sucking insect pests, the investigations were carried out on their incidence pattern within plant canopy.

A bulk crop of two stacked *Bt* cotton hybrids *viz*., RCH 2 BG II and Mallika BG II and non-*Bt* varietal cotton *i.e.* L 604 was raised in an area of 500 m^2 under normal agronomic practices without any insect pest management practices during two seasons, *kharif* 2009-10 and *kharif* 2010-11. Population count of aphids (adults), leafhoppers (nymphs and adults), whiteflies (adults) and thrips (adults) was taken from three leaves one each at top, middle and bottom portions from two monopodials and also from top three leaves of the main stem from 60 days after sowing to last picking at weekly interval on 25 randomly selected plants in bulk plot of each cotton type. The population data was averaged from all the weeks to arrive at the pest incidence at top, middle and bottom level of crop canopy and analyzed through Split Plot Design using Microsoft Excel.

Mean incidence pattern of sucking pests within plant canopy of the cotton hybrids/variety during twin years of both *kharifs* of 2009-10 and 2010-11 showed that there is significant variation in the occurrence of the insect pest at different heights in the plant canopy and among cotton hybrids/variety (Table 1).

Aphid populations were significantly higher and on par at bottom and middle canopy level compared to top in all the three cotton hybrids/variety. Aphid populations were non-significantly varied at all the three heights of plant canopy in both Mallika BG II and L 604 non-*Bt* and with significantly higher population compared to RCH 2 BG II. The aphid population was 8.00, 7.53 and 4.68 per leaf per plant in Mallika BG II, 7.23, 6.91 and 4.18 in L 604 non-*Bt* and 4.36, 4.01 and 2.63 in RCH 2 BG II at bottom, middle and top of the canopy, respectively. Similarly aphid numbers were lowest on the terminal and young leaves compared to matured leaves (Khan *et al*., 2000) in cotton crop. But the present results were contrary to the reports of Lampert (1989), who recorded that populations of *Myzus nicotianae* closely related to *Myzus persicae*, were highest on the leaves in the upper one-third of the plant in field-grown flue-cured tobacco in North Carolina.

Contrastingly significantly higher population of leafhoppers, thrips and whiteflies was recorded at top foliage followed by middle and bottom canopy level irrespective of the cotton hybrids/variety which might be due to easy penetration of its proboscis into the young or tender leaf tissue compared to matured leaves. Leafhopper populations were significantly high in RCH 2 BG II followed by L 604 non-*Bt* and Mallika BG II at any height of the plant canopy with population (no./leaf/plant) of 2.86, 1.94 and 1.72 at top canopy; 1.82, 1.38 and 1.31 at middle canopy and 1.56, 1.26 and 1.12 at bottom canopy in RCH 2 BG II, L 604 non-*Bt* and Mallika BG II, respectively. The observations of the present study were supported by the findings of Parajulee *et al*. (2006), who reported that cotton leafhoppers are more prevalent in upper one-third vertical stratum (65%) followed by middle (24%) and lower strata (11%). The present findings were not in favour of the results of Singh *et al.* (1995) who reported maximum nymphs of leafhoppers occurred in the middle canopy, followed by the lower and upper canopy in cotton.

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Table 1. Incidence pattern of sucking insect pests within plant canopy (Mean of two crop seasons of 2009-10 and 2010-11)

Leaf position	Number per leaf per plant															
	Aphids				Leafhoppers				Thrips				Whiteflies			
	M1	M2	M3	Mean	M1	M2	M3	Mean	M1	M2	M3	Mean	M1	M2	M3	Mean
S_1	2.63 (1.77)	4.68 (2.28)	4.18 (2.16)	3.83 (2.07)^{b}	2.86 (1.83)	1.72 (1.49)	1.94 (1.56)	2.17 (1.63)^{a}	1.06 (1.25)	1.89 (1.54)	1.45 (1.40)	1.47 (1.40)^{a}	0.89 (1.18)	1.51 (1.42)	1.36 (1.36)	1.25 (1.32)^{a}
S_2	4.01 (2.12)	7.53 (2.83)	6.91 (2.72)	6.15 (2.56)^{a}	1.82 (1.52)	1.31 (1.35)	1.38 (1.37)	1.51 (1.41)^{b}	0.54 (1.02)	0.79 (1.14)	0.94 (1.20)	0.76 (1.12)^{b}	0.57 (1.03)	0.61 (1.05)	0.55 (1.02)	0.58 (1.04)^{b}
S_3	4.36 (2.20)	8.00 (2.92)	7.23 (2.78)	6.53 (2.63)^{a}	1.56 (1.42)	1.12 (1.27)	1.26 (1.32)	1.31 (1.34)^{c}	0.50 (1.00)	0.71 (1.10)	0.79 (1.14)	0.67 (1.08)^{c}	0.36 (0.93)	0.48 (0.99)	0.52 (1.01)	0.45 (0.98)^{c}
MEAN	3.67 (2.03)^{2}	6.74 (2.67)^{1}	6.11 (2.55)^{1}		2.08 (1.60)^{1}	1.38 (1.37)^{2}	1.53 (1.42)^{2}		0.70 (1.09)^{2}	1.13 (1..26)^{1}	1.06 (1.24)^{1}		0.61 (1.05)^{2}	0.87 (1.15)^{1}	0.81 (1.13)^{1}	
	F Test	SEM±	CD at 5%		F Test	SEM±	CD at 5%		F Test	SEM±	CD at 5%		F Test	SEM±	CD at 5%	
Main treatments (M)	SIG	0.05	0.21		SIG	0.01	0.05		SIG	0.01	0.05		SIG	0.01	0.05	
Sub treatments (S)	SIG	0.03	0.10		SIG	0.01	0.03		SIG	0.01	0.02		SIG	0.02	0.05	
Interaction (MxS)	NS	0.06	NS		SIG	0.02	0.06		SIG	0.01	0.03		SIG	0.03	0.09	
(SxM)	NS	0.07	NS		SIG	0.02	0.04		SIG	0.01	0.03		SIG	0.03	0.06	

Note: MxS = To compare two sub plot treatment means at a given main plot treatment.
SxM = To compare two main plot treatment means at each level of sub plot treatment.

Values in parentheses are square root ($\sqrt{(X+0.5)}$) transformed values.
Values in each column/row with similar alphabets/numbers do not vary significantly at 5 % level.

Sub treatements: Leaf position
S_1 : Top leaf
S_2 : Middle leaf
S_3 : Bottom leaf

Main treatments: Cotton types
M1: RCH 2 BG II hybrid
M2: Mallika BG II hybrid
M3: L 604 non-*Bt* variety

Significantly higher population (no./leaf/plant) of thrips and whiteflies was recorded at top canopy in Mallika BG II (1.89 and 1.51) followed by L 604 non-*Bt* (1.45 and 1.36) and RCH 2 BG II (1.06 and 0.89) compared to middle (0.79 and 0.61 in Mallika BG II, 0.94 and 0.55 in L 604 non-*Bt* and 0.54 and 0.57 in RCH 2 BG II) and bottom (0.71 and 0.48 in Mallika BG II, 0.79 and 0.52 in L 604 non-*Bt* and 0.50 and 0.36 in RCH 2 BG II) canopy level. However, L 604 non-*Bt* recorded significantly higher thrips population at middle and bottom canopy level followed by Mallika BG II and RCH 2 BG II. But whitefly populations were higher and were on par in Mallika BG II and L 604 compared to RCH 2 BG II almost at all the heights in plant canopy. The results of the present study were in agreement with reports of Parajulee *et al*. (2006), who recorded more cotton thrips in upper one-third vertical stratum (51%) followed by middle (33%) and lower strata (16%). Similarly McPherson and Lambert (1995) who reported significantly more eggs and *Bemisia argentifolii* nymphs on the upper trifoliate leaves than on the lower trifoliate leaves on 'Braxton' and 'Cobb' soyabean cultivars. But Singh *et al*. (1995) who observed that white fly population was high in the middle of the plant canopy followed by the lower canopy, with negligible numbers of adult on the upper canopy.

However, mean population of leafhoppers, thrips and whiteflies at all the three levels of the plant canopy indicated that L 604 non-*Bt* was on par with Mallika BG II.

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Research Note
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ZINC REQUIREMENT TO RICE IN HIGH P SOIL WITH SUFFICIENT ZINC STATUS

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Use efficiency of applied phosphorus (P) is generally low (20%) and it is usually fixed very quickly, it is being retained in the top layers of the soil leading to saturation of P fixative sites in the soil. The continuous use of 'P' fertilizers resulted in 'P' accumulation of same in the top layers of soils. For Eg: The recent study under DAC project at Hyderabad indicated that the soils in 10 districts of A.P was found to contain soils with high available P to an extent of 66 per cent (Reddy *et al.*, 2013).

Zinc (Zn) deficiency in soils of rice tracts is one of the reasons for is low productivity. To overcome this constraint 50 kg $ZnSO_4$ ha^{-1} is recommended once in a year of 2-3 crops in zinc deficient soils of Andhra Pradesh. However, in view of occurrence of high 'P' in soils, it is necessary to work out the level of Zn required in such soil to obtain good yields as P and Zn are known to have antagonistic effect on their availability (Singh et al.,2006). In view of the above scenario, there is a need to find out the dose, frequency and mode of Zn application to rice in high 'P' soils although the soil was containing sufficient level of Zn as per current norms of limit.

A pot culture experiment was conducted during *kharif* season of 2013-2014 at Radio Tracer Laboratory, Agricultural Research Institute, Rajendranagar to find out the zinc requirement to rice crop in high P soils. The soil was sandy clay loam in texture, slightly alkaline in reaction (pH 7.8) with low salt content (0.894 dS m^{-1}) and medium in organic carbon (0.38%) status. The experimental soil was low in available N (196 kg ha^{-1}), high in available phosphorus (97 kg P_2O_5 ha^{-1}) and potassium (543 kg ha^{-1}) status. The available status of S, DTPA extractable Zn, Cu, Fe and Mn was 22, 1.02, 0.88, 18.96 and 4.82 mg kg^{-1}, respectively which were rated as sufficient. The experiment was laid out in a Completely Randomized Design with 21 treatments and three replications with rice as test crop (Variety: MTU-1010) under net house conditions. Three Phosphorus levels (P_1:0, P_2:100% Recommended dose of Phosphorus *i.e*; 60 kg P_2O_5 ha^{-1} and P3: ST based 'P' recommendation i.e;70% RDP) and seven levels of zinc Zn_1 : 0, Zn_2 : Soil application of 12.5kg $ZnSO_4$ ha^{-1}, Zn_3 : SA of 25 kg $ZnSO_4$ ha^{-1}, Zn_4 : SA of 37.5 kg $ZnSO_4$ ha^{-1}, Zn_5 : SA of 12.5 + 2FS (1st spray at 21 DAT & 2nd spray at PI stage, Zn_6 : SA of 25 kg $ZnSO_4$ ha^{-1} + 2FS, Zn_7 : only 2FS were employed to study the requirement of Zn to rice crop in high P soil with sufficient zinc status. All standard package of practices were followed throughout the experimental period. Grain and straw yield were recorded at of harvest.

Grain and straw yield of rice was significantly influenced by different levels of Zn and P application (Table1). The grain and straw yield of rice increased significantly from 21.90 to 23.34 and 25.01 to 27.14 g $plot^{-1}$, respectively with increasing Zn application from 0 to 25 kg $ZnSO_4$ ha^{-1} as soil application. The highest grain yield was obtained with application of 25 kg $ZnSO_4$ ha^{-1}, which was about 6.6 per cent higher over that of control (No application of Zn). Straw yield also followed the similar trend as that of grain even though slightly higher level of straw yield (27.36g $plot^{-1}$) was recorded with application of 37.5 kg $ZnSO_4$ ha^{-1}. The grain and straw yields recorded with application of 12.5 kg $ZnSO_4$ ha^{-1} + 2FS and 25 kg $ZnSO_4$ ha^{-1} + 2 FS were statistically on par with soil application of Zn alone @ 12.5 and 25 kg $ZnSO_4$ ha^{-1}. The lowest grain (21.90 g pot^{-1}) and straw yields (25.01 g pot^{-1}) were obtained from control (No zinc application) which were significantly inferior over few levels of Zn application either to soil alone or in combination with foliar sprays. In general, the rates of Zn application along with foliar sprays could not bring a significant increase in yield of rice over soil application alone. Application of Zn either to soil or in combination of soil + foliar applications to this high P soil also resulted in response to yield although the soil contained sufficient DTPA-Zn level. Application of Zn @ 25 kg $ZnSO_4$ ha^{-1} increased the rice grain yield by 7% only. Previous research results conducted on Zn deficient soils resulted in crop yield

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response in the range of 10 – 40% (Singhal and Rattan, 1999; Tathe *et al*., 2008). Increase in yield might be due to utilization of other nutrients under high Zn and P environment which may increase the dry matter yield and other yield parameters.

Grain and straw yield of rice significantly influenced by different levels of P application (Table 1) in the present story. Persual of data revealed that the highest grain (23.88 g pot^{-1}) and straw yields (27.87 g pot^{-1}) were recorded with application of 100 percent recommended dose of phosphorus and that was statistically on par with application of P @70% RDP. The grain and straw yields increased by 10.8 and 16.6 % with 100% RDP over control *i.e*., no P application in high P and Zn sufficient soil, while such increment due to 70% RDP application was 6.7 and 13.9 percent. However, obtaining response to complete application of P (100% RDP) is also resulting in higher and significant yield in this soil. At the same time the yields obtained with reduced P application below 100% RDP is also found to result in on par yield like that of 100% RDP (Table 1). Reduced P application by 30% from the current RDP is reported by Babu (2003) as a possible P saving measure without scarifying the yields in crops like rice. At the same time, irrespective of higher level of available P in the soil it is essential to provide a booster dose of P to crop in such soils for realizing higher yields.

Significant interaction of P and Zn on grain and straw yields were noticed with application of different levels of Zn and P (Table1). Application of 70% of RDP in conjunction with supply of 12.5 kg $ZnSO_4$ ha^{-1} to soil results in highest grain and straw yield. Even though the highest grain yield (24.28 g pot^{-1}) was recorded with application of 25 kg $ZnSO_4$ ha^{-1} + 2FS of Zn in combination with 100% RDP, the yield recorded at this combination was statistically on par when different levels of Zn was applied in conjunction with 70% RDP.

Therefore, application of 12.5 kg $ZnSO_4$ ha^{-1} or application of 2 foliar sprays of Zn

(at 21 DAT and at PI stage) is desired to obtain good yields in high P soils though the soil has sufficient zinc status. In high P and Zn sufficient sol application of 70% RDP was found economical to realize higher yields and can save phosphorus to an extent of 30% from RDP. The present study clearly revealed that application of 70% RDP in conjunction with supply of 12.5 kg $ZnSO_4$ ha^{-1} to soil results in highest grain and straw yield high P and Zn sufficient soil.

Table 1. Effect of different levels of zinc and phosphorus application on grain and straw yield of rice crop in high-P soil with sufficient zinc status.

Treatment	Grain Yield (g pot^{-1})				Straw Yield (g pot^{-1})			
	P-0	P-100% RDP	P-70% RDP	Mean	P-0	P-100% RDP	P-70% RDP	Mean
ZS-0	20.96	22.94	21.79	21.90	22.62	26.46	25.96	25.01
ZS-12.5 (SA)	21.69	23.95	22.65	22.76	23.38	27.69	27.00	26.02
ZS-25 (SA)	22.03	24.07	23.92	23.34	24.79	28.82	27.81	27.14
ZS-37.5 (SA)	21.84	23.92	23.01	22.92	25.02	29.02	28.04	27.36
ZS-12.5 (SA) + 2 FS	22.03	24.14	22.98	23.05	23.88	27.75	27.12	26.25
ZS-25 (SA) + 2 FS	21.86	24.28	23.12	23.09	24.94	28.28	27.88	27.03
2 FS of Zn	20.44	23.89	23.85	22.73	22.75	27.07	26.37	25.40
Mean	21.55	23.88	23.05		23.91	27.87	27.17	
	Zinc	Phosphorus	Zn X P		Zinc	Phosphorus	Zn X P	
CD at 5%	1.34	0.88	2.33		1.25	0.82	2.17	
SEm ±	0.66	0.43	1.15		0.62	0.40	1.08	

{ ZS = Zinc Sulphate, SA = Soil Application, FS = Foliar Sprays of Zn (@ 2g ZS lit^{-1}), RDP = Recommended Dose of P }

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PROFILE CHARACTERISTICS OF ORGANIC RED GRAM FARMERS OF DRY LAND AREAS OF KARNATAKA

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India is a country of village comprising of 5,80,781 villages. Rural India has 73.60 per cent of the population. This population is dependent on agriculture and allied activities for its livelihood. Agriculture is the primary sector of Indian economy. Apart from being the mainstay of nearly three fourth of the population, it contributes 32 per cent to the Gross Domestic Product (GDP) and 16 per cent of the total exports come from agriculture sector. India has golden history of ancient agriculture and has the credit of having contributed ancient agriculture practices to other parts of the world over the years.

In organic farming instead of compound chemicals such as chemical fertilizers, pesticides and herbicides, natural resources such as organic matters, mineral and microbes are used. Organic farming systems rely on large scale application of animal waste or Farm Yard Manure (FYM), compost, crop rotations, crop residues, green manuring, vermicompost, biofertilizers, bio-pesticides and biological control of pest and diseases. In India the use of organic manures in subsistence farming is an age old practice. Addition of organic manure improves structure, aeration, and water holding capacity of soils.

Organic farming is gaining momentum in India and in particular in Karnataka state, is at greater pace because it is sustainable, adoptable and eco-friendly. Growing awareness of consumers to use safe and healthy food and need to address ill effects of chemicals in agriculture production, restoration of soil health and fertility has played a key role in the emergence of organic agriculture sector since last two decades.

The Karnataka state was selected purposively for the study. The Gulbarga district of Karnataka state was selected purposively as organic red gram is the major crop in Gulbarga district.

Out of 10 mandals in Gulbarga district, mandals were selected randomly for the study. Two from each mandal a total of six villages were selected randomly. From the prepared list, 20 farmers were selected by simple random sampling procedure from each village thus the total sample for the study constituted 120 farmers.

The variables selected to study the profile of the farmers were age, education, farm size, farming experience, socio-economic status, annual income, training received, risk orientation, innovativeness, extension contact, input availability, market intelligence and perceived attributes. The data from the respondent farmers were collected with the help of schedules and scales through personal interview. The data collected were analysed and suitable interpretations were drawn. The statistical techniques like class interval, frequency and percentage were followed to analyse the data. Accordingly the respondents were classified into various groups.

The data were collected from the organic red gram farmers on selected profile characteristics. The data thus collected were analysed and interpreted.

It is evident from the Table 1, that majority (50.00%) of the organic red gram growing farmers belonged to young age, followed by middle (33.33%) and old (16.67%) age. Hence, from the results, it could be concluded that majority of organic red gram growing farmers belonged to young age group. In case of organic red gram farmers their interest, education and enthusiasm of young and middle aged farmers might have driven them towards a new farming system i.e organic farming. The unsustainable farming practices like using inorganic chemical fertilizers, problems of climate change i.e low rain fall and high temperature might have motivated the young and middle aged farmers towards organic farming. A lower percentage of old aged people might be due to their lack of enthusiasm and interest to learn new ways of

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Table 1. Distribution of respondents according to their profile characteristics(n=120)

Sl. No	Profile characteristics	Class	Frequency	(%)
1.	Age (years)	Young (up to 41)	60	50.00
		Middle aged (41-53)	40	33.33
		Old (>53)	20	16.67
2.	Education	Illiterate	27	22.50
		Can read and write only	28	23.30
		Primary school	47	39.20
		High school	13	10.80
		College and above	5	4.20
3.	Farm size	Marginal	65	54.20
		Small	44	36.60
		Large	11	9.20
4.	Farming experience	Low	65	54.20
		Medium	49	40.80
		High	6	5.00
5.	Socio-economic status	Low	30	25.00
		Medium	65	54.20
		High	25	20.80
6.	Annual income	Low	38	31.70
		Medium	72	60.00
		High	10	8.30
7.	Training received	Low	50	41.70
		Medium	56	46.60
		High	14	11.70
8.	Risk orientation	Low	20	16.70
		Medium	66	55.00
		High	34	28.30
9.	Innovativeness	Low	20	16.67
		Medium	60	50.00
		High	40	33.33
10.	Extension contact	Low	30	25.00
		Medium	61	50.80
		High	29	24.20
11.	Input availability	Low	45	37.50
		Medium	55	45.80
		High	20	16.70
12.	Market intelligence	Low	28	23.30
		Medium	65	54.20
		High	27	22.50
13.	Perceived attributes	Low	20	16.70
		Medium	65	54.10
		High	35	29.20

farming. The results were in confirmation with the findings reported by Savitha (2009) and Sivanarayana et.al (2008).

It could be observed from the Table 1, that, majority of the organic red gram farmers were educated up to primary school level (39.20%) followed by can read and write(23.30%), illiterate (22.50%), high school level(10.80%) and college level (4.20%).

Therefore from the above results it could be concluded that majority of the organic red gram farmers were educated up to primary school level. The reason due to the absence of enough formal education institutions might be the reason for discontinuation of education at primary level. The same results were presented by Gangadhar (2009) and Vasantha (2002).

It could be observed from the Table 1, that, majority (54.20%) of the organic red gram farmers had small farm size followed by medium (36.60%) and large (9.20%). Hence, from the above results, it could be concluded that majority of organic red gram farmers had small farm size. In organic farmers, the reasons for this could be that potentially taking up organic farming on a small scale is viable, practicable as the, results can be observed with a minimum risk. And there might be a reason of the fragmentation of ancestral land holding from generation to generation leading to sub division of land to smaller size of land holding. This is in conformity with Vijayalayan (2001) and Sudhakar (2002).

The results in the Table 1 indicated that, that, majority of the organic red gram growing farmers had low farming experience (54.20%) followed by medium (40.80%) and high farming experience (5.00%)

Hence, from the above results, it could be concluded that majority of organic red gram farmers had low farming experience. Majority the organic farmers were young aged with primary school level of education, afterwards they were engaged in farming. So their level of farming experience was low. This might be the reason for the above trend. This is in conformity with Kishor (2010) and Sriram (2000)

The results in the Table 1 indicated that, majority of the organic red gram growing farmers had medium socio economic status (54.20%) followed by low (20.80%) and high socio economic status (20.80%).

Hence, from the above results, it could be concluded that majority of organic red gram farmers had medium socio- economic status. The reason for the above trend might be majority of the respondents were belonged to small farm size and low farming experience so initial few years the organic farming technique gives low yield. This is in conformity with Shivaprasad (2005).

The results in the Table 1 indicated that, majority of the organic red gram growing farmers had medium annual income (60.00%) followed by low (31.71%) and high annual income (8.30%)

Hence, from the above results, it could be concluded that majority of organic red gram farmers had medium annual income. This trend indicates that the returns from the organic farming will be realized over a period of time it increases due to more demand for organic produce due to its quality of the grain. This is in conformity with Savitha (2009) and Sarthak and Prabuddharay (2010).

The results in the Table 1 indicated that, majority of the organic red gram growing farmers had medium training received (46.60%) followed by low (41.70%) and high training received (11.70%)

'Hence, from the above results, it could be concluded majority of the organic red gram farmers had received medium level of training followed by low training. It indicates that, the farmers were not aware about the training programmes conducted by various agencies and their importance. This is in conformity with Noorjehan (2004).

The results in the Table 1 indicated that, majority of the organic red gram growing farmers had medium risk orientation (55.00%) followed by high (28.30%) and low risk orientation (16.70%)

Hence, from the above results, it could be concluded that majority of organic red gram farmers had medium risk orientation. The reason behind such type of result in the study area, as organic red gram farming practices include new technologies, hence uncertainty of the new technology will make farmer to think to go or not for organic farming . The low yields for 3-5 years in organic farming and problem of labour availability, marketing etc acts as major barriers in adoption of organic farming in study area. This is in conformity with Patil et al. (2015) and Nirmala (2012).

The results in the Table 1 indicated that, majority of the organic red gram growing farmers had medium innovativeness (50.00%) followed by high (33.33%) and low innovativeness (16.67%)

Hence, from the above results, it could be concluded that majority of organic red gram farmers had medium innovativeness. The reason behind such type of result in the study area might be majority of the respondents were belonged to young age group and that had a lot of curiosity on organic farming for this reason they were medium innovativeness followed by high. This is in conformity with Natikar (2001)) and Suresh (2004).

The results in the Table 1 indicated that, majority of the organic red gram growing farmers had medium extension contact (50.80%) followed by low (25.00%) and high extension contact (24.20%)

Hence, from the above results, it could be concluded that majority of organic red gram farmers had medium extension contact. The reason substantiated for this trend was due to lack of extension staff with experience in organic farming to reach the farmers at the time of critical operations of organic red gram cultivation. This is in conformity with Sivanarayana et al. (2008) and Shantinirmala (2010).

The results in the Table 1 indicated that, majority of the organic red gram growing farmers had medium input availability (45.80%) followed by low (37.50%) and high input availability (16.70%).

Hence, from the above results, it could be concluded that majority of organic red gram farmers had medium input availability. This trend might be due to the fact that farmers less attracted towards bio-pesticides, bio-agents and pheromone traps and these are having more cost, the organic inputs sellers are less in the market, also organic farming requires organic manure's in plenty, as most of the farmers are not maintaining cattle, they were facing difficulties in purchasing and procuring organic manures. This is in conformity with Jaganathan et al. (2015).

The results in the Table 1 indicated that, majority of the organic red gram growing farmers had medium market intelligence (54.20%) followed by low (23.30%) and high market intelligence (22.50%).

Hence, from the above results, it could be concluded that majority of organic red gram farmers had medium market intelligence. This trend might be due to the fact that the marketing of organic red gram in villages were through middlemen and wholesalers, thus majority of the farmers sell their produce directly to the middlemen from the field to avoid the problem of long distance travel, poor connectivity to extension workers and lack of transportation facilities. Therefore due to poor marketing intelligence support for the organic produce, respondents are medium to less access to market in the study area. This is in conformity with Ploomi (2006) and Pramila (2004).

The results in the Table 1 indicated that, majority of the organic red gram growing farmers had medium perceived attributes (54.10%) followed by high (29.20%) and low perceived attributes on organic red gram farming (16.70%) .

Hence, from the above results, it could be concluded that majority of organic red gram farmers had medium perceived attributes. This trend might be due to the fact that the majority of the organic red gram farmers they were belonged to medium training received and extension contact on organic farming and the respondents were knew that the organic farming technology is having more beneficial to the soil as well as human beings so majority of the young farmers were having a good attitude on organic farming. This is in conformity with Kaur (2009).

The analysis of profile characteristics of organic red gram respondents indicates that majority of them were young aged with primary school education, small farm size and medium category in terms of farming experience, and socio- economic status, annual income, extension contact, training received, risk orientation, innovativeness, input availability, marker intelligence and perceived attributes.

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NUTRIENT UPTAKE OF *RABI* PIGEON PEA (*Cajanus cajan* (L) Millsp) AS INFLUENCED BY DIFFERENT NUTRIGATION LEVELS

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Pigeonpea (*Cajanus cajan* Millsp.) is an important crop amongst pulses. It plays a major role in the house hold economy of farmers by providing protein rich food, firewood and income to the resource poor small/marginal farmers in tropics and subtropics and has long been recognized for its attributes of high leaf fall and consequent contribution to the carbon and nitrogen economy of the soil (Rego and Rao, 2000). Pigeonpea grown during *rabi* season with limited irrigation water though drip system resulted in increased yield (Mahalakshmi *et al.*,2011). Nutrient uptake plays a significant role in deciding the pigeonpea yield and by knowing the level of nutrient accumulation in the crop helps in the formulating the efficient fertilization schedule, as most of the applied nutrients are lost through leaching, volatilization, denitrification and chemical fixation in soil. Practically very limited information is available on uptake of nutrients by pigeonpea crop grown with variable levels of recommended dose of fertilizers under drip nutrigation. So it has been considered worthwhile to study the uptake of nutrients in pigeonpea as affected by different nutrigation levels.

The field experiment was conducted at Water Technology Centre, College Farm, College of Agriculture, Rajendranagar, Hyderabad (Latitude 17^{0}19' N, Longitude 78^{0}23' E and altitude of 542.6 m above mean sea level) during *rabi*, 2012-13 in randomized block design with 3 replications and 8 treatments comprising of drip nutrigation of Nitrogen (N) and phosphorous (P_2O_5) (T_1 to T_6) and conventional soil application of fertilizers under drip (T_7) and furrow irrigation (T_8) as detailed in Table 1. The recommended dose of fertilizer (RDF) was 40, 50 and 20 kg N, P_2O_5 and potassium (K_2O) ha^{-1}, respectively. The half N, total P_2O_5 and K_2O of RDF was applied as basal before sowing and remaining half N was applied to soil 5 cm and below 5 cm away from crop rows, 20 days after sowing (DAS) in treatments of T_7 and T_8 through urea, di-ammonium phosphate and muriate of potash fertilizers. For treatments T_1 to T_6, total K_2O was applied as basal and N & P_2O_5 was applied as nutrigation in 12 equal splits (one during establishment at 14 DAS, 7 during vegetative stage from 27 DAS to 71 DAS, 3 during flowering from 78 to 95 DAS and last at pod development at 112 DAS) through urea and mono ammonium phosphate. The soil was sandy clay, moderately alkaline in reaction, non saline, medium in available nitrogen and potassium and high in available phosphorous. The irrigation water was moderately alkaline (pH-8.5), Class II (C_4S_1) without any residual alkalinity problem. Pigeonpea (PRG-158) was sown on 5th October 2012 by adopting a spacing of 0.60 m between the rows and 0.10 m between the plants within a row to maintain a desired plant population of 1,66, 666 plants ha^{-1}. Irrigations were scheduled based on the USWB Class A pan evaporation replenishment factor of 0.8 for treatments of drip irrigation and IW/PE ratio of 0.8 for furrow irrigation with mean irrigation water depth of 50 mm and the calculated irrigation water was delivered in surface irrigation treatment plot directly using a water meter and a flexible pipe. Total precipitation received during the cropping period was only 109.8 mm. Plant samples collected from net plot were air dried before drying in oven at 70^{0}C for 72 hours. Oven dried samples were ground in a Willeymill, passed through 2 mm sieve and were analysed for N, P and K concentrations using standard procedures and nutrient uptake kg ha^{-1} was calculated by multiplying respective nutrient concentration with total dry matter produced at different stages. The experimental data were analysed statistically by following Fischer's method of analysis of variance as per procedure suggested by Gomez and Gomez (1984). F–test was significant at P=0.05 and the results have been compared among treatments based on critical difference.

Nutrient uptake of *rabi* pigeonpea was significantly influenced by drip nutrigation treatments and was low at 30 DAS and increased gradually up to harvest. The mean N, P and K uptake increased from 62.3, 3.2 and 3.6 kg ha^{-1} at 30 DAS to 187.6, 23.8 and 53.9 kg ha^{-1} at harvest, respectively(Tables 1 to 3). Nitrogen uptake observed with drip nutrigation of 100% N +100 % P_2O_5 was significantly higher than

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rest of the drip nutrigation treatments at all growth stages studied except with drip nutrigation of 100% N with 50% P_2O_5 (T_1) at 30, 60 and 120 DAS and at harvest (Table 1). Uptake of N noticed with drip nutrigation of 80% N + 50% P_2O_5 (T_2) was found on par with drip nutrigation of 80% N with 100% P_2O_5 (T_5) and 60% N with 50 or 100% P_2O_5 (T_3 & T6) conventional soil application of RDF with method under drip irrigation (T_7). The higher N uptake recorded with nutrigation of 100% N with 100% P_2O_5 over 100 % RDF in conventional soil application with drip or furrow irrigation may be due to combined application of higher nitrogen and phosphorus fertilizers under this treatment enhanced the nutrients availability coupled with favourable soil moisture under drip irrigation, which produced more leaf area index (LAI) and dry matter resulted in higher yield together with slight improvement in nutrient concentration of grain and non-grain parts. Increasing N level increased the availability of nutrients in soil resulting production of more vegetative growth and root biomass lead to higher uptake of nutrients (Shankarlingappa *et al.,* 2000).

Phosphorus uptake realized with drip nutrigation of 100% N + 100% P_2O_5 (T_4) and 100% N with 50% P_2O_5 (T_1) was significantly higher than rest of the treatments except at 30, 60 and 90 DAS. Whereas at 120 DAS and at harvest, the uptake noticed in the later treatment was significantly superior over all other treatments (Table 2). Significantly higher phosphorus uptake with drip nutrigation treatments may be due to combined application of higher nitrogen and phosphorus fertilizers might have enhanced the nutrients availability coupled with the favourable soil moisture under drip irrigation leading to more LAI and high dry matter production. This could be attributed to the fact that added nitrogen and phosphorous increased nutrient content by providing balanced nutritional environment inside the plant and higher photosynthetic efficiency, which favoured growth and crop yield(Umesh *et al.*, 2013). Since, the uptake of nutrient is a function of dry matter accumulation and nutrient content, the increased dry matter accumulation together with higher nutrient content resulted in greater uptake of NPK. When P availability is enhanced in a symbiotically N- fixing system; N content in plants is normally increased (Buresh and Smithson, 1997). Increased levels of P can enhances uptake of NPK by seed and stalk was reported by Shankaralingappa *et al.,* (2000), Singh and Sekhon (2007), Chaudhari *et al.* (2010), Goud and Kale, (2010) and Subhash Babu *et al.* (2013).

Higher potassium uptake was observed at 30, 120 DAS and at harvest with drip nutrigation with 100 % N + 50% P_2O_5 (T_1) and 100% N + 100% P_2O_5 (T_4), which were on par with each other and significantly higher over rest of the treatments (Table 3), while at 60 and 90 DAS, drip nutrigation with 100%N+ 100% P_2O_5 (T_4) realized significantly higher potassium uptake over other treatments. On other hand, at 30 and 120 DAS and at harvest, potassium uptake noticed at drip irrigation with 100% RDF (T_7) with conventional soil application found on par with 60% or 80% N with 50% or 100% P_2O_5 drip nutrigation and at 60 and 90 DAS, potassium uptake was on par with 80% N + 50% P_2O_5 and 60 % or 80% N with + 100% P_2O_5. Whereas, furrow irrigation with 100% RDF in conventional soil application (T_8) recorded significantly lower potassium uptake over rest of the treatments at all the growth stages but it was on par with 60% N + 80% P_2O_5 (T_3) at 30, 90, 120 DAS and at harvest. Significantly higher potassium uptake recorded with drip nutrigation with 100 % N + 100 % P_2O_5 (T_4) may be due to combined application of higher nitrogen and phosphorus fertilizers at root zone with drip nutrigation enhanced the nutrients availability there by high dry matter production there by higher K uptake. The increase in nutrient content and uptake with phosphorous fertilization are in line those of Singh and Sekhon (2007), Singh and Yadav (2008) and Chaudhari *et al.* (2010). Umesh et al. (2013) also reported linear response of NPK uptake with grain yield with increase in NPK level from N_{25} P_{50} K_{25} to N_{25} P_{50} K_{25} kg ha^{-1}.

Conventional soil application of 100% RDF under drip irrigation (T_7) recorded on par uptake of N, P and K with drip nutrigation of 80% or 60% N with 50 or 100% P_2O_5 at 30, 60, 90 and 120 DAS and at harvest but it was significantly higher than conventional soil application of 100% RDF under furrow irrigation. On the other hand uptake of phosphorus under furrow irrigation with conventional soil application of 100% RDF (T_8) recorded on par phosphorus uptake with drip nutrigation with 60% N + 50% P_2O_5 (T_3) while it was significantly lower than rest of the treatments at 30, 60 DAS, 90 DAS and at harvest. Furrow irrigation with 100 % RDF (T_8) recorded significantly lower uptake of nutrients than all other treatments may be due to leaching of

nutrients and moisture variations between two successive irrigations (Parmodh sharma *et al.*, 2012) resulted in lower uptake of nutrients.

The present study revealed that higher N, P_2O_5 and K_2O uptake was observed at drip nutrigation of 100 % N and 100 % P_2O_5 followed by drip nutrigation of 100 % N and 50 % P_2O_5. The lower N, P_2O_5 and K_2O uptake was observed at furrow irrigation with 100 % RDF.

Table 1. Plant nitrogen uptake (kg ha^{-1}) at different growth stages of *rabi* pigeonpea as influenced by different drip fertigation treatments

Treatment	30 DAS	60 DAS	90 DAS	120 DAS	Harvest
T_1 - 100 % N + 50 % P_2O_5	74.9	115.9	153.9	186.3	240.1
T_2 - 80 % N + 50 % P_2O_5	59.9	92.5	122.0	142.4	187.8
T_3 - 60 % N + 50 % P_2O_5	48.1	**75.1**	94.8	109.4	146.1
T_4 - 100 % N + 100 % P_2O_5	89.2	130.0	178.6	204.2	270.5
T_5 - 80 % N + 100 % P_2O_5	67.5	98.6	135.5	150.9	199.8
T_6 - 60 % N + 100 % P_2O_5	57.3	83.8	113.0	119.7	164.1
T_7 - 100 % RDF - conventional soil application with drip irrigation	62.8	91.9	116.6	131.7	186.1
T_8 – 100 % RDF - conventional soil application with furrow irrigation	38.3	56.7	72.1	73.6	106.3
Mean	62.3	93.1	123.3	139.8	187.6
SEm ±	5.0	6.4	7.8	10.6	13.9
CD at 5%	15.1	19.5	23.6	32.0	42.2
CV (%)	13.8	12.0	10.9	13.1	12.8

Note: T_1 to T_6 by drip nutrigation

Table 2. Plant phosphorus uptake (kg ha^{-1}) at different growth stages of *rabi* pigeonpea as influenced by different drip fertigation treatments

Treatment	30 DAS	60 DAS	90 DAS	120 DAS	Harvest
T_1 - 100 % N + 50 % P_2O_5	4.6	7.5	10.5	16.2	31.9
T_2 - 80 % N + 50 % P_2O_5	3.1	5.3	7.6	12.2	23.5
T_3 - 60 % N + 50 % P_2O_5	1.9	3.5	5.4	9.1	17.0
T_4 - 100 % N + 100 % P_2O_5	5.7	9.1	12.6	19.6	37.0
T_5 - 80 % N + 100 % P_2O_5	3.8	6.7	8.3	13.8	26.3
T_6 - 60 % N + 100 % P_2O_5	2.5	5.0	6.2	10.6	20.1
T_7 - 100 % RDF - conventional soil application with drip irrigation	3.1	5.7	6.3	12.1	22.4
T_8 – 100 % RDF - conventional soil application with furrow irrigation	1.1	2.5	3.5	6.5	12.4
Mean	3.2	5.7	7.6	12.5	23.8
SEm ±	0.5	0.5	0.6	1.1	1.6
CD at 5%	1.5	1.4	1.9	3.2	4.9
CV (%)	26.7	14.3	14.6	14.5	11.8

Table 3. Plant potassium uptake (kg ha^{-1}) at different growth stages of *rabi* pigeonpea as influenced by different drip fertigation treatments

Treatment	30 DAS	60 DAS	90 DAS	120 DAS	Harvest
T_1 - 100 % N + 50 % P_2O_5	5.1	9.9	19.9	33.4	72.1
T_2 - 80 % N + 50 % P_2O_5	3.9	7.2	15.5	26.5	53.6
T_3 - 60 % N + 50 % P_2O_5	2.8	4.8	11.2	21.0	41.6
T_4 - 100 % N + 100 % P_2O_5	5.4	12.5	23.8	37.7	78.9
T_5 - 80 % N + 100 % P_2O_5	3.9	8.0	17.7	28.5	57.6
T_6 - 60 % N + 100 % P_2O_5	2.9	6.1	14.3	24.3	46.7
T_7 - 100 % RDF - conventional soil application with drip irrigation	3.0	6.9	15.2	25.8	51.2
T_8 – 100 % RDF - conventional soil application with furrow irrigation	1.9	3.3	8.2	13.6	29.6
Mean	3.6	7.3	15.7	26.4	53.9
SEm ±	0.3	0.5	1.1	2.2	4.3
CD at 5%	1.0	1.4	3.3	6.7	12.9
CV (%)	15.4	10.8	12.1	14.5	13.7

Note: T_1 to T_6 by drip nutrigation

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FLORAL BIOLOGY STUDIES IN THREE DIFFERENT VARIETIES OF FINGER MILLET (*Eleusine coracana* (L.) Gaertn.)

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An investigation to study the floral biology in relation to anthesis pattern in a spike and within a spikelet, Time of anthesis, blooming period and period of anther withering in three promising varieties of finger millet *viz*., HR 911, PR 202 and GPU 28 was carried out during 2008-09 and 2009-10. The study revealed that, all the three varieties under investigation showed basipetal manner of anthesis pattern in a spike and acropetal manner within a spikelet: the time of anthesis was recorded as 4.15 AM, 3.40 AM and 3.00 AM and blooming period recorded as 7-8, 9 and 8 days in GPU 28, HR 911 and PR 202, respectively. Duration of pollen emergence to anther withering in these varieties ranged from 25 to 30 minutes.

Finger millet (*Eleusine coracana* (L.) Gaertn.) also known as Ragi or African millet is an annual plant widely grown as an important food crop in the arid areas of Africa and South Asia. It ranks third in importance among the millets after sorghum and pearl millet in India. In India it is very popularly known as ragi and is grown in an area of 2 million hectares with a production of 2.6 million tons . Finger millet provides staple food for a large section of farming community and economically weaker sections in many parts of India. Important finger millet growing states are Karnataka, Tamil Nadu, Andhra Pradesh, Maharastra, Orissa, Jharkhand, Chattishgarh and Uttarakhand .

Finger millet sub species *coracana* belongs to family Graminae or Poacea. *Eleusine*, the generic name, is after *Eleusine* the Greek goddess of cereals. Common name 'Finger

millet' is derived from the finger-like branching of the panicle. The cultivated *E. coracana* is a tetraploid (2n=4x=36) and has morphological similarly to both *E. indica* (L.) Gaertn (2n=18) and E. *africana* O. Byrne (2n=36).

The inflorescence of ragi has been described by Coleman (1920) and Ayyangar (1932) as a terminal whorl bearing 2 to 10, but averaging 5 or 6 spikes arranged like a birds foot at the top of the peduncle. The lowest spike is separated by 2 to 5 cm from the other spikes and which arise from the same point at the end of the stem. This is lower spike appears to be a thumb or a bird's first claw; it is commonly referred to as the thumb and the other spikes as the fingers. In each finger, there are about 70 spikelets, each spikelet having five to seven complete flowers and an ear head contains 1,500 to 3,000 flowers.

Anthesis and pollination in *Eleusine coracana* have been studied and described by several authors, including Ayyangar (1932), Ayyangar and Wariar (1934), Chavan *et al*. (1955), Chavan and Shendge (1957) and Coleman *et al*. (1921). A study on floral biology is of prime importance in setting suitable breeding procedures. The information regarding time of anthesis, blooming period and pollen viability helps in suggesting suitable emasculation and crossing techniques nevertheless, it also helps to fix the time for effective pollination in a crop like ragi where self pollination is predominant and this enables to achieve sufficient amount of cross seeds upon hybridization. Ultimately, the success of any breeding procedure depends on this important prior knowledge. Previous knowledge about anthesis pattern confuses the botanists to go deeper into the morphological studies to elucidate many specific problems associated with the emasculation and pollination. Several reports also suggests that there is a difference in opinion about anthesis pattern in a spike and within a spikelet, hence in this present study an effort was made to study the floral biology and also to confirm the fact regarding anthesis pattern in a spike and within spikelet.

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The present investigation was carried out during 2008-09 and 2009-10 in the experimental plots of project coordinating unit (small millets) at Zonal Agricultural Research Station, University of Agricultural Sciences, Gandhi Krishi Vignana Kendra, Bengaluru-65.

The experiment consists of three popular varieties *viz*., HR 911, PR 202 and GPU 28. Special features of varieties selected for the study are listed in Table 1. The three varieties *viz*., HR 911, PR 202 and GPU 28 were grown both in field and pots in green house. These varieties were observed for floral organ related characters between 12 mid night and 6 AM with the help of magnifying lens from the initiation of flowering to till the end of flowering. The following observations were recorded.

Time of anthesis: It is the time at which first pollen dehiscence was observed.

Sequence of flower opening: In each finger there are about 70 spikelets, each spikelet having five to seven complete flowers. The direction of flowering within a spike and spikelet whether it is a top to bottom or bottom to top or starts at the centre and proceeds both the direction has been observed during 1 am to 6 am with the help of magnifying lens.

Days to complete blooming : Number of days required for complete emergence of the inflorescence.

Duration of anther to wither: Time taken from fresh anther emergence to its complete drying.

Observations on three promising varieties of finger millet viz., HR 911, PR 202 and GPU 28 revealed that, all the three varieties under investigation exhibits basipetal manner of anthesis pattern in a spike and acropetal manner within a spikelet (Table 2). Similar results were reported by Ayyangar (1932) and Warrior (1934), Chavan *et al*. (1955), Chavan and Shendge (1957) and Coleman *et al*. (1921).

The time of anthesis was recorded as 4.15 AM, 3.40 AM and 3.00 AM and complete blooming period ranges from 7-8 days, 9 days and 8 days in GPU 28, HR 911 and PR 202, respectively. Duration of pollen emergence to anther withering in these varieties ranges from 25 to 30 minutes (Table 2). These results are in conformity with Ayyangar (1932), Ayyangar and Warrior (1934), Chavan *et al*. (1955), Chavan and Shendge (1957) and Coleman *et al*. (1921).

The outcomes of the investigation helps to confirm the anthesis pattern in finger millet varieties and also provides the supporting evidence for previously generated findings about floral biology and its relevant characters. The time of anthesis helps to fix the time and appropriate stage for effective pollination, in order to achieve maximum crossed seed at the possible extent upon hybridization.

Table 1. Special features of varieties selected for the floral biology studies in finger millet

Varieties	Pedigree	Year of release	Recommended states	Institute where developed	Maturity (Days)	Ear shape and size
HR 911	UAS 1 x IE 927	1986	Karnataka	PC Unit, Bangalore	110-115	Straight and long fingers
PR 202	Pure line selection	1982	All finger millet growing states	ANGRAU, Hyderabad (AP)	115-118	Incurved fingers with small sized ears
GPU - 28	Indaf 5 x IE 1012	1998	Karnataka	PC Unit, Bangalore	110-115	Tip incurved fingers, semi compact and medium sized ears.

Table 2. Floral biology and its associated characters in three varieties of finger millet

Varieties	Time of anthesis	Sequence of flower opening		Days taken for complete blooming	Duration of pollen release to anther withering
GPU – 28	**1.15 AM**	**Within a spike**	**Within a spikelet**	7 to 8 days	25-30 minutes
		Top to bottom (Basipetal)	Bottom to top (Acropetal)		
HR 911	**3.40 AM**	Top to bottom (Basipetal)	Bottom to top (Acropetal)	9 days	30 minutes
PR 202	**3.00 AM**	Starts at 1/3rd of top and proceeds downwards (Basipetal)	Bottom to top (Acropetal)	8 days	25 minutes

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