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GROWTH CHARACTERS AND YIELD OF SUGARCANE SHORT CROP INFLUENCED BY FERTILIZERS AND MICROBIAL INOCULANTS

G. RAVITEJA*, B. VAJANTHA, A. PRASANTHI, M. RAVEENDRA REDDY, M.V.S. NAIDU AND G.P. LEELAVATHY

Department of Soil Science and Agricultural Chemistry, S.V. Agricultural College, ANGRAU, Tirupati-517 502.

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ABSTRACT

A field experiment was conducted at Agricultural Research Station, Perumallapalle, Tirupati, Acharya N.G. Ranga Agricultural University, Andhra Pradesh, India during 2021-22 to study the effect of fertilizers and microbial inoculants on growth and yield of sugarcane short crop. The experiment was laid out in randomized block design with ten treatments and replicated thrice. The treatments consists of 75%, 100% and 125% RDF in combination of solid and liquid microbial inoculants (*Gluconacetobacter*, PSB and KSB). Data on dry matter production, yield characters and yield parameters were recorded. Results revealed that 100% RDF along with sett treatment with liquid *Gluconacetobacter* @ 1 L ha^{-1}, PSB @ 1.25 L ha^{-1} and KSB @ 1.25 L ha^{-1} resulted significantly the highest dry matter production (6684, 29821, 37530 kg ha^{-1} at tillering, grand growth and harvest stages, respectively). It also enhanced tillering (119364 ha^{-1}), stalk population (93465 ha^{-1}), cane length (248 cm) and cane yield (97 t ha^{-1}).

KEYWORDS: Growth, Inorganic fertilizers, Microbial inoculants, Sugarcane and yield.

INTRODUCTION

Sugarcane is the most important commercial crop of India and plays a vital role in the agricultural as well as industrial economy. Sugarcane is a multipurpose crop that provides sugar, fiber, bio-fuel and manure apart from many by-products. It constitutes the major raw material for sugar production and for making gur and khandasari. Sugarcane has unique character of ratooning as several succeeding crops are raised from a single planting which is an integral component of the sugarcane production system.

Sugarcane (*Saccharum officinarum*) is a nutrient exhaustive crop that can uptake great amount of soil nutrients for its biomass production. In addition to micronutrient exportation, about 65 kg N, 90 kg P_2O_5 and 170 kg K_2O are taken up for a target yield of 50 t ha^{-1} (Kathiresan, 2008). A permanent manurial trial, conducted for 33 years at RARS, Anakapalle (Andhra Pradesh), revealed that sugarcane crop without addition of fertilizers yielded about 40 t ha^{-1} of cane annually. The soil nitrogen reserve under this crop, however, increased by 50 per cent of the initial value which was clearly indicated that the root-associated diazotrophs contributed significant quantity of nitrogen for sustaining the production of sugarcane (Suman, 2003). Inoculation of N-fixing microbes to sugarcane has increased the cane yield by 5-15 per cent and also improved the juice quality parameters, *viz*., sucrose and purity (Hari, 1995).

Gluconacetobacter diazotrophicus is a nitrogen-fixing bacterium highly specific to sugar-rich crops. It can excrete about half of its fixed nitrogen in a form that plant can use. It has also been reported that besides N fixation, all the strains of *G. diazotrophicus* produced Indole acetic acid in a culture medium supplemented with tryptophan in the range of 0.14 to 2.42 l g ml^{-1} (Fuentez *et al*., 1993). Furthermore, it has been reported its ability to solubilize inorganic phosphates from the soil and make available P for the inoculated crops. Hence, *Gluconacetobacter* inoculation to sugarcane significantly increased the cane length, dry matter production and number of stalks, resulting in the more cane yield. PSB application which constitutes increased P solubilization which by production of organic acids which solubilizes the fixed form of phosphates into available form resulting in more available P in soil. KSB is more effective in releasing K from inorganic and insoluble fractions of total soil K through solubilization. With this view, a field experiment was conducted to study the effect of soil application and sett treatment of solid and liquid *G. diazotrophicus,* PSB and KSB along with fertilizers on growth characters and yield of sugarcane short crop.

MATERIAL AND METHODS

A field experiment was conducted during 2021-22 at Agricultural Research Station, Perumallapalle, Tirupati, Acharya N. G. Ranga Agricultural University, geographically situated at 13° 36' 761" N latitude and

*Corresponding author, E-mail: gobidesitejasriyadav@gmail.com

79° 20' 704" E longitude with an altitude of 182.9 m above the mean sea level, which falls under Southern agroclimatic zone of Andhra Pradesh. The experiment soil was sandy loam in texture, neutral in reaction (7.36), normal in soluble salt concentration (0.232 dS m^{-1}), low in organic carbon (0.49%), available nitrogen (212 kg ha^{-1}) and medium in available phosphorus (40.12 kg ha^{-1}) and high in available potassium (282 kg ha^{-1}). The experiment consist of ten treatments *viz*., T_1: 100% RDF, T_2 : 125% RDF, T_3: 100% RDF + soil application of solid *Gluconacetobacter* + PSB + KSB, T_4 : 100% RDF + sett treatment with solid *Gluconacetobacter* + PSB + KSB, T_5 : 75% RDF + soil application of solid *Gluconacetobacter* + PSB + KSB, T_6 : 75% RDF + sett treatment with solid *Gluconacetobacter* + PSB + KSB, T_7 : 100% RDF + soil application of liquid *Gluconacetobacter* + PSB + KSB, T_8 : 100% RDF + sett treatment with liquid *Gluconacetobacter* + PSB + KSB, T_9 : 75% RDF + soil application of liquid *Gluconacetobacter* + PSB + KSB and T_{10} : 75% RDF + sett treatment with liquid *Gluconacetobacter* + PSB + KSB was laid out in randomized block design with three replications.

The crop was sown with a seed rate of 40,000 three budded setts ha^{-1}. The variety Swarnamukhi was planted. Recommended dose of inorganic fertilizers *viz*., 224:112:112 kg N : P_2O_5 and K_2O ha^{-1}, respectively were applied as per the treatments. Solid *Gluconacetobacter*, PSB and KSB were applied @ 10 kg ha^{-1} each as soil application. The recommended dose of solid biofertilizers for sett treatment was 10 kg - 1.25 kg - 1.25 kg ha^{-1} of *Gluconacetobacter,* PSB and KSB, respectively. Recommended dose of liquid *Gluconacetobacter*, PSB and KSB for soil application was 1 L, 1.25 L and 1.25 L ha^{-1}, respectively. Similar quantity of liquid *Gluconacetobacter*, PSB and KSB was used for sett treatment. All the other recommended practices were also adopted as per the crop requirement. Data on dry matter production, tiller count, stalk population, cane length and cane yield was recorded at respective stages. The collected data was statistically analyzed by following the analysis of variance for randomized block design as outlined by

Table 1. Dry matter production of sugarcane short crop as influenced by application of microbial inoculants and inorganic fertilizers

Treatments	Dry matter production (kg ha^{-1})		
	Tillering stage	Grand growth stage	At harvest
T_1	4704^{h}	20146^{g}	26057^{h}
T_2	5483^{f}	23426^{e}	30099^{ef}
T_3	5797^{d}	24956^{d}	31910^{c}
T_4	6291^{b}	27896^{b}	34960^{b}
T_5	5088^{g}	21495^{f}	28145^{g}
T_6	5436^{f}	23392^{e}	30463^{de}
T_7	6021^{c}	26308^{c}	32971^{c}
T_8	6684^{a}	29821^{a}	37530^{a}
T_9	5179^{g}	22293^{f}	29476^{g}
T_{10}	5640^{e}	24235^{de}	30395^{d}
F-Value	87.68**	73.06**	58.29**
P-Value	<0.01	<0.01	<0.01

**Significant at P = 0.01 level

Note : Same set of alphabets indicates no significant difference or at par with each other (DMRT)

Panse and Sukhatme (1985). Statistical significance was tested with 'F' test at 5 percent and 1 per cent level of probability. Further, multiple comparison tests have been done using Duncan's multiple range test (DMRT) to identify the homogenous groups of treatments using SPSS-20.

RESULTS AND DISCUSSION

Dry matter production

Data pertaining to dry matter production at tillering, grand growth and harvest was represented in Table 1. Application of 100% RDF + sett treatment with liquid *Gluconacetobacter* + PSB + KSB (T_8) resulted significantly the highest dry matter production at all stages of crop growth (6684, 29821 and 37530 kg ha^{-1}, respectively) followed by 100% RDF + sett treatment with solid *Gluconacetobacter* + PSB + KSB (T_4) at all stages of crop growth while the lowest was observed in control (100% RDF) (T_1) (4704, 20146 and 26057 kg ha^{-1}, respectively).

The highest dry matter production recorded with the combined application of 100% RDF and sett treatment with liquid *Gluconacetobacter* + PSB + KSB (T_8). This might be due to higher germination per cent which leads to more tiller population, shoot population caused by bioinoculants which produces more growth promoting substances, increased availability of nutrients due to atmospheric nitrogen fixation in the rhizosphere, solubilization of mineral nutrients, nutrient recycling by microbial inoculants and also readily available nutrients from inorganic fertilizers. (Viana *et al*., 2019). These results are in line with the findings of Banerjee *et al*. (2018).

Tiller count and stalk population

Data pertaining to tiller count and stalk population was presented in Table 2. Application of 100% RDF + sett treatment with liquid *Gluconacetobacter* + PSB + KSB (T_8) resulted in significantly highest number of tillers at 90 DAP and stalk population at 240 days after planting followed by 100% RDF + sett treatment with solid *Gluconacetobacter* + PSB + KSB (T_4). The lowest number of tillers and stalk population was observed in control (100% RDF) (T_1). Improvement in plant population in terms of number of tillers and stalk population might be due to immediate supply of nutrients from inorganic fertilizer and sustained supply of nutrients from organics along with biofertilizers during the plant growth. Application of biofertilizers increased tiller number, and stalk population probably due to plant growth regulator hormones secreted by microbial inoculants. Ethylene is the foremost phytohormone regulating this physiological process in sugarcane (Mishra *et al*., 2014). Moreover, application of PSB has ability to produce cytokinins which will be essential for cell division in tiller buds. These results are in conformity with the findings of Thakur *et al*. (2010) and Singh *et al*. (2016).

Cane length

Cane length of sugarcane was significantly affected by the application of microbial inoculants along with fertilizers (Table 2). Significantly the highest cane length (248 cm) was observed with the application of 100% RDF + sett treatment with liquid *Gluconacetobacter* + PSB + KSB (T_8) followed by 100% RDF + sett treatment with solid *Gluconacetobacter* + PSB + KSB (T_4) (242 cm). The lowest cane length (217 cm) was observed with (100% RDF) (T_1). Application of 100% RDF supplies nutrients in available form at initial stages of plant growth which plays an important role in metabolic process and activation of number of enzymes participating photosynthesis which inturn increased the plant growth and cane length. Application of biofertilizers improved soil environment in respect of nutrients for crop growth at active growing stages as a result of elevated root proliferation, cell multiplication and elongation leading to increased cane length. These findings are corroborated with the results obtained by Mathew and Varughese (2005), Shankaraiah (2007) and Singh *et al*. (2014).

Cane yield

Cane yield of sugarcane short crop was significantly differed with microbial inoculants and fertilizers application (Table 2). Significantly the highest cane yield (97 t ha^{-1}) was recorded with the application of 100% RDF + sett treatment with liquid *Gluconacetobacter* + PSB + KSB (T_8) and followed by 100% RDF + sett treatment with solid *Gluconacetobacter* + PSB + KSB (T_4) (92 t ha^{-1}). The control (100% RDF) (T_1) produced significantly the lowest cane yield (69 t ha^{-1}). The highest cane yield with 100% RDF + sett treatment with liquid *Gluconacetobacter* + PSB + KSB might be due to direct utilization of sugars present in setts by microbes as a food source which inturn leads to more microbial multiplication and leads to production of growth promoting substances. It helps in photosynthesis and translocation of substrates from source to sink *i.e.,* cane and leads to more cane yield. Sufficient quantity of nutrients supplied through chemical fertilizers provides readily available nutrients and application of biofertilizers may hasten the constant nutrient supply by nitrogen fixation in the rhizosphere, solubilization of mineral nutrients, enhanced rooting and

Table 2. Tiller count, stalk population, cane length and cane yield of sugarcane short crop as influenced by application of microbial inoculants and inorganic fertilizers

Treatments	Tiller count ha^{-1} at 90 DAP	Stalk population ha^{-1} at harvest	Cane length (cm)	Cane yield (t ha^{-1})
T_1	96005^{h}	69484^{g}	217^{h}	69^{h}
T_2	107512^{e}	78626^{e}	229^{f}	77^{f}
T_3	111477^{d}	83468^{c}	235^{d}	85^{d}
T_4	116508^{b}	88686^{b}	242^{b}	92^{b}
T_5	101752^{g}	74368^{f}	223^{g}	74^{g}
T_6	104542^{f}	79464^{de}	232^{e}	82^{e}
T_7	113603^{c}	84648^{c}	239^{c}	88^{c}
T_8	119364^{a}	93465^{a}	248^{a}	97^{a}
T_9	103585^{f}	77864^{ef}	228^{f}	81^{e}
T_{10}	110596^{d}	80542^{d}	234^{d}	84^{d}
F-Value	55.87**	62.14**	96.42**	80.08**
P-Value	<0.01	<0.01	<0.01	<0.01

**Significant at P = 0.01 level
Note : Same set of alphabets indicates no significant difference or at par with each other (DMRT)

plant establishment, better uptake of immobile nutrients such as P, improved nutrient cycling, improved plant tolerance to stress (biotic and abiotic) and amelioration of physical and biological environment. (Surendran and Vani, 2013). Similar results were reported by Indi *et al*. (2014) and Vajantha *et al*. (2019).

It can be concluded that combined application of 100% RDF + sett treatment with liquid *Gluconacetobacter* + PSB @ + KSB @ 1.25 is the most efficient nutrient management practice to obtain better growth, higher yields and quality of sugarcane short crop. Hence, it is the best practice to sustain higher productivity and to achieve economic profitability in Southern Agroclimatic Zone of Andhra Pradesh.

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PROFILE OF THE FARMERS CULTIVATING GROUNDNUT IN THE COASTAL SANDY SOILS OF SPSR NELLORE DISTRICT OF ANDHRA PRADESH

K. TEJASWINI*, P. BALA HUSSAIN REDDY, T. LAKSHMI AND P. MAHESWARA REDDY

Department of Agricultural Extension Education, S.V. Agricultural College, ANGRAU, Tirupati-517 502.

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ABSTRACT

The present study was conducted in the district of SPSR Nellore. To study the profile of groundnut farmers in coastal sandy soils, a total of 90 respondents were randomly selected and interviewed. The respondents were in middle age group, educated up to middle school (27.79%) and high school (24.44%), had small farm size (50.00%), medium experience in farming (58.90%), had medium extension contact (44.45%), medium mass media exposure (58.90%), medium level of innovativeness (74.44%), medium level social participation (83.33%), medium level scientific orientation (77.79%), medium level economic orientation (81.11%) and medium level risk orientation (78.90%).

KEYWORDS: Profile, Farmers, Groundnut cultivation, Coastal sandy soils.

INTRODUCTION

Coastal sandy soils are primarily present along the coastal length and are characterized by light texture with poor nutrient status, high leaching losses, low status of soil organic matter and with low microbial activity, deficit in Zinc, Iron and Boron (Singravel *et al.,* 2011). In addition to these, coastal sandy soils have low water holding capacity, low fertility and non-suitability for majority of crops, thus creating complex management problems for farmers to cultivate crops (Caldwell *et al.,* 2005). Inspite of poor soil conditions, farmers were cultivating groundnut crop with uncommon local practices for sustaining their livelihood in the coastal sandy soils. This study would thoroughly insight into the existing scenario of cultivation practices in groundnut crop and by taking into account the profile of the farmers. SPSR Nellore is one of the coastal districts having 167 km coastal length (Kannan, 2016). Groundnut is the major irrigated dry crop in SPSR Nellore district after rice and sugarcane and is cultivated in about 3354 hectares (*Rabi*, 2021-2022).

This study was taken as the cultivation is happening in uncommon farming situation and the farmers were following their own package of practices in coastal sandy soils. This study was proposed to understand the cultivation practices adopted by the farmers in coastal sandy soils and go through the issues related to intensive cultivation of groundnut crop in that ecosystem. In the light of above facts, it is felt necessary to assess the profile of groundnut farmers.

MATERIAL AND METHODS

In the present study, *Exploratory* and *Ex-post-facto* research designs were followed. The research was carried out in the SPSR Nellore district of Andhra Pradesh. It was selected purposively as it is having unique area of groundnut cultivation under coastal sandy soils. Three mandals of the district *viz.,* Vidavaluru, Kavali and Muthukur were selected purposively for the study based on the highest area of groundnut cultivation under coastal sandy soils. From each of the selected three mandals, two villages were chosen at random and from each of the selected villages, 15 respondents were selected on simple random sampling basis thus making a total of 90 respondents. The data was collected by personal interview method through a structured interview schedule and statistical techniques like arithmetic mean, standard deviation, frequencies and percentage were used.

RESULTS AND DISCUSSION

The data gathered during the study were analyzed and the results were presented in Table 1.

Age

Table 1 clearly depicted that more than half (62.23%) of the groundnut farmers were middle aged followed by young (23.33%) and old age (14.44%) respectively. The probable reason for the above trend might be that, middle age farmers occupy large section of the society and were

*Corresponding author, E-mail: tejuashu31@gmail.com

Table 1. Profile characteristics of Groundnut farmers

(n = 90)

S. No.	Category	Class Interval	Frequency (f)	Percentage (%)	Mean	S.D
I.	**Age**					
1.	Young age	(<35 years)	21	23.33		
2.	Middle age	(36-55 years)	56	62.23	-	-
3.	Old age	(56 years and above)	13	14.44		
II.	**Education**					
1.	Illiterate		1	1.11		
2.	Functionally literate		1	1.11		
3.	Primary school		20	22.22	-	-
4.	Middle school		25	27.79		
5.	High school		22	24.44		
6.	College level		21	23.33		
III.	**Farm size**					
1.	Marginal (<2.5 acres)		21	23.34		
2.	Small (2.5 to 5.0 acres)		45	50.00	-	-
3.	Medium (5.0 to 10.00 acres)		18	20.00		
4.	Big (> 10 acres)		6	6.66		
IV.	**Farming experience**					
1.	Low farming experience		20	22.22		
2.	Medium farming experience		53	58.90	16.94	10.49
3.	High farming experience		17	18.88		
V.	**Extension contact**					
1.	Low extension contact		23	25.55		
2.	Medium extension contact		40	44.44	26.44	8.73
3.	High extension contact		27	30.00		
VI.	**Mass media exposure**					
1.	Low mass media exposure		16	17.77		
2.	Medium mass media exposure		53	58.90	12.74	5.74
3.	High mass media exposure		21	23.33		
VII..	**Innovativeness**					
1.	Low innovativeness		17	18.88		
2.	Medium innovativeness		67	74.44	31.17	4.34
3.	High innovativeness		6	6.68		
VIII.	**Social participation**					
1.	Low social participation		13	14.44		
2.	Medium social participation		75	83.33	2.23	0.77
3.	High social participation		2	2.23		
IX.	**Scientific orientation**					
1.	Low scientific orientation		15	16.66		
2.	Medium scientific orientation		70	77.79	22.84	3.48
3.	High scientific orientation		5	5.55		
X.	**Economic orientation**					
1.	Low economic orientation		15	16.66		
2.	Medium economic orientation		73	81.11	22.17	3.86
3.	High economic orientation		2	2.23		
XI.	**Risk orientation**					
1.	Low risk orientation		16	17.77		
2.	Medium risk orientation		71	78.90	22.75	3.27
3.	High risk orientation		3	3.33		

more likely to be enthusiastic towards new ideas and comparatively matured and responsible than the young age group because of their already gained experiences. On the other side, the young age farmers showed less interest in farming as they were more interested in non-agricultural occupations and self-employment. While older farmers are gradually moving away from farming and preferred to stay at their homes and take care of the allied activities such as animal husbandry to avoid heavy drudgery and hard work involved in groundnut cultivation and were also giving their land either for lease or to other farmers. These findings are in line with the findings of Ramapadmaja and Umamaheswararao (2019).

Education

It could be seen from the Table 1 that 27.79 per cent of the groundnut farmers were educated up to middle school followed by high school (24.44%), college level (23.33%), primary school (22.22%), illiterate (1.11%) and functionally literate (1.11%) respectively. More than half (52.23%) of the groundnut farmers had middle school and high school level education followed by college level. It is clear that the availability of basic educational infrastructure in rural areas had increased, and that respondents had a better understanding of the necessity of education for their overall development. This trend was followed by primary school level, illiterate and functionally literate. These findings are in line with the findings of Rathod (2013).

Farm size

It is apparent from Table 1 that 50 per cent of the groundnut farmers were small followed by marginal farmers (23.34%), medium farmers (20.00%) and big farmers (6.66%). Increasing urbanisation and transformation in land use pattern to non-farm activities in the countryside could also be attributed as potential reasons for decrease in farm size. The result was matched with Muthukumar (2016) and Venuprasad *et al.* (2018).

Farming experience

Table 1 clearly depicted that 58.90 per cent of the groundnut farmers had medium followed by low (22.22%) and high (18.88%) farming experience. The probable reason might be that, majority of the farmers were of middle age and young age group as per the above findings. The above finding has resembled the findings of Deshmukh *et al.* (2018).

Extension contact

It is apparent from Table 1 that 44.45 per cent of the respondents were having medium extension contact followed by high (30.00%) and low (25.55%) extension contact. Majority (74.45%) of the farmers were included under medium to high extension contact. The probable reason for this trend might be the increase in frequency of contact between the farmers and Village Agricultural Assistants (VAAs) working in Rythu Bharosa Kendras (RBKs). The farmers with more inclination towards latest cultivation practices might have been approaching the agricultural officers and other higher cadre extension officers for getting latest developments in agriculture. The result is in conformity with the findings of Yashashwini (2013).

Mass media exposure

From Table 1 it could be seen that, 58.90 per cent of the respondents were having medium mass media exposure followed by high (23.33%) and low (17.77%) levels of mass media exposure. This clearly signifies the effective utilization of different mass media sources such as newspaper, television and other media by the farmers, which are now more accessible even in rural areas. On the other side, Illiterate farmers might have been grouped under low mass media exposure category. The above result is in conformity with Begum (2008) and Kalyan (2011).

Innovativeness

It is obvious from the Table 1 that 74.44 per cent of the Groundnut farmers had medium level of innovativeness followed by low (18.88%) and high (6.68%) levels of innovativeness. About 81.12 per cent of farmers had medium to high innovativeness and it could be attributed to good educational qualifications, knowledge and high extension contact of farmers enabling them to take up all practices with high precision. This might have developed self-confidence which in turn had impact on innovativeness from medium to low. This result was in agreement with Gudadur and Jahanara (2018).

Social participation

It could be seen from the Table 1 that 83.33 per cent of the respondents had medium level of social participation followed by low (14.44%) and high (2.23%) levels. The probable reason for the above trend might be that, being a member of the society everybody

needs to work together cooperatively to achieve higher returns. The need of being a member or office bearer in such societies which directly involve in farming is essential for taking up appropriate and timely operations in farm production. Hence the above trend was observed. These findings were in conformity with the findings of Khodifad (2010) and Patoliya (2013).

Scientific orientation

It is evident from the Table 1 that more than half (77.79%) of the respondents had medium scientific orientation followed by low (16.66%) and high (5.55%) of scientific orientation. Lack of proper awareness, knowledge and skills on latest recommended agricultural cultivation practices were due to scanty guidance by the extension personnel. On the other side the lower education also might have resulted in more than 90 per cent of the farmers with low to medium scientific orientation. Higher education might have helped the remaining 10 per cent of the farmers for high scientific orientation. The finding is in conformity with Thiyagarajan (2011).

Economic orientation

It is evident from the Table 1 that more than half (81.11%) of the respondents had medium economic orientation followed by low (16.66%) and high (2.23%) level of economic orientation. There was always an urge to earn money in the minds of people to increase the socio-economic status and improve their standard of living. The respondents of the present study were not an exception to this kind of urge. This desire to compete with each other in improving their standard of living to clear old debts and to fulfill family commitments resulted in medium economic motivation. The finding was similar to the results of Ghintala (2013).

Risk orientation

It is evident from the Table 1that more than half (78.90%) of the respondents had medium risk orientation followed by low (17.77%) and high (3.33%) of risk orientation. Failure of monsoon in the preceding crop seasons and lack of assured irrigation supply were might be the prime factors for placing majority of the respondents under medium level category of risk orientation. At the same time this result might be due to the fact that the young, educated and interested respondents with medium levels of scientific orientation were ready to face the risk while adopting the groundnut cultivation practices. The farmers with low risk orientation (17.77%) might be due to high investment per acre for the groundnut crop. The big farmers with higher education might have fell under high risk orientation category (3.33 %). The finding was similar to the results of Kumar (2012).

The profile of the groundnut farmers affects their level of success and failure in the cultivation of groundnut crop in the coastal sandy soils. The findings of the study clearly revealed that majority of groundnut farmers were middle aged, educated up to middle school with small farm size, medium farming experience, extension contact, mass media exposure, innovativeness, social participation, scientific orientation, economic orientation and risk orientation. These profile characteristics must be taken into account while formulating and implementing new cultivation practices and technologies which suits to the coastal sandy soils as it needs prudence attention.

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NUTRIENT UPTAKE AS INFLUENCED BY METHODS OF SOWING AND WEED MANAGEMENT PRACTICES IN SUMMER SESAME (*Sesamum Indicum* L.)

R. BHAVANI*, G. KRISHNA REDDY, P. MAHESWARA REDDY, P. LAVANYA KUMARI AND G. KARUNA SAGAR

Department of Agronomy, S.V. Agricultural College, ANGRAU, Tirupati-517 502.

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ABSTRACT

A field experiment was conducted during summer, 2022 at S.V. Agricultural College Farm, Tirupati. The experiment was laid out in split-plot design and replicated thrice. The treatments consisted of three methods of sowing (3) *viz.,* line sowing (M_1), broadcasting (M_2) and broadcasting with higher seed rate (M_3) assigned to main plots and four weed management practices (4) *viz*., pre-emergence application of butachlor 1.0 kg ha^{-1} (W_1), pre-emergence application of oxyfluorfen 0.075 kg ha^{-1} (W_2), hand weeding twice at 20 and 40 DAS (W_3) and unweeded check (Control) (W_4) allotted to sub plots. Among the methods of sowing highest uptake of N, P and K by sesame was with broadcasting higher seed rate. Hand weeding recorded significantly higher N, P and K uptake by sesame crop compared to other three weed management practices. Lower nutrient uptake of N, P and K by crop was with unweeded check.

KEYWORDS: Sesame, Methods of sowing, Pre-emergence herbicides, Nutrient uptake.

INTRODUCTION

Sesame (*Sesamum indicum* L.) is one of the foremost conventional oilseed crop cultivated in tropical, subtropical, Asian and African nations. It is one of the important oilseed crop in Indian agriculture, commonly known as til. Sesame oil contains the significant amount of polyunsaturated fatty acids, such as oleic and linolenic acids ranging from 30.9 to 52.5 per cent. India ranks first both in area and production of sesame in the world and the largest (40%) sesame exporter in the world. In India, sesame is cultivated in 16.22 lakh hectares, 6.57 lakh tonnes of production with a productivity 405 kg ha^{-1}. In Andhra Pradesh, sesame is grown in 39,000 hectares of area with 13,380 tonnes of production and productivity of about 343 kg ha^{-1} during 2019-2020 (www.indiastat.com). In most of the areas sesame crop is heavily infested by weeds and thereby resulting in heavy yield loss ranging from 16 to 68 per cent. The period from 15-30 days after sowing is the most critical period of crop-weed competition in sesame. Therefore, weed management is essential with pre-emergence herbicides in sesame to minimize the yield losses caused by weeds under different methods of sowing.

MATERIAL AND METHODS

The field experiment was conducted at S.V. Agricultural College, Tirupati campus of Acharya N.G. Ranga Agricultural University, Andhra Pradesh during summer, 2022. The soil of experimental field was sandy loam in texture, neutral in reaction, low in organic carbon (0.48%) available nitrogen (150 kg ha^{-1}), high in available phosphorus (77 kg ha^{-1}) and mediuin in available potassium (221 kg ha^{-1}). The experiment was laid out in split-plot design and replicated thrice. The treatments consisted of three methods of sowing (3) *viz.,* line sowing (M_1), broadcasting (M_2) and broadcasting with 1.5 times seed rate (M_3) assigned to main plots and four weed management practices (4) *viz.,* pre-emergence application of butachlor 1.0 kg ha^{-1} (W_1), pre-emergence application of oxyfluorfen 0.075 kg ha^{-1} (W_2), hand weeding at 20 and 40 DAS (W_3) and unweeded check (Control) (W_4) allotted to sub plots. In line sowing 30 cm x 15 cm spacing with a seed rate of 4 kg ha^{-1}, broadcasting with a seed rate of 5 kg ha^{-1} and broadcasting with 1.5 times seed rate with a seed rate of 7.5 kg ha^{-1}. The variety sarada (YLM-66) was sown on 19th of January and recommended dose of the fertilizer applied was 40-20-20 N-P_2O_5-K_2O kg ha^{-1}. Composite plant samples of crop as well as weeds from all the plots were collected at harvest and these samples were dried, ground into fine powder and used for estimation of N, P and K by using standard procedures outlined by Jackson (1973). The uptake of nitrogen, phosphorus and potassium at harvest by the crop and its associated weeds were calculated by multiplying the respective nutrient content with corresponding dry weights and expressed as kg ha^{-1}. All the other recommended practices were also adopted as per the crop requirement.

*Corresponding author, E-mail: bhavani.rapelli@gmail.com

Table 1. Uptake of nitrogen, phosphorus and potassium (kg ha^{-1}) by sesame at harvest as influenced by methods of sowing and weed management practices

Treatments	Nitrogen	Phosphorus	Potassium
Methods of sowing (3)			
M_1 : Line sowing	37.2	30.4	53.3
M_2 : Broadcasting	34.4	29.2	49.1
M_3 : Broadcasting with 1.5 times seed rate	39.1	33.4	56.0
SEm ±	0.14	0.22	0.56
CD (P = 0.05)	0.5	0.9	2.2
Weed management practices (4)			
W_1 : Butachlor 1.0 kg ha^{-1}	41.1	33.1	56.1
W_2 : Oxyflourfen 0.075 kg ha^{-1}	29.2	23.3	45.2
W_3 : Hand weeding at 20 and 40 DAS	45.3	37.2	59.0
W_4 : Unweeded check (Control)	33.3	30.0	49.1
SEm ±	1.10	0.69	0.58
CD (P = 0.05)	3.2	2.0	1.7
Interaction			
M at W			
SEm ±	1.91	1.20	1.01
CD (P = 0.05)	NS	NS	NS
W at M			
SEm ±	1.66	1.02	1.04
CD (P = 0.05)	NS	NS	NS

RESULTS AND DISCUSSION

The weed flora associated in the experimental field were *Cyperus rotundus* (40.0%), *Commelina benghalensis* (10.0%), *Cleome viscosa* (8.0%), *Boerhavia diffusa* (5.0%), *Phyllanthus niruri* (5.0%), *Dactyloctenium aegyptium* (5.0%) and *Digitaria sanguinalis* (4.0%). Nutrient uptake by sesame crop differed significantly due to methods of sowing and weed management practices. Interaction between these two practices was not statistically measurable. Among the methods of sowing, the highest uptake of N, P and K by sesame was with broadcasting higher seed rate due to lower weed infestation. Similar results have been reported by Rajpurohit *et al.* (2017). Hand weeding recorded significantly higher N, P and K uptake by sesame crop compared to other three weed management practices. This might be due to higher dry matter accumulation and higher nutrient content in sesame crop. The nutrient uptake by crop and associated weeds follows an inverse relationship as evident in the present investigations. Lower nutrient uptake of N, P and K by crop was with unweeded check due to low dry matter production and reduced nutrient uptake by the crop as a result of heavy weed competition. These results are in conformity with the results of Sahoo *et al*. (2017).

Nutrient uptake by weeds differed significantly due to methods of sowing and weed management practices. Interaction effect between these two factors was not statistically measurable. Among the methods of sowing, highest uptake of N, P and K by weeds was with broadcasting due to high weed population. The results are in line with the findings of (Umed *et al*., 2009). Among the weed management practices, highest uptake of N, P and K by weeds was with unweeded check, which was significantly higher than the rest of the weed management practices due to severe weed competition from weeds. In all the crops, highest uptake of N, P and K by weeds was with unweeded check as conformed by several researchers.

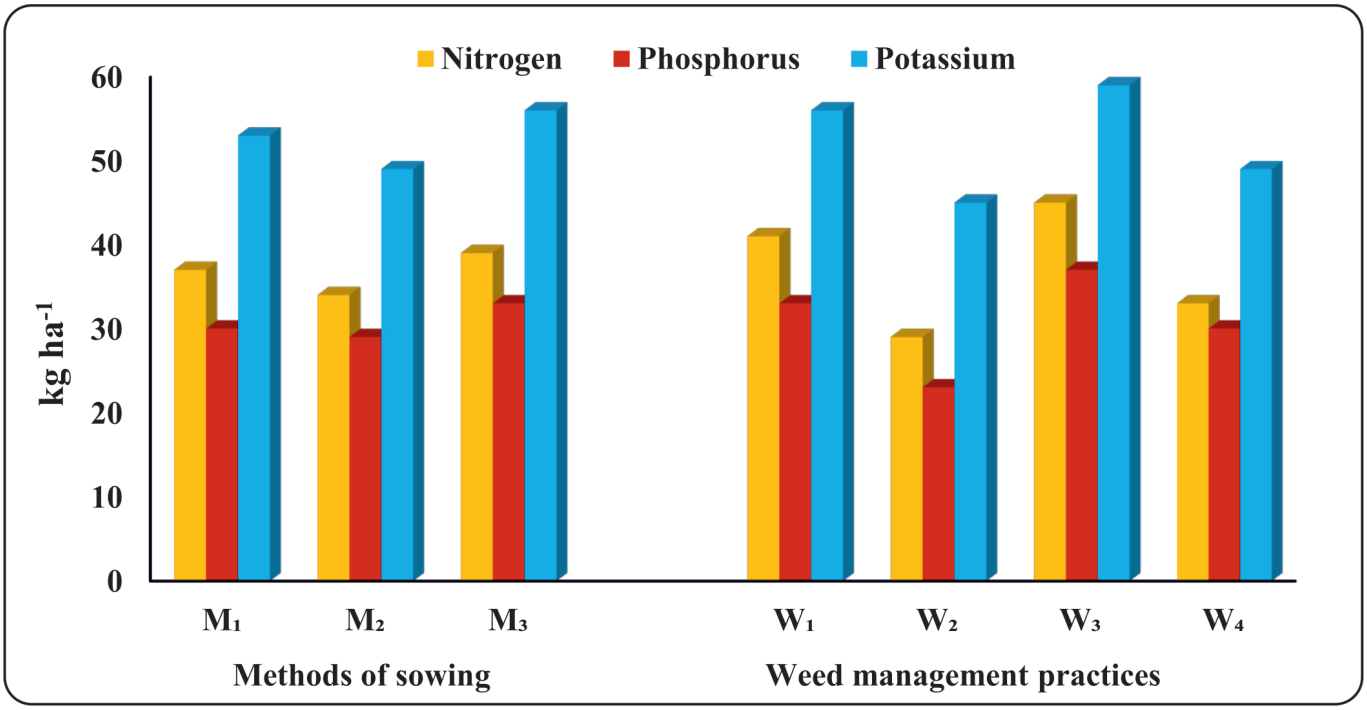

Fig. 1. Uptake of nitrogen, phosphorus and potassium (kg ha^{-1}) by sesame at harvest as influenced by methods of sowing and weed management practices.

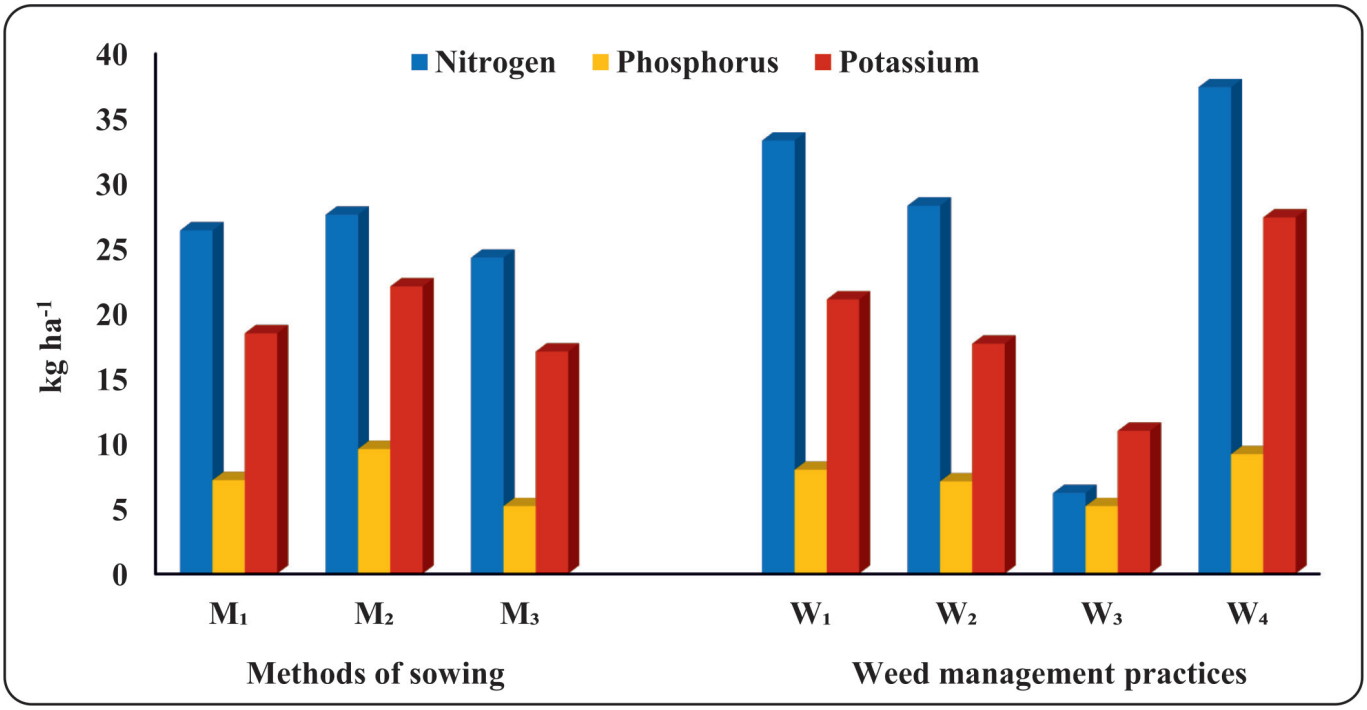

Fig. 2. Uptake of nitrogen, phosphorus and potassium (kg ha^{-1}) by weeds in sesame as influenced by methods of sowing and weed management practices.

Table 2. Uptake of nitrogen, phosphorus and potassium (kg ha^{-1}) by weeds in sesame at harvest as influenced by methods of sowing and weed management practices

Treatments	Nitrogen	Phosphorus	Potassium
Methods of sowing (3)			
M_1 : Line sowing	26.4	7.2	18.5
M_2 : Broadcasting	27.6	9.6	22.1
M_3 : Broadcasting with 1.5 times seed rate	24.3	5.2	17.1
SEm ±	0.24	0.22	0.32
CD (P = 0.05)	0.9	0.9	1.3
Weed management practices (4)			
W_1 : Butachlor 1.0 kg ha^{-1}	33.3	8.0	21.1
W_2 : Oxyflourfen 0.075 kg ha^{-1}	28.3	7.1	17.7
W_3 : Hand weeding at 20 and 40 DAS	6.2	5.2	11.0
W_4 : Unweeded check (Control)	37.4	9.2	27.4
SEm ±	0.81	0.31	0.59
CD (P = 0.05)	2.5	0.9	1.7
Interaction			
M at W			
SEm ±	1.49	0.55	0.31
CD (P = 0.05)	NS	NS	NS
W at M			
SEm ±	1.31	0.52	0.95
CD (P = 0.05)	NS	NS	NS

With regard to methods of sowing, highest uptake of N, P and K by sesame crop was due to broadcasting using higher seed rate. Among the weed management practices tried, hand weeding recorded significantly higher N, P and K uptake by sesame. Regarding the weed uptake among the methods of sowing, higher N, P and K uptake by weeds was with broadcasting and highest uptake of N, P and K by weeds was with unweeded check among different weed management practices.

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CORRELATION AND PATH ANALYSIS IN F_2 POPULATIONS OF GROUNDNUT (*Arachis hypogaea* L.) FOR YIELD AND YIELD ATTRIBUTES IN KADIRI 6 × J 11 CROSS

Y.V.S. JYOTHIRMAI*, M. SREEVALLI DEVI, K. JOHN AND B. RAMANA MURTHY

Department of Genetics and Plant Breeding, S.V. Agricultural College, ANGRAU, Tirupati-517 502.

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ABSTRACT

The experiment was conducted at dryland farm of S. V. Agricultural College, Tirupati during *kharif,* 2021. In the cross Kadiri 6 × J 11, number of primary branches plant^{-1}, number of mature pods plant^{-1}, harvest index, dry haulms yield plant^{-1}, kernel yield plant^{-1} showed positive significance for pod yield plant^{-1}. Based on the path analysis, kernel yield plant^{-1} exhibited high positive direct effect with pod yield plant^{-1} in all six crosses; hence importance should be given in selection process for the improvement of pod yield in groundnut.

KEYWORDS: Correlation, path analysis, groundnut, yield attributes.

INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is a vital crop among oilseeds, also known as "The king of oilseeds". It is a self-pollinated crop, an allotetraploid with a chromosome number 2n = 4x = 40. The cultivated groundnut belongs to family Fabaceae, sub family Papilionaceae. In the world, it is cultivated in 29.92 m ha, with a total production of 55.30 m t and productivity of 1851 kg ha^{-1} during 2021 (FAOSTAT, 2021). Globally, 41 per cent of groundnut produced is used for food purposes and 49 per cent is crushed for extraction of oil. In India, the total cultivated area of groundnut is 6.09 m ha, production is 10.21 m t with a productivity of 1676 kg ha^{-1}. In Andhra Pradesh, it is cultivated in an area of 0.87 m ha with a production of 0.78 m t and an average productivity of 894 kg ha^{-1} (Directorate of Economics and Statistics, 2021).

In the F_2 population, correlation and path analysis have to be studied to establish interrelationship among various yield attributes and also their contribution towards pod yield. Correlation coefficient analysis is useful to find out the nature and degree of association between various physiochemical traits including yield. Path coefficient analysis splits the correlation coefficient into direct and indirect effect towards yield as correlation analysis alone do not give a complete picture of the causal basis of association.

MATERIAL AND METHODS

The field experiment was conducted at dryland farm of S.V. Agricultural College, Tirupati during *kharif,* 2021 in Southern agro-climatic zone of Andhra Pradesh. Each F_2 generation of Kadiri 6 × J 11 cross along with the parents was raised in unreplicated plots. Data was recorded for the characters, plant height, number of primary branches plant^{-1}, number of secondary branches plant^{-1}, number of immature pods plant^{-1}, number of mature pods plant^{-1}, shelling per cent, harvest index, dry haulms yield plant^{-1}, kernel yield plant^{-1}, pod yield plant^{-1}. The data of the above have been subjected to statistical analysis for Character association (Johnson *et al*., 1955) and Path coefficient analysis (Dewey and Lu, 1959).

RESULTS AND DISCUSSION

Observations were recorded for 90 individual plants separately in Kadiri 6 × J 11 cross for all the characters. Yield is a complex character influenced by the environment and controlled by a large number of genes. The study of inter-relationships is necessary for understanding the association of simple traits with complex yield attributing traits. In the cross Kadiri 6 × J 11, pod yield plant^{-1} showed positive correlation with number of primary branches plant^{-1}, number of mature pods plant^{-1}, harvest index, dry haulms yield plant^{-1}, kernel yield plant^{-1}. Positive and significant correlation of pod yield with haulms yield, number of mature pods was reported by Pushkaran and Nair (1993). Similar findings were found by John *et al.* (2008) among six crosses and reported significant and positive association of pod yield plant^{-1} with number of mature pods plant^{-1}, kernel yield plant^{-1} and harvest index. Byadagi *et al.* (2018) reported significant and positive association of pod yield plant^{-1} with branches plant^{-1} among three crosses.

Plant height showed positive and significant

*Corresponding author, E-mail: jyothisubhanarayan@gmail.com

association with dry haulms yield plant^{-1} (0.6401). It had negative and significant correlation with harvest index (-0.4462). Number of primary branches plant^{-1} exhibited positive and significant association with number of mature pods plant^{-1} (0.3502), dry haulms yield plant^{-1} (0.2947), kernel yield plant^{-1} (0.2314) and pod yield plant^{-1} (0.2398).

Number of mature pods plant^{-1} revealed positive and significant association with shelling per cent (0.3709), harvest index (0.3616), dry haulms yield plant^{-1} (0.3764), kernel yield plant^{-1} (0.8694) and pod yield plant^{-1} (0.8349). Shelling per cent showed positive and significant association with kernel yield plant^{-1} (0.4728).

Harvest index registered positive and significant association with kernel yield plant^{-1} (0.4472) and pod yield plant^{-1} (0.4998). It had negative and significant correlation with dry haulms yield plant^{-1} (-0.5421). Dry haulms yield plant^{-1} exhibited positive and significant association with kernel yield plant^{-1} (0.3596) and pod yield plant^{-1} (0.3865). Kernel yield plant^{-1} performed high positive and significant association with pod yield plant^{-1} (0.9293). Number of secondary branches plant^{-1} and number of immature pods plant^{-1} showed no significant association with any other traits.

Path analysis provides information about the cause and effect of different yield components, which gives better index for selection other than mere correlation coefficients. In this cross, plant height exhibited positive correlation (0.1428) and negligible positive (0.0029) direct effect, number of primary branches plant^{-1} revealed a significant positive correlation (0.2398) and negligible positive (0.0222) direct effect, number of secondary branches plant^{-1} displayed a positive correlation (0.0898) and negligible positive (0.0251) direct effect, number of immature pods plant^{-1} displayed a positive correlation (0.0536) and negligible positive (0.0046) direct effect and number of mature pods plant^{-1} exhibited a significant positive correlation (0.8349) and negligible positive (0.0280) direct effect on pod yield.

Shelling per cent exhibited a positive correlation (0.1557) and negligible negative (-0.2824) direct effect, harvest index exhibited a significant positive correlation (0.4998) and moderate positive (0.2342) direct effect, dry haulms yield plant^{-1} revealed significant positive correlation (0.3865) and moderate positive (0.2149) direct effect and kernel yield plant^{-1} revealed significant positive correlation (0.9293) and high positive (0.8486) direct effect on pod yield (Table 2).

With regard to indirect effects, plant height showed low positive indirect effect *via* dry haulms yield plant^{-1} (0.1375), kernel yield plant^{-1} (0.1213); negligible positive indirect effects *via* other traits *viz.,* number of primary branches plant^{-1} (0.0041), number of immature pods plant^{-1} (0.0001), number of mature pods plant^{-1} (0.0040). It showed negligible negative indirect effect through number of secondary branches plant^{-1} (-0.0029), shelling per cent (-0.0197) and low indirect effect *via* harvest index (-0.1045).

Number of primary branches plant^{-1} showed low positive indirect effect *via* kernel yield plant^{-1} (0.1964); negligible positive indirect effects *via* other traits *viz.,* plant height (0.0005), number of mature pods plant^{-1} (0.0098), shelling per cent (0.0225) and dry haulms yield plant^{-1} (0.0633). It showed negligible negative indirect effect through number of secondary branches plant^{-1} (-0.0048), number of immature pods plant^{-1} (-0.0001) and harvest index (-0.0200).

Number of secondary branches plant^{-1} showed negligible positive indirect effects *via* other traits *viz.,* number of immature pods plant^{-1} (0.0007), harvest index (0.0333) and kernel yield plant^{-1} (0.0658). On the contrary, it showed negligible negative indirect effect through plant height (-0.0003), number of primary branches plant^{-1} (-0.0042), shelling per cent (-0.0222) and dry haulms yield plant^{-1} (-0.0083).

Number of immature pods plant^{-1} showed negligible positive indirect effects *via* other traits *viz.,* number of secondary branches plant^{-1} (0.0040), number of mature pods plant^{-1} (0.0008), harvest index (0.0031) and dry haulms yield plant^{-1} (0.0150), kernel yield plant^{-1} (0.0667). On the contrary, it showed negligible negative indirect effect through number of primary branches plant^{-1} (-0.0003), shelling per cent (-0.0404).

Number of mature pods plant^{-1} recorded high positive indirect effect *via* kernel yield plant^{-1} (0.7377); negligible positive indirect effects *via* other traits *viz.,* plant height (0.0004), number of primary branches plant^{-1} (0.0078), number of immature pods plant^{-1} (0.0001), harvest index (0.0847) and dry haulms yield plant^{-1} (0.0809). Conversely, it showed low negative indirect effect through shelling per cent (-0.1047).

Shelling per cent recorded high positive indirect effect *via* kernel yield plant^{-1} (0.4012); negligible positive indirect effects *via* other traits *viz.,* plant height (0.0002), number of secondary branches plant^{-1} (0.0020), number of immature pods plant^{-1} (0.0007), number of mature pods plant^{-1} (0.0104), harvest index (0.0065) and dry haulms yield plant^{-1} (0.0189). Conversely, it showed

Table 1. Phenotypic correlation for yield attributes in F_2 generation of Kadiri 6 × J 11 cross

	PH	NPB	NSB	NIMP	NMP	SP	HI	DHYP	KYPP	PYPP
PH	1.0000	0.1868	-0.1170	0.0155	0.1420	0.0698	-0.4462**	0.6401**	0.1429	0.1428
NPB		1.0000	-0.1900	-0.0144	0.3502**	-0.0796	-0.0855	0.2947**	0.2314*	0.2398**
NSB			1.0000	0.1578	-0.0010	0.0786	0.1420	-0.0387	0.0775	0.0898
NIMP				1.0000	0.0275	0.1429	0.0131	0.0700	0.0787	0.0536
NMP					1.0000	0.3709**	0.3616**	0.3764**	0.8694**	0.8349**
SP						1.0000	0.0279	0.0880	0.4728**	0.1557
HI							1.0000	-0.5421**	0.4472**	0.4998**
DHYP								1.0000	0.3596**	0.3865**
KYPP									1.000	0.9293**
PYPP										1.0000

Table 2. Phenotypic Path analysis of yield attributes in F_2 generation of Kadiri 6 × J 11 cross

	PH	NPB	NSB	NIMP	NMP	SP	HI	DHYP	KYPP	PYPP
PH	**0.0029**	0.0041	-0.0029	0.0001	0.0040	-0.0197	-0.1045	0.1375	0.1213	**0.1428**
NPB	0.0005	**0.0222**	-0.0048	-0.0001	0.0098	0.0225	-0.0200	0.0633	0.1964	**0.2398****
NSB	-0.0003	-0.0042	**0.0251**	0.0007	0.0000	-0.0222	0.0333	-0.0083	0.0658	**0.0898**
NIMP	0.0000	-0.0003	0.0040	**0.0046**	0.0008	-0.0404	0.0031	0.0150	0.0667	**0.0536**
NMP	0.0004	0.0078	0.0000	0.0001	**0.0280**	-0.1047	0.0847	0.0809	0.7377	**0.8349****
SP	0.0002	-0.0018	0.0020	0.0007	0.0104	**-0.2824**	0.0065	0.0189	0.4012	**0.1557**
HI	-0.0013	-0.0019	0.0036	0.0001	0.0101	-0.0079	**0.2342**	-0.1165	0.3795	**0.4998****
DHYP	0.0018	0.0065	-0.0010	0.0003	0.0105	-0.0249	-0.1270	**0.2149**	0.3051	**0.3865****
KYPP	0.0004	0.0051	0.0019	0.0004	0.0243	-0.1335	0.1047	0.0773	**0.8486**	**0.9293****

Residual effect (Phenotypic) = 0.1502
Bold: Direct effects; **Normal**: Indirect effects
** **:** significant at 1% level, * **:** significant at 5% level

PH: Plant height; **NPB:** Number of primary branches plant^{-1}; **NSB:** Number of secondary branches plant^{-1}; **NIMP:** Number of immature pods plant^{-1}; **NMP:** Number of mature pods plant^{-1}; **SP:** Shelling per cent; **HI:** Harvest index ; **DHY:** Dry haulms yield plant^{-1}; **KYP:** Kernel yield plant^{-1} ; **PYP:** Pod yield plant^{-1}

negligible negative indirect effect through number of primary branches plant^{-1} (-0.0018).

Harvest index recorded high positive indirect effect *via* kernel yield plant^{-1} (0.3795); negligible positive indirect effects *via* other traits *viz.,* number of secondary branches plant^{-1} (0.0036), number of immature pods plant^{-1} (0.0001) and number of mature pods plant^{-1} (0.0101). In contrast, it showed negligible negative indirect effect through plant height (-0.0013), number of primary branches plant^{-1} (-0.0019), shelling per cent (-0.0079) and dry haulms yield plant^{-1} (-0.1165).

Dry haulms yield plant^{-1} recorded high positive indirect effect *via* kernel yield plant^{-1} (0.3051); negligible positive indirect effects *via* other traits *viz.,* plant height (0.0018), number of primary branches plant^{-1} (0.0065), number of immature pods plant^{-1} (0.0003) and number of mature pods plant^{-1} (0.0105). In contrast, it showed negligible negative indirect effect through number of secondary branches plant^{-1} (-0.0010), shelling per cent (-0.0249) and harvest index (-0.1270).

Kernel yield plant^{-1} recorded low positive indirect effect *via* harvest index (0.1047); negligible positive indirect effects *via* other traits *viz.,* plant height (0.0004), number of primary branches plant^{-1} (0.0051), number of secondary branches plant^{-1} (0.0019), number of immature pods plant^{-1} (0.0004), number of mature pods plant^{-1} (0.0243) and dry haulms yield plant^{-1} (0.0773). In contrast, it showed low negative indirect effect through shelling per cent (-0.1335).

The results obtained from path analysis indicated that kernel yield plant^{-1} had high positive direct effect; harvest index and dry haulms yield plant^{-1} had moderate positive direct effect. Hence, due emphasis should be given to these traits in selection programme to improve pod yield plant^{-1}.

Harvest index exhibited moderate positive direct effect on pod yield and these results were in agreement with the findings of Suneetha *et al.* (2004) in fifteen F_1 s of groundnut. Dry haulms yield plant^{-1} exhibited a positive direct effect and the results obtained in the present study are in conformity with the findings of Moinuddin (1997) and John *et al.* (2011). Kernel yield plant^{-1} showed a high positive direct effect and these results were in accordance with the reports of Rao *et al.* (2012) on pod yield plant^{-1} in groundnut.

By and large, based on correlation coefficient analysis, it was concluded that the traits *viz.,* number of mature pods plant^{-1}, harvest index and kernel yield plant^{-1} had positive significant correlation with pod yield plant^{-1} in the cross studied. The data on path analysis elucidates the importance of kernel yield plant^{-1} to improve pod yield plant^{-1} in the F_2 populations studied.

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EFFECT OF DIFFERENT CHEMICALS AND BIOCONTROL AGENTS ON GROWTH OF *Rhizoctonia solani* INCITANT BANDED LEAF AND SHEATH BLIGHT ON BARNYARD MILLET UNDER *IN VITRO* CONDITIONS

T. PALLAVI*, T.S.S.K. PATRO, K.B. PALANNA, M. GURIVI REDDY AND M. SHANTHI PRIYA

Department of Plant Pathology, S.V. Agricultural College, ANGRAU, Tirupati-517 502.

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ABSTRACT

An *in vitro* experiment was conducted to evaluate the efficacy of different chemicals *viz.,* tebuconazole + trifloxystrobin 75WG @ 0.05%, propiconazole 25 EC @ 0.1% and biocontrol agents *viz., Trichoderma asperellum, Pseudomonas fluorescens, Bacillus subtilis* on *Rhizoctonia solani* that causes banded leaf and sheath blight on barnyard millet. The chemicals were evaluated at the recommended dose, 50% of recommended dose, 25% of recommended dose and the results revealed that the growth of the pathogen was inhibited completely *i.e.,* 100% and among the biocontrol agents *Trichoderma asperellum* was found to be more effective than *Pseudomonas fluorescens, Bacillus subtilis. Trichoderma asperellum* inhibited the growth of the pathogen upto 71.56%, while *Bacillus subtilis and Pseudomonas fluorescens* inhibited the growth of the pathogen upto 58.59% and 54.08% respectively.

KEYWORDS: Barnyard millet, banded leaf and sheath blight, chemicals, biocontrol agents.

INTRODUCTION

Barnyard millet (*Echinochloa frumentacea*) belongs to the family *Poaceae,* and the sub-family *Panicoideae* (Clayton and Renvoize, 2006). It is a short duration crop among all the millets with approximately six weeks crop growing period. It is known by various vernacular names like Shyama, Sanwa, Oodalu, Khira, Kutdrivalli all over India (ICRISAT, 2022). It is widely grown in India, China, Japan, Pakistan, Africa and Nepal (Paschapur *et al.,* 2021) and offers food security to many people of Asian and African countries, especially high altitude and tribal regions. Andhra Pradesh has 0.022 M ha area under millet cultivation with a production of 22 MT and a productivity of 1000 kg ha^{-1} (Indiastat, 2019-20). It is highly nutritive and has the lowest glycemic index (42.3%) which makes it an ideal food for the people suffering from lifestyle diseases like diabetes mellitus and cardiovascular problems (Anitha *et al.,* 2021). It tolerates many extreme environmental conditions and is one of the best remunerative crops to small and marginal farmers. However, it is prone to several biotic stresses of which fungal diseases like grain smut (*Ustilago panici-frumentacei),* leaf blast (*Pyricularia grisea*) and banded leaf and sheath blight (*Rhizoctonia solani)* results in considerable yield losses in barnyard millet. A versatile range of diseases are caused by the banded leaf and sheath blight (BLSB) pathogen which includes damping off, seed decay, aerial blight, stem canker, seed decay and root rot. Yield loss assessment studies revealed that the potential yield loss caused by the pathogen ranged from 52.7 to 67.2 per cent (Palanna *et al.,* 2021). In this context, different chemicals and biocontrol agents were evaluated to know their efficacy in inhibiting the growth of the pathogen under *in vitro* conditions.

MATERIAL AND METHODS

Different biocontrol agents *viz., Trichoderma asperellum, Pseudomonas fluorescens, Bacillus subtilis* were evaluated for their efficacy to inhibit the growth by dual-culture technique and the chemicals, tebuconazole + trifloxystrobin 75 WG, propiconazole 25 EC were evaluated at recommended dose, 50% of recommended dose, 25% of recommended dose by poisoned food technique. Tebuconazole + trifloxystrobin 75 WG was evaluated at 0.05%, 0.025%, 0.0125% while, propiconazole 25 EC was evaluated at 0.1%, 0.5%, 0.025%. The biocontrol agents were collected from Department of Biological Control, Vizianagaram. Chemicals were evaluated by poisoned food technique and to 50 ml of sterilized distilled water, required quantity of double strength fungicide was added and mixed thoroughly. This solution was poured into 50 ml of sterilized cool molten double strength PDA medium, mixed thoroughly and poured into Petri plates. Five mm

*Corresponding author, E-mail: tatinenipallavi@gmail.com

actively growing fungal disc from 4 days old culture was inoculated at the centre and then incubated at 28±1°C. Four replications were maintained for each fungicide. Medium without fungicide was kept as control. Biocontrol agents were tested by dual-culture technique and to test the efficacy of antagonistic fungus, 20 ml of sterilized melted PDA was plated in Petri plates (9 cm) and allowed to solidify. Mycelial discs measuring six mm diameter from three-day old cultures of both fungal antagonist and the test pathogen were placed at equidistant on sterile Petri plate containing PDA medium. The Petri plates with pathogen inoculated at one end alone, served as control. The Petri plates were then incubated at 28 ± 2°C. Four replications were maintained in each treatment. Growth of *Trichoderma*, test pathogen and zone of inhibition were measured after recording full growth of the pathogen in control plate. Per cent inhibition of mycelial growth of test pathogen in dual-culture and poisoned food technique was calculated by the formula:

$$I = \frac{C - T}{C} \times 100$$

where,

I = Per cent inhibition in growth of test pathogen

C = Radial growth of test fungus (mm) in control

T = Radial growth of test fungus (mm) in treatment

RESULTS AND DISCUSSION

Biocontrol agents *viz., Trichoderma asperellum, Bacillus subtilis and Pseudomonas fluorescens* and the chemicals like propiconazole 25% EC, tebuconazole + trifloxystrobin 75 WG were evaluated *in vitro* at the recommended dose *i.e.,* 0.1% for propiconazole and 0.05% for tebuconazole + trifloxystrobin and also at 50%, 25% of the recommended dose.

The growth of the pathogen was inhibited at different levels of which tebuconazole + trifloxystrobin @ 0.05%, propiconazole @ 0.1% was found to be effective when compared to tebuconazole + trifloxystrobin @ 0.025%, 0.0125% concentration and propiconazole @ 0.05%, 0.025% concentration. The radial growth of pathogen when tested with tebuconazole + trifloxystrobin @ 0.05%, 0.025%, 0.0125% was 0, 13.25 mm, 28.5 mm respectively, while the inhibition percent over control was 100%, 83.44%, 64.28% at 0.05%, 0.025%, 0.0125% respectively. In case of propiconazole 25 EC @ 0.1%, 0.05%, 0.025%, the radial growth of the pathogen was 0, 21 mm, 55.55 mm and the percent inhibition over control was 100%, 73.75%, 30.63% respectively (Table 1).

Among the biocontrol agents, *Trichoderma asperellum* was found to be effective among all as it inhibits the growth of *R. solani* upto 72.19%, while *Bacillus subtilis* inhibits the growth by 59.22%. However, *Pseudomonas fluorescens* was capable of inhibiting the pathogen by 54.22% only. The results revealed that the fungicides were effective in inhibiting the complete growth of the pathogen only at the recommended dose even under lab conditions (Table 2, Plate 1).

The results corroborated with the earlier findings of Usendi *et al.* (2020) who reported that *Trichoderma asperellum* (71.38% inhibition) was more effective in inhibiting the growth of the pathogen among different biocontrol agents tested which includes *Pseudomonas fluorescens* and *Bacillus subtilis*. In contrast to the present results, it was also reported that *Pseudomonas fluorescens* (64.44%) was more effective than *Bacillus subtilis* (61.38%). Among the chemicals tested, it was reported that propiconazole 25% EC @ 0.1% and tebuconazole + trifloxystrobin 75WG @ 0.1% inhibited the growth of the pathogen upto 100%.

The results were also in accordance with the findings of Kumar *et al.* (2017) who reported that propiconazole and carbendazim @ 1000 ppm could completely inhibit mycelial growth of *R. solani*. Similarly, Mahantesh *et al.* (2018) tested efficacy of propiconazole (5 to 100 ppm) on rice sheath blight pathogen *R. solani* under both *in vitro* and *in vivo* conditions and reported 100% mycelial inhibition was observed with propiconazole from 25 ppm onwards and under field conditions low disease severity of 45.76% was reported with 41.37% increase over control with yield of 67.72 q ha^{-1}.

In conclusion, the present investigation revealed that the chemicals were more effective than biocontrol agents in inhibiting the growth of the pathogen and the chemicals were effective at the recommended dose *i.e.,* tebuconazole + trifloxystrobin 75 WG @ 0.05% and propiconazole 25 EC @ 0.1%, while among the biocontrol agents *Trichoderma asperellum* was found to be more effective than *Bacillus subtilis* followed by *Pseudomonas fluorescens.*

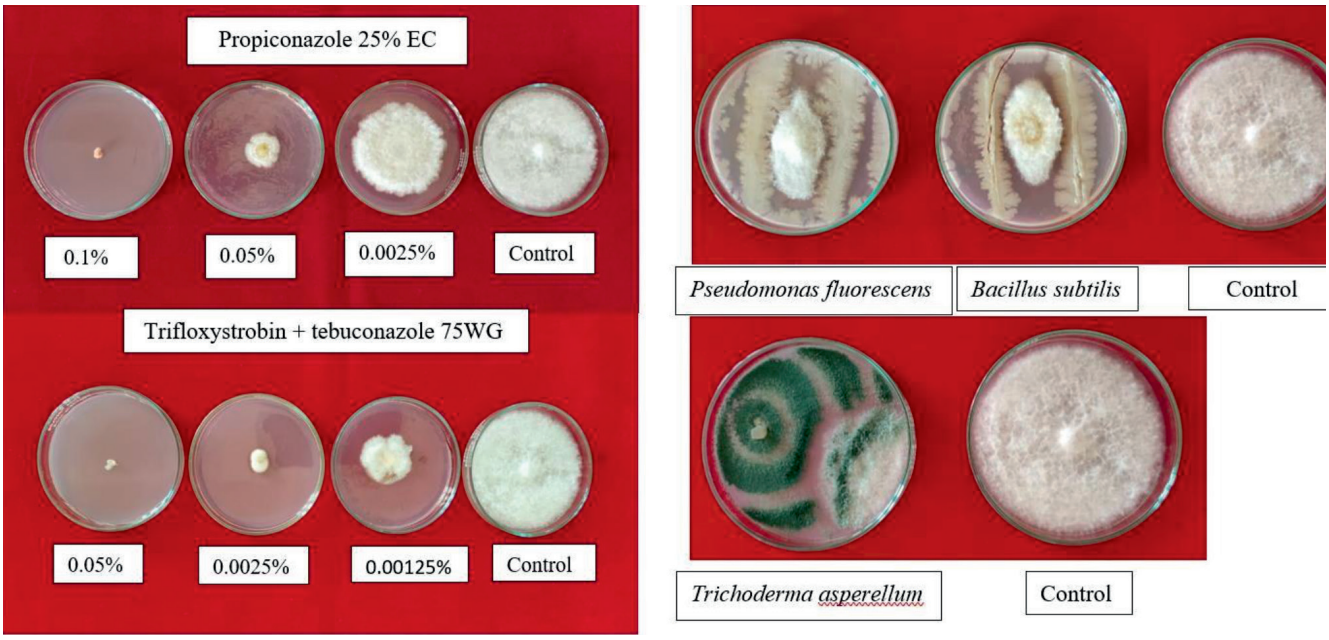
Table 1. ***In vitro*** **efficacy of fungicides against** ***R. solani***

Fungicide	Colony diameter (mm)*				Percent inhibition			
	Recommended dose	50% of recommended dose	25% of recommended dose	Mean	Recommended dose	50% of recommended dose	25% of recommended dose	Mean
Tebuconazole + Trifloxystrobin 75 WG (0.05% RD)	-	13.25	28.5	13.92	100	83.44	64.38	82.61
Propiconazole 25% EC (0.1% RD)	-	21	55.5	25.5	100	73.75	30.63	68.13
Mean	-	17.12	42.02	-	100	78.6	47.37	-
Control		80						
	Fungicide (F)	**Concentration (C)**	**F × C**					
SEm±	0.45	0.45	0.45					
CD (P≤ 0.05)	0.78	0.95	0.13					
CV (%)		4.59						

* : Mean of four replications
RD : Recommended dose

Table 2. Effect of biocontrol agents under in vitro conditions on growth of *R. solani*

Biocontrol agent	Mean radial growth(mm)*	% inhibition over control
Trichoderma asperellum	22.75	71.56
Pseudomonas fluorescens	36.74	54.08
Bacillus subtilis	33.13	58.59
Control	80	0.00
SEm±	0.92	
CD ($P \leq 0.05$)	1.3	
CV (%)	4.28	



Palet 1. *In vitro* efficacy of fungicides and biocontrol agents against *Rhizoctonia solani.*

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GENETIC VARIABILITY STUDIES FOR QUANTITATIVE TRAITS AND ITS COMPONENTS IN INBRED LINES OF PEARL MILLET (*Pennisetum glaucum* (L.) R. Br.)

I. PRAVEEN KUMAR*, M. SHANTHI PRIYA, L. MADHAVILATHA AND P. LATHA

Department of Plant Pathology, S.V. Agricultural College, ANGRAU, Tirupati-517 502.

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ABSTRACT

In the present study 70 pearl millet inbred lines were evaluated for 21 quantitative traits. Analysis of variance for 70 pearl millet inbred lines revealed significant differences among the germplasm lines for all the 21 traits studied indicating the presence of considerable genetic variability among the lines studied. The high estimates of GCV and PCV recorded for grain yield plant^{-1} followed by 1000 grain weight, panicle weight, green fodder yield plant^{-1}, dry fodder yield plant^{-1} and harvest index indicated the presence of high genetic variability for these characters. High heritability coupled with high genetic advance as per cent of mean was recorded for days to 50% flowering, spike length, spike girth, number of productive tillers plant^{-1}, plant height, 1000 grain, panicle weight, green fodder yield plant^{-1}, dry fodder yield plant^{-1}, threshing percentage, harvest index and grain yield plant^{-1} indicating the preponderance of additive gene action. These characters can be further improved by following simple selection procedure.

KEYWORDS: Pearl millet, PCV, GCV, Heritability, Genetic advance.

INTRODUCTION

Pearl millet (*Pennisetum glaucum* (L.) R. Br., 2*n* = 14) is an annual, C_4 cereal crop with high photosynthetic efficiency and belongs to the family Gramineae. It has its origin in central tropical Africa and is cosmopolitan throughout Africa and India's dry and semi-arid regions. Cumbu, black millet, spiked millet and candle millet are popular names while sajja is the local name in Andhra Pradesh. It is naturally cross pollinated (Allogamous) and the adaptation for cross pollination is Protogyny. Wind is the primary pollinator (anemophily).

Pearl millet is majorly grown in Rajasthan, Uttar Pradesh, Gujarat, Haryana, Karnataka, Maharashtra and Andhra Pradesh. In India, Pearl millet is cultivated in 7.65 million hectares with a production of 10.86 million tones and 1420 kg ha^{-1} productivity. In Andhra Pradesh, pearl millet is cultivated in 0.31 lakh hectares with a production of 0.71 lakh tones and a productivity of 2281 kg ha^{-1} (Directorate of Economics and Statistics, 2021).

Pearl millet is commonly known as a poor man's food and important among nutritious cereals. The composition of grains (per 100 g) reveals carbohydrates (67.5 g), protein (11.6 g), fat (5 g), fiber (1.2 g), mineral matter (2.3 g), calcium (42 mg) and phosphorus (296 mg). The grain consists high amount of vitamins (thiamine, riboflavin and niacin) and minerals (P, K, Mg, Fe, Zn, Cu and Mn). It being rich source of energy is comparable to rice, wheat, maize and sorghum. Protein content of pearl millet is higher than barley (11.5%), maize (11.1%), sorghum (10.4%) and rice (7.2%). It has a low glycemic index (GI), which helps in weight loss and aids in cholesterol reduction (ICAR - AICRP on pearl millet, 2018).

For yield improvement in any crop, it is essential to develop genetically stable genotypes having high yield potential. It is therefore, necessary to estimate relative amounts of genetic and non-genetic variability exhibited by different characters using suitable parameters like genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV) heritability (H) and genetic advance.

MATERIAL AND METHODS

In the present study 70 inbred lines of pearl millet were used. The experiment was conducted at Agricultural Research Station, Perumallapalle, Tirupati, during *Rabi* 2021. Experiment was laidout in randomized block design with two replications. In each replication every genotype was planted in three rows of three meters length by adopting 60 cm × 15 cm. All the recommended package of practices was adopted during entire crop season to raise healthy crop. Observations were recorded for 21 characters *viz.,* days to 50% flowering, days to maturity, SPAD chlorophyll meter reading at 45 DAS, SPAD chlorophyll meter reading at 65 DAS, specific leaf area at 45 DAS (cm^2 g^{-1}), specific leaf area at 65 DAS (cm^2 g^{-1}), leaf sheath length (cm), leaf blade

*Corresponding author, E-mail: praveeninukollu138@gmail.com

Table 1. Analysis of variance for yield and yield attributes in 70 inbred lines of pearl millet

S. No.	Characters	Mean sum of squares		
		Replications (df = 1)	Treatments (df = 69)	Error (df = 69)
1	Days to 50% flowering	16.457	93.477**	4.602
2	Days to maturity	13.207	87.208**	4.091
3	SPAD chlorophyll meter reading at 45 DAS	10.809	54.131**	19.152
4	SPAD chlorophyll meter reading at 65 DAS	15.114	104.664**	58.820
5	Specific leaf area at 45 DAS (cm^2 g^{-1})	807.408	1759.898**	511.374
6	Specific leaf area at 65 DAS (cm^2 g^{-1})	129.601	1891.645**	790.757
7	Leaf sheath length (cm)	1.629	7.452**	4.205
8	Leaf blade length (cm)	6.723	67.911**	17.149
9	Leaf blade width (cm)	0.394	0.384**	0.124
10	No of nodes plant^{-1}	0.833	0.977**	0.236
11	Spike length (cm)	0.003	27.541**	4.859
12	Spike girth (cm)	0.110	0.239**	0.037
13	Number of productive tillers plant^{-1}	0.001	0.759**	0.083
14	Plant height (cm)	219.250	917.970**	76.067
15	1000 grain weight (g)	2.345	10.607**	0.689
16	Panicle weight (g)	46.173	551.144**	45.659
17	Green fodder yield plant^{-1} (g)	286.286	2270.019**	191.920
18	Dry fodder yield plant^{-1} (g)	25.766	204.302**	21.248
19	Threshing (%)	0.140	198.391**	35.517
20	Harvest index (%)	1.783	98.552**	21.811
21	Grain yield plant^{-1} (g)	20.034	152.866**	13.092

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

length (cm), leaf blade width (cm), number of nodes plant^{-1}, spike length (cm), spike girth (cm), number of productive tillers plant^{-1}, plant height (cm), 1000 grain weight (g), panicle weight (g), green fodder yield plant^{-1} (g), dry fodder yield plant^{-1} (g), threshing (%), harvest index (%) and grain yield plant^{-1} (g). Data was subjected to statistical analysis for assessing phenotypic and genotypic coefficient of variation, heritability and genetic advance of percent of mean. Phenotypic and genotypic coefficients of variability were computed according to the methods suggested by Burton (1952). Heritability in broad sense was calculated as per the formula given by Allard (1960). Genetic advance was expressed as per cent of mean by using the formula suggested by Johnson *et al*. (1955).

RESULTS AND DISCUSSION

Analysis of variance for 70 pearl millet inbred lines revealed significant differences for all traits studied indicating the presence of considerable genetic variability among the genotypes studied (Table 1). Phenotypic coefficient of variance (PCV) was higher than genotypic coefficient of variance (GCV) for the traits studied indicating less interaction of traits with environment presented in Table 2.

The characters such as number of productive tillers plant^{-1} (GCV: 34.70%; PCV: 38.74%), 1000 grain weight (GCV: 21.75%; PCV: 23.22%), panicle weight (GCV: 40.89%; PCV: 44.43%), green fodder yield plant^{-1} (GCV: 39.52%; PCV: 43.01%), dry fodder yield

Table 2. Estimates of mean, range and genetic parameters for yield and yield attributes in 70 inbred lines of pearl millet

S. No.	Characters	Mean	Range		Variance		Coefficient of Variation		Heritability (Broad sense) (%)	Genetic advance (GA)	Genetic advance as per cent of mean (%)
			Min.	Max.	Genotypic	Phenotypic	Genotypic (%)	Phenotypic (%)			
1	Days to 50% flowering	58.97	44.00	80.50	44.44	49.04	11.30	11.88	90.62	13.07	22.17
2	Days to maturity	90.96	77.00	109.00	41.56	45.65	7.09	7.43	91.04	12.67	13.93
3	SPAD chlorophyll meter reading at 45 DAS	36.03	25.55	53.60	17.49	36.64	11.61	16.80	47.73	5.95	16.52
4	SPAD chlorophyll meter reading at 65 DAS	49.47	33.90	74.50	22.92	81.74	9.68	18.28	28.04	5.22	10.56
5	Specific leaf area at 45 DAS (cm^2 g^{-1})	146.52	98.71	244.31	624.26	1135.64	17.05	23.00	54.97	38.16	26.05
6	Specific leaf area at 65 DAS (cm^2 g^{-1})	160.69	104.79	237.85	550.44	1341.20	14.60	22.79	41.04	30.96	19.27
7	Leaf sheath length (cm)	13.60	7.09	18.40	1.62	5.83	9.37	17.75	27.85	1.39	10.19
8	Leaf blade length (cm)	45.44	32.90	61.40	25.38	42.53	11.09	14.35	59.68	8.02	17.65
9	Leaf blade width (cm)	3.07	2.31	4.40	0.13	0.25	11.75	16.42	51.24	0.53	17.33
10	No of nodes $plant^{-1}$	5.53	4.30	7.30	0.37	0.61	11.01	14.09	61.10	0.98	17.73
11	Spike length (cm)	20.56	13.40	28.20	11.34	16.20	16.38	19.58	70.00	5.80	28.24
12	Spike girth (cm)	2.49	1.69	3.32	0.10	0.14	12.81	14.95	73.47	0.56	22.62
13	Number of productive tillers $plant^{-1}$	1.68	1.00	4.20	0.34	0.42	34.70	38.74	80.23	1.07	64.02
14	Plant height (cm)	143.31	95.10	192.90	420.95	497.02	14.32	15.56	84.70	38.90	27.14
15	1000 grain weight (g)	10.24	5.54	14.58	4.96	5.65	21.75	23.22	87.80	4.30	41.99
16	Panicle weight (g)	38.88	11.00	101.80	252.74	298.40	40.89	44.43	84.70	30.14	77.52
17	Green fodder yield $plant^{-1}$ (g)	81.57	24.60	168.70	1039.05	1230.97	39.52	43.01	84.41	61.01	74.79
18	Dry fodder yield $plant^{-1}$ (g)	24.47	7.38	50.61	91.53	112.78	39.09	43.40	81.16	17.76	72.55
19	Threshing (%)	50.23	24.82	75.98	81.44	116.95	17.97	21.53	69.63	15.51	30.88
20	Harvest index (%)	30.87	14.29	46.39	38.37	60.18	20.07	25.13	63.76	10.19	33.01
21	Grain yield $plant^{-1}$ (g)	19.17	5.28	58.42	69.89	82.98	43.61	47.52	84.22	15.80	82.45

plant^{-1} (GCV: 39.09%; PCV: 43.40%) and harvest index (GCV: 20.07%; PCV: 25.13%) and grain yield plant^{-1} (GCV: 43.61%; PCV : 47.52%) showed higher estimates of coefficient of variation indicating the ample amount of variation among the inbred lines. Therefore, simple selection would be effective for further improvement of these characters.

Moderate estimates of coefficient of variation were observed for days to 50% flowering (GCV: 11.30%; PCV: 11.88%), SPAD chlorophyll meter reading at 45 DAS (GCV: 11.61%; PCV: 16.80%), specific leaf area at 45 DAS (GCV: 17.05%; PCV: 23.00%), specific leaf area at 65 DAS (GCV: 14.60%; PCV: 22.79%), leaf blade length (GCV: 11.09; PCV: 4.35%), leaf blade width (GCV: 11.75%; PCV: 16.42%), number of nodes plant^{-1} (GCV: 11.01%; PCV: 14.09%), spike length (GCV: 16.38%; PCV: 19.58%), spike girth (GCV: 12.81%; PCV: 14.95%), plant height (GCV: 14.32%; PCV: 15.56%) and threshing percentage (GCV: 17.97%; PCV: 21.53%). This indicated the existence of sufficient variability for attempting selection to improve these traits in the genotypes studied.

Low estimates of GCV and moderate estimates of PCV were observed for SPAD chlorophyll meter reading at 65 DAS (GCV: 9.68%; PCV:18.28%) and leaf sheath length (GCV: 9.37%; PCV: 17.75%). The character days to maturity (GCV: 7.09%; PCV: 7.43%) exhibited low estimates of coefficient of variation.

Out of 21 traits studied, high heritability was observed for 14 characters *viz.,* days to maturity (91.04%), days to 50% flowering (90.62%), 1000 grain weight (87.80%), plant height (84.70%), panicle weight (87.70%), green fodder yield plant^{-1} (84.41%), grain yield plant^{-1} (84.22%), dry fodder yield plant^{-1} (81.16%), number of productive tillers plant^{-1} (80.23%), spike girth (73.47%), spike length (70.00%), harvest index (63.76%), threshing percentage (69.63%) and number of nodes plant^{-1} (61.10%) in decreasing order of magnitude indicating that these characters were less influenced by environment. Higher values of heritability indicated that it may be due to higher contribution of genetic component and these traits were expected to remain stable under varied environmental conditions. Therefore, for improving these traits the selection will be more effective in early generation on the basis of *per se* performance of these traits.

Moderate estimates of heritability were observed for leaf blade length (59.68%), specific leaf area at 45 DAS (54.97%), leaf blade width (52.24%) SPAD chlorophyll meter reading at 45 DAS (47.73%) and specific leaf area at 65 DAS (41.04%).

Lower estimates of heritability were observed for SPAD chlorophyll meter reading at 65 DAS (28.04%), leaf sheath length (27.85%).

The characters *viz.,* grain yield plant^{-1} (82.45%), panicle weight (77.52%), green fodder yield plant^{-1} (74.79%), dry fodder yield plant^{-1} (72.55%), number of productive tillers plant^{-1} (64.02%), 1000 grain weight (41.99%), harvest index (33.01%), threshing percentage (30.88%), spike length (28.24%), plant height (27.14%), specific leaf area at 45 DAS (26.05%), spike girth (22.62%) and days to 50% flowering (22.17%) exhibited high genetic advance as per cent of mean. Moderate estimates of genetic advance as percent of mean were exhibited by specific leaf area at 65 DAS (19.27%), number of nodes plant^{-1} (17.73%), leaf blade length (17.65%), leaf blade width (17.33%), SPAD chlorophyll meter reading at 45 DAS (16.52%), days to maturity (13.93%), SPAD chlorophyll meter reading at 65 DAS (10.56%) and leaf sheath length (10.19%).

In the present investigation, high heritability coupled with high genetic advance as percent of mean was observed days to 50% flowering (h^2_b = 90.62%, GAM = 22.17%), spike length (h^2_b = 70.00%, GAM = 28.24%), spike girth (h^2_b = 73.47%, GAM = 22.62%), number of productive tillers plant^{-1} (h^2_b = 80.23%, GAM = 64.02%), plant height (h^2_b = 84.70%, GAM = 27.14%), 1000 grain weight (h^2_b = 87.80%, GAM = 41.99%), panicle weight (h^2_b = 84.70%, GAM = 77.52%), green fodder yield plant^{-1} (h^2_b = 84.41%, GAM = 74.79%), dry fodder yield plant^{-1} (h^2_b = 81.16%, GAM = 72.55%), threshing percentage (h^2_b = 69.63%, GAM = 30.88%), harvest index (h^2_b = 63.76%, GAM = 33.01%) and grain yield plant^{-1} (h^2_b = 84.22%, GAM = 82.45%) indicating the predominance of additive gene action. . Early and simple selection could be exercised due to fixable additive gene effects.

High heritability coupled with moderate genetic advance as per cent of mean was recorded for days to maturity (h^2_b = 91.04%, GAM = 13.93%) and number of nodes plant^{-1} (h^2_b = 61.10%, GAM = 17.73%) indicating that these characters were governed by additive gene effects and may express consistently in succeeding generations leading to greater efficiency of breeding programme.

Moderate heritability coupled with high genetic advance as per cent of mean was observed for specific leaf area at 45 DAS (h^2_b = 54.97%, GAM = 26.05%), while SPAD chlorophyll meter reading at 45 DAS (h^2_b = 47.73%, GAM = 16.52%), specific leaf area at 65 DAS (h^2_b = 41.04%, GAM = 19.27%), leaf blade length (h^2_b = 59.68%, GAM = 17.65%) and leaf blade width

(h^2_b = 51.24%, GAM = 17.33%) registered moderate estimates of both heritability and genetic advance as per cent of mean which indicated the preponderance of non-additive gene action. Hence, it could be suggested that improvement of these characters might be difficult through simple selection.

Low heritability coupled with moderate genetic advance as per cent of mean was observed for SPAD chlorophyll meter reading at 65 DAS (h^2_b = 28.04%, GAM = 10.56%) and leaf sheath length (h^2_b = 27.85%, GAM = 10.89%). It indicates that the character is highly influenced by environmental effects and selection would be ineffective.

To sum up with genetic parameters, high GCV, heritability and genetic advance as per cent of mean were observed for number of productive tillers plant^{-1}, 1000 grain weight, panicle weight, green fodder yield plant^{-1}, dry fodder yield plant^{-1}, threshing percentage, harvest index and grain yield plant^{-1} indicating scope for genetic improvement through simple selection for all these traits with an implication of genetic variation mainly due to the presence of additive gene action.

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EVALUATION OF EFFICACY OF SEED TREATMENT AND FOLIAR SPRAY ON SUCKING INSECT PEST INCIDENCE IN GROUNDNUT

P.V.L. PRAVALIKA*, K. DEVAKI, P. LATHA AND K. MANJULA

Department of Entomology, S.V. Agricultural College, ANGRAU, Tirupati-517 502.

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ABSTRACT

Seed treatment was done at the time of sowing with imidacloprid 600 FS and thiamethoxam 30 FS. Among the different treatments, seed treated with imidacloprid 600 FS @ 2.0 ml kg^{-1} (+ 4 ml water) seed was found more effective in reduction of thrips and leafhopper damage followed by thiamethoxam 70 FS @ 2.0 g kg^{-1} seed when compared to untreated control. At 35 days after sowing, foliar spray was imposed to known the efficacy of foliar spray in groundnut against sucking pests. Among the different treatments imidacloprid 600 FS seed treatment + imidacloprid 17.8 SL spray (T_8) and imidacloprid 600 FS seed treatment + thiamethoxam 25 WDG (T_6) were the best treatments with 64.3 and 63.9 per cent reduction over control against thrips. The treatments imidacloprid 600 FS seed treatment + thiamethoxam 25 WDG spray (T_6) and imidacloprid 17.8 SL spray (T_5) were the best treatments with 66.5 and 63.4 per cent reduction over control against leafhoppers.

KEYWORDS: Groundnut, Seed treatment, Sucking pests Imidacloprid, Thiamethoxam.

INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is one of the most important oilseed crops grown in India and contributes about 30 per cent of the total domestic supply of oil. Though India ranks first in area under groundnut cultivation, the productivity is quite low (1000 kg/ha) compared to that of USA (3000 kg/ha), China (2600 kg/ha), Argentina (2100 kg/ha) and Indonesia (1550 kg/ha). It is grown on 5.09 million hectares in India, with annual production of 10.41 million tonnes. Gujarath (4.13 million tonnes) is the leading producer of groundnut followed by Rajasthan (1.93 million tonnes) and Tamil nadu (0.94 million tonnes). [Anonymous, 2020-21. DES, Ministry of Agri. & FW (DAC & FW) Govt of India]. In Andhra Pradesh groundnut crop is grown in an area of 7.74 million hectares with annual production of 0.84 million tonnes and productivity of 1426 kg^{-1} ha, majoring in Chittoor, Anantapur and Kadapa districts. The reason for low productivity of groundnut is due to biotic and abiotic stresses. Insect pests and diseases are the major biotic stresses for groundnut production. The sucking insect pest complex comprising thrips (*Scirtothrips dorsalis* Hood) and leafhopper (*Empoasca kerri* Pruthi) are the major pests of importance on groundnut particularly during summer seasons and bunch varieties are severely infested. Among the sucking pests attacking the groundnut crop, thrips species occur as a complex, starting from vegetative stage till the harvest of the crop. Objective of the present study is to evaluate the effectiveness of the seed dressing chemicals in order to develop an effective management strategies for leafhoppers and thrips in groundnut ecosystem.

MATERIAL AND METHODS

A field experiment was conducted to evaluate the relative "efficacy of seed treatment and foliar spray on sucking insect pest incidence in groundnut" at college farm, S.V. Agricultural College, Tirupati, Andhra Pradesh during *kharif* 2021 in randomized block design with twelve treatments of three replications. The groundnut variety Dharani was used as test variety which is susceptible to the insect pests. The groundnut seed was treated with insecticides *viz.,* Imidacloprid 600 FS @ 2.0 ml kg-1 seed thiamethoxam @ 2.0 ml kg-1 seed (+ 4 ml water), For uniform covering of 1 kg seed, 5.0 ml of water was added to 1.0 ml of insecticide formulation and foliar spray was done at 35 DAS with thiamethoxam 25 WDG, imidacloprid 17.8 SL and monocrotophos 36 SL. Number of damaged leaves per plant dueto thrips and leafhoppers was recorded from five selected plants in each plot as per method suggested by Amin (1983). Data on per cent damage were subjected to angular transformation before statistical analysis. Per cent reduction of leaf damage by trips and leaf hoppers in treatments over control plots was estimated by using the formula given by Abbott (1925). The yield of groundnut was recorded from each plot and converted into yield per hectare.

*Corresponding author, E-mail: podilipravalika21@gmail.com

Population reduction over control (%) =

$$\frac{\text{Population in untreated cheek - Population in treatment}}{\text{Population in untreated cheek}} \times 100$$

RESULTS AND DISCUSSION

Foliar damage due to thrips at various intervals of seed treatment

Foliar damage due to thrips at 14 days after seed treatment

Foliar damage due to thrips was ranged from 3.1 to 14.1 per cent in different treatments. The seed treatment with imidacloprid (T_1, T_6, T_7, T_8) and thiamethoxam (T_2, T_9, T_{10}, T_{11}) recorded the lowest foliar damage compared to the treatments without seed treatment (T_3, T_4, T_5, T_{12}). The highest per cent reduction in thrips damage was observed in plots treated with imidacloprid 600 FS @ 2 ml kg^{-1} seed and thiamethoxam 70 WP @ 2 ml kg^{-1} seed with 78.25, 77.78, 77.54, 77.30, 76.83 and 76.60 per cent reduction over control, respectively and all treatments were on par with each other.

Foliar damage due to thrips at 21 days after seed treatment

Foliar damage at 21 days after treatment was ranged from 3.80 to 15.70 per cent in different plots. The highest per cent reduction over control was observed in plots treated with imidacloprid 600 FS @ 2 ml kg^{-1} seed and thiamethoxam 70 WP @ 2 ml kg^{-1} seed with 75.64, 75.42, 75.21, 75.00, 74.58, 74.15 and 73.52 per cent reduction over control, respectively and all treatments were on par with each other. The treatments T_3, T_4 and T_5 which are untreated with insecticides showed similar pest incidence as of control.

Foliar damage 28 days after seed treatment

Highest per cent reduction over control was observed in plots treated with imidacloprid 600 FS @ 2 ml kg^{-1} seed and thiamethoxam 70 WP @ 2 ml kg^{-1} seed with 63.74, 62.18, 61.99, 61.60, 61.01 and 60.43 per cent reduction over control, respectively and all treatments were on par with each other. The treatments T_3, T_4 and T_5 which are untreated with insecticides showed similar pest incidence as of control.

Foliar damage due to thrips at 35 days after seed treatment

The highest per cent reduction over control was observed in plots treated with imidacloprid 600 FS @ 2 ml kg^{-1} seed and thiamethoxam 70 FS @ 2 ml kg^{-1} seed with 59.24, 58.33, 57.79, 57.61, 57.07 and 56.70 per cent reduction over control, respectively and all treatments were at par with each other. The current results are in conformity with the findings of Neetam *et al.* (2013) who evaluated the bio-efficacy of imidacloprid 600 FS when applied as seed treatment at the rate of 2 g a.i kg^{-1} seed proved most effective against the sucking pests up to four weeks of seed germination. The results were also in agreement with that of Venkateswarlu and Vemana (2015) who found that imidacloprid 600 FS @ 2.0 ml kg^{-1} seed proved more effective in reduction of thrips damage followed by thiamethoxam 30 FS. Bhadane *et al*. (2007) postulated that imidacloprid could be used as effective insecticidal treatment for the control of thrips in groundnut cropping system. Dey *et al*. (2005) and Sinha and Sharma (2007) also reported that imidacloprid provided effective control of early sucking pest complex such as aphids, leafhoppers, thrips and whiteflies at 25 days after sowing in okra.

Table 1. Details of insecticides used for seed treatment and foliar spray in groundnut against sucking pests during *kharif,* 2021-22

S. No.	Insecticide	Tradename	Formulation	Dosage
Seed treatment				
1	Imidacloprid	Gaucho	600 FS	2 ml + 4 ml of waterkg^{-1} seed
2	Thiamethoxam	Averasuper	30 FS	2 ml + 4 ml of waterkg^{-1} seed
Foliar spray				
3	Thiamethoxam	Actara	25 WDG	0.2 g l^{-1}
4	Monocrotophos	Monokill	36 SL	1.6 ml l^{-1}
5	Imidacloprid	Confidor	17.8 SL	0.3 ml l^{-1}

Efficacy of different insecticides as seed treatment against thrips damage in groundnut

S. No.	Treatments	14 DAS		21 DAS		28 DAS		35 DAS		Mean per cent reduction	
		Per cent damage	Per cent reduction over untreated control	Per cent damage	Per cent Reduction over untreated control	Per cent damage	Per cent reduction over untreated control	Per cent damage	Per cent reduction over untreated control	Per cent damage	Per cent reduction over untreated control
1	Imidacloprid 600 FS (ST)	3.1	78.25 (62.19)	3.8	75.21 (60.15)	6.2	63.74 (44.62)	7.5	59.24 (41.40)	5.15	68.5 (49.91)
2	Thiamethoxam 70 FS (ST)	3.3	76.83 (61.22)	4.0	73.94 (59.29)	6.7	61.01 (41.47)	7.8	57.61 (40.34)	5.30	66.7 (49.52)
3	Thiamethoxam 25 WDG(FS)	11.5	18.44 (25.39)	13.8	12.08 (20.34)	16.2	5.07 (12.86)	17.1	6.88 (14.89)	14.68	10.2 (18.51)
4	Monocrotophos 36 SL (FS)	11.2	20.57 (26.81)	14.1	10.17 (17.76)	16.1	6.04 (14.10)	17.0	7.61 (15.82)	14.60	10.6 (18.95)
5	Imidacloprid 17.8 SL (FS)	11.6	17.97 (24.96)	14.0	10.81 (19.22)	16.2	5.26 (13.24)	17.3	5.98 (14.09)	14.78	9.5 (17.99)
6	T_1 followed by T_3	3.3	77.54 (61.71)	4.2	73.52 (59.01)	6.8	60.43 (42.23)	7.9	57.07 (42.22)	5.53	66.1 (50.29)
7	T_1 followed by T_4	3.2	77.30 (61.55)	3.9	74.15 (59.43)	6.6	61.60 (43.01)	7.8	57.79 (42.97)	5.37	67.1 (50.76)
8	T_1 followed by T_5	3.1	77.78 (261.88)	3.9	74.8 (59.73)	6.5	62.18 (41.79)	7.7	58.33 (41.54)	5.28	67.7 (50.15)
9	T_2 followed by T_3	3.3	76.83 (61.23)	4.1	75.00 (59.98)	6.8	60.43 (41.01)	8.0	56.70 (40.80)	5.52	66.2 (49.70)
10	T_2 followed by T_4	3.1	77.78 (61.88)	3.9	74.15 (59.47)	6.5	61.99 (41.70)	7.7	58.33 (40.65)	5.30	67.6 (49.82)
11	T_2 followed by T_5	3.2	77.30 (61.55)	4.0	74.58 (59.73)	6.7	61.01 (41.57)	7.8	57.79 (40.51)	5.41	66.9 (49.76)
12	Untreated control	14.1	-	15.7	-	17.1	-	18.4	-	16.33	-
	SE.m±	1.07		1.37		0.91		0.87		0.62	
	CD (5%)	3.26		4.15		2.75		2.65		1.88	
	CV (%)	2.28		3.10		2.91		2.33		1.52	

Figures in parathensis are angular transformed values
ST : Seed treatment; DAS : Days after treatment; FS : Foliar spray

Efficacy of different insecticides as foliar spray against thrips damage in groundnut

S. No.	Treatments	7 Days after spraying		14 Days after spraying		Percent mean reduction	
		Per cent damage	Per cent Reduction over untreated control	Per cent damage	Per cent reduction over untreated control	Per cent damage	Per cent reduction over untreated control
1	Imidacloprid 600 FS (ST)	10.5	44.48[g] (41.83)	12.0	39.29[e] (38.82)	11.27	41.8[f] (41.88)
2	thiamethoxam 30 FS (ST)	11.2	41.15[h] (39.89)	12.5	36.93[f] (37.43)	11.82	39.0[g] (38.99)
3	Thiamethoxam 25 WDG (FS)	7.4	61.17[d] (51.46)	8.8	55.31[b] (48.05)	8.10	59.0[b] (58.18)
4	Monocrotophos 36 SL (FS)	8.5	55.02[ef] (47.88)	10.2	48.57[d] (44.18)	9.35	51.7[e] (51.73)
5	Imidacloprid 17.8 SL (FS)	8.2	56.78[e] (48.90)	9.5	51.77[c] (46.02)	8.87	54.2[d] (54.22)
6	T_1 followed by T_3	5.9	68.73[b] (56.00)	8.1	59.19[ab] (50.30)	7.00	63.9[a] (63.86)
7	T_1 followed by T_4	6.3	66.97[c] (54.92)	9.8	56.32[b] (45.34)	8.02	58.6[bc] (58.61)
8	T_1 followed by T_5	5.6	70.48[a] (57.12)	8.2	60.54[a] (49.81)	6.92	64.3[a] (64.30)
9	T_2 followed by T_3	6.6	65.21[cd] (53.86)	9.4	53.29[bc] (46.49)	7.98	58.8[bc] (58.78)
10	T_2 followed by T_4	6.7	64.69[cd] (53.54)	9.2	54.13[bc] (46.98)[bc]	7.95	59.0[b] (58.96)
11	T_2 followed by T_5	6.3	66.62[cd] (54.71)	10.2	53.46 (43.98)	8.28	57.2 (57.24)
12	Untreated control	19.00	0.00	19.8	0.00	19.37	0.00
	SE.m±		0.54		0.55		0.34
	CD (5%)		1.63		1.64		1.02
	CV(%)		1.16		1.32		0.77

Figures in parathensis are angular transformed values
ST : Seed treatment; DAS : Days after treatment; FS : Foliar spray

Efficacy of different insecticides as seed treatment against leafhopper damage in groundnut

S. No.	Treatments	28 DAS		35 DAS		Percent mean reduction	
		Per cent damage	Per cent Reduction over untreated control	Per cent damage	Per cent Reduction over untreated control	Per cent damage	Per cent Reduction over untreated control
1	Imidacloprid 600 FS (ST)	3.0	49.15 (44.44)	4.0	46.71 (43.10)	3.5	48.0 (43.72)
2	Thiamethoxam 70 FS (ST)	3.1	46.89 (43.16)	4.1	44.80 (42.00)	3.6	46.3 (42.55)
3	Thiamethoxam 25 WDG (FS)	5.3	10.17 (27.41)	6.8	8.89 (18.18)	6.1	9.5 (23.09)
4	Monocrotophos 36 SL (FS)	5.3	9.60 (25.39)	6.7	10.22 (23.33)	6.0	10.00 (24.30)
5	Imidacloprid 17.8 SL (FS)	5.4	8.47 (23.74)	6.5	9.78 (21.89)	6.1	9.2 (22.77)
6	T_1 followed by T_3	3.0	49.72 (44.81)	3.8	48.89 (43.12)	3.4	49.3 (43.94)
7	T_1 followed by T_4	3.2	45.20 (42.19)	4.2	44.44 (43.69)	3.7	44.8 (43.04)
8	T_1 followed by T_5	3.1	48.02 (43.85)	3.7	43.56 (44.02)	3.7	45.5 (43.99)
9	T_2 followed by T_3	3.2	46.33 (42.81)	3.8	43.67 (43.22)	3.7	44.3 (43.07)
10	T_2 followed by T_4	3.0	48.59 (44.15)	3.6	43.11 (44.33)	3.7	45.5 (44.25)
11	T_2 followed by T_5	3.1	46.89 (43.02)	3.7	45.33 (43.37)	3.6	46.0 (43.23)
12	Untreated control	5.9	0.00 (0.00)	7.1	0.00 (0.00)	6.7	
	SE.m±		2.23		2.22		1.78
	CD (5%)		6.77		6.73		5.41
	CV (%)		6.37		6.55		5.18

Figures in parathensis are angular transformed values
ST : Seed treatment; DAS : Days after treatment; FS : Foliar spray

Efficacy of different insecticides as foliar spray against leafhopper damage in groundnut

S. No.	Treatments	7 Days after spraying		14 Days after spraying		Percent mean reduction	
		Per cent damage	Per cent reduction over untreated control	Per cent damage	Per cent reduction over untreated control	Per cent damage	Per cent reduction over untreated control
1	Imidacloprid 600 FS (ST)	4.7	44.12[e] (41.60)	5.6	42.47 (40.65)	5.2	43.3[d] (41.14)
2	Thiamethoxam 30 FS (ST)	4.6	45.49[d] (42.38)	5.7	41.44 (40.07)	5.0	44.8[d] (42.01)
3	Thiamethoxam 25 WDG (FS)	2.8	64.71[b] (53.56)	3.9	52.40[bc] (46.38)	3.3	58.9[c] (50.11)
4	Monocrotophos 36 SL (FS)	3.2	61.96[c] (51.92)	4.5	52.05[bc] (46.18)	3.9	57.8[cd] (49.47)
5	Imidacloprid 17.8 SL (FS)	3.1	66.67[b] (54.71)	4.4	54.45[bc] (47.54)	3.8	63.4[b] (52.79)
6	T_1 followed by T_3	2.5	70.59[a] (57.14)	3.6	63.00[a] (52.54)	3.1	66.5[a] (54.66)
7	T_1 followed by T_4	3.3	65.10[b] (53.79)	4.5	57.86[b] (48.32)	3.9	57.0[cd] (49.04)
8	T_1 followed by T_5	3.2	64.31[b] (53.29)	4.6	55.82[b] (48.34)	3.9	57.2[cd] (49.15)
9	T_2 followed by T_3	3.0	65.10[b] (53.76)	4.4	56.51[b] (48.73)	3.7	59.8[c] (50.64)
10	T_2 followed by T_4	3.2	64.71[b] (53.55)	4.6	56.13[b] (50.33)	3.8	57.2[cd] (49.14)
11	T_2 followed by T_5	3.3	65.49[b] (53.99)	4.5	59.25[b] (49.52)	3.9	57.6[cd] (49.37)
12	Untreated control	8.5	0.00	9.7	0.00	9.1	
	SE.m±		1.15		0.90		0.73
	CD (5%)		3.50		2.73		2.20
	CV(%)		2.46		2.11		1.64

Figures in parathensis are angular transformed values
ST : Seed treatment; DAS : Days after treatment; FS : Foliar spray

Foliar damage due to thrips after spray

Effect of foliar spray on incidence of thrips in groundnut crop is presented in table 2. Highest per cent reduction in foliar damage due to thrips was recorded in imidacloprid 600 FS seed treatment + imidacloprid 17.8 SL spray (T_8) followed by imidacloprid 600 FS seed treatment + thiamethoxam 25 WDG spray (T_6) with 70.48 and 68.73 per cent over untreated control. Foliar damage by thrips at 14 days after spraying was ranged from 8.2 to 19.80 per cent, the highest per cent reduction in thrips damage was recorded in T_8 (imidacloprid 600 FS seed treatment + imidacloprid 17.8 SL spray) and T_6 (imidacloprid 600 FS seed treatment+ thiamethoxam 25 WDG spray) with 60.54 and 59.19 per cent reduction over untreated control

From present study it was observed that the efficacy of seed treatment followed by sequential spray on groundnut, imidacloprid 600 FS seed treatment + imidacloprid 17.8 SL spray (T_8) and imidacloprid 600 FS seed treatment+ thiamethoxam 25 WDG spray (T_6) were the best treatments with 64.3 and 63.9 per cent reduction over control and the treatments were statistically at par with each other because of seed treatment at the sowing and foliar spray of insecticides at 35 DAS which shown better protection than the untreated control.

Pandiyan (2020) also reported that imidacloprid 17.8 SL @ 200 ml ha^{-1} was found to be effective in reducing thrips damage (16%) followed by thiamethoxam 25WG @ 200 g ha^{-1} (18%) as against 33% in untreated control. Khanpara *et al*. (2016) reported that spray of imidacloprid 200 SL @ 125 ml ha^{-1} or thiamethoxam 25 WG @ 200 g ha^{-1} or acephate 75 % SP @ 500 gm ha-1 at 15 days interval after initiation of pests were the most effective against thrips in groundnut.

Foliar damage due to leafhoppers at various intervals of seed treatment

Foliar damage at 28 Days After Seed Treatment

Leafhopper damage was absent during 14 and 21 days after seed treatment in all the treatments including untreated control due to weather conditions. Foliar damage due to leafhoppers was ranged from 3.0 to 5.9 per cent. The seed treatments with imidacloprid (T_1, T_6, T_7, T_8) and thiamethoxam (T_2, T_9, T_{10} ,T_{11}) recorded the lowest foliar damage compared recorded the lowest foliar damage compared to the treatments without seed treatment (T_3, T_4, T_5, T_{12}).The highest per cent reduction over control was observed in plots treated with imidacloprid 600 FS @ 2 ml/kg seed and thiamethoxam 70 WP @ 2ml kg^{-1} seed with 49.72, 49.15, 48.59, 48.02, 46.89, 46.33 and 45.20 per cent reduction over control, respectively and all treatments were on par with each other. The treatments T_3, T_4 and T_5 which are untreated with insecticides showed similar pest incidence as of control.

Foliar damage 35 Days After Seed Treatment

Foliar damage at 35 days after treatment was ranged from 3.6 to 7.1 per cent. imidacloprid and thiamethoxam treated plots offered protection against leafhoppers. The highest per cent reduction over control was observed in plots treated with imidacloprid 600 FS @ 2 ml/kg seed and thiamethoxam 30 FS @ 2ml/kg seed with 48.89, 46.58, 46.12, 45.66 and 45.21 per cent reduction over control, respectively and all treatments were at par with each other.

Foliar damage due to leafhoppers after spraying

Foliar damage due to leaf hoppers at 7 days after spraying was recorded from 2.8 to 8.5 per cent. The highest per cent reduction over control was recorded in plots treated with imidacloprid 600 FS seed treatment + thiamethoxam 25 WDG spray (T_6) was the best treatment with 70.59 per cent reduction over control. Foliar damage at 14 days after spraying was recorded from 3.6 to 9.7 per cent. The highest per cent increase in reduction over control among combination of seed treatment and spraying was recorded in plots treated with imidacloprid 600 FS seed treatment + thiamethoxam 25 WDG spray (T_6) with 63.0 per cent reduction over control.

The present studies are also in confirmation with the finding of Baraiay and Vyas (2002) who reported that imidacloprid 0.006 per cent as foliar spray found to be effective against *Empoasca keri* Pruthi in groundnut with moderately economic. Application of imidacloprid 17.8 SL @ 0.5 ml l^{-1} was found superior over the other treatments with higher per cent reduction (85.21 per cent) of leafhoppers followed by thiamethoxam 25 WG @ 0.3 g l^{-1} on okra (Hemadri *et al*., 2018).

Among the different treatments, seed treated with imidacloprid 600 FS was found to be more effective in reduction of the thrips and leafhopper damage by followed by thiamethoxam 30 FS. At 35 days after sowing the plots treated with (T_8) imidacloprid 600 FS seed treatment + imidacloprid 17.8 SL spray and imidacloprid 600 FS seed treatment + thiamethoxam 25 WDG (T_6) spray were the next best treatments with 64.3 and 63.9 per cent reduction over control against thrips and for leafhoppers the plots treated with imidacloprid 600 FS seed treatment + thiamethoxam 25 WDG spray (T_6) and imidacloprid 17.8 SL spray (T_5) were the best treatments with 66.5 and 63.4 per cent reduction over control.

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ASSESSMENT OF GENETIC VARIABILITY, HERITABILITY AND GENETIC ADVANCE FOR YIELD AND QUALITY TRAITS IN INDIGENOUS LANDRACES OF RICE (*Oryza sativa* L.)

K. DINESH KUMAR*, M. SREEVALLI DEVI, CH. SREELAKSHMI AND I. PARAMASIVA

Department of Genetics and Plant Breeding, S.V. Agricultural College, ANGRAU, Tirupati-517 502.

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ABSTRACT

In this investigation genetic variability, heritability and genetic advance was studied in 39 indigenous landraces of rice along with two checks for evaluation of yield and quality traits during kharif, 2021. Variance studies showed significant variations among all the indigenous landraces of rice for all the yield and quality traits, suggesting presence of significant amount of variance. Total grain panicle^{-1}, number of filled grains panicles^{-1}, number of chaffy grains plant^{-1} grain yield plant^{-1}, test weight, grain size, alkali spreading value and gel consistency showed high values of GCV and PCV. This indicates that considering these traits for direct selection will result in genetic improvement. The yield and quality traits which showed high estimates for genetic advance as % of mean along with high heritability were gel consistency, chaffy grain panicle^{-1}, total grain panicle^{-1}, filled grain panicle^{-1}, Kernel length after cooking (mm), alkali spreading value, protein (ppm), kernel breadth after cooking (mm), grain size (mm), grain length (mm), amylose content, grain breadth (mm), plant height (cm), grain yield plant^{-1} and test weight (g). This implied that additive gene activity influenced the inheritance of these traits, thus providing scope for further improvement through selection.

KEYWORDS: Genetic variability, heritability, genetic advance, indigenous landraces.

INTRODUCTION

Rice landraces, local varieties, indigenous lines play a pivotal role for food nutritional and health security besides resistance to diseases and pests. Rice is a food grain crop of global importance with special preference in all Asian countries. Grain yield improvement is the prime objective for plant breeders from several decades but demand for good quality rice also increased in current decade as living standards of people got gradually improved. Therefore, improvement of grain quality features of rice becomes utmost objective next to yield enhancement and has become major concern in the rice breeding programs to meet the consumer preference and market demand. Rice varieties having good milling parameters, good appearance quality, good cooking and eating parameters, can be considered as a superior grain quality rice variety which increases the total economic value of rice. Fine or short slender grain varieties with intermediate amylose and alkali spreading value, intermediate gel consistency and high-volume expansion of cooked rice is preferred by consumers.

Several studies on genetic variability parameters and descriptive statistics for grain quality traits have been previously conducted. In spite of that, unexploited genetic variability still exist in rice landraces which are of equally important in selecting the superior parents. These superior parents can give extreme heterosis and superior recombinants for better grain quality components. Genetic parameters such as genotypic coefficient of variation and phenotypic coefficient of variation are the important for mining the amount of variability present in the germplasm. Role of environmental attributes on the expression of any genotype and reliability of characters can be determined precisely by high broad sense heritability in conjunction with high genetic advance.

MATERIAL AND METHODS

The investigations were conducted at ARS, Nellore Acharya N.G. Ranga Agricultural University, Andhra Pradesh, India. The experimental material consisted of 41 indigenous landraces of rice (*Oryza sativa* L.) genotypes carried out during *Kharif*, 2021 in a Randomized Block Design with three replications for yield and quality traits and its attributes (days to 50% flowering, days to maturity, plant height (cm), panicle length (cm), number of panicle plant^{-1}, number of filled grain panicle^{-1}, number of chaffy grain panicle^{-1}, number of total gain panicle^{-1}, spikelet fertility (%), harvest index, 1000 grain weight (g), grain length (mm), grain breadth (mm), grain size (L/B ratio), kernel length (mm), kernel breadth (mm), kernel length after cooking (mm), kernel breadth after cooking (mm), alkali spreading value, gel consistency (mm), amylose content, protein (ppm) and zinc (ppm). Analysis of

*Corresponding author, E-mail: dineshkumarkumbha09@gmail.com

variance was carried out as suggested by Panse and Sukhatme (1967), GCV and PCV were carried out as per the methods suggested by Burton (1952). Heritability (BS) and Genetic Advance were estimated by using the formula suggested by Allard (1960) and Johnson *et al*. (1955) respectively.

RESULTS AND DISCUSSION

Analysis of variance

Analysis of variance was used to determine the degree of variation of observed characters among indigenous landrace of rice and the results are presented in tables 1 and 2. For all the characters, the study of variance showed extremely significant variations among the 41 indigenous landraces of rice, suggesting that significant genetic variation present in the material.

Genotypic and phenotypic coefficient of variance

For all the characters, the genotypic variance was smaller than phenotypic variance, which indicates that environment had masking effect on the expression of genetic variability (Table 3 and 4). The characters like number of total grain panicle^{-1} (GCV: 29.16%; PCV: 29.41%), number of filled grains panicles^{-1} (GCV: 29.52%; PCV: 29.83%), number of chaffy grains plant^{-1} (GCV: 29.52%; PCV: 29.83%) grain yield plant^{-1} (GCV: 36.73%; PCV: 40.18%) test weight (GCV: 21.94%; PCV: 24.82%), grain size (GCV: 24.14 %; PCV: 25.11%), alkali spreading value (GCV: 28.53%; PCV: 28,99%) and gel consistency (GCV: 46.97%; PCV: 47.04%) exhibited higher estimates of GCV and PCV indicating the ample amount of variation among the genotypes studied. Therefore, direct selection would be effective for the improvement of these characters. This was in conformity with the findings of Priyanka *et al.* (2020) and Thakure and pandey (2020) for number of total grain panicle^{-1}, Farooq *et al*. (2019) for number of filled grain panicle^{-1}, Babu *et al.* (2012) and Dhanwani *et al.* (2013) for number of chaffy grain panicle^{-1}, Singh *et al.* (2019) and Sharma *et al.* (2020) for grain yield panicle^{-1}.

Heritability and Genetic Advance

Estimating heritability helps breeders manage the resources needed to successfully select for desirable characteristics and achieve maximum genetic gain with minimal effort and resources. Broad sense heritability (h^2_b) is an estimate of the total contribution of the genetic variance to the total phenotypic variance of trait. It measures the relative amount of heritable portion of total variability and provides information on the extent to which a particular morphogenetic trait can be transmitted to successive generation.

All characters show high heritability *viz.,* gel consistency (99.70), chaffy grain panicle^{-1} (99.60), days to 50% flowering (99.30), total grain panicle^{-1} (98.30), filled grain panicle^{-1} (97.90), days to maturity (97.80), kernel length after cooking (mm) (97.70), alkali spreading value (96.80), protein (ppm) (94.90), kernel breadth after cooking (mm) (93.00), grain size (mm) (92.40), grain length (mm) (92.20), amylose content (91.90), grain breadth (mm)(85.90), plant height (cm) (85.40), grain yield plant^{-1} (83.60), test weight (g) (78.10), spikelet fertility (%) (78.10), kernel breadth (mm) (77.30), kernel length (mm) (68.40), panicle length (cm) (67.80), harvest index (%) (67.30), zinc (ppm) (66.70) and number of panicles plant^{-1} (45.80) indicating that these were less influenced by environment. These results are in line with the findings of Kurmanchali *et al.* (2019) and Jan and Kashyap (2020) for gel consistency, Dhanwani *et al.* (2013) for number of chaffy grain panicle^{-1}, Jan and Kashyap (2020) and Priyanka *et al.* (2020) for kernel length after cooking, Mithilesh *et al.* (2017) for alkali spreading value, Jan and Kashyap (2020) and Kumar *et al.* (2020) for kernel breadth after cooking, Kumar *et al.* (2018) and Priyanka *et al.* (2020) for grian yield plant^{-1}, Amegan *et al.* (2020) and Kumar and Kar (2020) and Thakur and Pandey (2020) for spikelet fertility, Kumar and Kar (2020) and Thakur and Pandey (2020) for panicle length, Chowdhury *et al.* (2016) for zinc and Pandey *et al.* (2018) number of panicle plant^{-1}.

Higher values of heritability indicated that it may be due to higher contribution of genetic component and these traits were expected to remain stable under varied environmental conditions. Therefore, for improving these traits the selection will be more effective in early generation on the basis of *per se* performance of these traits.

In the present investigation, high heritability coupled with high genetic advance as per cent of mean was observed for gel consistency (h^2_b = 99.70%, GAM = 96.63%), chaffy grain panicle^{-1} (h^2_b = 99.60%, GAM = 56.28%), total grain panicle^{-1} (h^2_b = 98.30%, GAM = 59.55%), filled grain panicle^{-1} (h^2_b = 97.90%, GAM = 60.19%), Kernel length after cooking (mm) (h^2_b = 97.70%, GAM = 20.31%), alkali spreading value (h^2_b = 96.80%, GAM = 57.82%), protein (ppm) (h^2_b = 94.90%, GAM = 32.35%), kernel breadth after cooking (mm) (h^2_b = 93.00%, GAM = 24.65%), grain size (mm) (h^2_b = 92.40%, GAM = 47.81%), grain length (mm) (h^2_b = 92.20%, GAM = 33.77%), amylose content (h^2_b = 91.90%, GAM = 33.71%), grain breadth (mm) (h^2_b = 85.90%, GAM = 23.55%), plant height (cm) (h^2_b = 85.40%, GAM

Table 1. Analysis of variance for 22 characters in 41 genotypes of rice

S. No.	Character	Mean sum of squares		
		Replications (df : 2)	Genotypes (df : 40)	Error (df : 80)
1.	Days to 50% flowering	0.40	217.06**	0.52
2.	Days to maturity	2.09	210.52**	2.49
3.	Plant height (cm)	22.44	917.85**	49.65
4.	Panicle length (cm)	1.20	12.53**	1.71
5.	No. of panicles plant $^{-1}$	3.61	6.52**	4.86
6.	No. of filled grains panicle^{-1}	33.06	6173.95**	42.94
7.	No. of chaffy grains panicle^{-1}	0.40	124.49**	0.91
8.	Total grains panicle^{-1}	14.79	8031.23**	46.07
9.	Spikelet fertility (%)	0.31	21.62**	1.84
10.	Test weight (g)	1.17	59.27**	5.07
11.	Harvest index (%)	0.07	109.54**	15.25
12.	Grain yield plant $^{-1}$	53.72	430.43**	68.26
13.	Grain length (mm)	0.07	5.33**	0.15
14.	Grain breadth (mm)	0.01	0.34**	0.02
15.	Grain size	0.04	1.50**	0.04
16.	Kernel length (mm)	0.15	1.07**	0.19
17.	Kernel breadth (mm)	0.01	0.20**	0.02
18.	Kernel length after cooking (mm)	0.01	1.54**	0.15
19.	Kernel breadth after cooking (mm)	0.03	0.45**	0.92
20.	Alkali Spreading value	0.01	1.72**	0.02
21.	Gel consistency	0.74	1115.45**	1.03
22.	Amylose Content	1.19	51.41**	1.46
23.	Protein (ppm)	0.26	4.82**	0.46
24.	Zinc (ppm)	1.38	6.73**	2.67

** : Significant at 5% level
* : Significant at 1% level
DAT : Days After Transplanting

Table 2. Genetic variability and genetic parameters for yield and grain quality traits in rice

S. No	Character	Mean	Range		Variance		Coefficient of Variation		Heritability (Broad Sense) (%)	Genetic advance	Genetic advance as per cent of mean (%)
			Min	Max	Genotypic	Phenotypic	Genotypic (%)	Phenotypic (%)			
1.	Days To 50% Flowering	108.22	90.33	127.5	72.18	72.70	7.85	7.88	99.30	17.44	16.11
2.	Days to maturity	138.79	123.33	160.00	69.64	71.24	6.01	6.08	97.80	17.00	12.25
3.	Plant height (cm)	140.81	69.27	158.87	289.40	339.05	12.08	13.08	85.40	32.38	22.99
4.	Panicle length (cm)	26.07	21.67	29.8	3.61	5.32	7.28	8.85	67.80	3.22	12.35
5.	Number of panicles plant^{-1}	10.73	8.00	15.47	1.56	3.40	11.62	17.18	45.80	1.74	16.20
6.	Filled grain panicle^{-1}	153.12	85.6	320.53	2043.67	2086.61	29.52	29.83	97.90	92.16	60.19
7.	Chaffy grain panicle^{-1}	23.51	13.62	49.47	41.43	41.62	27.38	27.44	99.60	13.23	56.28
8.	Total grain panicle^{-1}	176.94	104.00	369.99	2661.72	2707.79	29.16	29.41	98.30	105.37	59.55
9.	Spikelet fertility (%)	86.5	80.92	91.22	6.59	8.44	2.97	3.36	78.10	4.68	5.41
10.	Grain yield plant^{-1}	31.59	15.69	63.45	134.66	161.12	36.73	40.18	83.60	21.85	69.17
11.	Test weight (g)	19.38	11.67	30.67	18.07	23.14	21.94	24.82	78.10	7.74	39.93
12.	Harvest index (%)	50.25	42.86	64.96	31.43	46.68	11.16	13.60	67.30	9.48	18.86
13.	Grain length (mm)	7.69	5.31	11.47	1.72	1.87	17.07	17.78	92.20	2.60	33.77
14.	Grain breadth (mm)	2.66	1.84	3.41	0.11	0.13	12.34	13.31	85.90	0.63	23.55
15.	Grain size (mm)	2.89	1.33	4.67	0.49	0.53	24.14	25.11	92.40	1.38	47.81
16.	Kernel length (mm)	5.38	4.30	7.67	0.31	0.45	10.34	12.50	68.40	0.95	17.62
17.	Kernel breadth (mm)	2.63	2.22	3.45	0.06	0.08	9.29	10.57	77.30	0.44	16.82
18.	Kernel length after cooking (mm)	7.14	5.24	8.87	0.51	0.52	9.97	10.09	97.70	1.45	20.31
19.	Kernel breadth after cooking (mm)	3.09	2.01	3.93	0.15	0.16	12.41	12.87	93.00	0.76	24.65
20.	Alkali spreading value	2.64	1.33	4.33	0.57	0.59	28.53	28.99	96.80	1.53	57.82
21.	Gel consistency	41.03	16.00	91.00	371.47	372.50	46.97	47.04	99.70	39.65	96.63
22.	Amylose content	23.91	16.73	33.57	16.65	18.11	17.07	17.80	91.90	8.06	33.71
23.	Protein (ppm)	7.79	6.53	14.63	1.58	1.66	16.12	16.55	94.90	2.52	32.35
24.	Zinc (ppm)	16.48	14.34	20.72	1.92	2.88	8.42	10.30	66.70	2.33	14.16

= 22.99%), grain yield plant^{-1} (h^2_b = 83.60%, GAM = 69.17%) and test weight (g) (h^2_b = 78.10%, GAM = 39.93%) indicating the predominance of additive gene action. Therefore, phenotypic selection would be more effective for improvement of these characters. These results were in confirmation with the findings of Jan and Kashyap *et al.* (2020) for gel consistency, Dhanwani *et al.* (2013) for number of chaffy grain panicle^{-1}, Lingaiah *et al.* (2019) and Thakur and Pandey (2020) for number of total grain panicle^{-1}, Farooq *et al.* (2019) for number of filled grain panicle^{-1}, Devi *et al.* (2020) for kernel breadth after cooking, Radha *et al.* (2019) and Thakur and Pandey (2020) for grain size,

From the foregoing discussion, high heritability coupled with high genetic advance as per cent of mean was observed for gel consistency, number of chaffy grain panicle^{-1}, number of total grain panicle^{-1}, number of filled grain panicle^{-1}, kernel length after cooking, alkali spreading value, protein, kernel breadth after cooking, grain size, grain length, amylose content, grain breadth, plant height, grain yield plant^{-1} and 1000 grain weight the predominance of additive gene action and thus, direct selection for these traits would be effective.

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STUDIES ON SHEATH BLIGHT INCIDENCE OF RICE IN NELLORE AND CHITTOOR DISTRICTS OF ANDHRA PRADESH

P. KALAVATHI*, M.K. JYOSTHNA, P. MADHUSUDHAN AND K.V. HARIPRASAD

Department of Plant Pathology, KV.K, Kalikiri, Chittoor-517234.

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ABSTRACT

A roving survey was conducted during *rabi*, 2020-2021 in Nellore and Chittoor districts of Andhra Pradesh to assess the disease severity of sheath blight disease in rice. The per cent disease severity ranging from 6.11 to 13.44 per cent was noticed Maximum disease severity (13.44%) was recorded at Kothapalem village of Nellore district while minimum (6.11%) was recorded at Narasingapuram village of Chittoor district. The maximum disease was observed from tillering stage to harvesting stage.

KEYWORDS: Survey, sheath blight, rice, *Rhizoctonia solani.*

INTRODUCTION

Rice is the most important staple food crop in the world. Rice being a tropical plant, it can flourish in hot and humid climate. It can be grown in both *Kharif* & *Rabi* seasons. Rice is attacked by a number of fungal, bacterial and viral diseases. Among the fungal disease rice sheath blight is regarded as an internationally important disease. Sheath blight is a soil borne disease caused by the fungus *Rhizoctonia solani* Kuhn AG1-IA. This disease causes significant yield losses about 11.1-58.0 per cent depending on variety and stage of the crop (Chahal *et al.,* 2003).

Studies on the survey of disease in an area to know the current status of the disease in the various rice growing districts is essential to take decision regarding management of the disease. (Gangopadhyay and Chakrabarti, 1982). In India, this disease was first reported in Punjab, and later in Uttar Pradesh. Further, the disease was reported in Tamil Nadu, Kerala, Andhra Pradesh and Kashmir (Reddy and Reddy, 1986). Disease has been spreaded widely in terms of both occurrence and intensity over the past twelve years. It has become more prevalent on the improved varieties *viz.,* BPT 5204, JGL1798, JGL 384, Swarna, MTU1010, MTU1061 and MTU1075 (Prakasam *et al.,* 2013). The management of sheath blight of rice is to reduce the primary source of inoculum by killing sclerotia or to inhibit their germination. The disease has been efficiently controled by the use of systemic and non-systemic fungicides to seed, soil or foliage applications (Rabindran and Vidhyasekaran, 1996). Because of the hazardous residual effects of chemical fungicides in soil, in recent years several researches have been carried out to assess the potentiality of bio control agents for management of sheath blight, through the application of antifungal bacterial strains isolated from the soil (Nandakumar *et al.,* 2001). Distribution of *Bacillus* spp. in different ecological habitats and its endospore forming ability, sheath blight disease more possibly controlled by effective strains of *B. subtilis* among others bio control agents (Qin and Zhang, 2005).

MATERIAL AND METHODS

Roving survey was conducted during *Rabi* 2020-21 in major rice growing areas of Chittoor and Nellore districts. In each district, 3 mandals were selected, in each mandals 3 villages were taken. From each village, 3 fields were surveyed to study the disease severity of sheath blight disease.

Four one squire meter quadrants were randomly selected in each field and infected plants were counted in each quadrant based on relative lesions height. The disease severity was calculated based on a scale developed by IRRI, 2002.

Rating scale (based on relative lesion height)

0 - No infection observed

1 -Lesions limited to lower 20% of the plant height

3 - Lesions limited to 20-30% of the plant height

5 - Lesions limited to 31-45% of the plant height

7 - Lesions limited to 46-65% of the plant height

9 - Lesions observed more than 65% of the plant height

*Corresponding author, E-mail: pkalavathi139@gmail.com

Per cent disease index (PDI) was calculated as per the following formula given by Wheeler (1969).

PDI =

$$\frac{\sum \text{ of individual disease ratings}}{\text{Number of plants scored} \times \text{Maximum disease scale}}$$

Collection of Sheath blight symptoms

During survey characteristics symptoms on the leaf sheath at water level and the lesions in its early stages were circular or oblong with dark brown margin. The lesions were usually confined to the lower leaf sheaths at or near the water level described by Paracer and Chahal (1963). Those diseased samples were collected for isolation of *R. solani* Kuhn pathogen.

Isolation of pathogen

The causal organism *R. solani* Kuhn was isolated from the rice plants showing typical sheath blight symptoms under field conditions. Leaf sheath showing typical symptoms was washed in tap water for few minutes and leaf bits of 3-8 mm size were surface sterilized with 1% sodium hypochloride for one minute and then rinsed with sterile distilled water to remove the traces of sodium hypo chlorite. These leaf bits are then transferred to potato dextrose agar medium in petriplates and kept for incubation at 28 ± 2˚C. When the growth of the fungus from the leaf bits was seen on the PDA surface, the hyphal bits from the periphery of the culture growing in the petriplates was transferred to the PDA in culture tubes. The culture was purified by hyphal tip method and pure culture was maintained on PDA by regular sub culturing at frequent intervals. Pathogenicity of *R. solani* was proved by mycelial ball insertion technique as observed by Park *et al.,* (2008) and Nadarajah *et al*., 2014).

RESULTS AND DISCUSSIONS

The survey data is presented in the table 1. The data indicated that among the all locations surveyed, Nellore district recorded the per cent disease severity ranging from 8.7 to 13.44 while Chittoor district recorded comparatively less disease severity ranging from 6.11 to 12.36 per cent.

In Nellore District, the highest disease severity (13.44%) was recorded in Kothapalem (13.44%) of T.P Gudur (M), whereas the least disease severity (8.7%) was observed in Madharaj gudur of Nellore rural (M).

In Chittoor district, the highest disease severity was recorded in Reddivari palli (12.36%) of Chandragiri (M) whereas the least disease severity was observed in Narasingapuram (6.11%) of Chandragiri (M).

Stage of the crop

During the survey, the disease severity was recorded at different stages of rice crop. In eight villages disease severity was observed during panical intiation stage of the crop, in one village it was during the booting stage, in one village during the dough stage, in four villages it was during the grain filling stage and in four villages during the harvesting stage. Per cent disease severity during the panical intiation stage varied from 6.11 per cent to 13.44 per cent, whereas during the grain filling and harvesting stages it ranged from 8.33 per cent to 13.32 per cent and 8.14 per cent to 12.36 per cent respectively. In Nellore districts surveyed maximum severity was recorded during panical initiation stage and in Chittoor district surveyed maximum severity was recorded during harvesting stage.

In Nellore district, severity ranging from 9.81 per cent (Kothakaluva, Nellore rural (M)) to 13.44 per cent (Kothapalem, T.P gudur (M)) was recorded during the panical initiation stage whereas disease severity during the grain filling stage varied from 8.7 per cent (Madharaj gudur, Nellore rural (M)) to 13.32 per cent (Labur-1, Indhukur peta (M)). Disease severity during the harvesting stage was recorded only in Akuthota (10.35%) of Nellore rural (M), during the dough stage was recorded only in Jagadekapeta (11.43%) and booting stage was recorded only in Narayanareddy peta (9.99%) of Indukur peta (M).

In Chittoor district, panical initiation stage recorded disease severity ranging from 6.11 per cent (Narasingapuram, Chandragiri (M)) to 8.51 per cent (Gajulamadyam, Renigunta (M)). Disease severity observed during the harvesting stage of crop ranged between 8.14 per cent (Athur, Renigunta (M)) and 12.36 per cent (Reddivari palli, Chandragiri (M)) whereas disease severity during grain filling was observed only in Mittapalem (8.33%) of Chandragiri (M).

Crop variety

The per cent disease severity recorded in each variety varied depending upon the place of cultivation. MTU1010 variety was cultivated in six villages had disease severity ranging from 8.14 (Athur, Renigunta (M)) to 13.44 per cent (Kothapalem, T.P gudur (M)), NLR3449 variety was cultivated in three villages had disease severity ranging from 9.81 per cent (Kothakaluva, Nellure rural (M)) to 13.32 per cent (Labur-1, Indukur peta (M)) and ADT 37 variety was cultivated in seven villages disease severity ranged from 6.11 per cent in Narasingapuram village to 12.36 per cent in Reddivaripalli, village of Chandragiri

Table 1: Occurrence and distribution of sheath blight of rice in Chittoor and Nellore districts.

S. No.	Name of the District	Name of the Mandal	Name of the Village	Soil type	Rice variety	Crop stage	Disease severity (PDI	Latitude (Degrees)	Longitude (Degrees)
1	Nellore	T.P Gudur	Varigunda bit	Clay loamy	NLR-3354	Grain filling	12.77 (20.92)**	14.405462	80.041044
			Kotha palem	Clay loamy	MTU-1010	Panical intiation	13.44 (21.49)**	14.457603	80.1409
			Pedur	Clay loamy	MTU-1010	Panical intiation	12.95 (21.08)**	14.436321	80.072525
		Indukur peta	Jagadekapeta	Clay loamy	NLR-34449	Dough stage	11.43 (11.12)**	14.47986	80.069124
			Labur 1	Cla loamy	NLR-34449	Grain filling	13.32 (19.78)**	14.491693	80.066651
			Narayanareddy peta	Clay loamy	MTU-1010	Booting stage	9.99 (18.40)**	14.476833	80.663622
		Nellore (Rural)	Kothakaluva	Clay loamy	NLR-34449	Panical intiation	9.81 (18.20)**	14.46782	80.034808
			Akuthota	Clay loamy	NLR-3396	Harvesting	10.35 (18.75)**	14.42797	80.00156
			Madharaj gudur	Clay loamy	MTU-1010	Grain filling	8.7 (17.03)**	14.37824	80.038768
2	Chittoor	Chandragiri	Mittapalem	Clay loamy	ADT-37	Grain filling	8.33 (16.71)**	13.606174	79.324576
			Reddivaripalli	Clay loamy	ADT-37	Harvesting	12.36 (20.57)**	13.604789	79.313901
			Narasingapuram	Clay loamy	ADT-37	Panical initiation	6.11 (14.29)**	13.605866	79.34514
		Renigunta	Gajulamadyam	Clay loamy	ADT-37	Panical intiation	8.51 (16.93)**	13.609427	79.508246
			Athur	Clay loamy	MTU-1010	Harvesting	8.14 (16.51)**	13.579302	79.523961
			Ammavaripatnam	Clay loamy	MTU-1010	Harvesting	9.29 (17.69)**	13.5777103	79.526051
		Tirupati	Perumallapalli	Clay loamy	ADT-37	Panical initiation	8.15 (16.54)**	13.610073	79.349807
			C.Mallavaram	Clay loamy	ADT-37	Panical initiation	6.66 (14.93)**	13.596201	79.353069
			Satharbailu	Clay loamy	ADT-37	Panical initiation	7.77 (16.09)**	13.593061	79.35684
					CD(P=0.0%)		2.21 (2.24)**		
					SEm (±)		0.77 (0.78)**		
					SE (d)		1.08 (1.10)**		
					C.V		13.47 (7.42)**		

Note: Mean of three replications.
**Figures in parentheses are angular transformed values

Plate 1. Sheath blight symptoms on rice under field conditions observed during survey.

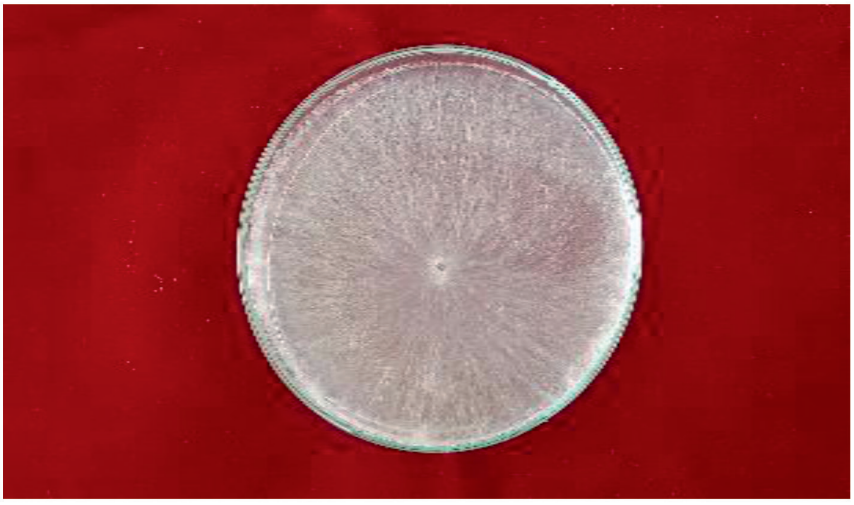

Plate 2a. Pure culture of *R. solani.*

Plate 2b. Immature sclerotia of *R. solani in vitro.*

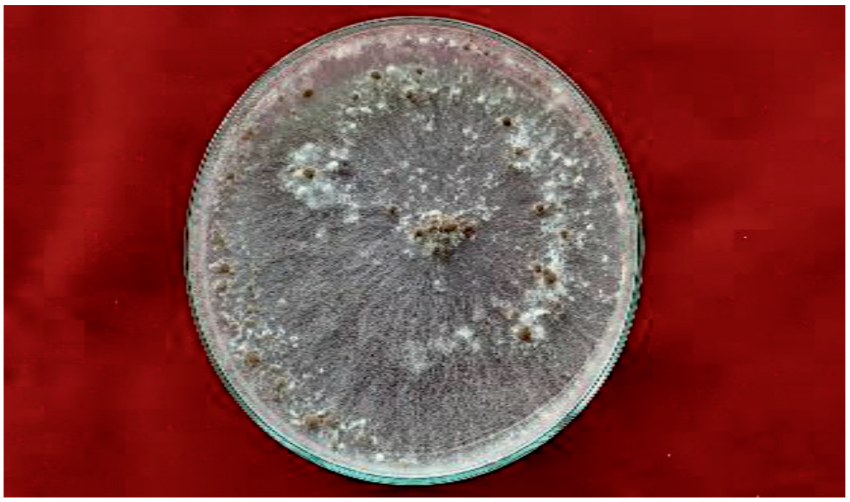

Plate 2c. Mature sclerotia of *R. solani in vitro.*

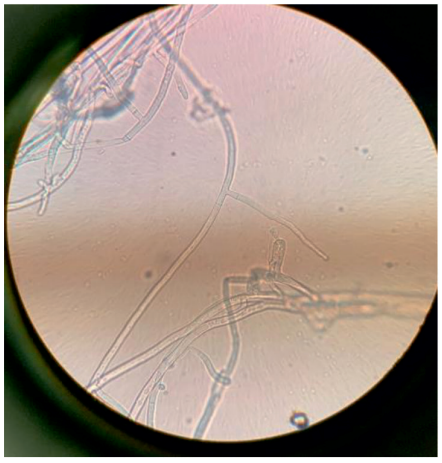

Plate 2d. Right angle branch of *R. solani.*

a) Control

b) Inoculated with sheath blight covered with aluminium foil

c) Appearance of disease symptoms after three days of inoculation of pathogen

Plate 3. Proving the pathogenicity of *R. solani* by mycelial ball insertion technique.

(M), whereas NLR3354 variety was cultivated only one village Varigunda bit (12.77%)of T.P gudur(M) and NLR3396 variety was cultivated in Akuthota (10.35%) of Nellore rural (M).

In Nellore district, disease sevierity in MTU1010 variety ranged from 8.7 per cent (Madharaj gudur, Nellore rural (M)) to 13.44 per cent (Kothapalem, T.P gudur (M)), NLR3449 variety ranging from 9.81 per cent (Kothakaluva, Nellure rural (M)) to 13.32 per cent (Labur-1, Indukur peta (M)) whereas disease severity in NLR3354 variety was observed only in varigunda bit (12.77%)of T.P gudur(M) and NLR3396 variety in Akuthota (10.35%) of Nellore rural (M).

In Chittoor district, disease sevierity in ADT 37 variety ranged from 6.11 per cent in Narasingapuram village to 12.36 per cent in Reddivaripalli, village of Chandragiri (M) and MTU1010 variety had disease severity 8.14% in Athur, 9.29% in Ammavaripatnam of Renigunta (M).

During survey both Chittoor and Nellore districts clay loam soils were the predominant type of soil for rice cultivated.

Similarly, Reddy *et al.* (2018) carried out survey for the assessment of sheath blight severity in rice in nine districts of Telangana state. In Adilabad district the maximum severity (9scale) was observed Huzurnagar and Miryalaguda villages. The disease was observed from panicle initiation to grain hardening stage. Whereas some other workers were found different growth stages susceptible for infection. Shahjahan *et al*. (1990) reported panicle initiation to booting stage is most susceptible stage for sheath blight infection. Pal *et al.,* (2016) also found grain filling stage as most susceptible for sheath blight disease to occur.

Similar results were also recorded by Kapse *et al*. (2012) and Pal *et al*. (2015) plant variety is the major factors influencing sheath blight disease. Pratiwi *et al*. (2021) reported disease severity on rice plants in Northern Sumatra, Indonesia. Highest disease incidence (99.48%) and the highest disease severity (12.38%) was recorded Sumber tani and Talawi in Batubara district.

Isolation of pathogen *R. solani*

The sheath blight pathogen was isolated from diseased samples collected during the survey and isolated by tissue segment method (Rangaswami and Mahadevan, 1999) Then purified by single hyphal tip method and were identified as *R. solani* based on morphological characters using the descriptions given by Banniza, 1996.

In PDA at 28±1°C the culture was obtained in 3 days of incubation, light brown in colour and occupying the entire Petriplate (Plate 2.2a). Pathogen produced dark brown, irregular, loose type of sclerotial bodies on the PDA (Plate 2.2b, 2.2c). Microscopic examination of the fungal culture revealed broad brown coloured hyphae branching at right angles (Plate 2.2d). These observations were in accordance with Sneh *et al*., 1991 who described hyphal branching at right angle, constriction at the point of branching of the mycelium and presence of a septum near the branching junction.

A roving survey was conducted during, *rabi*, 2020-2021 in Chittoor and Nellore districts of Andhra Pradesh to assess the disease severity of sheath blight disease in rice. In Nellore district, highest disease severity (13.44%) was recorded in Kothapalem of T.P Gudur mandal whereas the least disease severity was observed in Narasingapuram (6.11%) of Chandragiri mandal. The per cent disease incidence recorded in each variety varied depending on the place of cultivation disease severity during the panical intiation stage varied from 6.11 to 13.44 per cent, whereas during the grain filling and harvesting stages it ranged from 8.33 to 13.32 per cent and 8.14 to 12.36 per cent respectively. When compared to all the cultivars, maximum disease severity was recorded with MTU-1010 variety at Kothapalem (13.44%) of T.P gudur mandal, Nellore district and ADT 37 variety had recorded minimum disease severity of 6.11% in Narasingapuram of Chandragiri mandal, Chittoor district.

Rice sheath blight pathogen *Rhizoctonia solani* was isolated from the diseased samples obtained from during survey. Pathogenicity of *R. solani* was conducted in pots containing rice seedlings at maximum tillering stage by mycelial balls insertion technique.

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IMPACT OF SEED PRIMING WITH CHEMICALS ON SEED QUALITY OF CHICKPEA (*Cicer arietinum* L.)

SHAREEF JENNADA*, V. SAIDA NAIK, K. BAYYAPU REDDY AND S. VASUNDHARA

Department of Seed Science & Technology, S.V. Agricultural College, ANGRAU, Tirupati-517 502.

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ABSTRACT

The present experiment was conducted to know the impact of seed priming with chemicals on seed quality of chickpea, by subjecting seed of chickpea to various priming treatments *viz*., hydration, hydration followed by seed primed with 2% KH_2PO_4, 2% $CaCl_2$ and 100 ppm GA_3 for9 hours followed by shade drying to bring back its original moisture content. The primed seed along with untreated seed (control or check) was tested for seed quality parameters. Among priming treatments, seeds primed with GA_3 showed significantly higher seed quality parameters over other treatments. Among the genotypes, NBeG-452 was found to be superior over NBeG-119 in seed quality parameters. Among interactions, G_1T_5 (seed of NBeG-452 primed with 100 ppm of GA_3) showed significantly higher seed quality parameters like shoot length, root length, seedling length, seedling vigour index and field emergence over other interactions.

KEYWORDS: Gibberillic acid, NBeG-452, Priming, Seed quality parameters.

INTRODUCTION

Chickpea is a highly nutritious pulse crop and its seed is the main edible part of the plant, which is having a rich source of protein (23.3-28.9%), carbohydrate (52.0-70.0%), fat (4.0-10.0%), minerals (phosphorus, calcium, magnesium, iron and zinc) and vitamins. Globally, it is grown in an area of 137 lakh hectares with a production of 142.4 lakh tonnes and productivity of 1038 kg ha^{-1} (FAO STAT, 2019). Among the pulses, the chickpea occupies a predominant position in the country so it is known as the king of pulses. In India, chickpea takes first place in total pulse production followed by black gram with an area of 112 lakh hectares, production of 116.2 lakh tonnes and productivity of 1036 kg ha^{-1} (agricoop.nic.in, 2020-21). In Andhra Pradesh, it is grown in an area of 4.65 lakh hectares, with an annual production of 5.66 lakh tonnes and productivity of 1218 kg ha^{-1} (Third Advance Estimates, 2020-21, DES-AP).

Seed priming is an easy and suitable method to enhance seed quality, crop stand establishment in the field. It is a process of controlled hydration to such a level, that permits pre- germinative metabolic activity to proceed, but prevents the actual emergence of the radicle within the seed. Pre-sowing soaking of seed leads to increased tissue hydration, improve respiratory activity and redistribution of nutrients, stimulation of seedling growth and development. The virtue of different priming agents varies under different stresses and in different crop species (Ashraf and Foolad, 2005). Seed priming is a low-risk technology, which is easily adopted by resource poor farmers. It improves the yield of the crop in marginal areas by a combination of better crop establishment and enhancing the individual plant performance.

Keeping these in view, the present study was conducted to know the impact of seed priming with chemicals on seed quality of chickpea.

MATERIAL AND METHODS

The present experiment was conducted during 2021-2022 in a factorial completely randomized design with four replications at Agricultural Research Station, Jangamaheswarapuram, Guntur. Freshly harvested seeds of chickpea genotypes Desi (NBeG-452) and Kabuli (NBeG-119) type were collected from Regional Agricultural Research Station, Nandyal, Kurnool (dist). Seeds of chickpea genotypes were subjected to various priming treatments viz., hydration, hydration followed by seed priming with 2% KH_2PO_4, 2% CaCl2 and 100 ppm GA3 for 9 hours. After the priming duration, primed seed were shade dried to bring back to their original moisture content.

2% of KH_2PO_4 and $CaCl_2$ solutions were prepared by dissolving 20 g of respective chemicals in 1 litre of distilled water. 100 ppm of GA_3 was prepared by dissolving 100 mg of GA_3 in 10 mL of ethyl alcohol and making up the final volume to 1 litre using distilled water.

*Corresponding author, E-mail: jennadashareef@gmail.com

Soaking of seed with their respective chemical solutions using 1:5 seed weight to solution volume (w/v) ratio for 9 hours. Primed seeds were dried back to their original moisture content under the shade at room temperature. Along with the primed seed, un-primed seeds (control) were used for evaluation of seed quality by germination test.

Seed quality testing

Four replicates of 100 seeds from each treatment were placed at a uniform spacing in between two wetted germination paper towels. The paper towels were rolled, secured with rubber bands on both sides and kept in plastic trays in an upright position and the trays were incubated in the germinator at 25 ± 2 °C and 95% RH for 8 days. Data on germination and other seed quality parameters were recorded after 8 days of the test period as detailed below:

The number of normal seedlings was counted and expressed as germination (%) as per the formula:

Germination (%) =

$$\frac{\text{Number of normal seedlings}}{\text{Total number of seed sown}} \times 100$$

The root length, shoot length and seedling length was determined by randomly selecting ten normal seedlings in each treatment and each replication at the end of the germination count and expressed in centimeters. The root length was measured from the tip of the primary root to the base of the hypocotyl. Shoot length was measured from the tip of the primary leaf to the base of the hypocotyl. The seedling length was calculated by adding root and shoot lengths.

Seedling vigour index was computed by adopting the following formula as suggested by Abdul- Baki and Anderson (1973) and was expressed in whole number:

Seedling vigour index =

Germination (%) × Seedling length (cm)

Field emergence (%): One hundred seed from each treatment in each replication were counted and sown in well prepared soil at 3 cm depth. The field emergence was recorded on the 15th day after sowing and the field emergence percentage was calculated as per the formula:

Field emergence (%) =

$$\frac{\text{Number of seedlings emerged}}{\text{Total number of seed sown}} \times 100$$

Statistical analysis

The data were subjected to Analysis of Variance (ANOVA) by using SPSS software (version 16.0) at 1% and 5% level of significance.

RESULTS AND DISCUSSION

Seed Quality Parameters

Observations were recorded on various seed quality parameters after priming *viz*., germination, root length, shoot length, seedling length and seedling vigour index. Seed quality parameters were analyzed statistically and presented below with available literature:

Germination (%)

Seed priming showed a significant effect on germination percentage in genotype and treatment but it was not observed in genotype × treatment interaction (Table 2). The genotypes NBeG-452 and NBeG-119 recorded 89.95 and 55.7 per cent mean germination, respectively. The mean germination of treatments ranged from 67.5 to 77.0 per cent. The treatment T_5 was found highest mean germination over all the treatments while the least mean germination was observed in T_1 (67.5%). The treatments T_5 and T_4 recorded germination greater than the overall mean germination (72.25%). The treatment T_2 (72.25%) was slightly lower than T_3 (72.75%) but statistically on par with each other.

Improvement in germination with GA_3 was reported earlier in green gram (Ganesh *et al*., 2013), mung bean (Tiwari *et al*., 2015), bitter gourd (Islam *et al*., 2012) and mung bean (Sivakumar and Nandhita, 2017).

Root length (cm)

The genotype and treatment as well as genotype x treatment interaction in root length (cm) exhibited significant differences (Table 2). Among the two genotypes, NBeG-452 and NBeG-119 had a mean value of root length of 9.95 and 6.74 cm, respectively. The mean value of root length of treatments ranged from 7.63 to 9.13 cm with an overall mean of 8.34 cm. The treatment T_5 recorded the highest mean value (9.13 cm) followed by T_3 (8.91 cm), T_4 (8.16 cm), T_1 (7.90 cm) and T_2 (7.63 cm). Out of five treatments, two treatments (T_5 and T_3) exceeded the grand mean value of root length

Table 1. Mean sum of squares for seed quality traits in chickpea as affected by seed priming

Source	D.f	Germination (%)	Root length (cm)	Shoot length (cm)	Seedling length (cm)	Seedling vigor index I	Field emergence (%)
Genotype	1	5,531.67**	103.39**	11.64**	181.86**	8938322**	174.60**
Treatment	4	54.50**	3.37**	42.91**	67.97**	663701.3**	123.70**
Genotype × Treatment	4	5.09NS	6.35**	11.63**	31.64**	296934.8**	8.16*
Error	30	5.21	0.15	0.20	0.26	4600.02	2.79

*, ** Significant difference at 5% and 1% level, respectively

Table 2. Effect of seed priming on seed quality of chickpea genotypes

Treatment	Germination (%)			Root length (cm)			Shoot length (cm)			Seedling length (cm)			Seedling vigor index I			Field emergence (%)		
	G_1	G_2	Mean	G_1	G_2	Mean	G_1	G_2	Mean	G_1	G_2	Mean	G_1	G_2	Mean	G_1	G_2	Mean
T_1	84.25 (66.66)	50.75 (45.43)	**67.5 (56.05)**	8.38	7.41	**7.90**	6.42	7.97	**7.19**	14.80	15.38	**15.09**	1245.82	780.92	**1013.37**	82.25 (65.10)	72.75 (58.56)	**77.50 (61.83)**
T_2	89.75 (71.52)	54.75 (47.73)	**72.25 (59.63)**	8.52	6.73	**7.63**	8.01	7.96	**7.98**	16.52	14.69	**15.61**	1483.61	806.35	**1144.98**	86 (68.06)	81 (64.18)	**83.50 (66.12)**
T_3	91.25 (72.94)	54.25 (47.44)	**72.75 (60.19)**	10.78	7.04	**8.91**	10.00	10.36	**10.18**	20.88	17.39	**19.14**	1897.20	943.10	**1420.15**	86.75 (68.68)	79.25 (62.92)	**83.00 (65.80)**
T_4	91 (72.61)	58.25 (49.76)	**74.63 (61.18)**	10.34	5.99	**8.16**	12.70	9.41	**11.05**	23.04	15.40	**19.22**	2154.05	931.23	**1542.64**	89.25 (70.88)	87.5 (69.38)	**88.38 (70.13)**
T_5	93.5 (75.28)	60.5 (51.07)	**77.00 (63.17)**	11.74	6.51	**9.13**	14.89	10.93	**12.91**	26.63	17.69	**22.16**	2422.93	1014.88	**1718.90**	91.75 (73.41)	88.5 (70.22)	**90.13 (71.82)**
Mean	**89.95 (71.81)**	**55.7 (48.29)**	**72.83 (60.05)**	**9.95**	**6.74**	**8.34**	**10.40**	**9.32**	**9.86**	**20.37**	**16.11**	**18.24**	**1840.72**	**895.25**	**1368.01**	**87.20 (69.23)**	**81.80 (65.05)**	**84.50 (67.14)**
	G	**T**	**G × T**	**G**	**T**	**G × T**	**G**	**T**	**G × T**	**G**	**T**	**G × T**	**G**	**T**	**G × T**	**G**	**T**	**G × T**
S Em ±	0.51	0.81	1.14	0.09	0.14	0.19	0.10	0.16	0.22	0.12	0.18	0.26	15.17	23.98	33.91	**0.37**	**0.59**	**0.84**
CD (5%)	1.48	2.34	NS	0.25	0.40	0.56	0.29	0.46	0.65	0.33	0.53	0.74	44.01	69.59	98.42	1.08	1.71	2.42
CV (%)		3.80			4.66			4.54			2.81			4.96			2.49	

G_1 : NBeG-452 (Desi)
G_2 : NBeG-119 (Kabuli)

T_1 : Control
T_2 : Hydro priming
T_3 : Seed primed with 2% of KH_2PO_4
T_4 : Seed primed with 2% of $CaCl_2$
T_5 : Seed primed with 100 ppm of GA_3

(8.34 cm). The treatment T_2 (7.63 cm) was slightly lower than T1 (7.90 cm) but statistically on par with each other. In case of genotype x treatment interaction G_1T_5 recorded a significantly higher root length (11.74 cm) over the other interactions along with hydro- priming and control.

An increase in root length of seedlings with GA_3 was earlier observed in seeds of chilli, coriander (Debbarma *et al*., 2017), bitter gourd (Debbarma *et al*., 2018) and black gram (Dheeba *et al*., 2015).

Shoot length (cm)

For the trait shoot length, the genotype, treatment and genotype x treatment interaction showed a significant effect on seeds of chickpea with priming agents (Table 2). The mean shoot lengths of NBeG-452 and NBeG-119 were recorded as 10.4 and 9.32 cm, respectively. Among treatments, the shoot length had a mean value of 9.86 cm with a minimum length of 7.19 cm (T_1) and a maximum length of 12.91 cm (T_5). Three treatments (T_3, T_4 and T_5) recorded greater shoot length compared to an overall mean of the treatments (9.86 cm). The G_1T_5 interaction recorded a significantly higher shoot length (14.89 cm) over all the interactions.

Similar results were also reported by Chaturvedi *et al.* (2017) noticed an increase in shoot length in wheat by priming with GA_3. The increased shoot length is due to increased cell division within the apical meristem (Farooq *et al.,* 2008) and an early emergence was induced by the priming of seeds (Vishwas *et al.,* 2017).

Seedling length (cm)

The genotype, treatment and genotype x treatment interaction showed significant influence on the seedling length of chickpea by priming method (Table 2). Out of two genotypes, NBeG-452 exhibited maximum seedling length (20.37 cm) whereas minimum seedling length was recorded with NBeG-119 (16.11 cm). The mean value of treatments in seedling length ranged from 15.09 cm (T_1) to 22.16 cm (T_5). The overall mean of treatments (18.24 cm), was exceeded by three treatments (T_3, T_4 and T_5). The treatment T_3 (19.14 cm) was slightly lower than T_4 (19.22 cm) but statistically on par with each other. Among interactions, G_1T_5 showed a significantly higher seedling length (26.63 cm) followed by G_1T_4 (23.04 cm) and G_1T_3 (20.88 cm).

Enhancement of growth parameters might be the result of exogenous application of plant growth regulators through seed priming which improves the seed quality parameters by enhancing the process of cell division, cell enlargement and activation of several enzymes which are involved in the germination process. Similar results were reported earlier in wheat (Iqbal and Ashraf, 2007), mung bean (Tiwari *et al*., 2013) and chickpea (Rashid *et al*., 2004).

Seedling vigour index I

Significant difference was observed in genotype, treatment and genotype x treatment interaction of seedling vigour index on seeds of chickpea with priming agents (Table 2). The general mean value of genotypes NBeG-452 and NBeG-119 were 1840.72 and 895.25, respectively. The mean seedling vigour index of treatments ranged from 1013.37 (T_1) to 1718.90 (T_5) with an overall mean of 1368.01. Out of five treatments, T5 recorded the highest mean seedling vigour index (1718.90) followed by T_4 (1542.64), T_3 (1420.15) and T_2 (1144.98). While the lowest mean seedling vigour index was recorded with T_1 (1013.37). In case of genotype x treatment interaction G_1T_5 recorded a significantly higher seedling vigour index (2422.93) over the other interactions along with hydro-priming and control. Among ten genotype treatment interactions G_1T_5, G_1T_4 and G_1T_3 exceeded the mean interaction.

Improvement in growth parameters including vigour of seed might be the result of the application of GA3 through seed priming which could enhance the seed quality parameters during the seedling stage by enhancing the process of cell enlargement, cell division and activation of several enzymes involved in the germination process (Tiwari *et al*., 2015). Similar results were also observed in green gram (Ganesh *et al*., 2013), bitter gourd (Islam *et al*., 2012) and mung bean (Sivakumar and Nandhita, 2017).

Field emergence (%)

Significant effect was observed in genotype, treatment and genotype x treatment interaction in the trait of field emergence (%) (Table 4.3). The genotypes NBeG-452 and NBeG-119 were recorded at 87.2 and 81.80 percent mean field emergence, respectively. The treatments T4 and T5 recorded field emergence greater than the overall mean field emergence (84.5%). The treatment T_3 (83%) was slightly lower than T_2 (83.5%) but statistically on par with each other. Based on the mean performance of five treatments, the treatments

T_5, T_4, T_2, T_3 and T_1 recorded the highest per se performance in descending order for field emergence. In case of genotype x treatment interaction G_1T_5 recorded significantly higher field emergence (91.75%) over the other interactions along with hydro-priming and control. Out of ten interactions, six interactions G_1T_5, G_1T_4, G_2T_5, G_2T4, G_1T_3 and G_1T_2 were found to be higher field emergence than the overall mean of treatment interaction (84.5%).

Seed primed with GA_3 recorded higher field emergence these results were earlier found in green gram and mung bean by Devi *et al*. (2021) and Tiwari *et al*. (2015), respectively.

Among the various priming chemicals used in the present study, seeds primed with GA_3 showed significantly higher seed quality parameters like germination, root length, shoot length, seedling length and seedling vigour index over other treatments. In case of genotypes, NBeG-452 (Desi) recorded a better performance in seed quality than NBeG-119 (Kabuli). Among interactions, G_1T_5 recorded significantly superior seed quality parameters like shoot length, root length, seedling length and seedling vigour index over other interactions.

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STUDY ON MARKETING CONSTRAINTS OF TOMATO FARMERS IN CHITTOOR DISTRICT OF ANDHRA PRADESH

D. THABASUM NAZ*, P. BALA HUSSAIN REDDY, N. VANI AND SHAIK NAFEEZ UMAR

Institute of Agribusiness Management, S.V. Agricultural College, ANGRAU, Tirupati-517 502.

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ABSTRACT

Tomato, one of the most viewed crops in studies and NEWS reflects instability and frequent fluctuations in case of market related aspects starting from facilities for grading and packaging to sources for required information, transportation, availability of markets, malpractices at markets etc. affects the farmers share in consumer's rupee in tomato crop. Hence, this study aims to study constraints faced by tomato growers and chittoor district of Andhra Pradesh was purposely selected for this study as Andhra Pradesh rank first in tomato production in country which contribute 16.22 per cent of total production in India (Food and Agricultural Organization (FAO) Statistical data, 2020) and Chittoor district stands first in production of tomato in Andhra Pradesh. The study was conducted with a sample size of 120 tomato growing farmers from six top villages in production from three mandals of Chittoor district. The study revealed that malpractices in market was the major constraint faced by tomato growers and rank first, followed by mandi infrastructure and storage facilities ranked second and third in constraints whereas grading and packaging, market intelligence and transportation ranked fourth, fifth and sixth respectively in case of constraints faced by the sample tomato farmers.

KEYWORDS: Constraints, Mandi, Market intelligence, Grading, Malpractices, Packaging, Infrastructure, Instability, Fluctuations.

INTRODUCTION

Since thousands of years vegetables have been growing in India but now-a-days it has become an important commercial enterprise at both national and international levels. At present Tomato (*Lycopersicum esculentum*) is one among the most important and popular vegetable grown in India because of its higher production, high nutritive value and wide ecological amplitude.

Tomato cultivation (open field) in India has grown from 289,000 ha in 1991 to 865,000 ha by 2011 but the average yields have not kept similar pace the figures being 14.7 t ha^{-1} to 19.5 t ha^{-1} for respective years. The increased area reflects the high economic value to the growers and the demand of the ever increasing population.

The southern and central state s constitute much of India's production including the states of Andhra Pradesh, Telangana, Madhya Pradesh, Karnataka, Gujarat, Odisha, West Bengal, Chhattisgarh, Maharashtra, Bihar, Haryana, Uttar Pradesh and Tamil Nadu. Andhra Pradesh state alone contributes a share of 16.22 per cent of total Indian tomato production (FAOSTAT, 2020). The annual tomato production in Andhra Pradesh state 2450.67 thousand tonnes (Ministry of Agriculture and Farmers Welfare 2019-2020) 11.66 per cent of production in India in area of 61571 hectares with productivity of 42.49 tonnes ha^{-1}. (India Stat 2016-2017). In Andhra Pradesh, Chittoor district occupies the first place in production, with an area of 9858 hectares and a production of 43.37 thousand metric tonnes (District Horticulture Office, Chittoor, 2020-21) followed by Ananthapur and Kurnool districts which contribute to 20 per cent of state tomato production (RARS, Data base).

Despite the status, the tomato farmers are facing a lot of constraints relating to marketing that are hindering the growth of farmers along with the consumers. Hence there is need of understanding various constraints faced by farmers for strengthening the marketing of tomato, formulating of policies and schemes, guidance and training required to the farmers, proper communication of market information, facilitating exports *etc.* that can improvise the livelihood of tomato growers and end consumers of the country and create sustainable business model for tomato in India.

Hence, this study is conducted with the objective of analyzing marketing constraints faced by the tomato growing farmers in chittoor district.

MATERIAL AND METHODS

The study area, Chittoor district of Andhra Pradesh was purposively selected based on highest area under

*Corresponding author, E-mail: thabassumnaz23@gmail.com

Table 1. Constraints faced by tomato farmers

Particulars	Constraints	Farmer's response
Grading and packing	Non availability of labour	6%
	Higher labour charges and Non-availability of infrastructure	42%
	Non availability of infrastructure	28%
	No problem	24%
Storage facilities	No storage facility	82%
	No storage facility and inadequate cold storage facility in the village	18%
Transportation	Lack of vehicles	2%
	Vehicles not available in time	4%
	Non-availability of proper transportation	1%
	Lack of better connectivity to mandi	3%
	Vehicles not available in time and lack of better connectivity to mandi	8%
	Lack of vehicles & lack of better connectivity to mandi	1%
	No problem	81%
Matket intelligence	Information available for limited markets only, inadequate information	38%
	Information available for limited markets only, inadequate information and misleading information	5%
	Misleading information	47%
	No problem	10%
Mandi infrastructure	Inadequate space available in mandi	1%
	Inadequate space available in mandi and non-availability of auction platforms	7%
	Non-availability of auction platforms	9%
	Non-availability of adequate staff for auction	2%
	Non-availability of storage facility in mandi	27%
	No problem	54%
Malpractices in market	Deduct higher charges	1%
	Deduct higher charges and higher commissions	2%
	Deduct higher charges, higher commissions and quote lower price than actual	8%
	Higher commissions	32%
	Quote lower price than actual	27%
	No problem	30%

tomato cultivation. Out of 66 mandals in the district, top three with highest area under tomato cultivation were selected for the study *viz*., B.Kothakota, Kalakada and Gurramkonda mandals.

Two villages with highest area of tomato from each mandal were selected. The villages selected were B. Kothakota, Upparavaripalli, Penukondapalem, Devalapalli, Gurramkonda and Ellutla. 20 farmers from each village were selected randomly. Respondents were personally interviewed using well prepared, pre-tested interview schedule.

RESULTS AND DISCUSSION

To analyze the marketing constraints faced by the tomato growing farmers in Chittoor district

Grading and packaging

In Chittoor district, tomato growers had a problem regarding higher labour charges and non-availability of infrastructure (42.00%). About 28.00 per cent of the respondents reported that they are facing problems related to availability of infrastructure for grading and packaging. Some of the farmers (6.00%) express that non availability of labour for grading and packaging.

Storage facility

In Chittoor district a large portion (82.00%) of farmers are facing problems related to storage. As tomato is highly perishable crop due to non-availability of storage facilities the mature crop is picked and sold immediately.

Transportation

In case of transportation according to respondents 81.00 per cent of them do not have any problem relating to transportation. 8.00 per cent of the farmers report that during peak harvesting there would be problem relating to availability of vehicles and lack of better connectivity to mandi.

Market intelligence

47.00 per cent of the farmers report that information is misleading in the markets, 38.00 per cent of the farmers explained that Information is available for limited markets only and so they have inadequate information regarding markets.

Mandi infrastructure

54.00 per cent of the respondents report that they do not have any problems relating to mandi infrastructure. 27.00 per cent of the respondents express that there is no storage facility for the farmers at mandies in order to store their produce.

Malpractices in market

32.00 per cent of the respondents report that commission in high at markets by the commission agents. 30.00 per cent of the farmers said that they do not have any problem relating to malpractices at markets. 27.00 per cent of farmers said that quotes lower prices than actual price at markets, Farmers also have problem relating to higher charges at markets.

Table 2 shows the ranking given by the farmers relating to the marketing constraints faced by them. This explains that malpractices in markets rank first among the constraints with mean score of 72.6 followed by mandi infrastructure and storage facilities which rank second and third with mean scores of 58 and 56.35, grading and packaging rank fourth with mean score of 45.25, market

Table 2. Ranking of marketing constraints faced by tomato farmers

S. No.	Particulars	Mean	Rank
1.	Malpractices in market	72.60	I
2.	Mandi Infrastructure	58.00	II
3.	Storage Facilities	56.35	III
4.	Grading & Packaging	45.25	IV
5.	Market Intelligence	39.45	V
6.	Transportation	28.35	VI

intelligence rank fifth with a mean score of 39.45 and transportation rank sixth with mean score of 28.35.

From the study it is concluded that malpractices in markets and mandi infrastructure are the major constraints faced by the tomato farmers whereas market intelligence and transportation are the least affecting marketing constraints to the tomato farmers of Chittoor district of Andhra Pradesh.

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A STUDY ON CONSTRAINTS AND SUGGESTIONS ABOUT RYTHU BHAROSA KENDRAS (RBKs) PRODUCTS AND SERVICES BY THE BENEFICIARY FARMERS IN THE PRAKASAM DISTRICT OF ANDHRA PRADESH

K. ANANTHA DAMODARA REDDY*, P. BALA HUSSAIN REDDY, V. SAILAJA AND SHAIK NAFEEZ UMAR

Institute of Agribusiness Management, S.V. Agricultural College, ANGRAU, Tirupati-517 502.

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ABSTRACT

The present study was conducted to analyze the constraints faced by the farmers while using the products offered by Rythu Bharosa Kendra's (RBKs) particularly in the Prakasam district of Andhra Pradesh. 120 farmers from six RBKs were purposively chosen for the study from six villages and randomly selected and interviewed. The results of the study indicated that the sample farmers faced constraints mainly with the statements delay in seed availability during the sowing season, non-availability of need-based inputs. The limited supply of inputs, non-availability of crop-specific brands, non-functioning of the digital kiosk for ordering agri inputs having Garret's mean score of 67.13, 62.95, 53.28, 53.27, 49.46 and 45.59, respectively.

KEYWORDS: Rythu Bharosa Kendra (RBK), Constraints, Garret's Ranking, Farmers.

INTRODUCTION

Agriculture plays an important role in the Indian economy. The rural population in India was reported at 65.07 per cent in 2020 where more than 70 per cent of rural households depend on agriculture and allied sectors and account for ₹ 19.48 lakh crores of the country's Gross Value Added (GVA) (Department of Agriculture, Cooperation & Famers Welfare, 2020-21). About 51 per cent of geographical land is under cultivation which shows that agriculture plays an important role in the Indian economy. Whereas, the cropping intensity has increased by 25 per cent after the independence to about 136 per cent (DES, DAC & FW, 2016). India has emerged from a stage of food deficit to food surplus. India is the world's second-largest producer of rice, wheat, and other cereals. India is exporting cereal products due to the huge demand for cereals in the global market. In FY 2021 food grain production was recorded at 303.34 million tonnes. India ranks second in fruits and vegetable production in the world. Total horticulture production is estimated to be 331.05 million metric tonnes in 2020-21 (APEDA, 2020).

The Andhra Pradesh government launched Rythu Bharosa Kendras (RBK) for the farmers as one-stop solution for all agriculture and allied firms' products and services on May 30, 2020. RBK is a one-stop solution for all farm needs at the village level only. These RBKs are monitored jointly by the Department of Agriculture, Horticulture, AP Seeds, Sericulture, Fisheries, and Animal husbandry. The newly formed RBKs have digital kiosks and apps to assist the farmers in buying the Agri inputs like seeds, fertilizers, pesticides, livestock feeds, and veterinary medicine and the staff will deliver the product at an accurate time for the market price. After placing an order, it takes 48 hours to reach the farmer. RBKs prevent the middleman and spurious goods. An integrated call center has been established to address the problems and give solutions to them. With this call center, the farmers get the solution for their problems and the government also knows what type of problems are being faced by the farmers.

Value-added services like the "Rythu-Bharosa-welfare scheme" an input subsidy scheme has been introduced for providing financial support to purchase input products. Through this scheme, 50.58 lakh farmers families benefitted amount of ₹ 1036 crores by the Andhra Pradesh government (2022). Another valve-added service is "e-crop booking". It is all about documenting the farming land to get free crop insurance for the farmers. "Polam-Badi" is an extension program where farmers are trained in the field about minimum usage of inputs and getting maximum output and reducing the cost of cultivation. Weather forecasting and market information related to agriculture and allied sectors are also available at RBKs. Registration for tenant farmer's service is also offered by RBKs at the farm gate.

*Corresponding author, E-mail: dhamodhar.iabm20@gmail.com

RBKs are also acting as procurement centers and giving assurance to farmers for getting MSP for their products. RBKs are also providing the soil testing service.

MATERIAL AND METHODS

The study was conducted in the Prakasam district of Andhra Pradesh during the second quarter of 2022-23. Out of thirteen mandals in the Markapur revenue division of the Prakasam district, two mandals were selected randomly namely Giddaluru and Komarolu for the study. Three villages were selected purposively from each mandals having the highest number of farmers. The villages selected from the Giddalur Mandal were Munlapadu, Yellupalli and Ambavaram and from Komarolu Mandal were Balireddypalle, Pursohampalle and Thatireddypalle. A total of six villages having RBKs were purposively chosen for the study. Twenty beneficiary farmers were randomly selected from each of the RBKs of that particular village for the survey thus making the total sample size 120 farmers for the analysis of the statements, Garret's ranking technique was used. It is used to set the priorities or rank the level of information sources available on a general statement while purchasing the products at the RBKs. The formula used for this technique is

Per cent position =

$$\frac{R_{ij} - 0.5}{N_j} \times 100$$

where,

R_{ij} = rank given for i^{th} factor by j^{th} individual

N_j = number of factors ranked by j^{th} individual

RESULTS AND DISCUSSION

The data regarding the constraints faced by the sample farmers towards the purchase of products at Rythu Bharosa Kendras were collected and analyzed using Garrett Ranking technique and presented below in the Table 1.

Table 1 showed the farmer's preference for the severity of constraints they faced while purchasing products at Rythu Bharosa Kendras were ranked by using the Garrett score in the order of preference: Delay in seed availability during the sowing season (Rank1), Non-availability of need-based inputs (Rank 2), Limited supply of inputs (Rank 3), Non-availability of crop-specific brands (Ranks 4) With Garrett's mean scores of 67.13, 62.95, 53.28, 53.27 respectively. Delaying in

Table 1. Preference and ranking of constraints faced by the farmers to purchase products at RBK's

S. No.	Product constraints	Farmers	
		Garret's mean score	Rank
1.	Delay in seed availability during the sowing season	67.13	1
2.	Non-availability of need-based inputs	62.95	2
3.	The limited supply of inputs	53.28	3
4.	Non-availability of crop-specific brands	53.27	4
5.	Non-availability of fertilizer on time	49.46	5
6.	Non-functioning of Digital Kiosk for ordering Agri inputs	45.59	6
7.	Poor information regarding products available at RBK	44.47	7
8.	Non-functioning of Digital Kiosk for ordering Agri inputs	41.87	8
9.	Non-availability of product usage information	41.35	9
10.	Delay in fulfilling the orders	39.32	10

Table 2. Preference and ranking of constraints faced by the farmers for available services at RBK's

S. No.	Services constraints	Farmers	
		Garret's mean score	Rank
1	Non-availability of crop-specific advisory services	54.7	I
2	Non-availability of veterinary services	54.6	II
3	Delay in getting soil, seed and water test reports	53.7	III
4	Non-availability of a few services throughout the year	52.8	IV
5	Weather forecasting and market information not available at RBK	50.8	V
6	Discrimination in services to small, marginal and tent farmers	49.5	VI
7	Non-availability of crop-specific information.	48.1	VII
8	Delay in providing services at RBK	46.3	VIII
9	Poor extension services (Polambadi, trainings, etc)	44.6	IX
10	Poor information regarding services available at RBK	44.3	X

fulfilling the order and non-availability of product usage information are the least product purchase constraints faced by the sample farmers at RBKs with Garret's Mean scores of 39.32 and 41.35 respectively.

Table 2 shows the preference for major constraints faced by farmers to avail services at Rythu Bharosa Kendras a non-availability of crop-specific advisory services (Ranks1), non-availability of veterinary services (Rank 2), delay in getting soil and water report (Rank 3), non-availability of few services thought out the year (Rank 4) with Garrett's mean scores of 54.7, 54.6, 53.7, 52.8. Poor extension services and information regarding services available at RBK are the constraints having Garrett's mean scores of 44.6 and 44.3 respectively. Constraints like non-availability of crop-specific advisory services and the non-availability of veterinary services were perceived to be poor extension services and information regarding the services available at RBK were considered the least ranked constraints indicating that there were severe constraints regarding the statements.

Suggestions expressed by the farmers to overcome the problem in availability of products at the RBKs

Farmers experienced substantial constraints while purchasing products from RBKs such as the non-availability of need-based inputs, the non-availability of Agri inputs on time and the limited supply of inputs. is recommended that each RBK develop a crop-specific pre-monsoon order plan, taking into consideration cropping patterns from the previous two years, cropping area and major pests and diseases.

In order to identify the specific inputs that are needed in the region, it is advisable to place orders well in advance and maintain stocks at a minimum of 80 percent of the previous year's average annual usage. To accommodate for seasonal fluctuations in demand, it is recommended to review and adjust the order quantities after the monsoon season. Farmers face significant challenges in accessing essential services, including a lack of crop-specific advisory support and veterinary services. Additionally, there are delays in receiving results for soil, seed, and water tests. To address these issues, it is suggested that each RBKs develop and regularly update a database specific to various crops. Furthermore, staff should receive training in providing crop-specific advisory services, and technical personnel should be provided access to a mobile-based crop assessment tool to enhance the quality of these advisory services.

To further improve income for rural farm households engaged in secondary activities like animal husbandry, it is recommended to offer veterinary assistance services at all RBKs. This initiative would contribute to augmenting their income sources. These findings are in the line with the work of Murthy (2000).

Provide more crop-specific chemicals and also water-soluble fertilizers because the sample farmers in the study adopted micro-irrigation which is useful for fertigation.

Significant constraints faced by farmers at RBKs were problems in non-availability of updated land records, delay in seed availability during the sowing season, non-availability of need-based inputs and fertilizer on time. To overcome the above constraints farmers may be able to know about the advantages of more products and services. More subsidies for fertilizers and seeds providing crop-specific chemicals for enhancing production and profitability and the supply of subsidized farm machinery were significant suggestions of farmers for improving the reach of RBK interventions to farm households in Andhra Pradesh.

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CHALLENGES IN HINDERING THE PERFORMANCE OF FPOs IN ANANTAPUR DISTRICT

A. PRUTHVI ROYAL*, M. RAVI KISHORE, N.T. KRISHNA KISHORE AND P. LAVANYA KUMARI

Institute of Agribusiness Management, S.V. Agricultural College, ANGRAU, Tirupati-517 502.

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ABSTRACT

The purpose of the study is to find the challenges hindering the performance of FPOs. The study was carried out with the members and the Board of Directors from the FPOs in Anantapur District of Andhra Pradesh. Five FPOs were selected randomly selected by using simple random sampling methos for the purpose of the study. Total of 100 respondents, covering of five FPOs in the Anantapur district of Andhra Pradesh were selected. In India small holder farmers are suffering with market uncertainties as most policies and institutional supports favours large and progressive farmers and smaller farmers are devoid of them increasing wider gap between producers and consumers. Farmer Produces Organization plays an important role in promoting and strengthening member based institution of farmers. FPO's links smallholder's farmers to local, regional, national and international markets effectively. FPOs which are formed as Farmer Producer Company (FPCs) allow its member to access financial services, technical services, market oriented, economic and extension services and other input services. Prices in the local market and price fluctuations in the market are influenced by seasonality, and during the off-season, market prices significantly decline due to improper market connections and price erosion are some of the constrains faced by the FPOs.

KEYWORDS: Farmer Producer Organisations (FPO), Challenges, Performance, Simple random sampling.

INTRODUCTION

Small holder agriculture is argued to remain important for economic development and poverty reduction in developing countries, but its development is challenged by the need for institutional innovations to overcome market failures. There is a renewed interest from donors, governments and researchers in cooperative producer organizations as an institutional vehicle to improve smallholder agricultural performance, particularly through improved market participation. Small holder producers participation in market-oriented production holds potential for diversifying their incomes and increase agriculture productivity, hence promoting food security and poverty eradication. With numerous farming problems in developing countries, low agricultural productivity has negative effect on the economic welfare of the rural population. Farmers organizations have been suggested as a key tool to improve the living conditions of the resource-poor farmers in developing countries. Farmer groups are important institutions for transformation of small holder farming, increase productivity and income, thereby reducing poverty.

Farmers Producer Organization (FPOs) are essential institutions for the empowerment, poverty alleviation and advancement of farmers and the rural poor. Politically, FPOs strengthens the political power of farmers, by increasing the likelihood that their needs and opinions are heard by policy makers and the public. Economically, FPOs can help to farmers gain skills, access inputs, form enterprises, process and market their products more effectively to generate higher incomes. By organizing, farmers can access information needed to produce, add value, market their commodities and develop effective linkages with input agencies such as financial service providers, as well as output markets. FPOs can achieve economies of scale, thereby lowering the costs and facilitating the processing and marketing of agricultural commodities for individual farmers.

Farmers Producer Organisations are groups of rural producers coming together to form an organisation in order to pursue goals of members through technical and economic activities that benefit their members and maintaining relations with partner's operating in their economic and institutional environment. Cooperatives were established to improve the lives of farmers but the system was infected by several inadequacies. Now FPOs have emerged and they are expected to provide a commercial out look to the institutions there by putting the farmer at the top of the supply chain. Despite advantages, the FPOs have their own challenges. Majority of the members of the FPOs are small and marginal farmers.

*Corresponding author, E-mail: pruthvi.iabm20@gmail.com

Given the scenario, the major activities entrusted by the FPOs are providing inputs such as seed, fertilizer and machinery, market linkages, training and networking and financial and technical advice. There is a need for supporting institutions to make the FPOs popular. The aim of FPOs to bring about a change in the economy of the farmers.

The main aim of FPOs is to ensure better income for the producers through an organization of their own. Small producers do not have the volume individually (both inputs and produce) to get the benefit of economies of scale. Besides, in agricultural marketing, there is a long chain of intermediaries who very often work non-transparently leading to the situation where the producer receives only a small part of the value that the ultimate consumer pays. They will also have better bargaining power as the bulk suppliers of the produce and bulk buyers of the inputs.

MATERIAL AND METHODS

Anantapur was purposively selected for the study. Anantapur is majorly a drought-prone region with average rainfall of 556 mm and there exists huge scope for diversification in agriculture. Due to diversified farming, well established FPOs are operating in this area. At present, there are 90 FPOs present in the Anantapur district of Andhra Pradesh. Out of them, five FPCs that are functioning actively were randomly selected. Primary data was collected through personal interview method from farmers and directors of FPOs. The secondary data on agro economic features of the district was collected from Chief planning office, Anantapur district. The data regarding FPOs was also collected from Research report of ICRISAT and NABARD. From each FPO, farmers were selected randomly comprising of five board of directors and fifteen farmers making the sample size of 20 respondents from each selected FPO. The random selection was used based on the list of farmers collected from the FPOs. Thus, in Anantapur district, five FPOs, covering 75 FPO member farmers and 25 board of directors with a total of 100 respondents were selected for a study.

The garret ranking method was used to analyze the challenges that the five FPOs faced. The various challenges for the present study have been operationalized as obstacles or hurdles that the farmers and board of directors encountered in the FPOs. So that the interview schedule is prepared and openly inquire the challenges faced by the farmers and the board of directors. The first frequent challenges was selected by using Garret ranking technique

The order to merit that given by the respondent was converted into percent position using the following formula

$$\text{Per cent position} = \frac{R_{ij} - 0.5}{N_j} \times 100$$

Table 1. Challenges faced by the farmer producer organizations

S. No.	Constraints	Average Garett's score	Rank
1.	Remunerative price in local markets	86.67	I
2.	Fluctuation in market prices	82.67	II
3.	Lack of credit facility from institutional sources	77.34	III
4.	Weak backward and forward linkages	74.67	IV
5.	Inadequate storage and ware house facilities	72.0	V
6.	Quite of farmers from FPOs when there is loss	65.34	VI
7.	Lack of participation in activities of FPO	62.67	VII

where,

R_{ij} = Rank given for i^{th} variable by the jth respondents

N_j = Number of variables ranked by the jth respondents

With the help of Garrett's table, the per cent position is estimated and converted into scores, then for each constraint the per cent position values are evaluated and mean values of score is calculated. The factors having excessiveness mean value is considered to be the most important factor and ranked accordingly.

RESULTS AND DISCUSSION

The identified FPOs faced various problems like remunerative price in local markets, big fluctuation in market prices, lack of credit facility from institutional sources, weak backward and forward linkages, inadequate storage and ware house facilities, and lack of participation in activities of FPO was identified. Among the following constraints the remunerative price in local markets as a major constraint with the score of (86.67) followed by fluctuation in market prices (82.67), lack of credit facility from institutional sources (77.34), Weak backward and forward linkages (74.67), inadequate storage and ware house facilities (72.0), quite of farmers from FPOs when there is loss (65.34) and lack of participation in activities of FPO (62.67).

Remunerative price in local markets and whole sale markets observed as a major issue for the FPOs. Big fluctuations in market price due to the seasonality problem, particularly during off season, when the market price reduces drastically and the member farmers moves away from the FPOs due to these price fluctuations. Further due to the lack of credit, FPOs could not provide proper services like storage facilities, input facilities etc. Besides FPOs were not having good interaction with other organizations, so forward and backward linkages were less. The infrastructure facility in the selected FPOs are average as they are in the initial stages of their development.

The price in local markets and whole sale markets is a major issue for the FPOs and its members. Major fluctuations in market price is due to the seasonality problem, particularly during off season, when the market price reduces drastically and member farmers move away from the FPOs due to these price fluctuations and not getting proper linkages in the market and loss of price in the market. further Due to the lack of credit, the FPO could not provide proper services like storage facilities, warehouse facility, availability of machineries, input facilities etc.

Besides FPOs are not having good interaction with other organizations, so forward and backward linkages are less. The infrastructure facility in the selected FPOs are average as they are in the initial stages of their development.

- The group membership has the potential benefit to farmers by increasing their income and the Farmer Producer Organizations provide a good platform for marketing of output and this can immensely enhance farm productivity and increase income there by reducing the poverty.
- Remunerative price in local markets was found the major constraint faced by the FPOs (with the highest score of 86.67).
- Strengthening of backward and forward linkage of FPOs is the need of a hour for better performance of FPOs.
- Study on marketing linkages and networking followed by FPOs with respect to supply chain and value chain management can be taken up.

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YIELD ATTRIBUTES AND YIELD OF MAIZE (*Zea mays* L.) AS INFLUENCED BY CROP RESIDUES AND NUTRIENT MANAGEMENT PRACTICES

VIJAYA BHASKAR REDDY UPPALURU*, PRABHAKARA REDDY GADDAM, SRINIVASA REDDY MALLU AND P. KAVITHA

Department of Agronomy, Sugarcane Research Station, Vuyyuru.

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ABSTRACT

During *rabi*, 2014 and 2015 at Agricultural College, Mahanandi the yield attributes *viz.,* number of cobs plant^{-1}, cob length and hundred grain weight of maize were not influenced significantly due to residual nutrients, nutrient doses ± crop residues and their interaction except number of grains cob^{-1}. Graded levels of nitrogen exerted favorable influence on grain yield of maize. In the present study, the highest yield was obtained with the application of 250 kg and 300 kg N ha^{-1} in the previous season but the response to P levels was marginal. Significantly higher grain yield was recorded with F_2 (125% of F_1) which was however on par with F_4 (F_2 + *Kharif* crop residue incorporation) in both the years.

KEYWORDS: Crop residue, Yield attributes, Cobs, Grain yield and Stover yield.

INTRODUCTION

Maize (*Zea mays* L.) is an important cereal food crop cultivated both in tropical and temperate regions of the world with the highest production and productivity as compared to rice and wheat. In the world, maize is cultivated in an area of 146 million hectares with a production of 685 million tonnes and an average productivity of 4.7 t ha^{-1}. It is the third most important cereal after rice and wheat for human food by contributing to 9 per cent of India's food basket and 5 per cent to World's dietary energy supply (Saikumar *et al.*, 2012). India is the sixth largest producer of maize with 22.36 million tonnes of production from 9.40 million hectares, with a productivity of 2.4 t ha^{-1}. In Andhra Pradesh, it is cultivated in an area of 0.23 million hectares with a production of 1.41 million tonnes and productivity of 6.1 t ha^{-1} (ASG, 2016).

The demand for maize owing to burgeoning growth rate of poultry, livestock, fish and wet and dry milling industries is expected to increase from current level of 22.36 million tonnes to 45 million tonnes by 2030 (DMR, 2011). To meet the growing demand, enhancement of maize yield in coming years across all the growing locations in India is the big challenge. Maize is a heavy feeder of nutrients, especially nitrogen and phosphorus, the deficiency of which limits the growth, yield and quality of the crop. In order to meet such challenges, over dependence on chemical fertilizers alone would lead to gradual decline in organic matter content and native fertility status of the soil, which inturn reflects on the future productivity. In addition, due to recent escalation in prices of nitrogenous and phosphatic fertilizers, maize growers are facing crisis in purchase of the above fertilizers. On the other hand, organic manures need to be applied in bulk to meet the heavy nutrient requirement of hybrid maize for improving the fertility status of the soil on sustained manner, which is also not possible due to the scarcity of organic manures. Hence, a strategy of integrated use of nitrogen and phosphorus fertilizers in combination with any amount of cheaper organic source like previous crop residue, which is abundantly available locally should be tried to satisfy the crop requirement to produce higher yield, without impairing soil health. The application of organic residue (e.g., straw) to soils represents a valuable recycling strategy (Cayuela *et al*., 2009), which reduces in part our dependence on mineral fertilizers. Hence, the present study was under taken to examine the degree to which preceding maize can contribute to the succeeding maize and the appropriate fertilizer schedule.

MATERIAL AND METHODS

The field experiment was conducted at College Farm of Agricultural College, Mahanandi campus of Acharya N. G. Ranga Agricultural University, situated at 15.51°N latitude, 78.61°E longitude and at an altitude of 233.5 m above the mean sea level, in the scarce rainfall

*Corresponding author, E-mail: u.vijayabhaskarareddy@angrau.ac.in

zone of Andhra Pradesh. A composite soil sample was collected at random from 0-30 cm soil depth and analyzed for physico-chemical properties prior to start of the experiments. The soil was sandy loam in texture, neutral in reaction, low in organic carbon and available nitrogen (275 kg ha^{-1}), high in available phosphorus (153 kg ha^{-1}) and potassium (670 kg ha^{-1}) The experiment was conducted in the same plots of *kharif* season and was laid out in a split-plot design with three replications.

Treatments

There were nine main plots consisting of three nitrogen levels and three phosphorus levels of *kharif* season and four sub plots comprising of fertilizer and crop residue management practices.

Main plot treatments

Nine main plots (residual nutrients) consisting combination of three nitrogen levels 200, 250 and 300 kg N ha^{-1} (N_1, N_2 and N_3 respectively) and three phosphorus levels 40, 60 and 80 kg P_2O_5 ha^{-1} (P_1, P_2 and P_3 respectively) of *kharif* season.

Sub plot treatments

Four sub plots (nutrient doses ± crop residues) comprising of fertilizer and crop residue management practices. F_1 : Recommended dose of N and P_2O_5 (250 kg N and 80 kg P_2O_5 ha^{-1}) , , F_2 : 125% of F_1, F_3 : F_1+ *Kharif* crop residue incorporation and F_4 : F_2+ *Kharif* crop residue incorporation. A common dose of 60 kg K_2O ha^{-1} was applied to all the plots.

The crop was sown at a spacing of 75 cm × 15 cm. The test cultivar was P-3396 a single cross hybrid with the yield potential ranging from 7.5 to 8.0 t ha^{-1}. After harvest of the economic produce of *kharif* maize the stover was allowed to dry in the field itself and plot wise weight of the crop residue was recorded.

Length of the cob from blunt end to shank tip of cobs harvested from five tagged plants was measured and the average of each treatment was expressed as cob length in cm. Total number of grains cob^{-1} from cobs harvested from five tagged plants was counted and the mean value was presented as number of grains cob^{-1}. Hundred grains randomly drawn from the composite sample of grain yield of net plot of each treatment were weighed and expressed in g. Grain from net plot was sun dried sufficiently, cleaned thoroughly, weighed and expressed in kg ha^{-1}. Stover obtained from net plot was thoroughly sun dried to a constant weight and expressed in kg ha^{-1}.

RESULTS AND DISCUSSION

Number of cobs $plant^{-1}$

Residual nutrients (main plots), nutrient doses ± crop residues (sub plots) and their interaction did not affect the number of cobs $plant^{-1}$ during both the years. All the main and sub plot treatments recorded one cob $plant^{-1}$ and without having any significant interaction during both the years.

Cob length

Crop sown in N_2P_3 (250 kg N + 80 kg P_2O_5 ha^{-1}) main plot in the first year and N_3P_1 (300 kg N + 40 kg P_2O_5 ha^{-1}) in the second year resulted in higher cob length which was however on par with all the remaining main plots during both the years. With regard to sub plots, higher cob length was recorded with F_2 (125% of F_1) in the first year and F_4 (F_2+ *Kharif* crop residue incorporation) in the second year, which was statistically on par with the remaining sub plots.

Number of grains cob^{-1}

Numbers of grains per cob were significantly affected by residual nutrients (main plots), nutrient doses ± crop residues (sub plots), but the interaction was not significant during both the years. Crop sown in N_3P_3 (300 kg N + 80 kg P_2O_5 ha^{-1}) main plot in the first year and N_2P_2 (250 kg N + 60 kg P_2O_5 ha^{-1}) in the second year resulted in significantly more number of grains cob^{-1}, which were however on par with all the remaining main plots except with N_1P_2 (200 kg N + 60 kg P_2O_5 ha^{-1}) and N_1P_3 (200 kg N + 80 kg P_2O_5 ha^{-1}) during both the years.

With regard to sub plots more number of grains cob^{-1} were recorded with F_2 (125% of F_1) in both the years, which were statistically on par with F_1 (Recommended dose of N and P_2O_5) and F_4 (F_2+ *Kharif* crop residue incorporation) during the first year and with F_3 (F_1+ *Kharif* crop residue incorporation) and F_4 (F_2+ *Kharif* crop residue incorporation) during the second year.

Hundred grain weight

Crop sown in N_3P_1 (300 kg N + 40 kg P_2O_5 ha^{-1}) main plot in the first year and N_2P_2 (250 kg N + 60 kg P_2O_5 ha^{-1}) in the second year resulted more hundred grain weight, which were however on par with all the remaining main plots during both the years. With regard

Table 1. Cob length (cm) of *rabi* maize as influenced by crop residue and nutrient management practices

	***Rabi*, 2014**					***Rabi*, 2015**				
	F_1	**F_2**	**F_3**	**F_4**	**Mean**	**F_1**	**F_2**	**F_3**	**F_4**	**Mean**
N_1P_1	16.7	16.5	16.7	16.9	**16.7**	17.0	17.7	17.9	18.0	**17.6**
N_1P_2	15.4	16.8	16.5	16.2	**16.2**	16.4	16.3	17.3	17.1	**16.8**
N_1P_3	16.6	15.7	14.4	16.6	**15.8**	15.6	15.2	16.5	16.8	**16.0**
N_2P_1	16.1	16.6	16.3	16.1	**16.3**	17.1	16.5	15.9	16.9	**16.6**
N_2P_2	16.6	17.6	16.5	16.0	**16.7**	16.5	16.9	15.8	16.8	**16.5**
N_2P_3	16.7	17.1	16.7	17.0	**16.9**	16.0	15.7	16.4	17.5	**16.4**
N_3P_1	16.2	16.4	17.9	16.1	**16.7**	17.2	17.5	17.6	16.5	**17.2**
N_3P_2	16.1	16.2	16.8	17.4	**16.6**	16.8	17.6	16.9	16.6	**16.9**
N_3P_3	15.8	17.1	17.0	17.2	**16.8**	17.0	17.3	17.1	17.0	**17.1**
Mean	**16.2**	**16.7**	**16.5**	**16.6**		**16.6**	**16.7**	**16.8**	**17.0**	

	***Rabi*, 2014**		***Rabi*, 2015**	
	SEm ±	**CD (P = 0.05)**	**SEm ±**	**CD (P = 0.05)**
NP	0.22	NS	0.51	NS
F	0.20	NS	0.26	NS
NP at F	0.57	NS	0.85	NS
F at NP	0.44	NS	1.02	NS

to sub plots, more hundred grain weight was recorded with F_4 (F_2+ *Kharif* crop residue incorporation) in both the years, which were statistically on par with the remaining sub plots.

In the present study the different yield attributing characters *viz.,* number of cobs per plant, cob length and hundred grain weight were not influenced by the residual nitrogen and phosphorus levels as well as crop residues. Whereas number of grains per cob were significantly influenced by residual nutrients. Similar observations on the yield attributing characters due to residual nutrients were reported by Maobe *et al.* (2010) in sandy clay loam soils.

Grain yield

Variation in grain yield was significant due to residual nutrients (main plots) and nutrient doses ± crop residues (sub plots) but their interaction was not significant during both the years.

Graded levels of nitrogen exerted favorable influence on grain yield of maize. In the present study, the highest yield was obtained with the application of 250 kg and 300 kg N ha^{-1} in the previous season but the response to P levels was marginal. Higher level of biomass accrual and efficient translocation of assimilates to the sink due to the sufficient and continuous supply of nitrogen and other nutrients throughout the crop period might be the reason. These results are in accordance with the findings of Kiran (2004).

The highest grain yield of hybrid maize was produced with the application of 125% recommended dose of N and P_2O_5 alone, however comparable with along with crop residue incorporation, application of 100% recommended dose of N and P_2O_5 alone, while it was found to be the lowest with the application of 100% recommended dose of N and P_2O_5 along with crop residue incorporation. The higher level of grain yield was due to the favourable influence of consistent and adequate availability of nutrients especially nitrogen throughout the crop growth period, which favoured the production of photosynthates coupled with better partitioning to the sink, under higher level of nitrogen and phosphorus. The

Table 2. Number of grains cob^{-1} in *rabi* maize as influenced by crop residue and nutrient management practices

	Rabi, 2014					*Rabi*, 2015				
	F_1	F_2	F_3	F_4	Mean	F_1	F_2	F_3	F_4	Mean
N_1P_1	627	579	541	682	**607**	576	593	582	590	**585**
N_1P_2	567	628	569	542	**577**	518	516	660	563	**564**
N_1P_3	542	592	524	544	**551**	545	592	539	587	**567**
N_2P_1	597	614	596	590	**599**	620	624	590	601	**609**
N_2P_2	595	615	585	606	**600**	639	647	580	621	**622**
N_2P_3	609	604	620	603	**609**	551	625	585	611	**593**
N_3P_1	563	615	588	592	**590**	572	622	623	630	**612**
N_3P_2	609	621	563	606	**600**	599	615	614	637	**616**
N_3P_3	608	620	602	614	**611**	634	638	590	594	**614**
Mean	**591**	**610**	**577**	**598**		**583**	**608**	**596**	**606**	

	Rabi, 2014		*Rabi*, 2015	
	SEm ±	CD (P = 0.05)	SEm ±	CD (P = 0.05)
NP	10.7	32	12.9	39
F	7.4	21	8.6	24
NP at F	21.9	NS	32.0	NS
F at NP	21.5	NS	36.9	NS

results are in conformity with those of Singh *et al.* (2000) and Ramu (2005).

Stover yield

Variation in stover yield was significant due to residual nutrient effects (main plots) and nutrient doses ± crop residues (sub plots) but their interaction was not significant during both the years.

The lowest stover yield was recorded in F_1 (Recommended dose of N and P_2O_5) during both the years of study. Significant interaction was not observed during both the years with regard to stover yield of maize.

Graded levels of nitrogen exerted favorable influence on stover yield of maize. In the present study, the highest stover yield was obtained with the application of 300 kg N ha^{-1} in the previous season but the response to P levels was not consistent. Higher level of biomass accrual and efficient translocation of assimilates to the sink due to the sufficient and continuous supply of nitrogen and other nutrients throughout the crop period might be responsible for the production of elevated level of stover yield. These results corroborate with the findings of Kiran (2004), Ahmad *et al.* (2007), Verma *et al.* (2013) and Pandiaraj *et al.* (2015).

The higher stover yield of maize was produced with the application of 125% recommended dose of N and P_2O_5 alone in the first year and 125% recommended dose of N and P_2O_5 along with crop residue incorporation in the second year. The higher level of stover yield was due to the favourable influence of consistent and adequate availability of nutrients throughout the crop growth period, which favored the production of photosynthates coupled with better partitioning to the sink and better vegetative growth as evidenced by enhanced dry matter production under higher level of nitrogen and phosphorus with crop residue incorporation. The results are in conformity with those of Singh *et al.* (2000) and Ramu (2005).

Application of 250 kg N and 60 kg P_2O_5 ha^{-1} during *kharif* season and 125% recommended dose of N and

Table 3. Hundred grain weight (g) of *rabi* maize as influenced by crop residue and nutrient management practices

	Rabi, 2014					*Rabi*, 2015				
	F_1	F_2	F_3	F_4	Mean	F_1	F_2	F_3	F_4	Mean
N_1P_1	26.9	27.0	27.1	28.1	**27.3**	27.4	27.2	27.0	27.2	**27.2**
N_1P_2	27.1	27.5	26.0	26.1	**26.7**	25.8	26.3	25.7	26.0	**26.0**
N_1P_3	26.2	26.3	26.4	26.5	**26.3**	27.0	26.8	26.8	27.2	**27.0**
N_2P_1	26.1	26.9	26.3	26.4	**26.4**	26.3	26.4	25.8	28.1	**26.7**
N_2P_2	27.2	27.7	27.5	26.6	**27.2**	26.7	27.7	26.9	28.0	**27.3**
N_2P_3	26.3	27.0	26.5	27.9	**26.9**	26.5	26.2	25.1	28.2	**26.5**
N_3P_1	27.5	27.8	27.2	28.5	**27.8**	26.8	26.6	26.2	27.7	**26.8**
N_3P_2	27.2	27.5	26.1	27.0	**27.1**	26.9	27.2	26.7	27.3	**27.0**
N_3P_3	27.4	27.3	27.3	28.1	**27.5**	26.5	27.8	25.7	28.1	**27.0**
Mean	**26.9**	**27.2**	**26.7**	**27.3**		**26.7**	**26.9**	**26.2**	**27.5**	

	Rabi, 2014		*Rabi*, 2015	
	SEm ±	CD (P = 0.05)	SEm ±	CD (P = 0.05)
NP	0.33	NS	0.76	NS
F	0.27	NS	0.30	NS
NP at F	0.77	NS	1.10	NS
F at NP	0.65	NS	1.52	NS

Table 4. Grain yield (kg ha^{-1}) of *rabi* maize as influenced by crop residue and nutrient management practices

	Rabi, 2014					*Rabi*, 2015				
	F_1	F_2	F_3	F_4	Mean	F_1	F_2	F_3	F_4	Mean
N_1P_1	6864	6999	6990	7024	**6969**	7055	7116	6998	7152	**7080**
N_1P_2	6954	6969	6813	7185	**6980**	6421	6838	6129	7197	**6646**
N_1P_3	6413	6890	6375	6919	**6649**	5881	6456	6252	6670	**6315**
N_2P_1	6746	7704	6431	6767	**6912**	5819	7421	6521	6749	**6628**
N_2P_2	7990	7436	6862	7649	**7484**	7130	7384	7148	7409	**7268**
N_2P_3	7738	7828	6815	7339	**7430**	7366	7433	7334	7493	**7406**
N_3P_1	7864	7406	6972	6852	**7273**	7183	7249	7261	7408	**7275**
N_3P_2	6765	7931	7129	7252	**7269**	7363	7677	6858	7024	**7230**
N_3P_3	6931	7259	7213	8026	**7357**	7359	7458	7441	7561	**7455**
Mean	**7140**	**7380**	**6844**	**7224**		**6842**	**7226**	**6882**	**7185**	

	Rabi, 2014		*Rabi*, 2015	
	SEm ±	CD (P = 0.05)	SEm ±	CD (P = 0.05)
NP	144.4	433	321.5	964
F	110.1	310	135.3	381
NP at F	320.4	NS	476.5	NS
F at NP	288.9	NS	643.1	NS

Table 5. Stover yield (kg ha^{-1}) of *rabi* maize as influenced by crop residue and nutrient management practices

	Rabi, 2014					*Rabi*, 2015				
	F_1	F_2	F_3	F_4	Mean	F_1	F_2	F_3	F_4	Mean
N_1P_1	9277	10757	9891	8748	**9668**	7773	8294	7811	8147	**8006**
N_1P_2	8937	9893	9249	8755	**9208**	7265	7632	7646	7811	**7589**
N_1P_3	8049	8943	9333	8219	**8636**	7377	7757	7732	7854	**7680**
N_2P_1	8657	10850	10059	9067	**9658**	8046	8247	8627	8769	**8422**
N_2P_2	9983	10057	9773	9950	**9941**	8252	8944	8752	8930	**8719**
N_2P_3	9687	9729	8967	9763	**9537**	8149	8296	8668	8756	**8467**
N_3P_1	10763	11605	10055	10413	**10709**	8514	8593	8648	8905	**8665**
N_3P_2	9181	12343	11456	10322	**10826**	8674	9309	9319	9222	**9131**
N_3P_3	9165	11455	9861	9644	**10031**	8780	9330	9306	9278	**9173**
Mean	**9300**	**10626**	**9849**	**9431**		**8092**	**8489**	**8501**	**8630**	

	Rabi, 2014		*Rabi*, 2015	
	SEm ±	CD (P = 0.05)	SEm ±	CD (P = 0.05)
NP	251.5	754	165.6	497
F	163.7	461	118.0	332
NP at F	494.3	NS	348.6	NS
F at NP	503.1	NS	331.2	NS

P either with or without incorporation of residues of previous season during *rabi* along with recommended dose of potassium was found to be the optimum fertilizer dose for maize - maize cropping sequence.

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SCREENING OF FINGER MILLET (*Eleusine coracana*) GENOTYPES AGAINST PINK STEM BORER

M. LOKESWARIDEVI*, K.V. HARI PRASAD, G.S. PANDURANGA, L. MADHAVI LATHA AND T.M. HEMA LATHA

Department of Entomology, S.V. Agricultural College, ANGRAU, Tirupati-517 502.

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ABSTRACT

A field trial was conducted at Agricultural Research Station, Perumalapalle, Tirupati District, Andhra Pradesh, India for evaluating 100 finger millet genotypes along with four varieties as check entries (Vakula, Tirumala, Indravati, GPU-67 for identification as a source of resistance against pink stem borer, during *kharif* 2021 and late *rabi* 2021-22. During *kharif*, 83 genotypes were placed under highly resistant category with <10 per cent dead heart incidence, 12 genotypes under moderately susceptible (10.1 - 40%) and five genotypes under highly susceptible category (>40%) to pink stem borer infestation. During late *rabi* 2021-22, 80 genotypes were placed under highly resistant category with <10 per cent dead heart incidence, 15 genotypes under moderately susceptible (10.1 to 40.0%) and five genotypes under highly susceptible (>40%) to pink stem borer.

KEYWORDS: Finger millet, pink stem borer, resistance, per cent dead heart.

INTRODUCTION

Finger millet, *Eleusine coracana* Gaertn, popularly known as ragi is popular among small millets (Finger millet, kodo millet, foxtail millet, barnyard millet, proso millet and little millet). It is a highly nutritive crop which can be cultivated in varying climatic conditions with minimum care and management. Its high fiber content, quality protein, mineral compositions are its distinctive nutritional properties that contribute significantly to its nutritional security. Finger millet is a hardy crop and has a quick rejuvenating capacity to various biotic and abiotic stresses and needs very little irrigation, has short crop cycle and is well suited for cultivation under adverse climatic conditions.

The dietary fiber, vitamins and polyphenols available in finger millet have several health benefits. The crop is gaining importance in recent years because of a rise in health awareness among diabetic and obese Indian population. Regulation of glucose homoeostasis and prevention in accumulation of high cholesterol can be achieved by regular intake of finger millet.

The crop is grown in India, Sri Lanka, Nepal, parts of Africa, Madagascar, Malaysia, Uganda, Japan etc., and 85 per cent of the world's production is contributed from India. In India, finger millet is grown in an area of 1.19 m. ha with a production of 1.98 million tonnes giving an average productivity of 1661 kg per ha. Karnataka accounts for 56.21 and 59.52 per cent of area and production of finger millet followed by Tamil Nadu (9.94% and 18.27%), Uttarakhand (9.40% and 7.76%) and Maharashtra (10.56% and 7.16%), respectively.

In Andhra Pradesh, it was grown over an area of 34 thousand hectares with a production of 44,880 tonnes with an average productivity of 1320 kg/ha in 2019-20 (indiastat.com,2021). Major finger millet growing districts of Andhra Pradesh are Visakhapatnam. Vijayanagaram, Chittoor and Anantapur. Being a subsistence crop, finger millet does not attract the attention of synthetic insecticides and as such development of resistant varieties for insect pests and diseases is a cost effective and viable option that is environmentally friendly.

The potential for development of varieties with insect and disease resistance is enormous and is the need of the hour Efforts should be intensified to identify and improve germplasm or accessions or genotypes having in built resistance to biotic and abiotic stresses that can be effectively utilized in to breeding programmes for varietal improvement. In view of the importance and lack of related information on insect pest in finger millet particularly the ragi pink stem borer, the present investigations on "Studies on plant resistance in finger millet (*Elesine coracana*) to insect pest complex" was taken up with the following.

*Corresponding author, E-mail: suryagangalokeswari@gmail.com

Experimental Material

The experimental material utilized for the present study comprised of 100 indigenous finger millet genotypes that were collected from various states of India for which the seed material was collected from IIMR -Indian Institute of Millet Research, Hyderabad. The details of procurement of seed material the genotypes were presented in Table 1.

Crop raising

All the agronomic practices were adopted as per the recommendations of ANGRAU in raising the crop expect management practices during the experiment period. The experiment on screening of genotypes for insect resistance was carried out under field conditions by raising 100 Finger millet genotypes along with four check varieties *i.e.,* Vakula. Tirumala, Indravati, GPU-67 during *kharif* 2021 and late *rabi* 2021-22. Nursery was raised as per the recommended package of practices at ARS, Perumalapalle. Tirupati for field experiments. The nursery beds were well prepared by ploughing 4 or 5 times until fine tilth was achieved. The main field was ploughed thoroughly thrice with a tractor drawn cultivator and levelled after removing all the stubbles and weeds. The experiment was laid out in randomized block design (RBD) with 100 genotypes along with four check varieties. Each entry was replicated twice. In each replication the genotypes were sown in 2 rows of 3 meters length with a spacing of 22.5 cm between rows and 10 cm between the plants within the row. The fertilizers *i.e.,* 60 kg N, 30 kg P_2O_5, and 20 kg K_2O hectare^{-1} in the form of urea, single super phosphate and murate of potash, respectively were applied as basal dose as per recommendation. Irrigation and weeding operations were taken during crop growth period to raise good crop

Method of Observations

During the period of study, major insect that was observed was ragi pink stem borer and hence data was regarding per cent dead heart incidence due to pink stem borer is presented here. The incidence of ragi pink stem borer on different genotypes was recorded at weekly intervals. The data on the pest incidence *i.e.,* dead hearts in each genotype and in each replication was recorded.

The data on per cent pest incidence was calculated by using the following formula:

Perst incidence (%) =

$$\frac{\text{Number of infested plants by pink stem borer}}{\text{Total number of plants (healthy + infested)}} \times 100$$

Grouping of Genotypes Based on Per cent Dead Heart Incidence

Resistance or susceptibility of genotypes was categorized based on per cent dead heart incidence, following a three-point (1-3) rating scale given by Sekhar *et al.* (2016) (Table 2).

Statistical Analysis

The data on pest incidence in terms of per cent dead heart was subjected to angular transformations and analysed for getting Analysis of Variance (ANOVA) prescribed for randomized block design with the help of SPSS statistical package (SPSS, 2020).

RESULTS AND DISCUSSION

Response of Finger Millet Genotypes to pink stem borer incidence *kharif* 2021

Mean per cent dead heart incidence at weekly intervals *kharif* 2021

Number of dead hearts on different finger millet genotypes were recorded from 28 to 77 days after sowing at weekly intervals during *kharif*, 2021 (Table 3). The highest incidence of dead hearts by pink stem borer was observed at 63 DAS (36th meteorological week observation) in highly susceptible genotype EN 70 hence per cent dead hearts at 63 DAS was taken as a criteria for scoring of genotypes under different categories.

The reaction of 104 (100 test entries + four checks) finger millet genotypes against pink stem borer incidence was expressed as per cent dead hearts incidence. The per cent dead heart incidence in test genotypes was ranged from 8.13 to 67.3 with an average incidence of 15.52 per cent dead heart incidence during *kharif*, 2021 (Table 3). The genotypes were grouped into different resistance categories based on the per cent dead heart incidence at 63 DAS as given by Sekhar *et al.* (2016) (Table 2). 83 genotypes were placed under highly resistant category with <10 per cent dead heart incidence, 12 genotypes under moderately susceptible (10.1-40%) and five genotypes under highly susceptible category (>40%) to pink stem borer infestation. Four entries IC 00618624, IC 00618651, E 318 and E 326 were highly susceptible to blast and could not survive for getting data on dead heart incidence (Table 3).

The genotypes showing no dead hearts or <10 per cent incidence are *viz.,* IC 0476623, IC 0476587, IC0476095, IC 0475407, IC 0475125, IC 0474816, IC 0475386, IC 0473882, IC 0007953, IC 0007954, IC

Table 1. List of Finger millet genotypes used for screening of experiment

S. No.	Genotype	S. No.	Genotype	S. No	Genotype
1.	IC 0476623	36.	IC 00622073	71.	IC 0627147
2.	IC 0476587	37.	IC 00600278	72.	SEA 72
3.	IC 0476095	38.	IC 00622084	73.	IC 0627175
4.	IC 0475407	39.	IC 00622089	74.	ER 37
5.	IC 0475125	40.	IC 00622112	75.	ER 41
6.	IC 0474816	41.	IC 00622139	76.	IC 0627178
7.	IC 0475386	42.	IC 00621996	77.	IC 0627179
8.	IC 0473882	43.	IC 00622007	78.	IC 0627180
9.	IC 0007953	44.	IC 00622010	79.	ER 53
10.	IC 0007954	45.	IC 00622031	80.	ER 55
11.	IC 0066140	46.	IC 00622036	81.	ER 61
12.	IC 0478686	47.	IC 00322041	82.	ER 62
13.	IC 0478746	48.	IC 00622046	83.	ER 64
14.	IC 0478792	49.	IC 00622053	84.	ER 67
15.	IC 0478444	50.	IC 0624939	85.	ER 73
16.	IC 0478819	51.	IC 0624940	86.	ER 75
17.	IC 0478832	52.	IC 0624941	87.	ER 76
18.	IC 0478442	53.	IC 0624997	88.	ER 81
19.	IC 0478656	54.	IC 0628917	89.	ER 83
20.	IC 0478693	55.	IC 0628944	90.	ER 99
21.	IC 0478710	56.	IC 0628956	91.	E 318
22.	IC 0478766	57.	SEJ 137	92.	E 326
23.	IC 0478821	58.	EN 8	93.	EN 70
24.	IC 0478862	59.	EN 22	94.	EN 95
25.	IC 0478935	60.	EN 38	95.	EN 96
26.	IC 0478181	61.	EN 46	96.	EN 98
27.	IC 0478319	62.	EN 52	97.	EN 99
28.	IC 0478543	63.	E 265	98.	EN 112
29.	IC 0478640	64.	SEA 7	99.	MLT 10
30.	IC 00618624	65.	SEA 11	100.	MLT 11
31.	IC 00618651	66.	IC 0627123	101.	VAKULA
32.	IC 00622057	67.	SEA 23	102.	TIRUMALA
33.	IC 00622063	68.	IC 0627127	103.	INDRAVATI
34.	IC 00622068	69.	SEA 38	104.	GPU- 67
35.	IC 00622069	70.	IC 0627139		

Table 2. Pest rating scale based on per cent dead heart incidence

Pest Rating score	Per cent Dead Heart Incidence	Pest Reaction
1	Less than <10%	Highly Resistant
2	10.1 – 40.0	Moderately susceptible
3	More than 40.0%	Highly susceptible

0066140, IC 0478686, IC 0478746, IC 0478792, IC 0478444, IC 0478819, IC 0478832, IC 0478442, IC 0478656, IC 0478693, IC 0478710, IC 0478766, IC 0478821, IC 0478862, IC 0478935, IC 0478319, IC 0478543, IC 0478640, IC 00622063, IC 00622068, IC 00622069, IC 00622073, IC 00622084, IC 00622089, IC 00622112, IC 00621996, IC 00622007, IC 00622010, IC 00622031, IC 00622036, IC 00622046, IC 00622053, IC 0624939, IC 0624940, IC 0624941, IC 0628917, IC 0628944, IC 0628956, SEJ 137, EN 8, EN 22, EN 38, EN 52, E 265, SEA 7, SEA 11, IC 0627123, SEA 23, IC 0627127, SEA 38, IC 0627139, IC 0627147, SEA 72, IC 0627175, IC 627179, IC 0627180, ER 53, ER 55, ER 61, ER 62, ER 64, ER 67, ER 76, ER 81, ER 83, ER 99, EN 95, EN 96, EN 98, EN 99, EN 112, MLT- 11 and Indravati and these genotypes were given the score of 1.

The genotypes IC 0478181 (28.1%), IC 00600278 (31.32%), IC 00622139 (34.485%), IC 00322041 (25.50%), EN 46 (23.71%), IC 0627178 (18.89%), ER 73 (36.8%), ER 75 (37.06%), MLT-10 (31.03%), Vakula (34.87%), Tirumala (23.35%) and GPU-67 (16.13%) recorded per cent incidence from 10.1 to 40% were given pest score of two were classified as moderately susceptible category.

The genotypes which recorded per cent dead hearts incidence from 41.04 to 67.3 per cent were given pest scoring of three and were classified as highly susceptible *viz.,* EN 70 (67.3%), IC 00622057 (50.74%), IC 0624997 (46.25%), ER 37 (42.41%) and ER 41 (40.04%).

Late *rabi,* 2021-22

Number of dead hearts on different finger millet genotypes during late *rabi,* 2021-22 was recorded from 28 to 77 days after sowing at weekly intervals (Table 3). The highest incidence of dead hearts by pink stem borer was observed at 56 DAS (12th meteorological week observation) in highly susceptible genotype EN 70 hence per cent dead heart at 56 DAS was taken as a criteria for scoring of genotypes under different categories.

During late *rabi*, 2022, the per cent dead heart incidence in test genotypes ranged from 8.13 to 64.64 with an average 14.08 per cent dead heart incidence during late *rabi*, 2022. Out of 104 genotypes screened for resistance to dead heart incidence, 80 genotypes were placed under highly resistant category with <10 per cent dead heart incidence, 15 genotypes under moderately susceptible (10.1 to 40.0%) and five genotypes under highly susceptible (>40%) to pink stem borer. Four entries IC 00618624, IC 00618651, E 318 and E 326 were highly susceptible to blast and hence we couldn't get any panicles out of it Table 3.

The genotypes showing no dead hearts or <10 per cent incidence *viz.,* IC 0476587, IC 0476095, IC 0475407, IC 0475125, IC 0475386, IC 0473882, IC 0007953, IC 0007954, IC 0066140, IC 0478686, IC 0478746, IC 0478792, IC 0478444, IC 0478181, IC 0478819, IC 0478832, IC 0478442, IC 0478656, IC 0478693, IC 0478766, IC 0478821, IC 0478862, IC 0478935, IC 0478319, IC 0478543, IC 0478640, IC 00622063, IC 00622068, IC 00622069, IC 00622073, IC 00622084, IC 00622089, IC 00622112, IC 00621996, IC 00622007, IC 00622010, IC 00622031, IC 00622036, IC 00622046, IC 00622053, IC 0624939, IC 0624940, IC 0624941, IC 0628917, IC 0628944, IC 0628956, SEJ 137, EN 8, EN 22, EN 38, EN 52, E 265, SEA 7, SEA 11, IC 0627123, SEA 23, IC 0627127, SEA 38, IC 0627139, IC 0627147, SEA 72, IC 0627175, IC 0627179, IC 0627180, ER 53, ER 55, ER 61, ER 62, ER 64, ER 67, ER 76, ER 81, ER 83, ER 99, EN 95, EN 96, EN 98, EN 99, EN 112, MLT- 11 and Indravati, these genotypes were given the score of one.

The genotypes IC 0476623 (10.44%), IC 0474816 (10.17%), IC 0478710 (18.16%), IC 00600278 (30.42%), IC 00622139 (33.485%), IC 00322041 (24.50%), EN 46 (23.32%), IC 0627178 (20.25%), ER 73 (32.88%), ER 75 (35.26%), MLT-10 (30.85%), Vakula (34.76%), Tirumala (23.57%) and GPU-67 (13.71%) which recorded per cent incidence score from 10.1 to 40% were classified under moderately susceptible category with

Table 3. Mean per cent dead heart incidence at highest per cent incidence of *Sesamia inferens kharif,* 2021 and late *rabi,* 2021-22

S. No	Genotype	*kharif* 2021	*rabi 2022*	S. No	Genotype	*kharif* 2021	*rabi 2022*
		63 DAS	56 DAS			63 DAS	56 DAS
1	IC 0476623	1 (8.127)	9.98 (10.447)	53.	IC 0624997	36.08 (46.252)	36.72 (47.699)
2	IC 0476587	1 (8.127)	1 (8.127)	54.	IC 0628917	1 (8.127)	1 (8.127)
3	IC 0476095	1 (8.127)	1 (8.127)	55.	IC 0628944	1 (8.127)	1 (8.127)
4	IC 0475407	1 (8.127)	1 (8.127)	56.	IC 0628956	1 (8.127)	1 (8.127)
5	IC 0475125	1 (8.127)	1 (8.127)	57.	SEJ 137	1 (8.127)	1 (8.127)
6	IC 0474816	1 (8.127)	9.74 (18.18)	58.	EN 8	1 (8.127)	1 (8.127)
7	IC 0475386	1 (8.127)	1 (8.127)	59.	EN 22	1 (8.127)	1 (8.127)
8	IC 0473882	1 (8.127)	1 (8.127)	60.	EN 38	1 (8.127)	1 (8.127)
9	IC 0007953	1 (8.127)	1 (8.127)	61.	EN 46	18.14 (23.714)	18.25 (23.326)
10	IC 0007954	1 (8.127)	1 (8.127)	62.	EN 52	1 (8.127)	1 (8.127)
11	IC 0066140	1 (8.127)	1 (8.127)	63.	E 265	1 (8.127)	1 (8.127)
12	IC 0478686	1 (8.127)	1 (8.127)	64.	SEA 7	16.52 (22.12)	1 (8.127)
13	IC 0478746	1 (8.127)	1 (8.127)	65.	SEA 11	1 (8.127)	1 (8.127)
14	IC 0478792	1 (8.127)	1 (8.127)	66.	IC 0627123	1 (8.127)	1 (8.127)
15	IC 0478444	1 (8.127)	1 (8.127)	67.	SEA 23	1 (8.127)	1 (8.127)
16	IC 0478819	1 (8.127)	1 (8.127)	68.	IC 0627127	13.25 (18.90)	1 (8.127)
17	IC 0478832	1 (8.127)	1 (8.127)	69.	SEA 38	1 (8.127)	1 (8.127)
18	IC 0478442	1 (8.127)	1 (8.127)	70.	IC 0627139	1 (8.127)	1 (8.127)
19	IC 0478656	1 (8.127)	1 (8.127)	71.	IC 0627147	1 (8.127)	1 (8.127)
20	IC 0478693	1 (8.127)	1 (8.127)	72.	SEA 72	1 (8.127)	1 (8.127)
21	IC 0478710	1 (8.127)	14.19 (22.12)	73.	IC 0627175	1 (8.127)	1 (8.127)
22	IC 0478766	1 (8.127)	1 (8.127)	74.	ER 37	35.32 (42.413)	34.32 (41.186)
23	IC 0478821	1 (8.127)	1 (8.127)	75.	ER 41	35.73 (40.040)	33.84 (40.24)
24	IC 0478862	1 (8.127)	1 (8.127)	76.	IC 0627178	13.24 (18.890)	15.89 (20.247)
25	IC 0478935	1 (8.127)	1 (8.127)	77.	IC 0627179	1 (8.127)	1 (8.127)
26	IC 0478181	13.12 (28.105)	8.9 (17.35)	78.	IC 0627180	1 (8.127)	1 (8.127)
27	IC 0478319	1 (8.127)	1 (8.127)	79.	ER 53	1 (8.127)	1 (8.127)
28	IC 0478543	1 (8.127)	1 (8.127)	80.	ER 55	1 (8.127)	1 (8.127)
29	IC 0478640	1 (8.127)	1 (8.127)	81.	ER 61	1 (8.127)	1 (8.127)
30	IC 00618624	0.000	0.000	82.	ER 62	1 (8.127)	1 (8.127)
31	IC 00618651	0.000	0.000	83.	ER 64	1 (8.127)	1 (8.127)
32	IC 00622057	39.64 (50.746)	37.64 (48.746)	84.	ER 67	1 (8.127)	1 (8.127)
33	IC 00622063	1 (8.127)	1 (8.127)	85.	ER 73	18.5 (36.848)	17.9 (32.884)
34	IC 00622068	1 (8.127)	1 (8.127)	86.	ER 75	19.18 (37.060)	18.2 (35.263)
35	IC 00622069	1 (8.127)	1 (8.127)	87.	ER 76	1 (8.127)	1 (8.127)
36	IC 00622073	1 (8.127)	1 (8.127)	88.	ER 81	1 (8.127)	1 (8.127)
37	IC 00600278	17.52 (31.320)	17.02 (30.42)	89.	ER 83	1 (8.127)	1 (8.127)
38	IC 00622084	1 (8.127)	1 (8.127)	90.	ER 99	1 (8.127)	1 (8.127)
39	IC 00622089	1 (8.127)	1 (8.127)	91.	E 318	0.000	0.000
40	IC 00622112	1 (8.127)	1 (8.127)	92.	E 326	0.000	0.000
41	IC 00622139	26.04 (34.485)	25.94 (33.485)	93.	EN 70	42.035 (67.300)	41.85 (64.643)
42	IC 00621996	1 (8.127)	1 (8.127)	94.	EN 95	1 (8.127)	1 (8.127)
43	IC 00622007	1 (8.127)	1 (8.127)	95.	EN 96	1 (8.127)	1 (8.127)
44	IC 00622010	1 (8.127)	1 (8.127)	96.	EN 98	1 (8.127)	1 (8.127)
45	IC 00622031	1 (8.127)	1 (8.127)	97.	EN 99	1 (8.127)	1 (8.127)
46	IC 00622036	1 (8.127)	1 (8.127)	98.	EN 112	1 (8.127)	1 (8.127)
47	IC 00322041	19.28 (25.501)	19.07 (24.5)	99.	MLT 10	23.55 (31.029)	23.01 (30.859)
48	IC 00622046	1 (8.127)	1 (8.127)	100.	MLT 11	1 (8.127)	1 (8.127)
49	IC 00622053	1 (8.127)	1 (8.127)	101.	VAKULA	25.25 (34.867)	25.1 (34.768)
50	IC 0624939	1 (8.127)	1 (8.127)	102.	TIRUMALA	18.85 (23.357)	18.85 (23.57)
51	IC 0624940	1 (8.127)	1 (8.127)	103.	INDRAVATI	1 (8.127)	1 (8.127)
52	IC 0624941	1 (8.127)	1 (8.127)	104.	GPU- 67	11.29 (16.127)	10.59 (13.71)
					F test	**Sig.**	**Sig.**
					SEm	**6.82**	**6.51**
					CD	**11.12**	**11.01**

Values in the parenthesis are Angular transformed values; Sig. Significant at 0.05 per cent level of significance
NS : Non significant; DAS : Days After Sowing

pest incidence score of two.

The genotypes which recorded per cent dead hearts incidence 40.24 to 64.64 per cent were classified as highly susceptible with pest incidence score of three *viz.,* EN 70 (64.64%), IC 00622057 (48.74%), IC 0624997 (47.69%), ER 37 (41.186%) and ER 41 (40.24%).

Similar to the present findings, several workers have grouped test genotypes into different categories based on per cent dead heart incidence. Basavaraj and Biradar (2017) reported that among 123 genotypes of pearl millet screened for stem borer *Chilo partellus* incidence, 80 genotypes showed highly tolerant reaction (0-20% dead heart), 31 genotypes exhibited tolerant reaction (21-40% dead heart), 12 genotypes were found to be moderately tolerant. Genotypes *viz.,* CPBLT-123, TPBLT-110, TPBLT-116, TPBLT-117 and TPBLT-118 among B lines, CPRT-104, CPRT-109, CPRT-125 and LPRT-125 among R lines showed less than 5 per cent dead heart incidence were classified as resistant to pearl millet stem borer.

Vishvendra *et al.* (2017) reported low percentage of dead heart incidence by *Chilo partellus* in PMH-117 (5.33) which is a resistant variety and maximum in Hybrid Madhuri (45.92) which is a susceptible variety after 45 days of maize sowing. Swami and Bajpai (2006) screened eight selected maize varieties against maize stem borer *Chilo partellus* and found that only PARBHAT and MAHI DHAWAL were found relatively resistant against this pest with mean dead hearts in the range of 19.97 and 26.26 per cent.

Sasmal *et al.* (2018) reported per cent dead heart incidence in sorghum by *Sesamia inferens* in the range of 6.4-29.5 and 9.5-27.2 per cent during *rabi* 2012-13, 2013-14 respectively. The pooled mean of two season data indicated that the finger millet genotypes: PRM 9002, KOPN 933, OEB 28, RAU 8 and Champabati recorded less than 10 per cent dead hearts (DH). Among these genotypes, OEB 28 recorded lowest dead hearts (8.4% DH) PRM 9002 (8.6%DH) which showed resistance against *S. inferens*. The genotypes GPU 75, VL 352, BR 4, BBM 11, VL 352, GPU 79, OEB 87, OEB 303, OEB 265, Godavari, Dibyasinha, Nilachala, Subhra, Chilika, OEB532, VL 149, OEB 22, Bhairabi, AKP 2, OEB 312 had dead heart incidence within 10-20% which showed moderate resistance against *S. inferens*. Remaining finger millet genotypes: OEB 225, OEB 311, OEB 52 and OEB 526 recorded more than 20% DH incidence which showed susceptible against *S. inferens* in the experiment. Similarly, Patel *et al.* (2021) conducted screening experiments with sorghum varieties against stem borer, *C. partellus* and observed that lesser than 69.47 per cent dead hearts were found in the varieties of AFS-28 and SSG-59-3 showing resistance. While, more than 69.47 but less than 83.0 per cent dead hearts were observed in the varieties of AFS-26, AFS-30 and AFS-36 recording moderate resistance.

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