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CONTENTS

Time Series Analysis of Onion Prices from Solapur Market of Maharashtra, India **124-128**
Suma, H.K., S. Rajeswari, K. Umadevi and Sk. Nafeez Umar

Yield, Nutrient Uptake and Post-Harvest Soil Available Nutrient Status of Proso Millet as Influenced by Varieties and Nitrogen Levels **129-133**
K. Leela, C. Nagamani, S. Tirumala Reddy, A. Prasanthi and G. Karuna Sagar

Influence of Different Organic Nutrient Sources on Yield, Nutrient Uptake and Soil Fertility Status of Foxtail Millet [*Setaria italica* (L.) Beauv.] **134-138**
M. Hima Bindu, S. Hemalatha, N.V. Sarala, B. Vajantha and G. Karuna Sagar

Profile of Accion Fraterna-Ecology Centre (AFEC) Beneficiary Farmers of Ananthapuramu District of Andhra Pradesh **139-143**
M. Rajeswari, S.V. Prasad, V. Sailaja and N. Sunitha

Profile Characteristics of Village Agricultural Assistants (VAAs) of Rythu Bharosa Kendras (RBKs) in Kurnool District of Andhra Pradesh **144-148**
B. Mamatha, M. Sathish Rahul, P. Ganesh Kumar and C. Nagamani

An Analysis of the Determinants of Groundnut on Farm Efficiency in Ananthapuramu District of Andhra Pradesh, India **149-152**
U. Sandhya Rani, S. Hyma Jyothi, A. Amarender Reddy, S. Rajeswari and B. Ramana Murthy

Genetic Variability Studies for Yield and Yield Attributing Characters in Rice (*Oryza sativa* L.) **153-158**
B. Hema Sai, B. Rupesh Kumar Reddy, M. Shanthi Priya and Eswarraya Ramireddy

Yield and Nutrient Uptake of Finger Millet (*Eleusine coracana* (L.) Gaertn.) as Influenced by Organic Nutrient Management Practices **159-163**
G.V.S.S. Rupa Sree, Y. Reddi Ramu, N. Sunitha, P.V.R.M. Reddy and G. Karuna Sagar

Effect of Weather Parameters on the Incidence of Thrips in *Rabi* Groundnut **164-169**
Gayathri. K, Manjula. K, Hariprasad. K.V and Gurivi Reddy. M

Genetic Parameters for Quantitative and Early Seedling Vigour Related Traits in Rice (*Oryza Sativa* L.) under Dry Direct Seeded Rice Conditions **170-173**
Yamasani Mounika Reddy, Raguru Pandu Vasanthi, Bommaka Rupesh Kumar Reddy, Bandela Ramana Murthy and Lakshminarayana R. Vemireddy

Studies on the Effect of Irrigation Regimes and Nitrogen Rates on Canopy Temperature and SCMR Values (SPAD Chlorophyl Meter Readings) of Maize (*Zea mays* L.) **174-179**
T. Bala Srikanth, D. Saida Naik, S. Narender Reddy and B. Balaji Naik

Impact of COVID-19 on Agriculture in Chittoor District of Andhra Pradesh **180-183**
Ch. Shiva Jyothi, Josily Samuel, S. Rajeswari and P. Lavanya Kumari

Screening of Urdbean Genotypes against Leaf Crinkle Disease under Field Conditions **184-187**
M. Sushma, K. Bayyapu Reddy, G. Bindu Madhavi, M. Raghavendra and B. Rupesh Kumar Reddy

Evaluation of Advanced Breeding Lines of Groundnut (*Arachis hypogaea* L.) for Yield and Yield Attributes **188-194**
G. Vineela Neeharika, C. Kiran Kumar Reddy, B. Rupesh Kumar Reddy and P. Lavanya Kumari

Nitrogen Uptake as Influenced by Precision Nitrogen Management in *Rabi* Rice (*Oryza sativa* L.) **195-200**
D. Sowmya, S. Hemalatha, U. Vineetha, A. Prasanthi and G. Karuna Sagar

Andhra Pradesh J Agril. Sci : 8(3): 124-128, 2022

TIME SERIES ANALYSIS OF ONION PRICES FROM SOLAPUR MARKET OF MAHARASHTRA, INDIA

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ABSTRACT

The present study was conducted to know the behaviour of prices of onion in Solapur market of Maharashtra by using the multiplicative model of time series analysis. The time series data was collected for the period of 15 years from 2005 to 2019 from the NHRDF. The moving average method was used to know the price behaviour of onion. The results shown that there was an increasing trend in prices of onion in market and also observed the seasonal variation in prices of onion. The highest seasonal index was observed in the month of November and the lowest seasonal index was observed in the month of May. There were no existence of price cycles and also there was no periodicity in the irregular fluctuations for onion prices of Solapur market.

KEYWORDS: Multiplicative, Trend, Seasonal index, Periodicity, Fluctuations

INTRODUCTION

India occupied first place in onion production in the world with 26.48 million tonnes followed by China, USA and others (FAOSTAT: 2020-21). Onions play an important role in India in earning foreign exchange due to increased exports in the recent decades, because of increased production and higher demand in international market (Gummagolmath *et al*., 2020).

Onion is an important ingredient of Indian culinary used as a vegetable and spice, and it has also immense medicinal and therapeutic value (Sendhil, 2012). As the demand for onions is inelastic (Ahmed and Singla, 2017), excessive supply due to favourable weather conditions and shortage in supply due to excessive rainfall or drought were the major reasons for the fluctuations in prices of onion. High demand rigidity, indispensable utilization in Indian diets and a near necessity (Saxena *et al.,* 2020) makes the onion a market sensitive crop.

In India, major onion-producing states were Maharashtra, Karnataka, Madhya Pradesh, Gujarat, Bihar, Andhra Pradesh, Rajasthan, Haryana and Telangana. Among these states Maharashtra contributes 28.32 per cent of India's onion production. Hence, the state of Maharashtra is called as 'onion basket of India' (Shah, 2020). Thus, in the light of the above background the present paper seeks to analyse the price behaviour of onion in Solapur market of Maharashtra.

MATERIAL AND METHODS

Solapur market was purposively selected for the study as it is one of the largest onion markets in the state of Maharashtra. To determine the objectives of the study time series data on monthly prices of onion was collected from the NHRDF for the Solapur market for the period of 15 years from 2005 to 2019. A multiplicative time series model was employed to study the components of time series *viz.,* trend, seasonal, cyclical and irregular fluctuations.

$$Y_t = T_t \times S_t \times C_t \times I_t$$

where,

Y_t = Time series data on prices

T_t = Trend component

S_t = Seasonal variations

C_t = Cyclical movements

I_t = Irregular fluctuations

a) Trend component:

Over a long period, time series is likely to show tendency to either increase or decrease over time. Ordinary least squares method was employed to ascertain the trend in prices. The equation adopted for this purpose is specified as

$$Y_t = a + bX_t + U_t$$

where,

Y_t = trend value at time t

X_t = Time

U_t = Random disturbance term

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a = intercept and

b = Slope coefficient

The goodness of fit of trendline to the data was tested by the coefficient of multiple determination which is denoted by R^2.

b) Seasonal variations:

Twelve months moving average was employed to work out the seasonal indices in onion prices.

The steps involved in the construction of seasonal Index by this method are

1. Generating a series of 12 months moving totals.
2. Generating a series of 12 months moving averages.
3. Generating a series of centred 12 months moving averages.
4. Expressing each original value as a percentage of corresponding centered moving average.
5. Arranging the percentages of moving averages in the form of monthly arrays and calculating the average index for each month.
6. Adjusting the averages to make their sum equal to 1200.

This was done by calculating the correction factor and multiplying the average for the month by the correction factor, which was estimated as follows (Table 1)

$$K = 1200/S$$

Percentage of centred 12 months moving average provided an index of seasonal and irregular components combined because,

$$(P_t / M.A)\ 100 = (T_t \times C_t \times S_t \times I_t)\ 100 / (T_t \times C_t) = (S_t \times I_t)100$$

The irregular component was removed in the process of averaging each month's ratio over the years and also through correction factor.

c) Cyclical movements

Cyclical variations are long term oscillatory movements with duration of greater than one year. The most commonly used method for estimating cyclical movement of time series is the residual method by eliminating the seasonal variation and trend. This is accomplished by dividing (Y_t) by corresponding (S) for time 't'

Symbolically,

$$\frac{T.C.S.I}{S} = T.C.I \text{ and } \frac{T.C.I}{T} = C.I.$$

Taking the three-year moving average of the above series will yield the cyclical component.

a) **Irregular fluctuations:**

It was estimated as residual component by using the estimates of model prices and cyclical components.

$$I_t = \frac{P_t}{T_t \times C_t} \times 100$$

$$= \frac{T_t \times C_t \times I_t}{T_t \times C_t} \times 100$$

$$= I_t \times 100$$

RESULTS AND DISCUSSION

Trend component

The trend component in prices gives the information of whether the prices were moving in increasing or decreasing direction or stagnant in nature over a long period of time. Generally, trends in agricultural prices are associated with general inflation and deflation in the economy and with factors specific to agricultural products, including changes in the tastes and preference of consumers, increase in population and income and technological changes in production (Tomek and Robinson, 1972). The results revealed that there was an increasing trend in prices of onion in Solapur market which presented in Fig. 1. The annual increment of price was found to be ₹ 5.58 per quintal. The results were significant at 1% level of significance. R-square results in the conclusion that the time contributed 19 per cent to the change in prices. The trend line constructed was 261.0 + 5.58*t. Similar findings also observed with the Selvi *et al.* (2020) and Areef *et al*. (2020).

Seasonal variations

Seasonal variations are the alterations that take place sporadically throughout the same time every year. Seasonal price changes mimic a cycle with at least a 12-month cycle. The general pattern of variation in prices is lower prices during the post harvesting months and higher prices during the pre-harvest or off-season months is a normal feature for many agricultural commodities and it is repeated year after year. Some of the factors that affect the extent of seasonality in prices include rise or

Table 1. Average of percentage centred 12 months moving average and computation of seasonal index for observations

Year	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec
2005	*	*	*	*	*	*	S	S	S	S	S	S
2006	S	S	S	S	S	S	S	S	S	S	S	S
**	*	*	*	*	*	*	*	*	*	*	*	*
**	*	*	*	*	*	*	*	*	*	*	*	*
2019	S	S	S	S	S	S	S	S	S	S	S	S
Mean	*	*	*	*	*	*	*	*	*	*	*	1200
Adjusted	*	*	*	*	*	*	*	*	*	*	*	100
Seasonal index												

Table 2. Seasonal indices of onion prices in Solapur market

S. No.	Month	Seasonal indices
1	January	97.79
2	February	97.98
3	March	74.05
4	April	60.87
5	May	57.66
6	June	81.03
7	July	111.18
8	August	124.89
9	September	124.12
10	October	124.44
11	November	130.00
12	December	115.95

fall in production, unseasonality or heavy rainfall, poor storage, early harvesting, lack of retention power by growers and exports etc. (Gummagolmath *et al.,* 2020).

In order to analyse the seasonal variation in onion prices in the Solapur market, seasonal indices were computed by adopting 12 months moving average method. The seasonal indices represented in Table 2 and Fig. 2. From the results, it was cleared that the highest seasonal index of prices was observed in the month of November followed by October and September with values of 130.00, 124.44 and 124.12 respectively. May had the lowest price seasonal index with value of 57.66. From the results it was observed that there was rising trend in prices of onion from June to November and decline in the prices from December to May. In Maharashtra onion was majorly cultivated in rabi season, and the rabi onions which has longer shelf life hits the market during the months of January to May. Hence there was a declining tendency in prices during this period. By the month of June and July the stocks of rabi onion diminishes and the kharif onion reaches the market. Hence the kharif onion attracts the traders and fetches a good price to the farmers. Hence there was an increasing trend in prices during the period from June to November.

Cyclical movements

The residual method was commonly used to know the cyclical movements in the prices of onion in Solapur market. The results of cyclical variations in prices of onion in market are presented in Fig. 3. From the results it was concluded that there were no price cycles identified in the prices of onion in Solapur market.

Irregular fluctuations

Irregular price movements represent that part of the price behavior, which is not systematic. No generalizations can be made about such fluctuations. The results of irregular price fluctuations were shown in Fig. 4. From the results, it was cleared that there

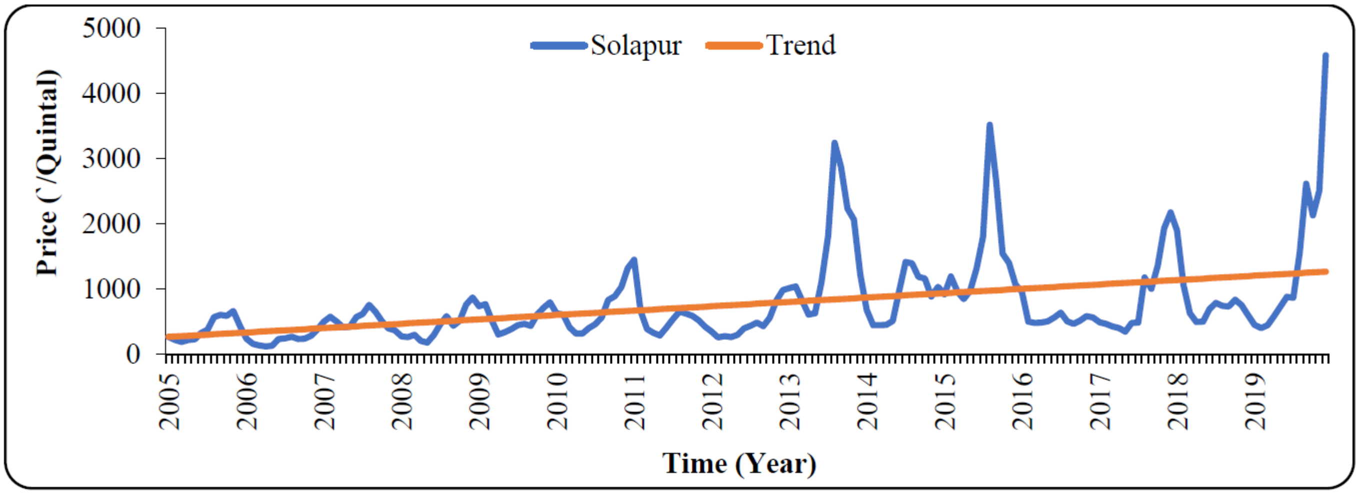

Fig. 1. Trends in prices of onion in Solapur market.

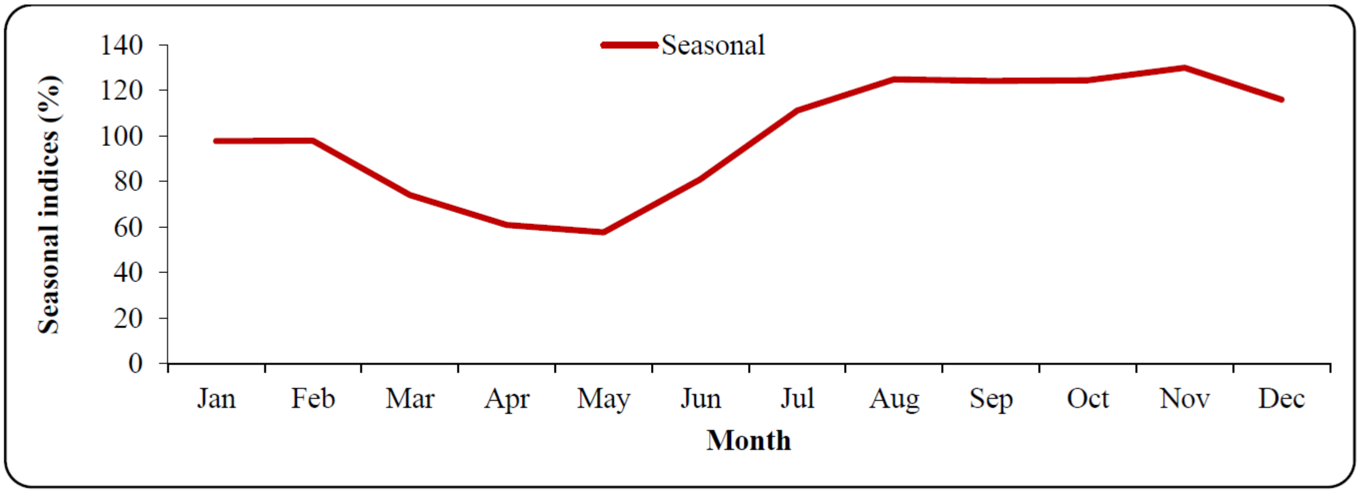

Fig. 2. Seasonal indices of onion prices in Solapur market.

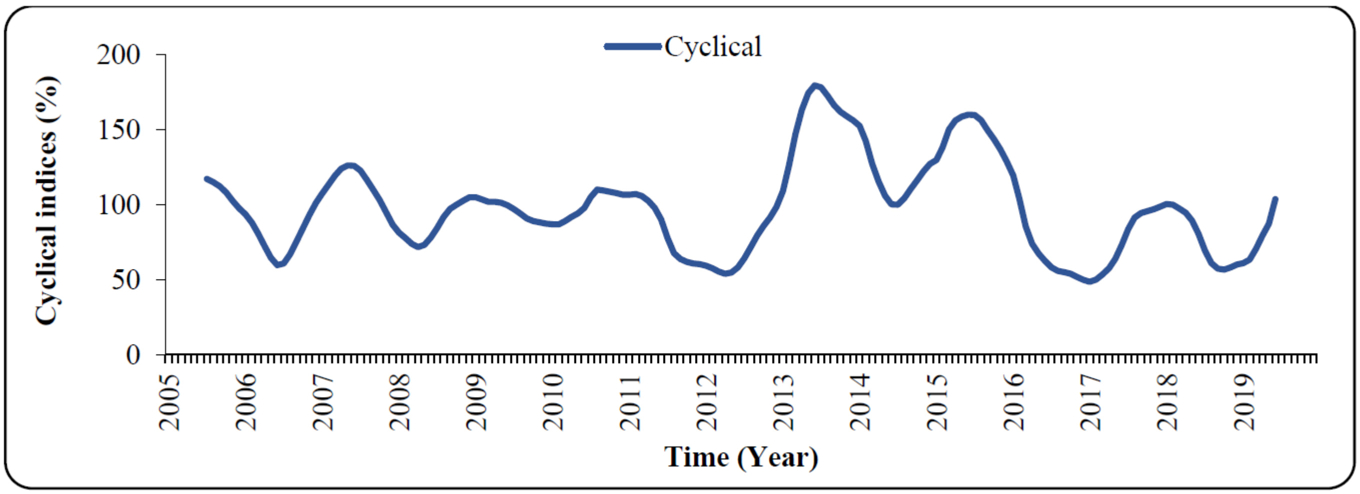

Fig. 3. Cyclical indices of onion prices in Solapur market.

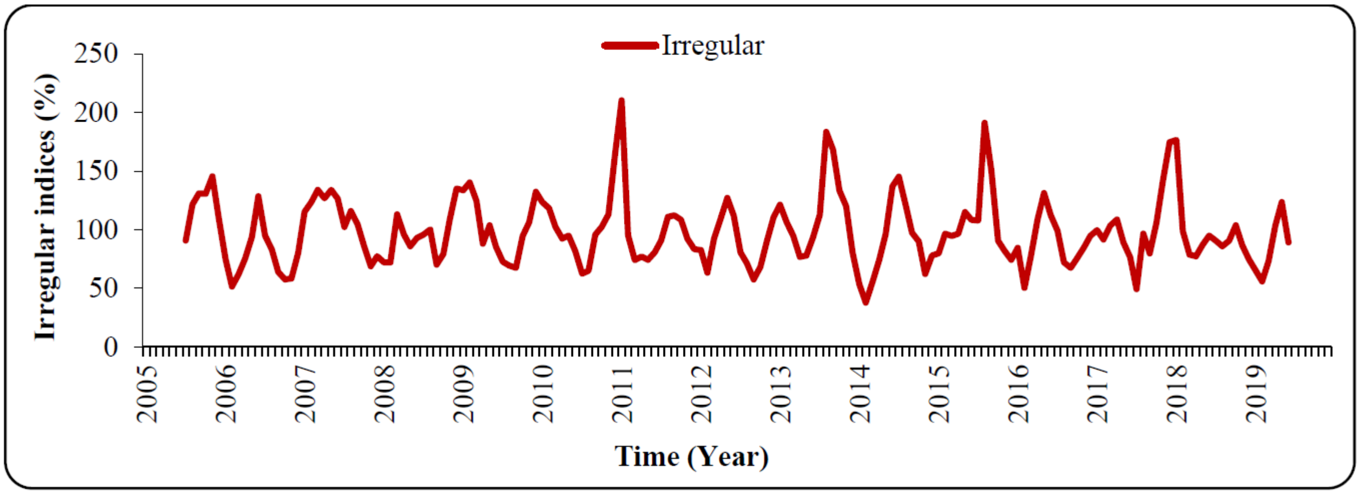

Fig. 4. Irregular indices of onion prices in Solapur market.

was no periodicity in the irregular fluctuations in their occurrence in Solapur market.

The present study proved the existence of four components of time series in the prices of onion in Solapur market. Increasing trend in the prices of onion was observed in the present study. Seasonal variation in prices plays a very important role in onion. Highest seasonal index was found in the month of November and the lowest seasonal index was found in the month of May. Price cycles were not observed in prices of onion during the period of study.

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YIELD, NUTRIENT UPTAKE AND POST-HARVEST SOIL AVAILABLE NUTRIENT STATUS OF PROSO MILLET AS INFLUENCED BY VARIETIES AND NITROGEN LEVELS

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ABSTRACT

A field experiment was conducted during *kharif*, 2021 on sandy loam soils of Tirupati in a split-plot design with four proso millet varieties (TNAU 202, GPUP 8, GPUP 21 and PPV 1) in combination with three nitrogen levels (20, 40 and 60 kg N ha^{-1}). The results of the experiment revealed that among the four proso millet varieties, PPV 1 recorded the higher grain and straw yield, nutrient uptake and lower amount of post-harvest soil available nutrients. Application of 60 kg N ha^{-1} markedly improved the yield, nutrient uptake and post-harvest soil available nutrients. The results concluded that the proso millet variety PPV 1 or TNAU 202 with the application of 60 kg N ha^{-1} was more productive and maintains soil health.

KEYWORDS: Proso millet, varieties, nitrogen, yield

INTRODUCTION

Proso millet, also known as broomcorn millet, common millet, hog millet, russian millet and various other names in different regions, is an important small millet. Proso millet is well adapted to a wide range of soil conditions and has high energy efficiency. It has the potential for agricultural diversification because of its lower water and nutrient requirements. In comparison to other basic cereals, proso millet grains are high in proteins, vitamins, minerals and micronutrients. As a result, it can meet both food and nutritional needs. Despite its immense potential, the crop has yet to acquire widespread acceptance and is still seen as a poor man's food.

In India, the yield potential of proso millet is poor when compared to the potential output. So, the selection of suitable variety is an important factor responsible for enhancing the productivity of millets. Growing variety with short duration, medium height, drought resistance and high yielding capacity is most important to get viable yields under semi-arid regions. Nitrogen is the first limiting nutrient in most of the Indian soils among the three major nutrients. The addition of nitrogen promotes healthy, vigorous, green pigmented plants and increases the proliferation and distribution of roots. As several crop species are specific in their nitrogen requirement levels, there is a need for fixation of optimum dose of nitrogen as per the requirement. Hence, it is necessary to find out the suitable variety and correct dose of nitrogen for maximizing proso millet yields in the Southern Agro-climatic Zone of Andhra Pradesh.

MATERIAL AND METHODS

The present investigation was carried out at dryland farm, S.V. Agricultural College, Tirupati campus of Acharya N.G. Ranga Agricultural University which is in the Southern Agro-climatic Zone of Andhra Pradesh. The experiment was laid out in a split-plot design with four main plots and three sub-plots replicated thrice. The main plots consist of four varieties *viz*., V_1: TNAU 202, V_2: GPUP 8, V_3: GPUP 21 and V_4: PPV 1 and three sub-plots consist of nitrogen levels *viz*., N_1: 20 kg N ha^{-1}, N_2: 40 kg N ha^{-1} and N_3: 60 kg N ha^{-1}. The crop was sown at a spacing of 25 cm x10 cm. The experimental field was sandy loam in texture which is low in organic carbon (0.26 %). The soil is neutral in reaction (pH 6.9), low in available N (134 kg ha^{-1}) and medium in available phosphorus (43 kg ha^{-1}) and potassium (228 kg ha^{-1}). Total rainfall of 591.4 mm was received in 34 rainy days during the crop growing period. Nitrogen was applied as per the treatments in the form of urea and phosphorus

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was applied to all the plots in common as basal in the form of SSP. Available soil nitrogen (N) was estimated by the method as described by Subbiah and Asija (1956), soil available phosphorus was determined as described by Olsen *et al*. (1954) using a spectrophotometer and soil available potassium was estimated by neutral normal ammonium acetate extraction method using flame photometry (Stanford and English, 1949) and were expressed in kg ha^{-1}. Plant samples collected for estimation of dry matter production were used to estimate the nutrient uptake by the crop at harvest. The oven dried samples of plant material were ground in a willey mill and analyzed for N, P and K contents. The nitrogen, phosphorus and potassium uptake were calculated by multiplying the nutrient content of the plant sample with the corresponding total dry matter and expressed in kg ha^{-1}. The data collected were analyzed statistically following the procedure given by Panse and Sukhatme (1978) wherever the treatment differences were significant, critical differences were worked out at a five per cent probability level. Treatment differences that were not significant are denoted as NS.

RESULTS AND DISCUSSION

YIELD

Among the proso millet varieties tried, higher grain and straw yield was recorded with the PPV 1 (V_4) which was however comparable with TNAU 202 (V_1). The next best variety was GPUP 21 (V_3) followed by GPUP 8 (V_2) with significant disparity between each other. The variety GPUP 8 (V_2) registered significantly lower grain and straw yield (Table. 1). The difference in yields among the varieties can be attributed to their genetic potentiality to utilize and translocate photosynthates from source to sink. The superiority of the variety PPV 1 (V_4) in producing number of tillers m^{-2}, number of productive tillers m^{-2}, panicle length and grain weight $panicle^{-1}$ which had positive effect on the yield of proso millet. Similar results were reported by (Thirumala, 2020).

The highest grain and straw yield were realized with the application of 60 kg N ha^{-1} (N_3) which was significantly superior to the rest of the treatments tried (Table 1). It was followed by 40 kg N ha^{-1} (N_2) and 20 kg N ha^{-1} (N_1) in the order of descent with significant differences between them. Lower grain and straw yield were with the application of 20 kg N ha^{-1} (N_1). The improvement in yield with enhanced nitrogen application might be attributed to better availability and uptake of nutrients which in turn lead to efficient metabolism. Higher levels of biomass accrual and efficient translocation of photosynthates from source to sink at higher N level might be responsible for the production of an elevated level of yield stature. The results of the present investigation were in agreement with the findings of Hasan *et al*. (2013) and Vimalan *et al.* (2019).

NUTRIENT UPTAKE

The uptake of nutrients *i.e.* nitrogen, phosphorus and potassium were higher with the variety PPV 1 (V_4) which was however comparable with that of TNAU 202 (V_1). The next best variety was GPUP 21 (V_3) which was significantly higher than that of GPUP 8 (V_2) and latter recorded the lower nutrient uptake (Table. 1). The difference in the rooting pattern of varieties might have resulted in a difference in nutrient uptake. The variety PPV 1 (V_4) could be efficient in exploring the nutrients exhaustively from the soil. The present investigation confirms the documented evidence of Prabudoss *et al*. (2014), Sarawale *et al*. (2017) and Vimalan *et al*. (2019).

Application of 60 kg N ha^{-1} (N_3) resulted in higher nutrient uptake followed by that with 40 kg N ha^{-1} (N_2) and 20 kg N ha^{-1} (N_1) in the order of descent with significant difference between any two of the three nitrogen levels tested (Table. 1). Application of 60 kg N ha^{-1} (N_3) might have improved the microbial activity through enhanced root exudates and increased translocation of nutrients which probably have contributed to higher nitrogen, phosphorus and potassium contents respectively in the plant tissue. These results are in accordance with the findings of Jyothi *et al*. (2016) and Chavan *et al*. (2018).

POST-HARVEST SOIL AVAILABLE NUTRIENT STATUS

The higher values of post-harvest soil available nitrogen, phosphorous and potassium were recorded with the variety GPUP 8 (V_2) followed by GPUP 21 (V_3) and TNAU 202 (V_1) with a significant difference between any two of the three varieties in the order of descent. The variety PPV 1 (V_4) recorded lower post-harvest soil available nutrients, which was however comparable with that of TNAU 202 (V_1) (Table. 2). Better nutrient uptake efficiency of the variety PPV 1 (V_4) might have reflected in low post-harvest soil available nitrogen, phosphorous and potassium. There was increase in post-harvest soil

Table 1. Yield and nutrient uptake of proso millet at harvest as influenced by varieties and nitrogen levels

Treatments	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Nitrogen uptake (kg ha^{-1})	Phosphorus uptake (kg ha^{-1})	Potassium uptake (kg ha^{-1})
Varieties (V)					
V_1 - TNAU 202	1599	2579	30.6	16.0	55.3
V_2 - GPUP 8	1097	2137	26.1	12.0	46.7
V_3 - GPUP 21	1367	2356	28.0	13.5	51.1
V_4 - PPV 1	1619	2620	31.7	16.9	58.7
SEm±	37.5	60.8	0.48	0.39	1.06
CD (P=0.05)	132	214	1.7	1.3	3.7
Nitrogen levels (N)					
N_1 - 20 kg ha^{-1}	1152	2187	20.4	12.3	49.5
N_2 - 40 kg ha^{-1}	1457	2433	28.6	15.1	53.3
N_3 - 60 kg ha^{-1}	1653	2647	37.3	16.5	56.1
SEm±	42.2	60.7	0.45	0.34	0.85
CD (P=0.05)	128	183	1.4	1.0	2.5
Varieties (V) × Nitrogen levels (N)					
N at V					
SEm±	64.9	105.3	0.83	0.69	1.83
CD (P=0.05)	NS	NS	NS	NS	NS
V at N					
SEm±	78.4	116.2	0.88	0.68	1.75
CD (P=0.05)	NS	NS	NS	NS	NS

available nutrients with variety GPUP 8 (V_2) which have lower uptake efficiency of nutrients as resulted from the present experiment is similar to the findings of Nigade and More (2013) and Triveni *et al*. (2018).

Post-harvest soil available nitrogen increased significantly with successive increments in nitrogen level from 20 to 60 kg ha^{-1} (Table. 2). Due to increase in nitrogen application, there was increase in the root exudates that act as a substrate for the micro-organisms and mineralize the organic nitrogen, thus increasing the nitrogen status of the soil. Higher soil available phosphorus and potassium were with 20 kg N ha^{-1} (N_1) which was significantly higher than that of 40 kg N ha^{-1} (N_2). Significantly lower soil available phosphorus and potassium were with 60 kg N ha^{-1} (N_3). Application of 60 kg N ha^{-1} (N_3) has led to better uptake of phosphorus and potassium from the soil, resulting in their lower availability in the soil at harvest. These results corroborate the findings of Kiranmai (2015).

In conclusion, the present investigation revealed that higher productivity of proso millet and soil health could be obtained with the cultivation of variety PPV 1 or TNAU 202 with the application of 60 kg N ha^{-1} during *kharif* in Southern Agro-climatic zone of Andhra Pradesh.

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Table 2. Post-harvest soil available nitrogen, phosphorus and potassium as influenced by varieties and nitrogen levels of proso millet

Treatments	Available nitrogen (kg ha^{-1})	Available phosphorus (kg ha^{-1})	Available potassium (kg ha^{-1})
Varieties (V)			
V_1 - TNAU 202	121.7	30.7	172.9
V_2 - GPUP 8	142.0	38.8	192.1
V_3 - GPUP 21	132.5	34.9	182.6
V_4 - PPV 1	117.9	29.2	171.0
SEm±	2.66	0.98	3.03
CD (P=0.05)	9.3	3.4	9.0
Nitrogen levels (N)			
N_1 - 20 kg ha^{-1}	118.3	36.4	189.3
N_2 - 40 kg ha^{-1}	130.9	33.5	178.5
N_3 - 60 kg ha^{-1}	142.1	29.9	166.4
SEm±	3.20	0.79	3.07
CD (P=0.05)	9.6	2.4	9.6
Varieties (V) × Nitrogen levels (N)			
N at V			
SEm±	4.61	1.70	6.06
CD (P=0.05)	NS	NS	NS
V at N			
SEm±	5.87	1.62	6.26
CD (P=0.05)	NS	NS	NS

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INFLUENCE OF DIFFERENT ORGANIC NUTRIENT SOURCES ON YIELD, NUTRIENT UPTAKE AND SOIL FERTILITY STATUS OF FOXTAIL MILLET [*Setaria italica* (L.) Beauv.]

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ABSTRACT

A field experiment was conducted during *rabi,* 2021-22 on sandy loam soils of dryland farm at S.V. Agricultural College, Tirupati, Acharya N.G. Ranga Agricultural University, Andhra Pradesh in foxtail millet. The experiment was laid out in split-plot design with three main plots and five sub plot treatments replicated thrice. Main plot treatments consisted of three sources of manure *viz.,* Recommended dose of N through farmyard manure (M_1), Recommended dose of N through vermicompost (M_2) and Recommended dose of N through poultry manure (M_3) and sub plot treatments consisted of five foliar applications *viz.,* Water spray (S_1), Vermiwash @ 5 % spray (S_2), Panchagavya @ 3 % spray (S_3), Humic acid @ 0.5 % spray (S_4) and Seaweed extract @ 0.3 % spray (S_5) allotted to sub-plots. Among the different manures tried, higher yield and nutrient uptake was recorded with the application of recommended dose of nitrogen through poultry manure or vermicompost and higher post-harvest soil nutrient status was recorded with the application of RDN through farmyard manure or vermicompost. Among the foliar application, spraying of 3 % panchagavya or 0.3 % seaweed extract twice at 30 and 45 DAS recorded higher yield and nutrient uptake whereas, post-harvest soil fertility status was not influenced.

KEYWORDS: Proso millet, varieties, nitrogen, yield

INTRODUCTION

Millets are an important source of food and fodder in semi-arid regions and are growing more crucial as the world's population rises. Each millet has high level of fiber, non-starchy polysaccharides and a few special nutrients. Millets have been dubbed "nutritious grains" due to their higher protein quality and availability of important amino acids. Foxtail millet (*Setaria italica* L.), one of the eight millets, is a dry land crop of the graminaceae family. The low glycemic index (50.8) of this millet is a very good alternative for diabetic patients. 100 grams of foxtail millet contains 351 calories, 12.3 g of protein, 4.3 g of total fat, 60.9 g of carbohydrate and 8 g of fiber (Vanithasri *et al.,* 2012).

In the recent energy crisis, synthetic fertilizers are becoming exorbitantly expensive and declining soil fertility insist the use of organic manures in crop production (Upendranaik *et al.,* 2018). Mainly in recent days, organic farming is in high demand because of the perceived benefits to the environment as well as human health. A vital component of organic farming is providing organic sources of nutrients to promote growth as well as to sustain soil quality. Plants should be fed with foliar nutrition as a practical alternative to increase yield. Hence, use of properly designed organic foliar sprays like humic acid extract, seaweed extract, vermiwash and panchagavya are the best ways to correct the micronutrient deficiencies encountered in organic cultivation.

MATERIAL AND METHODS

The experiment was conducted during *rabi*, 2021-22 at dryland farm, S. V. Agricultural College, Tirupati campus of Acharya N. G. Ranga Agricultural University which is geographically situated at 13.5° N latitude and 79.5° E longitude at an altitude of 182.9 m above mean sea level in the Southern Agro-climatic Zone of Andhra Pradesh. The present experiment was laid out in a split-plot design and replicated thrice. The treatments included three organic manure levels *viz.,* Recommended dose of N through farmyard manure (M_1), Recommended dose of N through vermicompost (M_2) and Recommended dose of N through poultry manure (M_3) and five foliar applications *viz.,* Water spray (S_1), Vermiwash @ 5% spray (S_2), Panchagavya @ 3% spray (S_3), Humic acid @ 0.5% spray (S_4) and Seaweed extract @ 0.3% spray (S_5) at 30 and 45 DAS allotted to the sub-plots. The soil of the experimental field was sandy loam, neutral in soil reaction, low in organic carbon (0.35%) and available

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nitrogen (176.0 kg ha^{-1}), medium in available phosphorus (27 kg ha^{-1}) and available potassium (219 kg ha^{-1}). The crop was sown at 22.5 cm x 10.0 cm spacing with a seed rate of 8 kg ha^{-1}. The variety SiA 3156 of foxtail millet was sown on 22nd of october and recommended dose of the fertilizer 40:20 kg N P_2O_5 ha^{-1}. All the other recommended practices were also adopted as per the crop requirement.

RESULTS AND DISCUSSION

YIELD

The grain and straw yield were very much influenced by different organic sources. Among the organic manures, higher yield of foxtail millet was recorded with the application of poultry manure (M_3), followed by vermicompost (M_2), which were at par with each other. The above two treatments were significantly superior to the farmyard manure (M_1). Among the foliar applications, higher yield was seen with the application of panchagavya @ 3% (S_3) followed by seaweed extract @ 0.3% (S_5) which were on par with each other and in turn significantly superior to rest of the treatments. This was followed by vermiwash @ 5% (S_2) and humic acid @ 0.5% (S_4) and were at par with each other and significantly superior to water spray (S_1) which recorded lower yield (Table 1).

During this study, organic manures might have acted as nutrient sources facilitating higher removal by plants. This might have helped in improvement of growth and yield attributes due to higher concentration of macro and micro nutrients in conjunction with steady nutrient release throughout the crop period in poultry manure and also due to the rich source of NPK. Presence of plant growth regulators like auxins, gibberellins and cytokinins in vermicompost might have enhanced the plant growth and overall yield when compared to farmyard manure. The better yield with panchagavya was ascribed due to the higher production of plant growth regulators which have helped in enhancing the biological efficiency of the crop compared to other foliar sprays. Since poultry manure and panchagavya contain high nitrogen and high macro & micro nutrients and growth promoting substances which might have helped in increased yield attributes and yield (Table. 1). These results are in conformity with Sangeetha *et al*. (2013), Priya and Satyamoorthi (2019) and Raviraja *et al*. (2020).

NUTRIENT UPTAKE AT HARVEST

During the study, among the manurial treatments the nitrogen and potassium uptake by plant was higher with the application of poultry manure (M_3), which was on par with the application of vermicompost (M_2) and both the treatments were significantly superior to farmyard manure (M_1). With regards to phosphorus uptake by plant, significantly higher values were seen with the application of poultry manure (M_3) compared to other treatments. The higher nutrient uptake in poultry manure was due to the fact that it produced more humic acid which form water soluble chelated phosphorus which helped in easy release of phosphorus to the crop. It helped in supplying the nutrients in soluble form for a quite longer period by not allowing the entire soluble form into solution, to come in contact with soil and other inorganic constituents, thereby minimizing fixation and precipitation from the manures, so that the plant roots can very well compete with loss mechanisms and absorb more nutrients as a result of increased cation exchange capacity with increased organic matter content leading to better yield. These findings are in agreement with Sangeetha *et al*. (2013), Prakash *et al*. (2018) and Nayak *et al*. (2020).

Among the foliar sprays higher nutrient uptake was observed with panchagavya @ 3% (S_3) closely followed by seaweed extract @ 0.3% (S_5) which were significantly superior over other treatments. The next best treatment in obtaining higher nutrient uptake by crop was vermiwash @ 5% (S_2) closely followed by humic acid @ 0.5% (S_4) which were comparable with each other. Significantly lower values were noticed under water spray (S_1). Higher nutrient uptake in panchagavya and seaweed extract was due to the presence of several enzymes and beneficial microorganisms which might have helped in better nutrient uptake, which might have increased the biological efficiency of the crop and thereby creating the better source and sink relationship in the plant that might have contributed for greater absorption and translocation of nutrients. The results corroborate the findings of Raverkar *et al*. (2016), Ananda *et al*. (2018) and Mathukiya *et al*. (2020).

POST-HARVEST SOIL NUTRIENT STATUS

During the study, higher post-harvest soil available nitrogen, phosphorus and potassium were noticed with the application of farmyard manure (M_1), which was

Table 1. Yield and nutrient uptake at harvest (kg ha^{-1}) of foxtail millet as influenced by different sources of manure and foliar application

Treatments	Grain yield	Straw yield	Nitrogen uptake	Phosphorus uptake	Potassium uptake
Sources of manure (M)					
M_1 : RDN through farmyard manure	828	1575	32.6	12.6	41.5
M_2 : RDN through vermicompost	999	1754	41.4	16.8	51.4
M_3 : RDN through poultry manure	1026	1845	46.7	19.3	56.9
SEm±	23.5	37.4	1.56	0.47	1.55
CD (P=0.05)	92	147	6.1	1.9	6.1
Foliar application (S)					
S_1 : Water spray	846	1460	34.8	13.6	40.3
S_2 : Vermiwash @ 5% spray	930	1678	38.9	16.2	48.2
S_3 : Panchagavya @ 3% spray	1045	1956	45.7	18.6	59.8
S_4 : Humic acid @ 0.5% spray	926	1635	38.7	15.3	46.2
S_5 : Seaweed extract @ 0.3% spray	1010	1896	43.0	17.6	54.6
SEm±	25.6	48.6	1.08	0.46	1.95
CD (P=0.05)	75	142	3.2	1.3	5.7
Sources of manure (M) × Foliar application (S)					
M at S					
SEm±	46.1	84.1	2.29	0.85	3.39
CD (P=0.05)	NS	NS	NS	NS	NS
S at M					
SEm±	52.6	92.1	3.48	1.06	3.46
CD (P=0.05)	NS	NS	NS	NS	NS

comparable with the application of vermicompost (M_2) and both were significantly superior to poultry manure (M_3). However, available nitrogen, phosphorus and potassium were not influenced by the foliar sprays (Table 2).

The mineralization of organic manures and release pattern of nutrients in to the soil solution differ according to the sources. The enhanced nitrogen status of the soil might be attributed to increased rhizo-microorganisms multiplication through the incorporation of FYM or vermicompost due to the conversion of bound nitrogen into inorganic form. Application of poultry manure also might have enhanced the availability of nitrogen to the crop which may consequently lead to lower status in the soil after harvest as compared to other manures. The results are in conformity with the findings of Banerjee *et al.* (2013) and Nayak *et al.* (2020).

Due to decomposition of organic manures, various acids are produced which solubilizes phosphatase and phosphate bearing minerals and lowers the phosphorus fixation and increases the availability and also helps in reducing the K- fixation in soil due to its higher capacity to hold K in available form. The results are in agreement with the findings of Rana *et al*. (2015).

On the basis of experimental study, it was concluded that application of recommended dose of nitrogen through poultry manure or vermicompost and foliar spraying of 3% panchagavya or 0.3% seaweed extract

Table 2. Post-harvest soil available nitrogen (N), phosphorus (P_2O_5) and potassium (K_2O) (kg ha^{-1}) of foxtail millet as influenced by different sources of manure and foliar application

Treatments	N	P_2O_5	K_2O
Sources of manure (M)			
M_1 : RDN through farmyard manure	206	36.9	251
M_2 : RDN through vermicompost	199	35.0	239
M_3 : RDN through poultry manure	174	29.5	211
SEm±	2.8	0.80	6.3
CD (P=0.05)	11	3.1	25
Foliar application (S)			
S_1 : Water spray	187	33.2	222
S_2 : Vermiwash @ 5% spray	200	36.0	240
S_3 : Panchagavya @ 3% spray	190	31.8	231
S_4 : Humic acid @ 0.5% spray	196	35.4	244
S_5 : Seaweed extract @ 0.3% spray	192	32.4	233
SEm±	5.1	1.39	7.8
CD (P=0.05)	NS	NS	NS
Sources of manure (M) × Foliar application (S)			
M at S			
SEm±	8.3	2.48	12.7
CD (P=0.05)	NS	NS	NS
S at M			
SEm±	6.2	2.10	8.3
CD (P=0.05)	NS	NS	NS

twice at 30 and 45 DAS found better in respect to yield and nutrient uptake of foxtail millet which also help in maintaining soil fertility with the use of organic manures for Southern Agro-climatic Zone of Andhra Pradesh.

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PROFILE OF ACCION FRATERNA-ECOLOGY CENTRE (AFEC) BENEFICIARY FARMERS OF ANANTHAPURAMU DISTRICT OF ANDHRA PRADESH

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ABSTRACT

The present study was conducted in Ananthapuramu district of Andhra Pradesh. To study the profile of Accion Fraterna Ecology Centre beneficiary farmers, a total of 120 respondents were randomly selected and interviewed. The results revealed that the beneficiary farmers were in middle age (36-55 years) group (53.33%), educated up to primary school (23.33%) and functionally literate (20.00%), belongs to marginal and small farmers (75.83%), had medium annual income (59.17%), medium farming experience (62.50%), had medium extension contact (58.33%), medium mass media exposure (62.50%), medium training undergone (64.16%), medium economic orientation (60.00%), had medium social participation (63.33%), scientific orientation (65.00%).

KEYWORDS: Profile, Accion Fraterna Ecology Centre, land holding, extension contact.

INTRODUCTION

Non Governmental Organizations (NGOs) in recent days have taken lion's share in promoting and implementing different developmental activities and thereby declining the role of state in social welfare services. Non Governmental Organizations as a third sector institutional frame work are playing a crucial role in providing strong support to the development issue. NGOs today, whether voluntary or government, are accepted fact of life. NGOs have an important role, especially where the government and private sectors are showing less interest. The NGOs hitherto emerged in their traditional areas of agriculture and development of socio economic status of people with other services.

There are an estimated 10 million NGOs worldwide (*Global journal*). Bangladesh Rural Advancement Committee (BRAC) is the largest NGO in the world, in terms of number of employees as of September 2016 which was established by Sir Fazle Hasan Abed in 1972 after the independence of Bangladesh present in all 64 districts of Bangladesh and 11 other countries like Asia, Africa, and the Americas (Wikipedia, 2016).

India has nearly 3.4 million non-governmental organisations (NGOs), working in a variety of fields ranging from disaster relief to advocacy for marginalised and disadvantaged communities (*The Conversation,* 2019). Universal Versatile Society (UVS) is a popular NGO in India which focusing on agriculture, environment, rural development, education, and women empowerment.

There are total 3917 NGOs working in Andhra Pradesh for various social welfare activities whereas in Andhra Pradesh there are total 87 NGOs working in Ananthapuramu district for various social welfare activities. Out of these, Rural Development Trust is the top most NGO working for rural people and RDTs AF-Ecology Centre (AFEC) is another leading NGO working for peoples empowerment, watershed development, drought management, environmental development and policy advocacy.

"AFEC" focus was on people welfare in the villages through health care and education. After a prolonged drought, more attention was given to the watershed development in order to assure sufficient drinking water and water for food production. After successful development this activity was handed over to the government and AF concentrated to the small and marginal groundnut farms towards sustainable agricultural practices, farm diversification and other agricultural and non agricultural activities to improve sustainable rainfed agriculture.

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This study was aimed to know the different parameters of the centre in which is making good improvement in livelihoods of farming community.

MATERIAL AND METHODS

In the present study *ex post facto* research design was followed. Kerlinger (1973) defined *ex post facto* research design is a systematic empirical enquiry in which the independent variables have not been directly manipulated because they have already occurred or they are inherently not manipulable.

Andhra Pradesh state was purposively selected for the study as the researcher hails from the same state and is familiar with the local language and culture. Ananthapuramu district was purposively selected because the NGO named Accion Fraterna Ecology Centre was oldest and maximum number of beneficiaries were benefited through this NGO since its inception. Three mandals were purposively selected based on highest number of beneficiaries belonged to this NGO. From each mandal, two villages were selected by simple random sampling procedure. From each village, twenty beneficiary farmers were selected by simple random sampling procedure, thus making a total of 120 beneficiaries. The data were collected by personal interview method through a structured interview schedule and statistical techniques like Arithmetic mean, Standard deviation, Frequencies and Percentages were used.

RESULTS AND DISCUSSION

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

Age

Table 1 clearly depicted that majority (53.33%) of the beneficiary farmers were middle aged followed by 25.00 per cent belonged to old age group and 21.67 per cent belonged to young age group. The reason for above trends might be that middle age group are active group of people adopting the programmes and planning of NGOs in their respective areas whereas old aged farmers considering vast farming experience to take benefits of NGO activities regarding agriculture from time to time and young age group were engaged in non-agricultural activities such as cell phone repairing, driving, nano enterprises. The findings are in line with the results reported by Basantia (2011), Sagitra (2015), Mandoli (2016) and Gayatri (2018).

Education

It could be seen from the Table 1 that 23.33 per cent of the beneficiary farmers were educated up to primary school followed by functionally literates (20.00%), middle school (19.17%), high school (15.00%), Illiterates (11.67%) and college level (10.83%) levels of education. It could be inferred from results that a greater number of the beneficiary farmers could not go for higher education because of their financial problems, requirement of man labour in their farm and non-availability of higher educational facilities in their villages. Similar findings were reported by Sunanda *et al*. (2014).

Annual income

It is clearly illustrated from Table 1 that majority (59.17%) of beneficiary farmers belonged to medium annual income level followed by those with high (22.50%) and low (18.33%) levels of annual income.The possible reason for enhanced income may be the regular and continuous exposure of the beneficiaries to different agricultural programmes organized by the NGO. This finding was in conformity with the findings as reported by Jasiwal (2008), Sahu (2010), Uikey (2012) and Soni (2014).

Farm size

It is clearly depicted from Table 1 that majority (53.33%) of beneficiary farmers were small farmers followed by marginal farmers (22.50%), Medium farmers (20.00%) and big farmers (4.17%). Farm size has a substantial influence on agricultural sustainability from the aspect of economy, environment and society. The target group of NGO was small and marginal farmers. Because they were resource poor i.e., inability to procure quality agri inputs, lack of water and poor yields from rainfed agriculture, inability to market their produce at remunerative price. Hence most of the beneficiary farmers were constituted under the small and marginal farmers category. This finding was in conformity with the findings of More (2011).

Farming experience

It is apparent from Table 1 that majority (62.50%) of beneficiary farmers belonged to medium farming experience followed by high (19.17%) and low (18.33%) levels of farming experience. The reason might be due to the fact that majority of the beneficiary farmers belonged to middle age followed by old age group. Majority of

Table 1. Profile of AFEC beneficiary farmers

(n = 120)

S. No.	Category	Class Interval	Frequency (f)	Percentage (p)	Mean	S.D
I.	**Age**					
1.	Young age	(<35 years)	26	21.67		
2.	Middle age	(36-55 years)	64	53.33	-	-
3.	Old age	(56 years and above)	30	25.00		
II.	**Education**					
1.	Illiterate		14	11.67		
2.	Functionally literate		28	20.00		
3.	Primary school		24	23.33	-	-
4.	Middle school		23	19.17		
5.	High school		18	15.00		
6.	College level		13	10.83		
III.	**Annual income**					
1.	Low annual income		22	18.33		
2.	Medium annual income		71	59.17	53158.33	26379.92
3.	High annual income		27	22.50		
IV.	**Farm Size**					
1.	Marginal farmer	< 2.5 acres	27	22.50		
2.	Small farmer	2.5-5.0 acres	64	53.33	-	-
3.	Medium farmer	5.0-10 acres	24	20.00		
4.	Big farmer	> 10 acres	5	4.17		
V.	**Farming Experience**					
1.	Low experience		22	18.33		
2.	Medium experience		75	62.50	20.22	9.36
3.	High experience		23	19.17		
VI.	**Training undergone**					
1.	Low training undergone		19	15.83		
2.	Medium training undergone		77	64.16	3.55	1.00
3.	High training undergone		24	20.00		
VII.	**Extension contact**					
1.	Low extension contact		20	16.67		
2.	Medium extension contact		70	58.33	38.75	3.16
3.	High extension contact		30	25.00		
VIII.	**Mass media exposure**					
1.	Low mass media exposure		24	20.00		
2.	Medium mass media exposure		75	62.50	8.05	2.56
3.	High mass media exposure		21	17.50		
IX.	**Social participation**					
1.	Low social participation		25	20.83		
2.	Medium social participation		76	63.33	4.69	1.11
3.	High social participation		19	15.83		
X.	**Economic orientation**					
1.	Low economic orientation		16	13.33		
2.	Medium economic orientation		72	60.00	26.09	1.84
3.	High economic orientation		32	26.67		
XI.	**Scientific orientation**					
1.	Low scientific orientation		16	13.33		
2.	Medium scientific orientation		78	65.00	25.63	2.26
3.	High scientific orientation		26	21.66		

the younger generation have not chosen farming as a profession and it was continued by their parents only. Some of the young farmers were engaged in agriculture or other small business after the dropout from school. Hence most of the AFEC beneficiary farmers had medium farming experience. This result was in accordance with the results of Rameshwar (2016).

Training undergone

It is evident from the Table 1 that majority (64.16%) of the beneficiary farmers had medium training undergone followed by high (20.00%) and low (15.83%) level of training undergone. This might be due to the fact that AFEC beneficiary farmers attended most of the training programs organized by the AFEC. Most of the young and enthusiastic farmers participated in training programs regularly organized by the AFEC. Few beneficiaries belonged to low training undergone category due to lack of awareness regarding usefulness of training programs, being busy with their farm operations, lack of interest in sparing their time to participate in the training programs. Similar findings were observed with the findings of Reddy (2019).

Extension contact

It could be inferred from Table 1 that majority (58.33%) of beneficiary farmers had medium extension contact followed by high (25.00%) and low (16.67%) levels of extension contact. The probable reason might be that most of the AFEC beneficiary farmers had frequent contact with AFEC extension functionaries only. Farmers nearer to Agricultural Research Stations, DAATTC centre and KVK had moderate contact with scientists for seeking information. Their frequency of contact with Department of Agriculture was rare. The beneficiary farmers sought timely extension support from AFEC officials regarding agriculture and other allied activities. AFEC might have motivated the beneficiaries to have more contact with extension personnel to have the benefits of developmental programmes and to earn more income in order to bring change in their standard of living. This trend was observed similar with that of Rameshwar (2016) and Chauhan (2017).

Mass media exposure

It is evident from the Table 1 that nearly three-fifth (62.50%) beneficiary farmers had medium level of mass media exposure followed by low (20.00%) and high (17.50%) levels of mass media exposure.

Mass media plays a vital role in farming and reflects public opinion, connecting the world to individuals and reproducing the self-image of society. The above trend has been observed as most of the AFEC beneficiary farmers had medium level of education. However demonstrations, field visits, meetings, exposure visits, agri-tech exhibitions organized by NGO and KVKs had improved the knowledge level of beneficiary farmers on latest technologies, drought mitigation practices, sustainable agriculture, natural farming in rainfed areas. Beneficiary farmers had moderate access to newspapers, journals, television, mobile applications and regular contacts with fellow NGO members. This finding had drawn its support from the findings of Sagitra (2015).

Social participation

It is evident from the Table 1 that a great majority (63.33%) of the AFEC beneficiary farmers had medium level of social participation followed by low (20.83%) and high (15.83%) levels of social participation respectively. The reason behind this may be that AFEC is a voluntary organization where farmers have a frequent contact with each other on activities of NGO. Being influenced by the NGOs and realizing the strength and benefits of community participation in adoption of technology, beneficiary farmers have formed sasya mitra groups, farmer producer organisations and involved in other participatory works. Further awareness created by the NGOs about the importance of social institutions, education and innovativeness might have increased the tendency of farmers to be a member of one or more organization. This finding was in line with findings of Rameshwar (2016).

Economic Orientation

It is apparent from Table 1 that 60.00 per cent of the AFEC beneficiary farmers had medium economic orientation followed by high (26.67%) and low (13.33%) levels of economic orientation. The possible reason for this trend might be that farmers still consider agriculture as a subsistence occupation and not looking it as commercial avenue. Due to implementation of various training programmes and activities, their farm income was increased after the intervention of NGO. So farmers start to maintain better life style indicates that the beneficiary farmers are become more cautious about the economic condition and ready to try their level best to improve income. This finding was in line with the findings of Biradar and Basavaraj (2008) and Mandoli (2016).

Scientific Orientation

It is clear from the Table 1 that 65.00 per cent of the respondents were having medium scientific orientation followed by high (21.66%) and low (13.33%) levels of scientific orientation. The higher percentage of beneficiary farmers (65.00°/o) were showing medium scientific orientation. It has been usually observed that the farmers who are small and marginal farmers and resource poor were having less scientific orientation. However with the contact of NGO and other developmental agencies, they become slightly higher in the reasoning abilities which enhance the scientific orientation, the finding as supported to the Uikey (2012), Soni (2014) and Chauhan (2017).

From the above research work it can be concluded that the majority of the AFEC beneficiary farmers in the study area belonged to middle age group and were having education up to primary school with medium annual income, had small and marginal land holding with medium farming experience. Further, majority of the AFEC beneficiary farmers had medium training undergone, had medium extension contact, medium mass media exposure, medium social participation, medium economic orientation and medium scientific orientation.

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Andhra Pradesh J Agril. Sci : 8(3): 144-148, 2022

PROFILE CHARACTERISTICS OF VILLAGE AGRICULTURAL ASSISTANTS (VAAs) OF RYTHU BHAROSA KENDRAS (RBKs) IN KURNOOL DISTRICT OF ANDHRA PRADESH

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ABSTRACT

The present study was conducted on the profile characteristics of Village Agricultural Assistants (VAAs) of RBKs in Kurnool district of Andhra Pradesh. A total of 110 respondents were randomly selected and interviewed. The results of the study indicated that the respondents were in young age (<35 years) group (82.73%) with Under Graduation (4 and 5 years) (43.64%) and diploma (36.36%), had medium organizational climate (65.45%), communication skills (56.36%), job performance (72.73%), training undergone (58.18%), information seeking behaviour (49.09%), job involvement (46.36%), perceived work load (60.00%) and job satisfaction (65.45%).

KEYWORDS: Profile characteristics, Village Agricultural Assistants, perceived work load.

INTRODUCTION

Andhra Pradesh is a state primarily based on agriculture. The new Andhra Pradesh government has pledged to do everything it takes to ensure the welfare of farmers. It is crucial to create a platform at the village level where government services can be enhanced both qualitatively and quantitatively. A solid integrated platform is required to efficiently provide advisory services and cater the needs of every farmer.

The Government of Andhra Pradesh established 10,641 Rythu Bharosa Kendras (RBKs) on 30th May 2020 with an expenditure of 200 crores in all Gram panchayats. The RBK services include Agri Input Shop with an objective to make available quality inputs at right price and right time at villages backed by integrated advisory through Farmer Knowledge Centre which is a training centre. The functionaries of RBKs include Village Agricultural Assistants/Village Horticultural Assistants/Sericulture Assistants, Village Animal Husbandry Assistants/Village Fisheries Assistants in the respective RBKs.

At present, State Department of Agriculture, Andhra Pradesh is implementing various programs like Polambadi, National Seed Project (NSP) and others for the benefit of the farmers. The success of these programs depends on how well they are planned, implemented and reached into the hands of the farmers. The extension personnel like VAAs who are working closely with and for the farmers have a great responsibility on them for achieving the good results. It not only depends on number of VAAs but also their socio-economic attributes.

MATERIAL AND METHODS

Ex post facto research design was followed for conducting the study. This design was appropriate because the phenomenon has already occurred. Kerlinger (1973) defined *Ex post facto* research design as any systematic empirical enquiry in which the independent variables have not been directly manipulated because they have already occurred or they are inherently not manipulable. He further stated that *Ex post facto* studies can be devised to deduce theories, identify behavioural phenomenon and explore conditions under which a phenomenon occurs.

Andhra Pradesh state was selected purposively for the study as the researcher hails from the same state and is familiar with the local language. Kurnool district of Andhra Pradesh was selected purposively for the study as the researcher hails from the same district. Out of 11 Agricultural Divisions, one mandal from each division namely Adoni, Chagalmari, Aspari, Pamulpadu, Peapully, Owk, Kurnool, Orvakal, Banganapalli, Devanakonda and Yemmiganur with a maximum number of RBKs were selected purposively. Ten villages were selected from each mandal by simple random sampling procedure making a total of 110 villages. All the Village Agricultural Assistants of RBKs of 110 villages will be selected purposively making a total of 110 respondents.

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RESULTS AND DISCUSSION

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

Age

It could be observed from Table 1 that majority of the respondents (82.73%) belonged to young age (<35 years) category followed by middle (36-55 years) (17.27%) age. The major reason for this trend might be that RBKs were newly started by state government and the VAAs were mass recruited and the qualification for appointing VAAs is Diploma/B.Sc/M.Sc/Ph.D. The findings were in accordance with the Murai (2017), Deepti (2019), Davidson (2021).

Education

It could be observed from Table 1 that majority of the respondents (43.64%) belong to undergraduate (4 and 5 years) followed by Diploma (36.36%), Post Graduate and above (10.91%) and Under Graduation (3 years) (9.09%). The major reason for this trend might be that educational qualification for the post of VAA was from Diploma to Ph.D. It may be inferred that most of them entered the service after Under Graduation (4 and 5 years) and Diploma.

Organizational Climate

It is apparent from Table 1 that majority of the respondents (65.45%) perceived to be under medium organizational climate followed by 18.18 per cent under low organizational climate and 16.36 per cent under high organizational climate. The major reason for this trend might be due to the fewer chances for taking independent decisions by the VAAs as well as the work pressure to accomplish assigned task within deadlines. Another factor could be that lack of recognition for good work and feedback on performance.

Communication skills

It is noticed from Table 1 that majority of the respondents (56.36%) possessed medium level of communication skills followed by 30.91 per cent possessed high level of communication skills and 12.73 per cent possessed low level of communication skills. The major reason for this trend was that because VAAs were posted to their proximity areas which help them to communicate well with the farmers and provide services to them. The VAAs spoke in an understandable way, provided information on time which helped them to sustain interest all through the work. This result confirms the findings of Talukdar (1984), Shinde *et al.* (1997), Gurav (2006), Thorat (2008) and Hanif (2015).

Job performance

It is implied from Table 1 that majority of the respondents (72.73%) had medium level of job performance followed by 18.18 per cent of the respondents had high level of job performance and 9.09 per cent of the respondents had low level of job performance. The major reason for this trend was due to their level of understanding about their duties and responsibilities and their acquaintance with the activities to be done according to needs of the farmers. It may be inferred that majority of the VAAs were engaged in the activities attached to their position to a good extent. This result confirms the findings of Madhavan (2015), Padmakumar and Annasaheb (2016), Deotale (2017).

Training undergone

It is apparent from Table 1 that majority of the respondents (58.18 %) had medium level of training followed by 29.09 per cent of the respondents had high level of training and 12.73 per cent had low level of training. The major reason for this trend was that VAAs were having trainings as per the needs based on their local conditions and occasionally few VAAs were sent to mandal level office for trainings. This result confirms the findings of Senchowa (2017), Bortamuly and Das (2018).

Information seeking behaviour

It is observed from Table 1 that nearly half of the respondents (49.09%) had medium information seeking behaviour followed by 30.00 per cent had high information seeking behaviour and 20.90 per cent had low information seeking behaviour. The major reason for this trend was because most of the VAAs hold degree and diploma and were well aware of the sources of information which enable them to use the information sources like newspaper, magazines, mobile phone, internet etc., This result confirms the findings of Jeeva *et al.* (2013), Madhavan (2015) and Padmakumar *et al.* (2017).

Job involvement

It is noticed from Table 1 that nearly half of the respondents (46.36%) had medium level of job

Table 1. Profile characteristics of Village Agricultural Assistants

(n = 110)

S. No.	Category	Class Interval	Frequency (f)	Percentage (p)	Mean	S.D
I.	**Age**					
1.	Young age	(<35 years)	91	82.73		
2.	Middle age	(36-55 years)	19	17.27	-	-
3.	Old age	(>56 years)	0	0.00		
II.	**Education**					
1.	Diploma		40	36.36		
2.	Undergraduate (3 years)		10	9.09		
3.	Undergraduate (4 and 5 years)		48	43.64	-	-
4.	Post Graduate and above		12	10.91		
III.	**Organizational climate**					
1.	Low		20	18.18		
2.	Medium		72	65.45	73.3	7.07
3.	High		18	16.36		
IV.	**Communication skills**					
1.	Low		14	12.73		
2.	Medium		62	56.36	10.44	1.01
3.	High		24	30.91		
V.	**Job performance**					
1.	Low		10	9.09		
2.	Medium		80	72.73	52.30	5.35
3.	High		20	18.18		
VI.	**Training undergone**					
1.	Low		14	12.73		
2.	Medium		64	58.18	10.71	1.4
3.	High		32	29.09		
VII.	**Information seeking behaviour**					
1.	Low		23	20.90		
2.	Medium		54	49.09	29.48	3.06
3.	High		33	30.00		
VIII.	**Job involvement**					
1.	Low		20	18.18		
2.	Medium		51	46.36	26.61	2.13
3.	High		39	35.45		
IX.	**Perceived workload**					
1.	Low		10	9.09		
2.	Medium		66	60.00	15.59	1.82
3.	High		34	30.90		
X.	**Job satisfaction**					
1.	Low		14	12.73		
2.	Medium		72	65.45	26.81	2.40
3.	High		24	21.82		

involvement followed by 35.45 per cent had high level of job involvement and 18.18 per cent had low level of job involvement. The major reason for this trend was due to their sincerity interest and dedication to serve the farming community. It can be inferred that the VAAs who had medium to high involvement were more contended with work, work environment and had a desire for excellence and favourable feelings towards the system in which he works. This result confirms the findings Kulkarni (2001), Ahire (2005), Bhople *et al.* (2000), Singh *et al.* (2011), Mishra *et al.* (2011), Potawade (2012), Hanif (2015) and Dhananjay (2016).

Perceived work load

It is evident from Table 1 that majority of the respondents (60.00 %) perceived their workload under medium followed by 30.90 per cent perceived their work load under high and 9.09 per cent perceived their work load as low. The major reason for this trend was that assigning more number of villages under the VAAs and overburden of work. A single VAA need to take care of all the farmers under his jurisdiction and the VAAs were not superiors they need to perform different roles. This result confirms the findings of Gopika (2014).

Job satisfaction

It is implied from Table 1 that majority of the respondents (65.45%) had medium level of job satisfaction followed by 21.82 per cent had high level of job satisfaction and 12.73 had low level of job satisfaction. The major reason for this trend might be due to the fact that the job security as they have less opportunity to enter into government sector and most of the VAAs entered the post immediately after their education coupled with interesting nature of job, working relationship with colleagues and high job performance. The findings are in accordance with Madhavan (2015), Dhananjay (2016), Obabire *et al.* (2019), Manobharathi *et al.* (2020) and Davidson *et al.* (2021).

The profile of the Village Agricultural Assistants plays an immense role in the effective functioning of RBKs. The findings of the study revealed that majority of the respondents were in young age (<35 years) group with Under Graduation (4 and 5 years) and diploma had medium organizational climate, communication skills, job performance, training undergone, information seeking behaviour, job involvement, perceived work load and job satisfaction. This study will help the administrators to strengthen the role of VAAs in effective implementation of RBKs.

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AN ANALYSIS OF THE DETERMINANTS OF GROUNDNUT ON FARM EFFICIENCY IN ANANTHAPURAMU DISTRICT OF ANDHRA PRADESH, INDIA

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ABSTRACT

This paper addresses the determinants that are influencing the farm efficiency of the groundnut cultivating farmers in Ananthapuramu district of Andhra Pradesh. A total of 200 groundnut cultivating farmers were selected purposively and interviewed. Multiple linear regression is used to identify the determinants. Results revealed that government seed are found to be the most important determinants. Farming experience, education qualification, land holding, cost of cultivation, type of land and government seed showed significant 0 and were identified as chief determinants. Treatment, family size, irrigation source, small farmers group, medium farmers group, own seed, private seed and variety seems to be unrelated to the farm efficiency of farmers and were not found as key factors in predicting farm efficiency of groundnut farmers.

KEYWORDS: Multiple linear regression, determinants, Efficiency, farming experience, farm efficiency.

INTRODUCTION

Groundnut is the most important oilseed crop grown in India. The annual production of groundnuts is approximately 7180.5 thousand tonnes, with nine states contributing more than 100 thousand tonnes each. Gujarat, Rajasthan, Tamil Nadu, Andhra Pradesh, Karnataka, Madhya Pradesh, West Bengal, and Telangana are the major groundnut producing states in India. Groundnut cultivation is practiced on around 85 lakh hectares of land in India (Department of science & technology, 2019). Oil seeds however contribute to the agricultural economy in India, however, they are only second in terms of value and production to food grains. Because of the importance of edible oil in one's daily diet, demand for groundnut production has increased. Consumption levels are expected to rise further as a result of increased income and population. Currently, production is insufficient to meet demand and oil is traded internationally. As a result, efforts should be made to extend groundnut production area so that numerous by products produced from them can be made available to the inevitable population.

Keeping in view of the above facts, the present study is to identify the determinants that are influencing the groundnut farmers on farm efficiency in Ananthapuramu district of Andhra Pradesh was undertaken. As Ananthapuramu district ranks first in the state of Andhra Pradesh in cultivation of groundnut 2021.

MATERIAL AND METHODS

Ananthapuramu district was purposively selected for the research study as it is predominant in groundnut cultivation, contains fertile red soils, good irrigation facility and highest groundnut seed subsidy distribution in Andhra Pradesh. Four villages in the two mandals having maximum area under groundnut cultivation were purposively chosen. The required information pertaining to cultivation of groundnut and other related parameters were collected from the sample respondents on well-structured survey schedule designed for the purpose for the year 2021 kharif season.

In order to identify the determinants of groundnut farmers on farm efficiency variables the statistical term Multiple Linear Regression Analysis was used to analyse the linear effect of two or more explanatory variables (X_1, X_2, …. X_i) on a response variable (Y) using multiple regression analysis for mathematical modelling by SPSS software 16 version.

$$Y = a + bX_1 + bX_2 \text{ ------ } + \mu$$

RESULTS AND DISCUSSIONS

The variables considered for the present study include dependent (gross returns) and 14 independent variables selected were treatment (non-subsidized seed, subsidized seed), farming experience, family size, educational qualification, type of land, land

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holding, Cost of cultivation, irrigation source, small farmers, medium farmers, government seed, own seed, private seed and variety to examine whether they were statistically significant and if yes, the direction of their mutual relationship.

Multiple regression analysis is a study focused on the combined influence of 14 independent variables up on one dependent variable using a linear model. In this study multiple linear regression analysis was used for identifying determinants of groundnut farmers on farm efficiency in the study area.

Table 1 provides the R, R^2, adjusted R^2 values, and the standard error of the estimate, which can be used to determine how well a regression- model fits the data. R^2 is a statistical measure of how close the data are to the fitted regression line. It is also called the coefficient of determination or the coefficient of multiple determination for multiple linear regression. Values 0.68 or 68 per cent indicated that the model explains all the variability of the response data around its mean. Adjusted R^2 also specifies how well the terms fit in a curve or in a line, and also adjusts for the number of terms in a model. Adjusted R^2 will always be less than or equal to R^2. A value of 0.66 or 66 per cent indicates a model that perfectly predicts values in 66 per cent variation in the Gross returns. One of the assumptions of regression is that the observations are independent. If observations are collected over time, it is likely that successive observations are related. If there is no auto correlation where subsequent observations are related, the Durbin–Watson statistic should be between 1.5 and 2.5. The Durbin–Watson statistic of the present study was 2.03 and therefore the data was not auto correlated.

Table 1. Multiple linear regression model summary

Model Summary[b]					
Model	R	R^2	Adjusted R^2	Standard Error of the Estimate	Durbin-Watson Statistic
1	0.82[a]	0.68	0.66	10049.68	2.03

a. Predictors: (Constant), treatment (non-subsidized=0, subsidized=1), farming experience, family size, educational qualification, type of land, land holding, Cost of cultivation, irrigation source, small farmers, medium farmers, government seed, own seed, private seed and variety

b. Dependent Variable: Gross returns

The F- ratio in the ANOVA tests (Table 2) whether the overall regression model is a good fit for the data. The sum of squares column, the degrees of freedom column (d.f), the mean sum of square column (MSS), the F column, and the p- value or observed significance of F were shown. From the d.f column, it was grasped that k= 14, the fourteen predictor variables and that n =200, sample size of the study. The MSS was 10099.60 which means that s^2= 10099.60. The F ratio given under column F was 28.48 and p-value was 0.000 which was given under the significant column. Since p-value was less than 0.05, it implies that the calculated regression coefficient was significant and the variance in the independent variable contributes to the change in the dependent variable. Therefore, it was inferred that the farmers farm efficiency depends on the some of the selected explanatory variables. Hence, variance in any one of the explanatory variables really contributes to change in performance of the farmers.

Looking at the p-value of the t-test for each predictor in table 3 it was observed that p value of farming experience, education qualification, land holding, cost of cultivation, type of land and government seed have approximately zero value or closer to 0.05 (5% level of significance). The effect of these explanatory variables was found to be positively significant and were the chief determinants. But explanatory variables viz., treatment, family size, irrigation source, small farmers group, medium farmers group, own seed, private seed and variety were found to be positively non-significant. This may indicate that respondents with greater groundnut farming experience, education qualification, land holding, cost of cultivation, type of land and government seed could afford to take risk in adoption of subsidies

Table 2. The F- ratio in the ANOVA tests

	ANOVA[a]					
	Model	Sum of Squares	d.f	Mean Sum of Square	F	Significance (p-value)
1	Regression	4026857.88	14	287632.35	28.48	0.000[b]
	Residual	1868429.28	185	10099.60		
	Total	5895287.17	199			

a. Dependent Variable: Gross returns

b. Predictors: (Constant), treatment (non-subsidized=0, subsidized=1), farming experience, family size, educational qualification, type of land, land holding, Cost of cultivation, irrigation source, small farmers, medium farmers, government seed, own seed, private seed and variety

Table 3. t-statistic and the p-value from SPSS

	Model	Regression coefficients (β)	t-test	p-value
β_0	(Constant)	-9567.36	-0.408	0.684
X_1	Treatment (non-subsidized seed = 0, subsidized seed = 1)	167.02	1.581	0.116
X_2	Farming experience	3.87***	4.383	0.000
X_3	Family Size	-1.47	-0.257	0.797
X_4	Education qualification	30.22**	3.414	0.001
X_5	Type of land	-65.09**	-2.572	0.011
X_6	Land holding	163.52***	8.145	0.000
X_7	Cost of cultivation	0.005***	5.397	0.000
X_8	irrigation source	34.73	1.332	0.184
X_9	Small farmers group	14.74	0.839	0.402
X_{10}	Medium farmers group	4.48	0.098	0.922
X_{11}	Government seed	-215.113*	-1.955	0.052
X_{12}	Own seed	-12.03	-0.298	0.766
X_{13}	Private seed	-0.19	-0.005	0.996
X_{14}	Variety	-0.18	-0.006	0.996

and attain benefit from them. Finally, the effect of treatment, family size, irrigation source, small farmers group, medium farmers group, own seed, private seed and variety seems to be unrelated to the farm efficiency of farmers and were not key factors in predicting farm efficiency of groundnut farmers.

Hence, the multiple regression equation was formulated by (Equation):

$$Y = -9567.362 + 167.02X_1 + 3.87X_2 - 1.47X_3 + 30.22X_4 - 65.09X_5 + 163.52X_6 + 0.005X_7 + 34.73X_8 + 14.74X_9 + 4.48X_{10} - 215.113X_{11} - 12.03X_{12} - 0.190X_{13} - 0.127X_{14} + \mu$$

A similar regression model was employed by Bhatta *et al.* (2009). They estimated the determinants of farmers' willingness to pay for organic agriculture inputs and found that the total variation of unlabelled and labelled organic vegetables was explained to the extent of 58 per cent and 63 per cent by the selected independent variables like education, age, family income and family size.

The study on analysis of the determinants of groundnut on farm efficiency in Ananthapuramu district of Andhra Pradesh brought out the following conclusions: To identify the determinants of the groundnut farmers regression analysis was used, farming experience, education qualification, land holding, cost of cultivation, type of land and government seed had a significant impact influencing the farm efficiency of farmers. But explanatory variables viz., for treatment, family size, irrigation source, small farmers group, medium farmers group, own seed, private seed and variety were found to be non-significant and were not key factors in predicting farm efficiency of groundnut farmers.

It was suggested that as main component of cost of cultivation in groundnut is seed cost for increased farm efficiency among small and marginal groundnut farmers, government needs to take measures for increased supply of groundnut seed on subsidy for increased farm efficiency.

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GENETIC VARIABILITY STUDIES FOR YIELD AND YIELD ATTRIBUTING CHARACTERS IN RICE (*Oryza sativa* L.)

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ABSTRACT

In the present study, analysis of variance for 60 rice genotypes revealed significant differences among the genotypes for 15 yield and yield attributes indicating the presence of considerable amount of genetic variability among the rice genotypes. Higher estimates of PCV and GCV observed for number of chaffy grains panicle^{-1}, number of filled grains panicle^{-1}, number of spikelets panicle^{-1}, grain yield plant^{-1} and thousand grain weight showed ample amount of variation for these traits. High heritability coupled with high genetic advance as per cent of mean was observed for days to 50% flowering, days to maturity, thousand grain weight, number of chaffy grains panicle^{-1}, grain L/B ratio, grain width, plant height, number of spikelets panicle^{-1}, number of filled grains panicle^{-1} and grain yield plant^{-1} indicating the predominance of additive gene action and direct selection would be effective for improvement of these traits.

KEYWORDS: PCV, GCV, Heritability, Genetic Advance.

INTRODUCTION

Rice (*Oryza sativa* L.) is a widely grown crop, staple food and major calorie source for over 3 billion people on the earth. It occupies a pivotal place in Indian agriculture as it is a staple food for more than 70% of population and source of livelihood for about 150 million rural households (Devi *et al*., 2022).

Globally rice is cultivated in 164.19 million hectares of area with production of 756 million tonnes (FAO, 2020). In India, rice is grown around in 45.07 million hectares with a production of 122.27 million tonnes of grains (Directorate of Economics and Statistics, 2021). In Andhra Pradesh, rice is a major crop cultivated in 2.55 million hectares with a production of 13.08 million tonnes annually with a productivity of 5.13 tonnes hectare^{-1} (Directorate of Economics and Statistics, 2021).

Exploiting existing genetic variability in the population is the principle behind every successful crop improvement programme. Presence of adequate genetic variability provides an opportunity for plant breeder to select desirable genotypes for hybridization. Assessment of heritability is useful in defining genetic relationship between parents and progeny and to understand the characters that are under genetic control. Heritability estimates accompanied with genetic advance is useful in measuring genetic gain under selection, to predict genetic advance of the trait and also to formulate suitable selection procedure.

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^2_{bs}) and genetic advance.

The present investigation was conducted to elucidate the information regarding variability, heritability and genetic advance in promising rice genotypes.

MATERIAL AND METHODS

The present investigation was carried out during *kharif* 2021 at Wetland Farm, S.V. Agricultural College, Tirupati, Chittoor District, Andhra Pradesh, India, located at geographical co-ordinates of 13°54' N *latitude* and 79°54' E *longitude*, and 182.9 m *altitude*. Experiment

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was laid out in randomized block design with two replications. In each replication, every genotype was transplanted in two rows of two meters length with a spacing of 20 cm × 15 cm. All the recommended package of practices were adopted during entire crop season to raise healthy crop. Observations were recorded for 15 yield and yield attributing characters. Data was subjected to statistical analysis for assessing phenotypic and genotypic coefficient of variation (Burton, 1952), heritability (Allard, 1960) and genetic advance as percent of mean (Johnson *et al*., 1955).

RESULTS AND DISCUSSION

Analysis of variance revealed significant differences among genotypes for all the 15 yield and yield attributing characters indicating the presence of sufficient genetic variability among the genotypes (Table 1). Phenotypic coefficient of variance (PCV) was slightly higher than genotypic coefficient of variance (GCV) for the traits studied indicating less interaction of traits with environment (Table 2).

High estimates of GCV and PCV were observed for number of chaffy grains panicle^{-1} (GCV = 44.37 %; PCV = 45.32 %), number of spikelets panicle^{-1} (GCV = 26.53%; PCV = 28.50%), number of filled grains panicle^{-1} (GCV = 26.29%; PCV = 29.12%), grain yield plant^{-1} (GCV = 23.81%; PCV = 29.76%) and thousand grain weight (GCV = 20.20%; PCV = 220.32%). This indicated the presence of extensive inherent variability in these traits remain unaltered by environmental conditions among the genotypes, which in turn was more useful for exploitation in selection.

Similarly, high estimates of GCV and PCV were reported by Lakshmi *et al*. (2021), Singh *et al*. (2021) and Saha *et al.* (2019) for number of chaffy grains panicle^{-1}; Singh *et al.* (2022) and Saha *et al.* (2019) for number of spikelets panicle^{-1}; Devi *et al.* (2022), Gupta *et al.* (2022), Singh *et al.* (2022), Lakshmi *et al.* (2021), Singh *et al.* (2021) and Saha *et al.* (2019) for number of filled grain panicle^{-1}; Devi *et al*. (2022), Gupta *et al*. (2022), Bhargavi *et al*. (2021), Lakshmi *et al*. (2021), Singh *et al*. (2021) and Saha *et al.*(2019) for grain yield plant^{-1}; Devi *et al*. (2022), Bhargavi *et al*. (2021) and Saha *et al.* (2019) for thousand grain weight.

Grain L/B ratio (GCV = 15.10%; PCV = 15.59%), days to 50% flowering (GCV = 14.78%; PCV = 14.79%), plant height (GCV = 14.18%; PCV = 15.14%), days to maturity (GCV = 12.34%; PCV = 12.35%) and grain width (GCV = 11.41%; PCV = 11.84%) had moderate values for GCV and PCV. While, number of effective tillers plant^{-1} had moderate GCV (17.93%) and high PCV (24.17%). This indicated the existence of sufficient variability for attempting selection to improve these traits in the genotypes studied. These findings were in consonance with Gupta *et al*. (2022), Priyanka *et al*. (2020) for grain L/B ratio; Gupta *et al*. (2022), Singh *et al*. (2022), Lakshmi *et al*. (2021), Singh *et al*. (2021), Sudeepthi *et al*. (2020) and Dhavaleswar *et al*. (2019) for plant height and Bhargavi *et al*. (2021) and Lakshmi *et al*. (2021) for days to 50% flowering.

Low estimates of GCV and PCV were recorded for spikelet fertility % (GCV = 7.46%; PCV = 7.90%), grain thickness (GCV = 7.09%; PCV = 7.35%), indicating narrow range of variability for these traits there by restricting the scope of simple selection. Similar kind of low estimates of variability was also reported by Sudeepthi *et al*. (2020) Swapnil *et al*. (2020) and Dhavaleshvar *et al.* (2019) for spikelet fertility %. While, grain length (GCV = 9.93%; PCV = 10.20%) and Panicle length (GCV = 9.17%; PCV = 11.05%) had low GCV and moderate PCV estimates which was supported by findings of Bhargavi *et al*. (2021) and Lakshmi *et al*. (2021) for panicle length.

High heritability was observed for all the characters except number of effective tillers plant^{-1} (55.00%) which registered moderate heritability. Days to 50% flowering and days to maturity had highest heritability value (99.90%) followed by thousand grain weight (98.90%), number of chaffy grains panicle^{-1} (95.80%), grain length (94.80%), grain L/B ratio (93.70%), grain width (92.90%), grain thickness (92.90%), spikelet fertility % (89.20%), plant height (87.70%), number of spikelets panicle^{-1} (86.70%), number of filled grains panicle^{-1} (81.50%), panicle length (68.80%) and grain yield plant^{-1} (64.00%).These characters can serve as effective selection parameters during breeding programmes for the improvement of productivity. Simple selection based on *per se* performance is effective for improving the performance of these characters.

Likewise, high estimates of heritability were reported by Devi *et al.* (2022) and Bhargavi *et al.* (2021) for days to 50% flowering, thousand grain weight and grain yield plant^{-1}; Gupta *et al.* (2022) and Bhargavi *et al.* (2021) for both days to maturity and grain L/B ratio; Lakshmi *et al.* (2021), Singh *et al.* (2021) and Saha *et al.* (2019) for both number of chaffy grains panicle^{-1} and plant height; Bhargavi *et al.* (2021) for both grain length and grain width; Singh *et al.* (2022), Swapnil *et al.*

Table 1. Analysis of Variance for yield and yield attributing characters in 60 rice genotypes

S. No.	Characters	Mean sum of squares		
		Replications (df = 1)	Genotypes (df = 59)	Error (df = 59)
1	Days to 50% flowering	0.01	429.83**	0.25
2	Days to maturity	0.03	493.58**	0.36
3	Plant height	54.41	613.19**	40.22
4	Panicle length	0.94	13.66**	2.53
5	Total number of effective tillers plant^{-1}	1.78	6.93**	2.01
6	Number of chaffy grains panicle^{-1}	0.43	628.55**	13.34
7	Number of filled grains panicle^{-1}	36.08	5220.04**	532.84
8	Number of spikelets panicle^{-1}	44.41	7586.69**	541.68
9	Spikelet fertility	0.05	79.73**	4.55
10	Grain yield plant^{-1}	45.58	55.56**	12.19
11	Thousandgrain weight	0.02	36.19**	0.21
12	Grain length	0.01	1.60**	0.04
13	Grain width	0.02	0.20**	0.01
14	Grain thickness	0.00	0.03**	0.00
15	Grain L/B ratio	0.04	0.51**	0.02

** : Significant at 1% level

(2020) and Saha *et al.* (2019) for number of filled grains panicle^{-1} and number of spikelets panicle^{-1}; Singh *et al.* (2021), Sudeepthi *et al.* (2020) and Saha *et al.* (2019) for spikelets panicle^{-1}; Singh *et al.* (2022) and Bhargavi *et al.* (2021) for panicle length and moderate heritability were reported by Devi *et al.* (2022) and Singh *et al.* (2021) for number of effective tillers plant^{-1}.

Highest genetic advance as per cent of mean was observed for number of chaffy grains panicle^{-1} (89.48%) followed by number of spikelets panicle^{-1} (50.88%), number of filled grains panicle^{-1} (48.88%), thousand grain weight (41.37%), grain yield plant^{-1} (39.24%), days to 50% flowering (30.44%), grain L/B ratio (30.10%), number of effective tillers plant^{-1} (27.41%), plant height (27.35%), days to maturity (25.40%) and grain width (22.66%).On contrary, moderate values of genetic advance as per cent of mean were observed for grain length (19.92%), panicle length (15.66%), spikelet fertility (14.52%) and grain thickness (14.07%).

Heritability refers to the heritable portion of phenotypic variance. The magnitude of heritability indicates the reliability with which the genotype will be recognized by its phenotype expression. Heritability (h^2_{bs}) coupled with genetic advance as per cent of mean (GAM) will bring out the genetic gain expected from selection than heritability alone (Johnson *et al.,* 1955). Hence, high heritability coupled with high genetic advance as per cent of mean could be considered for the selection of elite genotypes.

High heritability coupled with high genetic advance as per cent of mean was recorded in number of days to 50% flowering (h^2_{bs} = 99.90%; GAM = 30.44%), days to maturity (h^2_{bs} = 99.90%; GAM = 25.40%), thousand grain weight (h^2_{bs} = 98.90%;GAM= 41.37%), number of chaffy grains panicle^{-1} (h^2_{bs} = 95.80%; GAM = 89.48%), grain L/B ratio (h^2_{bs} = 93.70%; GAM = 30.10%), grain width (h^2_{bs} = 92.90%; GAM = 22.66%), plant height (h^2_{bs} = 87.70%; GAM = 27.35%), number of spikelets panicle^{-1} (h^2_{bs} = 86.70%; GAM = 50.88%), number of filled grains panicle^{-1} (h^2_{bs} = 81.50%; GAM = 48.88%) and grain yield plant^{-1} (h^2_{bs} = 64.00%; GAM = 39.24%). It indicates the presence of additive gene action and less influence of environment on expression of these characters. Early and simple selection could be exercised due to fixable additive gene effects.

Table 2. Variability and genetic parameters for yield and yield attributing characters in 60 rice genotypes

S. No.	Character	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	**DFF**	99.14	77.00	155.00	214.79	215.04	14.78	14.79	99.90	30.17	30.44
2	**DM**	127.28	99.00	186.50	246.61	246.97	12.34	12.35	99.90	32.33	25.40
3	**PH**	119.40	92.50	182.50	286.48	326.71	14.18	15.14	87.70	32.65	27.35
4	**PL**	25.74	20.30	32.50	5.57	8.10	9.17	11.05	68.80	4.03	15.66
5	**ET**	8.75	5.50	13.00	2.46	4.47	17.93	24.17	55.00	2.40	27.41
6	**CG**	39.53	13.50	88.90	307.61	320.95	44.37	45.32	95.80	35.37	89.48
7	**FG**	184.18	91.00	306.60	2343.60	2876.44	26.29	29.12	81.50	90.02	48.88
8	**TS**	223.71	134.40	357.60	3522.51	4064.18	26.53	28.50	86.70	113.82	50.88
9	**SF**	82.17	66.98	92.27	37.59	42.14	7.46	7.90	89.20	11.93	14.52
10	**GY**	19.56	9.49	33.22	21.68	33.88	23.81	29.76	64.00	7.68	39.24
11	**TGW**	21.00	13.01	29.30	17.99	18.20	20.20	20.32	98.90	8.69	41.37
12	**GL**	8.89	7.45	10.88	0.78	0.82	9.93	10.20	94.80	1.77	19.92
13	**GW**	2.75	2.18	3.49	0.10	0.11	11.41	11.84	92.90	0.62	22.66
14	**GT**	1.68	1.33	2.00	0.01	0.02	7.09	7.35	92.90	0.24	14.07
15	**L/B**	3.28	2.28	4.77	0.25	0.26	15.10	15.59	93.70	0.99	30.10

DFF : Days to 50% flowering; CG : Number of chaffy grains panicle^{-1}; TGW : Thousand grain weight (g); DM : Days to maturity; FG : Number of filled grains panicle^{-1}; GL : Grain length (mm); PH : Plant height (cm); TS : Number of spikelets panicle^{-1}; GW : Grain width (mm); PL : Panicle length (cm); SF : Spikelet fertility (%); GT : Grain thickness (mm); ET : Total number of effective tillers plant^{-1}; GY : Grain yield plant^{-1} (g); L/B : Grain L/B ratio

A similar kind of results for high heritability coupled with high genetic advance was earlier reported by Devi *et al*. (2022), Bhargavi *et al*. (2021) and Lakshmi *et al.* (2021) for days to 50% flowering, grain yield plant^{-1}, thousand grain weight; Lakshmi *et al.* (2021), Singh *et al*. (2021) and Saha *et al.* (2019) for number of chaffy grains panicle^{-1} and number of filled grains panicle^{-1}; Singh *et al*. (2022) and Saha *et al.* (2019) for number of spikelets panicle^{-1}; Singh *et al*. (2022), Lakshmi *et al.* (2021) and Dhavaleswar *et al*. (2019) for plant height; Gupta *et al*. (2022) and Bhargavi *et al*. (2021) for grain L/B ratio.

Grain length (h^2_{bs} = 94.80%; GAM = 19.92%), grain thickness (h^2_{bs} =92.90%; GAM= 14.07%), spikelet fertility % (h^2_{bs}= 89.20%; GAM = 14.52%) and panicle length (h^2_{bs} = 68.80%; GAM= 15.66%) had high heritability but moderate genetic advance as per cent of mean. The high heritability is exhibited due to favourable environment effect rather than the genotype and selection for such characters may not be rewarding. These characters showing high heritability along with moderate genetic advance can be improved by intermating superior genotypes of segregating population developed from combination breeding.

These results were in accordance with Bhargavi *et al*. (2021) and Saha *et al.* (2019) for panicle length; Bhargavi *et al.* (2021) for grain length and Sudeepthi *et al.* (2022) for spikelet fertility.

Number of effective tillers plant^{-1} showed moderate heritability and high genetic advance as per cent of mean (h2bs = 55.00%; GAM = 27.41%). It shows the presence of additive gene action. Hence, selection may be effective for the improvement of this character.

From the foregoing discussion, it was evident that number of chaffy grains panicle^{-1}, number of filled grains panicle^{-1}, number of spikelets panicle^{-1}, grain yield plant^{-1} and thousand grain weight exhibited sufficient variation among genotypes and hence direct selection may be effective for these characters. PCV is greater than GCV for all these characters which indicates less influence of environment on expression of traits.

High heritability coupled with high genetic advance as per cent of mean was recorded in number of days to 50% flowering, days to maturity, thousand grain weight, number of chaffy grains panicle^{-1}, grain L/B ratio, grain width, plant height, number of spikelets panicle^{-1}, number of filled grains panicle^{-1} and grain yield plant^{-1}. It indicates the presence of additive gene action in inheritance of these characters and the influence of environment is less on expression of these characters. Early and simple selection could be exercised due to fixable additive gene effects observed for yield and its components in the present study material.

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YIELD AND NUTRIENT UPTAKE OF FINGER MILLET (*Eleusine coracana* (L.) Gaertn.) AS INFLUENCED BY ORGANIC NUTRIENT MANAGEMENT PRACTICES

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ABSTRACT

A field experiment entitled "Yield and nutrient uptake of finger millet (*Eleusine coracana* (L.) Gaertn.) as influenced by organic nutrient management practices" was conducted at S. V. Agricultural College Farm, Tirupati, Acharya N. G. Ranga Agricultural University, Andhra Pradesh, India during *rabi*, 2021-22. The experiment was laidout in split-plot design and replicated thrice. The treatments consisted of four organic manures *viz.,* M_1: 100% N through Farmyard manure, M_2: 100% N through Poultry manure, M_3: 100% N through Sheep manure and M_4: 100% N through Vermicompost, assigned to main plots, five foliar sprays *viz.,* F_1: Water spray, F_2: Waste decomposer, F_3: Panchagavya @ 3%, F_4: Jeevamrutha @ 10% allotted to sub plots. Among the different organic manures, application of 100% N through poultry manure resulted in significantly higher grain yield, straw yield and nutrient uptake over rest of the treatments tried. Foliar application of waste decomposer recorded significantly higher grain yield, straw yield and nutrient (N, P and K) uptake by finger millet. The interaction between the organic manures and foliar sprays was not statistically traceable.

KEYWORDS: Finger millet, Organic manures and Foliar sprays.

INTRODUCTION

In the recent times, millets have gained popularity due to their high nutritional value, well-documented health advantages, adaptability to a variety of environments, sustainability to low-input agriculture and feasibility for growing organically. The majority of millet crops are native to India and are known as "Nutri-Cereals" because they provide the vital nutrients needed for normal human body functioning. Nearly 97% of millets are produced in the developing countries, within the semi-arid tropics of Asia and Africa.

Finger millet being rich in calcium, iron and protein with a balanced amino acid profile and lower glycemic index offers plausible health benefits and thus referred as a miracle grain. Recently it is re-emerging as a vital dietary food crop owing to increased public awareness due to it's nutritional value. Finger millet is a versatile climate resilient crop with wider adaptability to adverse weather conditions with low input requirement, which made it an outstanding subsistence food crop.

The information on sustainable productivity of finger millet with use of organic manures *viz*., poultry manure, farmyard manure, sheep manure and vermicompost in finger millet is essential. The soil is loosing its productivity over years making the farming more miserable. In order to bring back the productivity of soil, there is a need to improve physical, chemical and biological properties of soil. Organic farming is being advocated as an alternate farming system for sustainable agriculture. A stage has reached that supplementary and complementary role of organic materials is being felt once again for sustainable agriculture and to keep the soil health.

To compensate the slow release of nutrients from the bulky organic manures, foliar nutrition provides an excellent way for absorption of nutrients as it can be applied directly to the site of metabolism through translocation of nutrients during peak periods of crop growth. Plants absorb nutrients more efficiently through their stomata in the leaves than through root absorption, thus organic foliar supplementation is safe to crop (Sujatha *et al*., 2016). As a result, using appropriately formulated foliar sprays such as waste decomposer, panchagavya and jeevamrutha are the best ways to ameliorate the micronutrient deficiencies encountered in organic cultivation. They are proved to contain macro, micronutrients, essential amino acids, growth promoting factors like IAA, GA and rich in microbial diversity. Variety of beneficial microorganisms present in the foliar sprays may activate biological reactions to restore soil fertility, further acting as plant growth stimulants (Swaminathan, 2005 and Sreenivasa *et al.*, 2011).

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MATERIALS AND METHODS

A field experiment entitled "Yield and nutrient uptake of finger millet (E*leusine coracana* (L.) Gaertn.) as influenced by organic nutrient management practices" was conducted during *rabi,* 2021-22 at dryland farm of S.V. Agricultural College, Tirupati, Acharya N. G. Ranga Agricultural University, which is located in the Southern Agro-Climatic Zone of Andhra Pradesh, which is geographically located at 13.5°N latitude and 79.5°E longitude and at an altitude of 182.9 m above the mean sea level. The soil of experimental field was sandy loam in texture, neutral in reaction, low in organic carbon (0.26%) and available nitrogen (194 kg ha^{-1}), medium in available phosphorus (27 kg ha^{-1}) and available potassium (204 kg ha^{-1}). The experiment was laidout in a split-plot design with three replications. The treatments include four organic manure levels *viz.,* M_1: 100% N through Farmyard manure, M_2: 100% N through Poultry manure, M_3: 100% N through Sheep manure and M_4: 100% N through Vermicompost assigned to main plots and five foliar sprays *viz.,* F_1: Water spray, F_2: Waste decomposer, F_3: Panchagavya @ 3% spray and F_4: Jeevamrutha @ 10% at 20, 40 and 60 DAT allotted to sub plots. The crop was sown at 25 cm x 10 cm spacing with a seed rate of 5 kg ha^{-1}. The variety Tirumala was sown on 25th of November and recommended dose of the fertilizer 60 kg N: 30 kg P_2O_5: 20 K_2O ha^{-1} was applied. All the other recommended management practices were also adopted as per the crop requirement. The collected data was statistically analyzed following the analysis of variance for split-plot design as given by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

GRAIN YIELD

Among the organic manures, soil application of 100% N through poultry manure (M_2) recorded significantly highest grain yield followed by 100% N through vermicompost (M_4), which was however comparable with 100% N through farmyard manure (M_1). Significantly lowest grain yield of finger millet was recorded with soil application of 100% N through sheep manure (M_3).

The highest grain yield recorded with application of poultry manure (M_2) might be due to higher concentration of macro and micronutrients in conjunction with steady nutrient release throughout the crop growth period. Poultry manure produces more humic acid, which form water soluble chelated phosphorus, which might have helped in easy release of phosphorus to the crop, which in turn resulted in increased grain yield. These results are in conformity with those of Jagadeesha *et al*. (2010), Sangeetha *et al*. (2013), Prakash *et al*. (2018), Priya and Satyamoorthi (2019), Aravind *et al*. (2020) and Ledhan *et al*. (2021).

Among the organic foliar sprays, application of waste decomposer (F_2) recorded significantly the highest grain yield, followed by jeevamrutha @ 10% (F_4), which was however, comparable with panchagavya @ 3% (F_3).

Foliar application of waste decomposer resulted in increased absorption and translocation of nutrients, which might have resulted in increased grain yield. Waste decomposer is a promising tool for achieving good quality crop and high yield as it is having microorganisms, which secrets primary metabolites including polyketides and alkanes. Besides this, it also produces glucanase, which trigger defence mechanism and thus, ultimately resulted in higher grain yield. The lowest grain yield was recorded with water spray due to the non-availability of nutrients. The lowest grain yield recorded with water spray (F_1) might be due to poor source sink relationship owing to inadequate supply of nutrients. These results are in conformity with (Meena, 2021).

STRAW YIELD

Among the organic manures, soil application of 100% N through poultry manure (M_2) recorded significantly higher straw yield of finger millet, followed by 100% N through vermicompost (M_4), which was comparable with 100% N through farmyard manure (M_1). Soil application of 100% N through sheep manure (M_3) recorded significantly lowest straw yield of finger millet.

The highest straw yield associated with application of 100% N through poultry manure (M_2) might be due to better availability of NPK and micronutrients in poultry manure, which might have enhanced the plant activity thereby higher dry matter, which in turn resulted in higher straw yield. These results are in conformity with those of Gawade *et al*. (2013), Pallavi *et al*. (2016) and Reddy *et al*. (2021).

Among the organic foliar sprays, application of waste decomposer (F_2) recorded significantly the highest straw yield in finger millet. The straw yield recorded with

Table 1. Yield and nutrient uptake of finger millet at harvest as influenced by organic manures and foliar sprays

Treatments	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Nitrogen uptake (kg ha^{-1})	Phosphorus uptake (kg ha^{-1})	Potassium uptake (kg ha^{-1})
Organic manures (M)					
M_1 : 100% N through Farmyard manure	1306	2294	87.8	24.3	85.3
M_2 : 100% N through Poultry manure	1388	2439	105	29.6	102
M_3 : 100% N through Sheep manure	1217	2162	73.8	19.3	71.8
M_4 : 100% N through Vermicompost	1315	2309	90.8	25.8	91.7
SEm±	19	36	1.93	0.65	2.08
CD (P = 0.05)	67	125	6.8	2.3	7.3
Foliar sprays (F)					
F_1 : Water spray	1214	2054	77	20.9	75.6
F_2 : Waste Decomposer	1440	2585	103	28.2	98.6
F_3 : Panchagavya @ 3%	1284	2267	86.2	24.4	86.3
F_4 : Jeevamrutham @ 10%	1289	2327	90.5	25.5	90.4
SEm±	23	71	2.71	0.61	2.00
CD (P = 0.05)	67	209	7.9	1.8	5.9
Organic manures (M) × Foliar sprays (F)					
M at F					
SEm±	38	128	5.07	1.24	4.04
CD (P = 0.05)	NS	NS	NS	NS	NS
F at M					
SEm±	44	173	3.87	1.30	4.16
CD (P = 0.05)	NS	NS	NS	NS	NS

application of jeevamrutha @ 10% (F_4) and panchagavya @ 3% (F_3) were comparable with each other. The lowest straw yield in finger millet was recorded with water spray (F_1).

The highest straw yield was recorded with foliar spray of waste decomposer (F_2) might be due to rise in microbial count in the soil thus enabling the environment congenial for release of nutrients and enzymes by decomposing the crop residue, thereby enhancing plant activity, which in turn resulted in better plant stand, more LAI, higher dry matter production and ultimately resulted higher straw yield (NCOF, Ghaziabad).

NUTRIENT UPTAKE

During the study, among the organic manures, significantly highest nutrient (nitrogen, phosphorus and potassium) uptake by plant was observed with application of 100% N through poultry manure (M_2). Application of 100% N through vermicompost (M_4) and 100% N through farmyard manure (M_1) were the next best nutrient uptake treatments and were comparable with each other. The lowest nutrient uptake was recorded with application 100% N through sheep manure (M_3).

The higher nutrient uptake in poultry manure was due to the fact that it produces more humic acid, which form water soluble chelated phosphorus, which helped in easy release of phosphorus to the crop. It helps in supplying the nutrients in soluble form for a quite longer period by not allowing the entire soluble form to come in contact with soil and other inorganic constituents, thereby minimizing fixation and precipitation of nutrients. Probably adequate supply of nutrients could have resulted in higher uptake of nutrients. These findings are in agreement with Hossain *et al*. (2010), Sangeetha *et al*. (2013), Prakash *et al*. (2018) and Nayak *et al*. (2020). Further, organic manures reduced the loss of nutrients through leaching and made available to plant, which created a balancing effect on supply of nitrogen, phosphorus and potassium.

Application of poultry manure could have released the nutrients slowly into the soil solution to match the required absorption pattern of finger millet. Similar findings are also reported by Devegowda (1997) and opined that poultry manure contain higher concentration of macro and micronutrients that contributed to the higher availability and uptake of nutrients than farmyard manure, vermicompost and sheep manure.

Among the foliar sprays, significantly the highest nutrient uptake was observed with waste decomposer (F_2) followed by jeevamrutha @ 10% (F_4), which was however, comparable with panchagavya @ 3% (F_3). Significantly the lowest nutrient uptake was noticed with water spray (F_1).

The increase in uptake of nutrients with foliar spray of waste decomposer is due to the fact that it contains beneficial microorganisms along with plant growth stimulating substances and nutrients, which might have increased the biological efficiency of the crop plants and thereby creating the better source and sink relationship, which might have contributed for greater absorption and translocation of nutrients (NCOF, Ghaziabad).

In conclusion, the present investigation revealed that higher productivity of finger millet and soil health could be obtained with the application of 100% N through poultry manure along with foliar spraying of waste decomposer at 20, 40 and 60 DAT during *rabi* in Southern Agro-Climatic Zone of Andhra Pradesh.

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EFFECT OF WEATHER PARAMETERS ON THE INCIDENCE OF THRIPS IN RABI GROUNDNUT

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ABSTRACT

The details on the correlation between various weather parameters and the occurrence of major sucking pests like thrips in Groundnut will be extremely useful in developing better Integrated Pest Management (IPM) methods, as weather parameters determine the pest's population build up and severity. Field experiment conducted to study the incidence of thrips in Groundnut during rabi,2021-22 revealed that thrips population and damage on the crop commenced from 15 DAS and continued up to the end of the crop period. Thrips population reached peak during 6th SW of 2022 at 64 DAS with 6.44 thrips/plant. The infestation level reached to peak level from 64 DAS (97.05%) and there after became 100% by the end of crop period. However, the highest number of thrips (6/plant) was recorded during 64 to 78 DAS (i.e., 6,7 and 8 SW'S, February 2022). Correlation of weather parameters viz.,Maximum and Minimum Temperatures, Morning and Evening Relative Humidity, Rainfall and Sunshine hours with the incidence of Thrips revealed that thrips showed non-significant positive correlation with Max., Min. Temperatures, Morning Relative Humidity and sunshine hours and Negative correlation with Evening RH and Rainfall.

KEYWORDS: Thrips, Standard Week (SW), Weather Parameters, Correlation.

INTRODUCTION

Groundnut, *Arachis hypogea* L., is a tetra foliate legume with yellow sessile flowers and subterranean pods which belongs to the family Fabaceae. The word *Arachis hypogea* was derived from two Greek words, *Arachis* which means 'legume' and *hypogea* means 'below ground'. South America is considered to be the primary centres of origin for groundnut because of the presence of diversity of wild species in that continent. It is also known as peanut, monkey nut, earth nut *etc.* It is the fourth principal source of edible oil and the third largest source of vegetable protein grown in tropical and subtropical countries. India is one of the world's largest exporters and trades closely with Brazil, the US and China with a 20-25% stake in global markets. (IOPEPC *kharif* - 2017).

Groundnut is described as the "King of oil seeds" because of its high oil content (43-45%) and protein (25-28%) and also a valuable source of vitamins *viz*., B, E and K. Groundnut cake after oil extraction is a high protein animal feed and haulm provides quality fodder. The edible oil is used for cooking. It is commonly used in preparation of medicines and high-quality soaps.

India is one of the leading countries in the cultivation of groundnut, grown in 4. 82 million hectares, with a production of 9.95 million tonnes and an average productivity of 2063 kg/ha. (www.indiastat.com, Ministry of Agriculture and Farmers welfare, Government of India, 2020). In Andhra Pradesh, groundnut occupies an area of 0.66 million hectares with a total production of 0.848 million tonnes and productivity of 1284 kg/ ha (www.indiastat.com). Amongst different districts of Andhra Pradesh, in Chittoor, groundnut is grown in an area of 1.08 lakh hectares, with a total production of 2.04 lakh tonnes and productivity of 1732 kg ha^{-1} (*kharif*) and 3050 kg ha^{-1} (*rabi*) (Directorate of Economics and Statistics, 2020). Despite of its high production potential, the actual yield in the farmer's field is quite low, largely because of major rainfed cultivation, and the crop may be harmed by either mid-season or late season drought and also due to insects and diseases.

Groundnut crop is attacked by about 100 species of insect pests (Baskaran and Rajavel, 2013). A total of 13 species of sucking insect pests were found feeding and damaging the groundnut crop (Kandakoor *et al*., 2012). The major sucking pests of groundnut includes thrips *viz., Scirtothrips dorsalis* Hood*, Frankliniella schultzei* Trybom*, Thrips palmi* Karny, *Caliothrips indicus* Bannall and leafhopper, *Empoasca kerri* Pruthi and aphid, *Aphis craccivora* Koch, apart from few other minor sucking pests (Gocher and Ahmed, 2019).

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Thrips mainly feed by lacerating and sucking the sap from leaves. Thrips live in young foliage especially between the folded groundnut leaflets and flowers that inhibit terminal buds and flowers. Both nymphs and adults feed by rasping the surface of rapidly growing leaf tissues and suck the released plant fluid. They cause tiny scars on leaves leading to stunted plant growth. Damaged leaves may become papery and distorted, infested terminal leaves lose colour, rolled up and drop before maturity (Chisholm and Lewis, 1984). Apart from the direct damage by thrips, they play a significant role in transmission of viral diseases. Thrips act as vectors for bud necrosis/stem necrosis disease caused by tomato spotted wilt virus and the disease has affected 2,25,000 hectares in Anantapur district during *kharif*, 2000 causing a monitory loss of 3 billion rupees (Rao *et al*., 2003).

In recent seasons, these thrips have been noticed as menace to groundnut crop by attaining major pest status creating the necessity of attentive management than defoliators. The details on the correlation between various weather parameters and the occurrence of major sucking pests like thrips and leafhoppers will be extremely useful in developing better Integrated Pest Management (IPM) methods, as weather parameters determine the pest's population build up and severity. Hence, by considering the economic importance of thrips in groundnut, the present effect of weather parameters on incidence of thrips was carried out during *rabi* 2021-22.

MATERIALS AND METHODS

Details of experiment

The experiment was laid out in a plot size of 10 m x 10 m. The experiment was conducted with Dharani, a local popular variety of groundnut. Sowing of crop was carried out with a seed rate of 80 kg/ha with a spacing of 22.5 x 10 cm during *rabi* season at Dry land farm (l3°37'35'' N, 79° 21'52'' E), S.V. Agricultural College, Tirupati.

Observations on foliar damage and population of thrips and leafhoppers

At 15 DAS, five 1 m^2 areas were earmarked with pegs and each m^2 was labeled as 1, 2, 3, 4 and 5. From each m^2 area, the data on thrips and leafhoppers incidence and their population was recorded at weekly intervals starting from 15 days after sowing up to 106 days after sowing (Harvesting). Field observations were made as suggested by Kandakoor *et al.*, 2012.

Studying the incidence of thrips (*S. dorsalis*, *M. usitatus*, *F. schultzei* and *T. palmi*)

Recording the foliar damage by thrips

Foliar damage in each m^2 area was observed every time from 5 randomly selected tagged plants. Total no. of leaves were counted and multiplied with 4 and noted down as total no. of leaflets. Then from each plant, total no. of leaflets damaged by thrips were counted and recorded. Per cent leaves damaged by thrips was calculated by using the mean data obtained from 5 m^2 areas. The symptoms like fresh and old scratches on leaflets, mottling of leaflets, white pale spots on leaflets, elongation of leaflets due to all the rasping symptoms were considered for recording the leaf damage by thrips. Per cent leaf infestation data was subjected to angular transformation and statistical analysis (One way Repeated measures ANOVA) was carried using SPSS software

Recording the population of thrips

In each earmarked plant top growing portion was bent onto a clean A4 white paper and tapped gently. Tapping was carried out gently 4 to 5 times up to the time that almost all the thrips were fallen on to the paper from test plant. Terminal growing point was selected for counting, because it was observed that most of the thrips were preferring to feed on the tender parts where the leaves are highly succulent. No. of thrips fallen on to the paper were counted and noted down and the procedure was continued for all the tagged plants. Mean no. of thrips was calculated and subjected to square root transformation and statistical analysis was carried out using SPSS software.

Correlation studies

The weather parameters viz., maximum temperature (°C), minimum temperature (°C), rainfall (mm), relative humidity (%) and sunshine (hrs) were recorded at meteorological observatory, RARS, Tirupati. The mean weather data per 7 days (one week) was calculated from the recorded data. Correlation studies were carried out to know the impact of temperature, rainfall and relative humidity on the incidence of thrips.

RESULTS AND DISCUSSION

Recording the incidence of Thrips

During *rabi* 2021-22, field incidence of thrips in terms of foliar damage and population was recorded from 52nd standard week of 2021 to 12th standard week of 2022. The data indicated that the thrips damage was first noticed in 52nd SW of 2021 (15 DAS, I FN of December).

During 52nd SW of 2021(I FN of December), the intensity of damage was increased to 23.88 and the symptoms like rasping symptoms were observed on leaflets. The population was 1.84 thrips per plant (Table 1, 2).

Thrips belongs to the order Thysanoptera, having the rasping and sucking type of mouthparts (Asymmetrical type). They feed on leaf tissue by puncturing the epidermal (outer) layer of the host tissue and sucks the contents out of the cell which results in the discoloured flecking, silvering, scratches on leaves and elongation of leaves. The damage symptoms on leaflets were taken into consideration for recording the of percent foliar damage done by thrips.

The following symptoms were observed from the tender unopened and mature leaflets during the crop growth period.

- White minute spots on leaflets
- Old and fresh scratches on leaflets
- Narrowing, mottling and cupping of leaflets
- Elongation of leaflets due to rasping by thrips

Table 1. Incidence of Thrips at different periods of data record during *rabi,* 2021-22

Period	Standard week	Days after sowing	Mean % leaflet damage
17 Dec.- 23 Dec., 2021	51	15 DAS	14.90 (22.66)
24 Dec. -31 Dec., 2021	52	22 DAS	23.88 (29.24)
01 Jan. - 07 Jan., 2022	1	29 DAS	40.50 (39.52)
08 Jan.-14 Jan., 2022	2	36 DAS	51.93 (46.11)
15 Jan.- 21 Jan., 2022	3	43 DAS	72.24 (58.21)
22 Jan.- 28 Jan., 2022	4	50 DAS	82.12 (65.01)
29Jan. - 04 Feb., 2022	5	57 DAS	83.77 (66.26)
05 Feb. -11 Feb., 2022	6	64 DAS	97.05 (80.56)
12 Feb.-18 Feb., 2022	7	71 DAS	98.56 (83.42)
19 Feb.- 25 Feb., 2022	8	78 DAS	98.11 (82.94)
26 Feb.- 04 Mar., 2022	9	85 DAS	98.19 (83.07)
05 Mar.-11 Mar., 2022	10	92 DAS	98.96 (84.27)
12 Mar.-18 Mar., 2022	11	99 DAS	99.79 (87.77)
19 Mar.- 25 Mar., 2022	12	106 DAS	99.85 (88.17)
		Total Mean	**75.70** (65.51)

The values are means of five replications; Figures in parenthesis are angular transformed values.

Sum of One-way Repeated Measures ANOVA

Source of variation	df	F-value	p-value
DAS	13	2120.941**	.000
Error (DAS)	52		

**Significance at 1% level.

- Brown scratching spots representing rasping symptoms
- Scratches observed in various sizes

Symptoms of damage by thrips was observed at 15 Days After Sowing. At 15 DAS *i.e.,* during the 51st Standard week of 2021(I FN of December), 14.9 percent of leaflets were damaged by thrips and the population of thrips recorded was 1.32 per plant. Symptoms like white minute spots and fresh scratches on leaflets were noticed during the period of data record. At 29 DAS, during the 1st Standard week of 2022 (29 DAS, I FN of January), the percentage of foliar damage was raised from 23.88 to 40.5 percent and the population also increased from 1.84 to 2.96 thrips per plant. Same symptoms which were observed during the previous weeks was observed. In 2nd Standard week (36 DAS, I FN of January), 51.93 per cent damage was recorded and the population increased from 2.96 to 3.36 thrips per plant (Table 1, 2). Symptoms of damage observed during this period were fresh scratches in unopened leaflets and old scratches on matured leaflets along with narrowing of leaflets.

During the 3rd SW (43 DAS, II FN of January), damage recorded was 72.24 per cent and the thrips count recorded was increased from 3.36 to 3.56 per plant. This period has recorded the thrips population not only on the leaflets but also the rasping and scratchings were observed from flowers. Symptoms like narrowing, mottling and elongation of leaflets were observed during this period. A significant increase in damage was recorded from 4th SW (50 DAS, II FN of January) i.e., from 72.24 to 82.12 percent when the thrips population was 3.72 per plant. Same symptoms which were observed during the 3rd SW were noticed (Table 1, 2).

A slight increase in damage percentage was observed during the 5th standard week *i.e.,* from 82.12 to 83.77. The thrips count also increased from 3.72 to 4.16 per plant. At 64 DAS, i.e., 6th standard week of 2022 (I FN of February) almost all the leaflets were damaged by thrips. A highest damage percentage of 97.05 and the highest number of thrip count of 6.44 per plant was also recorded during this period.

From 7th SW (71 DAS, I FN of February, 2022) to 10th SW (92 DAS, I FN of March, 2022) the damage percentage varied from 98.56 to 98.96 and the thrip count shown a decline in population. The per cent foliar damage recorded from 7th, 8th, 9th and 10th was 98.56, 98.11, 98.19 and 98.96 per cent respectively and the population count recorded from these weeks was 5.88, 5.68, 4.6 and 4.44 respectively. By the last weeks of crop period i.e., 11th (99 DAS, I FN of March, 2022) and 12th SW's (106 DAS, II FN of March, 2022), the damage was still increased. The percent damage and thrips population noticed at 11th and 12th SW's was 99.79, 99.85 and 3.28, 3.68 respectively. All the symptoms such as old brown scratches on leaflets due to rasping and sucking by thrips, narrowing, elongation, mottling and cupping of leaflets were observed during the end of crop period (Table 1, 2).

From the Table 1 and 2, it is clearly evidenced that there is significant difference in incidence of thrips both in terms of foliar damage and population (F-value significant, p-value<0.05) between different standard weeks within the crop period.

Correlation studies

Correlation with weather parameters revealed that Thrips population showed non-significant positive correlation with Max temp. (r=0.261), Min Temp. (r=0.032), Sunshine hours (r=0.497) and morning relative humidity (r=0.131), whereas evening relative humidity (r=-0.336) and rainfall (r=-0.279) showed non-significant negative correlation. Foliar damage percentage done by thrips correlated with weather parameters showed significant positive correlation with Max temp. (r=0.99) and non-significant positive correlation with Min Temp. (r=0257) and Sunshine hours (r=0.375) whereas morning relative humidity (r=-0.360), evening relative humidity showed significant negative correlation (r=-0.654) and rainfall (r=-0.254) showed non-significant negative correlation.

The results are in agreement with Naresh *et al.* (2018) who reported the peak incidence of thrips on groundnut was observed from 52nd SW of 2015 to 17th SW of 2016. Saritha *et al.* (2020) reported that thrips attained peak in the 31st SMW and decreased till the

Table 2. Occurrence of Thrips population at different periods of data record during rabi, 2021-22

Period	Standard week	Days after sowing	Thrips Population/ plant
17 Dec.- 23 Dec., 2021	51	15 DAS	1.32 (1.70)
24 Dec. -31 Dec., 2021	52	22 DAS	1.84 (1.89)
01 Jan. - 07 Jan., 2022	1	29 DAS	2.96 (2.24)
08 Jan.-14 Jan., 2022	2	36 DAS	3.36 (2.37)
15 Jan.- 21 Jan., 2022	3	43 DAS	3.56 (2.13)
22 Jan.- 28 Jan., 2022	4	50 DAS	3.72 (2.16)
29Jan. - 04 Feb., 2022	5	57 DAS	4.16 (2.25)
05 Feb. -11 Feb., 2022	6	64 DAS	6.44 (2.72)
12 Feb.-18 Feb., 2022	7	71 DAS	5.88 (2.57)
19 Feb.- 25 Feb., 2022	8	78 DAS	5.68 (2.57)
26 Feb.- 04 Mar., 2022	9	85 DAS	4.6 (2.37)
05 Mar.-11 Mar., 2022	10	92 DAS	4.44 (2.30)
12 Mar.-18 Mar., 2022	11	99 DAS	3.28 (2.04)
19 Mar.- 25 Mar., 2022	12	106 DAS	3.68 (2.13)
		Total Mean	**3.92 (2.24)**

The values are means of five replications; Figures in parenthesis are angular transformed values.

Sum of One-way Repeated Measures ANOVA

Source of variation	df	F-value	p-value
DAS	13	3.38**	.000
Error (DAS)	52		

**Significance at 1% level.

38th SMW. Kumbar *et al.* (2021), where the incidence of thrips were noticed from vegetative stage to the end of crop period with peak incidence during post flowering to pod formation stage.

The results of present investigation are in line with Naresh *et al.* (2018) noticed that thrip population has shown positive correlation with maximum temperature and negative association with other weather factors like relative humidity which were in accordance with present results. Kumbhar *et al.* (2021) reported the positive influence of maximum and minimum temperatures on the thrips infestation was in conformity with the present findings. Similarly, Vijayalakshmi *et al.* (2017) also reported that population of thrips has shown nonsignificant positive correlation with minimum temperature and nonsignificant negative correlation with relative humidity. Kandakoor *et al.* (2012) noticed that thrips showed nonsignificant positive correlation with minimum temperature and sunshine hours and negative correlation with rainfall in groundnut crop.

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GENETIC PARAMETERS FOR QUANTITATIVE AND EARLY SEEDLING VIGOUR RELATED TRAITS IN RICE (*Oryza sativa* L.) UNDER DRY DIRECT SEEDED RICE CONDITIONS

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ABSTRACT

A study was conducted involving 40 rice genotypes for genetic variability of yield, yield attributes and early seedling vigour related traits under dry Direct Seeded Rice (DSR) conditions. The analysis of variance revealed significant differences for all the characters studied indicating the presence of considerable amount of variability among the genotypes. Phenotypic coefficient of variation was slightly higher than the corresponding genotypic coefficient of variation for all the traits under study. The characters *viz*., number of chaffy grains panicle^{-1}, 1000-grain weight, grain yield plant^{-1}, number of filled grains panicle^{-1} and seedling vigour index – II recorded high PCV, GCV, heritability (broad sense) and genetic advance as per cent of mean indicating that these characters were governed by additive gene action and simple selection would be more rewarding for their improvement.

KEYWORDS: Rice, dry DSR, heritability, genetic advance as per cent of mean, coefficient of variation.

INTRODUCTION

Rice (*Oryza sativa* L.) is the most important staple food crop. Rice is commonly cultivated by transplanting seedlings into the puddled soil. This transplanting method is water-intensive and labour-intensive and hence, less profitable. It leads to methane gas emissions as well and, hence, not eco-friendly; disturbs the physical properties of the soil thereby affecting the production of succeeding upland crops. These constraints necessitate a shift from puddled transplanting to Direct Seeded Rice (DSR). Direct seeding can be classified as (1) Wet-DSR, (in which sprouted seeds are broadcasted or sown in lines on wet soil), (2) Dry DSR, (where dry seeds are drilled or broadcasted on un puddled, dry soil). (3) Water seeding (where sprouted seeds are broadcasted in the standing water) (Mahender *et al*., 2015). Compared to wet and water DSR methods, dry DSR is more useful in many situations, as it involves less labour utilization, saves time to sow the crop, and utilizes less water. The dry DSR technique has made rice cultivation possible in areas with limited availability of water and labour. However, the major problems associated with direct seeding rice are intense weed competition in the early phases. Varieties with higher vigour under dry direct seeded conditions must be selected to enhance the competitiveness and initial crop establishment in DSR.

MATERIAL AND METHODS

The investigation was carried out during *Kharif*, 2021 at wet land farm, Sri Venkateswara Agricultural College, Acharya N. G. Ranga Agricultural University, Tirupati, Andhra Pradesh, India. The experimental material consists of 40 rice genotypes including advanced breeding lines, released varieties and land races grown in a Randomized Block Design with three replications under dry Direct Seeded Rice (DSR) conditions. Observations were recorded for yield and its attributes *viz.,* days to 50% flowering, days to maturity, panicle length (cm), plant height (cm), no. of panicles plant^{-1}, no. of filled grains panicle^{-1}, no. of chaffy grains panicle^{-1}, spikelet fertility (%), 1000 grain weight (g), grain length (mm), grain breadth (mm), grain L/B ratio and grain yield plant^{-1}. Early seedling vigour related traits such as germination percentage, shoot length (cm), root length (cm), seedling height (cm), seedling vigour index – I and seedling vigour index – II were recorded on the 14th day of germination test under laboratory conditions. Genotypic and phenotypic coefficients of variations were carried out as per the formula suggested by Burton (1952), while heritability and genetic advance were estimated according to Allard (1960) and Johnson *et al*. (1955) respectively.

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Table 1. Genetic parameters for yield, yield attributes and early seedling vigour related traits in 40 rice genotypes

S. No.	Character	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	95.81	63.67	112.00	171.93	195.98	13.69	14.61	87.73	25.30	26.41
2	Days to maturity	121.33	89.67	138.00	144.45	181.76	9.91	11.11	79.47	22.07	18.19
3	Plant height (cm)	78.83	62.07	120.67	206.44	252.97	13.23	20.18	81.61	26.74	33.92
4	Panicle length (cm)	20.99	16.93	26.60	5.14	9.23	10.31	14.47	55.74	3.49	16.62
5	No. of panicles plant^{-1}	9.42	6.00	13.67	2.03	3.45	15.11	19.72	58.70	2.25	23.35
6	No. of filled grains panicle^{-1}	127.44	30.33	227.33	966.62	1158.93	24.40	26.71	83.40	58.49	45.90
7	No. of chaffy grains panicle^{-1}	17.48	7.00	30.33	42.23	45.36	37.19	38.54	93.10	12.92	73.92
8	Spikelet fertility (%)	88.25	77.78	93.38	6.15	12.68	2.81	4.04	48.50	3.56	4.03
9	1000 grain weight (g)	21.33	10.82	36.43	50.60	54.62	33.35	34.65	92.63	14.10	66.13
10	Grain length (mm)	7.74	6.41	8.51	0.29	0.35	6.89	7.60	82.34	1.00	12.89
11	Grain breadth (mm)	2.60	1.94	3.10	0.09	0.10	11.71	12.44	88.55	0.59	22.69
12	Grain L/B Ratio	3.02	2.28	4.03	0.14	0.15	12.44	13.00	91.53	0.74	24.53
13	Grain yield plant^{-1}	21.54	11.08	39.76	31.93	37 34	26.25	28.36	85.66	10.78	50.05
14	Germination (%)	87.41	66.67	100.00	95.06	107.60	11.15	11.37	88.35	13.38	21.60
15	Shoot length (cm)	9.21	6.82	13.53	1.20	2.03	11.91	15.47	59.31	1.74	18.90
16	Root length (cm)	9 53	5.67	13.13	1.36	2.87	14.33	17.79	64.90	2.27	23.73
17	Seedling height (cm)	18.65	14.21	26.65	4.93	5.60	11.91	12.69	88.09	4.30	23.03
18	Seedling vigour index-I	1623.17	1201.33	2532.33	75284.39	82089.48	16.90	17.65	91.71	541.29	33.35
19	Seedling vigour index-II	12.81	5.56	20.67	9.12	9.56	23.57	24.12	95.47	6.03	47.44

RESULTS AND DISCUSSION

The analysis of variance revealed significant differences for all the characters studied indicating the presence of considerable amount of variability among the genotypes. The grand mean, range, variance, phenotypic and genotypic coefficients of variation, heritability and genetic advance as percentage of mean are presented in Table 1.

The phenotypic coefficient of variation was slightly higher than the corresponding genotypic coefficient of variation indicating that the existing variation is not only due to differences among the genotypes but also due to environment. Highest estimates of GCV was recorded for number of chaffy grains panicle^{-1} (37.19%), followed by 1000-grain weight (33.35 %), grain yield plant^{-1} (26.25%), number of filled grains panicle^{-1} (24.40 %), seedling vigour index – II (23.57%). This indicated the presence of extensive inherent variability among the genotypes, which is more useful for exploitation in selection. Similar higher estimates of variability were reported earlier by Dhanwani *et al*. (2013) for number of chaffy grains panicle^{-1}; Ekka *et al.* (2015), Ashok *et al.* (2016), Devi *et al.* (2020), Mishra *et al.* (2021) and Shrestha *et al.* (2021) for Grain yield plant^{-1} and Devi *et al.* (2020) for number of filled grains panicle^{-1} and 1000-grain weight

High heritability was recorded for the characters *viz.,* seedling vigour index – II (95.47 %), number of chaffy grains panicle^{-1} (93.10%), 1000-grain weight (92.63 %), seedling vigour index- I (91.71%), grain L/B ratio (91.58%), grain breadth (88.55 %), germination percentage (88.35%), seedling height (88.09 %), days to 50% flowering (87.73 %), grain yield plant^{-1} (85.66%), number of filled grains panicle^{-1} (83.40 %), grain length (82.34 %), plant height (81.61%), days to maturity (79.47%) and root length (64.90%), while moderate heritability was observed for shoot length (59.31%), number of panicles plant^{-1} (58.70 %), panicle length (55.74 %) and spikelet fertility (48.50%) indicating that these characters can be selected and improved through simple phenotypic selection. Similar kind of high estimates of heritability were also reported by Akshitha *et al*. (2020) for germination percentage , root length , seedling height, seedling vigour index –I and II , Abawa (2022) for number of chaffy grains panicle^{-1}; Metwally *et al.* (2022) for 1000-grain weight and plant height; Thakur and Pandey (2020) for grain L/B ratio, grain breadth and grain length; Thakur and Pandey (2020) for days to 50% flowering and grain yield plant^{-1}; El-Hadi *et al.* (2017) for number of filled grains panicle^{-1}; Mishra *et al.* (2021) for days to maturity.

High heritability coupled with high genetic advance as per cent of mean was recorded for seedling vigour index – II (95.47%; 47.44%), number of chaffy grains panicle^{-1} (93.10%;73.92%), 1000-grain weight (92.63%; 66.13%), seedling vigour index- I (91.71%; 33.35%), grain L/B ratio (91.58%; 24.53%), grain breadth (88.55%; 22.69%), germination percentage (88.35%; 21.60%), seedling height (88.09%; 23.03%), days to 50% flowering (h^2_{bs} = 87.73%; GAM = 26.41%), grain yield plant^{-1} (85.66%; 50.05%), number of filled grains panicle^{-1} (83.40%; 45.90%), plant height (81.61%; 33.92%) and root length (64.90%; 23.78%) suggesting better scope of their improvement through selection, as these characters were predominantly governed by additive gene effects.

Similar results of high heritability coupled with high genetic advance as per cent of mean have been reported by Mishra *et al*. (2019) for seedling vigour index – II, seedling vigour index- I and root length; Abawa (2022) for number of chaffy grains panicle^{-1}**;** Abawa (2022) for plant height**;** Gokulakrishnan *et al.* (2014) for grain breadth; Gokulakrishnan *et al.* (2014) and Thakur and Pandey (2020) for grain L/B ratio; Kumar *et al.* (2018) for 1000-grain weight; Radha *et al.* (2019), Thakur and Pandey (2020) and Abawa (2022) for grain yield plant^{-1}; Ekka *et al.* (2015) and Devi *et al.* (2017) for number of filled grains panicle^{-1}.

Based on the above results, it could be concluded that the characters, number of chaffy grains panicle^{-1}, 1000-grain weight, grain yield plant^{-1}, number of filled grains panicle^{-1} and seedling vigour index – II recorded high PCV, GCV, heritability (broad sense) and genetic advance as per cent of mean indicating that these characters were governed by additive gene action and simple selection would be more rewarding for their improvement.

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STUDIES ON THE EFFECT OF IRRIGATION REGIMES AND NITROGEN RATES ON CANOPY TEMPERATURE AND SCMR VALUES (SPAD CHLOROPHYL METER READINGS) OF MAIZE (*Zea mays* L.)

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ABSTRACT

The present research was carried out with the objective of studying the effect of irrigation regimes, nitrogen rates and their functional relationship on morpho-physiological, biochemical parameters and yield attributes in maize at Agricultural Research Institute, PJTSAU, Rajendranagar, Hyderabad. The maize seed variety of Cargill-900 is taken for investigation with main treatment as irrigation regimes at 60% DASM (I_1) (Depletion of available soil moisture), 40% DASM (I_2) and 20% DASM (I_3) and sub treatments as nitrogen rates at 90 kg N ha^{-1} (N_1), 180 kg N ha^{-1} (N_2) and 240 kg N ha^{-1} (N_3). The data was recorded on Physiological parameters like canopy temperature (T_{leaf}-T_{air}) (^{o}c) and SPAD chlorophyll meter readings. Among the irrigation regimes highest chlorophyll meter readings and lowest canopy temperature (T_{leaf}-T_{air}) was recorded at 20% DASM (I_3) and the decreasing trend of chlorophyll meter readings and increasing trend of canopy temperature (T_{leaf}-T_{air}) was recorded with increasing the Depletion of available soil moisture (i.e. from 20% DASM (I_3) to 40% DASM (I_2) and finally to 60% DASM (I_1),which has recorded lowest chlorophyll meter readings and highest canopy temperature (T_{leaf}-T_{air})). Among the nitrogen rates highest chlorophyll meter readings and lowest canopy temperature (T_{leaf}-T_{air}) was recorded at 240 kg N ha^{-1} (N_3) and the decreasing trend of chlorophyll meter readings and increasing trend of canopy temperature (T_{leaf}-T_{air})was recorded with decreasing the nitrogen rates (i.e. from 240 kg N ha^{-1} (N_3) to 180 kg N ha^{-1} (N_2) and finally to 90 kg N ha^{-1} (N_1),which has recorded lowest chlorophyll meter readings and highest canopy temperature (T_{leaf}-T_{air})). Among the interaction of irrigation regimes and nitrogen rates the treatment combination of 20% DASM in conjunction with 240 kg N ha^{-1} (I_3N_3) recorded significantly highest chlorophyll meter readings and lowest canopy temperature (T_{leaf}-T_{air}) compared to all other treatment combinations but remained on par with treatment combination of 20% DASM in conjunction with 180 kg N ha^{-1} (I_3N_2) of canopy temperature, treatment combination of 40% DASM in conjunction with 240 kg N ha^{-1} (I_2N_3) of chlorophyll meter readings and the lowest chlorophyll meter readings and highest canopy temperature (T_{leaf}-T_{air}) was recorded at treatment combination of 60% DASM in conjunction with 240 kg N ha^{-1} (I_1N_3). Data pertaining to before and after irrigation was found that the chlorophyll meter readings decreased after irrigation when compared to before irrigation. At 60% DASM (I_1) irrigation regime the chlorophyll meter readings decreased comparatively more than 40% DASM (I_2) and the negligible amount of decrease in chlorophyll meter readings is found in 20% DASM (I_3) after irrigation.

KEYWORDS: Irrigation regimes, Nitrogen rates, Canopy temperature, Chlorophyll.

INTRODUCTION

Maize is less water demanding and gives higher yield per hectare. By growing maize farmers save 90% of water, 70% of power compared to paddy, its yield increased with Compound annual growth rate (CAGR) of 5% and 4% in U.S.A and Brazil respectively in last 4 years. Difference in maize yield between India and world is 130%. Maize consumption growing at a Compound annual growth rate (CAGR) of 11% in last 5 years, Poultry feed accounts for 47% of maize consumption, it acts a source of more than 3,500 products including specialized maize like QPM "Quality Protein Maize". Only 15% of cultivated area of maize is under irrigation. Bihar and Tamil Nadu has almost reached 100% hybridization in maize. Maize contributes 11% to total size of Indian seed industry. Global Maize production reaches 1040 M MT (Million metric tonnes). India stands at 5th rank in maize hybridization. 5-7% of maize produced in India lost due to improper storage. Maize production must grow at 15% Compound annual growth rate (CAGR).

Water stress at any stage of development shows impact on physiological parameters and yield attributes in maize such as plant height, leaf area index, grain yield per hectare, as well as number of ears per plant, grain yield per cob and 1000 kernels weight, water stress occurring during vegetative and tasseling stages reduced plant height and leaf area development. Short-duration water deficits during the rapid vegetative growth period caused 28–32% loss of final dry matter weight. Much greater losses of 66–93% could be expected as a result of prolonged water stress during tasseling and ear formation stages (Cakir *et al.,* 2004).

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Nitrogen is very important and essential element for plant growth and development. It shows impact on morphological characteristics like increasing rates of nitrogen, reduced the number of days for silking and tasseling, but increased the number of days to physiological maturity. Plants were remained green for longer period with increased nitrogen rates. Increased nitrogen rates also show impact on yield attributes like increase in number of cobs per plant, cob length, cob diameter and increased number of grains per cob (Shrestha *et al.,* 2018).

The interactive effects of water and nitrogen shows impact on many morphological, physiological parameters and yield attributes on maize plant like enhanced net assimilation rate, increased leaf area duration, chlorophyll content at anthesis, biomass yield, kernel yield when supplied with optimal nitrogen (160 kg N ha^{-1}) and well-watered conditions. In contrast, supra-optimal (320 kg N ha^{-1}), zero nitrogen and water stress had detrimental effects on these parameters except chlorophyll content at anthesis. The optimal nitrogen level improved drought resistance (Molla *et al*., 2014).

MATERIAL AND METHODS

Location of the experimental site

The experiment was carried out in the research farm of Agro Climate Research Centre, Agricultural Research Institute, Professor Jayashankar Telanagana State Agricultural University, Rajendranagar, Hyderabad. It is situated at 17°32'N latitude, 78°39'E longitude and at an altitude of 542.3m above MSL in the Southern Telangana Agro- Climatic Zone in Telangana State. According to troll's classification, it falls under semi-arid tropics.

Treatment Details

Mainplots	**Subplots**
Irrigation-Scheduling	Nitrogen-levels
I1: 60%DASM	**N1**: 90 kg N ha^{-1}
I2: 40%DASM	**N2**: 180 kg N ha^{-1}
I3:20%DASM	**N3**: 240 kg N ha^{-1}

P_2O_5: 60 kg ha^{-1}applied as basal; K_20: 50 kg ha^{-1} applied in two equal splits(common to all treatments), each at six leaf and tasselling stage of maize.

Canopy temperature (°C) (T_{leaf}-T_{air}).

The canopy temperature of maize was measured using Portable photosynthesis system LI-6800) hand held Infrared Thermometer (IRT) (Blad and Rosenberg, 1976) and the mean value of five observations in each plot was expressed as °C.

SCMR values (SPAD Chlorophyll meter readings).

The leaf chlorophyll meter readings was measured by using MC-100 Chlorophyll content meter.

RESULTS AND DISCUSSIONS

SCMR values (SPAD Chlorophyll meter readings)

The effect of irrigation scheduling and nitrogen levels on Chlorophyll meter readings (spad meter) measured at different phenophases were summarized (Table 1).

Irrigation scheduling

The influence of irrigation scheduling on Chlorophyll meter readings was found to be significant at all crop stages. Increase in moisture levels from I_1 to I_3 (20% DASM) increased the Chlorophyll meter readings respectively. Highest Chlorophyll meter readings was recorded at silking stage. The crop irrigated at I_3 (20% DASM) maintained more Chlorophyll meter readings of 61.28 and 52.11% at silking and dough stages, respectively as compared to other irrigation treatments.

Data recorded at before and after irrigation was found that the Chlorophyll meter readings decreased after irrigation when compared to before irrigation. Pertaining to before and after irrigation indicates that at 60% DASM (I_1) irrigation regime the Chlorophyll meter readings decreased comparatively more than 40% DASM (I_2) and the negligible amount of decrease in Chlorophyll meter readings is found in 20% DASM (I_3) after irrigation. Similar results were shown by Szeles *et al.* (2012).

The influence of irrigation levels on Chlorophyll meter readings has shown that the lower Chlorophyll meter readings was recorded at poorly irrigated conditions compared to moderate and highly irrigated conditions this may be due decrease in Chlorophyll meter readings from water stressed plants provided evidence that water deficiency degraded the photosynthetic pigments and changed the leaf morphology in corn canopies. Similar results were shown by Genc *et al*. (2013).

Nitrogen levels

Chlorophyll meter readings was significantly influenced by different levels of Nitrogen. Increase in nitrogen levels increased Chlorophyll meter readings respectively. The crop received with N_3 (240 kg N ha^{-1}) recorded significantly more chlorophyll of (62.6, 48.3) which was on par with N_2 (180 kg N ha^{-1}) and remained comparatively higher than N_1 (90 kg N ha^{-1})

Table 1. Effect of irrigation and nitrogen levels on SCMR values (SPAD Chlorophyll meter readings)

	SCMR values (SPAD Chlorophyll meter readings)															
	6 Leaf stage				Silking stage				Dough stage				Physiological maturity stage			
Treatments	N_1	N_2	N_3	**Mean**	N_1	N_2	N_3	**Mean**	N_1	N_2	N_3	**Mean**	N_1	N_2	N_3	**Mean**
I_1	45.94	50.39	54.79	50.37	55.03	58.00	59.83	57.62	40.23	38.47	37.77	38.82	28.67	27.90	24.97	27.18
I_2	48.08	52.69	55.64	52.14	56.07	61.20	63.90	60.39	43.63	46.57	51.13	47.11	27.53	29.10	31.33	29.32
I_3	48.46	54.94	56.40	53.27	57.43	62.30	64.10	61.28	48.93	51.47	55.93	52.11	28.37	31.47	31.60	30.48
Mean	47.50	52.67	55.61	51.93	56.18	60.50	62.61	59.76	44.27	45.50	48.28	46.01	28.19	29.49	29.30	28.99
Factors	**SEm ±**	**SEd**	**C.D.**		**SEm ±**	**SEd**	**C.D.**		**SEm ±**	**SEd**	**C.D.**		**SEm ±**	**SEd**	**C.D.**	
I	0.26	0.36	1.00		0.48	0.68	1.90		1.13	1.60	4.45		0.40	0.56	1.56	
N	0.29	0.40	0.88		0.52	0.74	1.61		0.25	0.35	0.76		0.31	0.44	0.96	
IiNi-IiNj	0.50	0.70	1.53		0.90	1.28	NS		0.43	0.61	1.32		0.54	0.76	1.66	
IiNi-IjNi	0.48	0.68	1.59		0.88	1.25	NS		1.19	1.68	4.57		0.59	0.84	2.05	

Irrigation : I_1 - 60% DASM, I_2 - 40% DASM, I_3 - 20% DASM
Nitrogen : N_1 – 90 kg N ha^{-1}, N_2 – 180 kg N ha^{-1}, N_3 – 240 kg N ha^{-1}

The influence of nitrogen levels on Chlorophyll meter readings has shown that the lower Chlorophyll meter readings was recorded at lower nitrogen application conditions compared to moderate and higher nitrogen rates this is due to decrease in Chlorophyll meter readings as nitrogen is considered an essential constituent of chlorophyll. Similar findings were also observed by Singh (2010).

Interaction effect

The interaction effect of irrigation scheduling and nitrogen levels was found significant at six leaf, dough and physiological maturity stages and increased with increase in irrigation and nitrogen levels. Among the different treatment combinations, the crop irrigation scheduled at 20% DASM in conjunction with 240 kg N ha^{-1}(I_3N_3) recorded significantly more Chlorophyll meter readings of 56.40, 55.93 and 31.60 at six leaf, dough and physiological maturity stages, respectively. The interaction effect of irrigation scheduling and nitrogen levels was not significant at silking stage of the crop growth.

The influence of irrigation and nitrogen levels has shown that Chlorophyll meter readings decreased with decreased irrigation and nitrogen levels as water deficiency degraded the photosynthetic pigments and changed the leaf morphology in corn canopies and nitrogen which is considered an essential constituent of chlorophyll. These findings are in line with Dinh *et al.* (2017).

Canopy temperature (Tleaf -Tair)

The data pertaining to Canopy temperature (Tleaf -Tair) recorded at different phenophases was presented in (Table 2).

Irrigation scheduling

The Canopy temperature (Tleaf -Tair) was influenced by irrigation scheduling at all crop phenological stages. The crop irrigation scheduled at 20% DASM (I_3) showed significantly lower Canopy temperature (Tleaf -Tair) of -0.47, -0.87, -0.62 and -0.32 when compared to irrigation scheduled at 40% DASM (I_2) and 60% DASM (I_1) at 6^{th} leaf, tasseling, dough and physiological maturity stages, respectively. The Canopy temperature (Tleaf -Tair) recorded under I_1 (60% DASM) remained significantly higher to I_2 (40% DASM) and I_3 (20% DASM) at all crop stages.

Data recorded at before and after irrigation was found that the Canopy temperature (Tleaf -Tair) decreased after irrigation when compared to before irrigation. Pertaining to before and after irrigation indicates that at 60% DASM (I_1) irrigation regime the Canopy temperature (Tleaf -Tair) decreased comparatively more than 40% DASM (I_2) and the negligible amount of decrease in Canopy temperature (Tleaf -Tair) is found in 20% DASM (I_3) after irrigation.

The influence of irrigation levels on canopy temperature has shown that with increase in irrigation levels the canopy temperature gradually decreased this is due to increase in soil moisture uptake which finally increased transpiration rate. Similar results were shown by Majumder (2015).

Nitrogen levels

The effect of nitrogen dose on Canopy temperature (Tleaf -Tair) was found to be significant only at 6^{th} leaf stage and remained non-significant at silking, dough and physiological maturity stages. The crop supplied with 240 kg N ha^{-1} (N_3) recorded significantly lowest Canopy temperature (Tleaf -Tair) of -0.488 compared to other nitrogen treatments at 6^{th} leaf stage.

The influence of nitrogen rates has shown that with increase in nitrogen levels the canopy temperature gradually decreased this is due to nitrogen application might have promoted the absorption of soil moisture which ultimately increased the transpiration rate and decreased the canopy temperature. Similar results were shown by Yan *et al*. (2010).

Interaction effect

The interaction effect of irrigation scheduling and nitrogen levels on Canopy temperature (Tleaf -Tair) was significant at silking, dough and physiological maturity stages and remained non significant at 6 leaf stage. The treatment combination 20% DASM in conjunction with 240 kg N ha^{-1} (I_3N_3) recorded significantly lower Canopy temperature (Tleaf -Tair) of -0.923, -0.65 and 0.437 when compared to all treatment combinations at silking, dough and physiological maturity stages respectively but remained on par with treatment combination 20% DASM in conjunction with 180 kg N ha^{-1} (I_3N_2) at silking, dough and physiological maturity stages. The treatment combination 60% DASM in conjunction with 240 kg N ha^{-1} (I_1N_3) recorded significantly higher Canopy temperature (Tleaf -Tair) when compared to all treatment combinations at silking, dough and physiological maturity stages.

Interaction effect of irrigation scheduling and nitrogen levels on canopy temperature has shown that with increase in irrigation and nitrogen levels canopy temperature gradually decreased this is due to increased transpiration rate. These findings are in line with Zien *et al.* (2004).

Table 2. Effect of irrigation and nitrogen levels on canopy temperature (T_{leaf}-T_{air}) (°C)

	Canopy temperature															
	6 Leaf stage				Silking stage				Dough stage				Physiological maturity stage			
Treatments	N_1	N_2	N_3	Mean	N_1	N_2	N_3	Mean	N_1	N_2	N_3	Mean	N_1	N_2	N_3	Mean
I_1	-0.38	-0.41	-0.46	-0.42	-0.59	-0.52	-0.36	-0.49	-0.27	-0.25	-0.17	-0.23	0.07	0.10	0.23	0.13
I_2	-0.42	-0.45	-0.49	-0.45	-0.67	-0.67	-0.75	-0.69	-0.38	-0.42	-0.43	-0.41	-0.13	-0.18	-0.25	-0.19
I_3	-0.43	-0.46	-0.51	-0.47	-0.79	-0.89	-0.92	-0.87	-0.55	-0.64	-0.65	-0.62	-0.34	-0.40	-0.44	-0.39
Mean	-0.41	-0.44	-0.49	-0.45	-0.68	-0.69	-0.68	-0.68	-0.40	-0.44	-0.42	-0.42	-0.13	-0.16	-0.15	-0.15
Factors	SEm ±	SEd	C.D.		SEm ±	SEd	C.D.		SEm ±	SEd	C.D.		SEm ±	SEd	C.D.	
I	0.002	0.003	0.008		0.012	0.017	0.049		0.011	0.015	0.044		0.003	0.005	0.014	
N	0.005	0.006	0.014		0.008	0.011	NS		0.012	0.016	NS		0.007	0.009	NS	
IiNi-IiNj	0.004	0.011	NS		0.021	0.019	0.048		0.019	0.028	0.068		0.006	0.016	0.037	
IiNi-IjNi	0.007	0.010	NS		0.016	0.023	0.059		0.020	0.028	0.066		0.010	0.014	0.032	

Irrigation : I_1 - 60% DASM, I_2 - 40% DASM, I_3 - 20% DASM
Nitrogen : N_1 – 90 kg N ha^{-1}, N_2 – 180 kg N ha^{-1}, N_3 – 240 kg N ha^{-1}

The crop response to added nitrogen depends on soil moisture status. As degree of water stress increases the response to nitrogen at higher dose was nullified and negative impact was observed. Under severe water stress situation at 60% DASM the crop growth was adjusted to lower dose of 90 kg N ha^{-1}. The plant has exhibited moisture stress symptoms like leaf rolling early in treatment at 60% DASM in conjunction with 240 kg N ha^{-1}(I_1N_3) plots when compared to treatment at 60% DASM in conjunction with 90 kg N ha^{-1} (I_1N_1) plots. These results are in line with the findings of Pandey *et al* (2000) who reported that, under deficit irrigated condition the maize crop responded positively up 120 kg N ha^{-1} and further increase in nitrogen dose from 120 kg to 160 kg, negative results were observed.

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IMPACT OF COVID-19 ON AGRICULTURE IN CHITTOOR DISTRICT OF ANDHRA PRADESH

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ABSTRACT

COVID-19 impact has led to severe and widespread increase in global food insecurity, affecting vulnerable households in almost every country. The pandemic is worsening day by day, causing disruption in human activities, a high mortality rate toll and a direct economic impact. The study analysed the impact of COVID-19 on farmer households' income in Chittoor district of Andhra Pradesh. The necessary data was collected from the respondent farmers via pretested schedule. Multiple linear regression analysis was used to identify factors that influence covid-19's impact on farmers. The results showed that COVID, farm size, livestock possession and yield were found significantly determine the income of the farm households. Paired t test and difference in difference analysis were used to analyse impact of COVID-19 on farmer households. The results show that a medium farm household lost an average of ₹ 96,848 per farm household per year, followed by marginal farmer with ₹ 29,299 and small farmers with ₹ 1,992 per household per year. Over all the decline in income of farmers is around 52 per cent and significant impact of COVID-19 on farmers income is seen. The major implication of the study is to find the mitigation actions against such disasters if further faced in future.

KEYWORDS: Impact, COVID-19, Households income.

INTRODUCTION

The economic impact of a pandemic is multidimensional. The globe is currently gripped by such a pandemic, known as COVID-19, is currently sweeping the globe and serves as a harsh shock by upending many assumptions. The shock it caused is unprecedented and almost no industry is unaffected or spared by this pandemic. All sectors ranging from education to tourism, agriculture to luxury are all affected in some manner and the virus has no obstacles to cross international borders, by this the globe seems unable to share the risk. As rightly put by Maliszewska *et al.* (2020), what is started as a local shock in China has now become global shock, leaving the world in "medically induced coma" (Lemieux *et al,* 2020). In the commodities and labour markets, an economic shock is often examined from both the supply and demand sides. Such an examination during the time of COVID-19 will give us with a gloomy vision of languished industry and reduced economic activity. Understanding the extent of a combined demand and supply shock, in which the economy is affected by lower demand for and supply of products, services, and even labour, is critical for making sound policy decisions. It was anticipated that COVID-19, which has brought about unprecedented labour market shock and unemployment crisis, would produce more disruption in sectors and occupations than the 2018 financial crisis. According to the International labour Organization 2020, worldwide working hours decreased by 4.5 per cent (equal to 130 million full-time employment) in the first quarter of 2020 and by 10.5 per cent in the second quarters. Researchers from all across the world have previously studied the economic ramifications of job losses and shuttered enterprises.

Moreover, the Chittoor region was found to be reporting a large number of COVID-19 cases in Andhra Pradesh as per data available in COVID-19 ArogyaAndhra portal of government of Andhra Pradesh. Apart from this, a study about impact of COVID-19 on income loss of people belonging to Chittoor region becomes relevant as majority of people in this region depend on the foreign remittance and agriculture for their livelihood. Thus, it is presumed that mobility restrictions and lockdown measured adopted by different countries of the world to arrest the spread of virus have greatly affected the lives of the people in this region as there are a large number of people working across the globe.

MATERIAL AND METHODS

In India, Andhra Pradesh state was selected purposively for present research study. 26 districts spread across the 3 regions- Uttaraandhra, Costal Andhra and Rayalaseema, in the first stage, out of 8 districts in Rayalaseema region, 1 district was randomly selected, Viz Chittoor district. From Chittoor district, 2 mandals were selected randomly, *Viz* Chandragiri and Ramachandrapuram mandals, this was followed by a random selection of 2 villages from each mandal. Two

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villages with primary occupation as agriculture and allied sector and also COVID-19 affected area were selected randomly from each mandal, thus making a total of four villages selected for the present study. From Chandragiri mandal, Gangudupalli and Panapakam villages were selected, from Ramachandrapuram mandal C. Ramapur and Sorakayalapalem villages were selected. From each selected village fifteen farm households who were affected with COVID-19 pandemic in first phase and fifteen farm households who were not affected with COVID-19 pandemic were selected randomly, thus making a total of 120 farmers for collecting the necessary information related to the objectives of the present research study.

Data analysis

The socioeconomic characteristics of the paddy farmers during the COVID-19 pandemic were examined using percentages, descriptive statistics, and simple averages. In order to shed light on the research study and enable a meaningful interpretation of the findings, averages and percentages were calculated. In order to show the impact of COVID-19 on respondent farmer households' income, paired t test was used and across groups and along the time, to assess the COVID-19 impact on income difference in difference analysis was used. Multiple linear regression analysis was used to analyse the variables/ factors that influence COVID-19's impact on farmer households.

RESULTS AND DISCUSSION

Income and employment details of the respondents

In order to assess the combined effect of COVID on farmers income, pired t test was used and the results show the significant reduction in income from crop, livestock and non-farm compared to off-farm in both COVID affected and not affected farmer respondents and was also seen that there is 50 and 43 per cent decline in the total income of the COVID affected and not affected respondents respectively in COVID year. By this we can state that there was significant effect of COVID on the farmer household respondent's income. The net income loss incurred by the farmers was 80 per cent and 70.50 per cent in COVID affected and not effected respondent farmers respectively in COVID year.

Impact of COVID on income of farmers across land sizes

Impact of COVID on income of farmers across land sizes i.e., marginal (<2.47 acre), small (2.5-4.9 acre) and medium (5-10 acre) were analysed using the Difference in Difference analysis and result is presented in Table 1. It can be observed that the estimate derived in the first differences demonstrated the difference between farm households' incomes during a previous normal year and a COVID year (₹ 2,73,630, ₹ 4,66,047, ₹ 3,75,850 for marginal, small and medium category farmers respectively) and between COVID affected and not affected farmer respondents' incomes (₹ 72,345, ₹ 2,00,228, ₹ 1,74,832 for marginal, small and medium category farmers respectively), respectively. The double difference was done in between initial differences and result states that medium farm household lost an average of ₹ 96,848 per farm household per year, followed by marginal farmer with ₹ 29,299 and small farmers with ₹ 1,992 per household per year. The results are in line with the findings of Nandi *et al.* (2021); Ceballos *et al.* (2020).

Impact of COVID on income of farmers

The income variations brought on by COVID were quantified and understood using the Difference in Difference analysis, estimations were made and the result is presented n Table 2. Results state that the estimate derived in the first differences demonstrated the difference between farm households' incomes during a previous normal year and a COVID year (₹ 3,18,982)

Table 1. Impact of COVID on income of farmers across land sizes (₹/household/year)

S. No.	Variable	Coefficients		
		Marginal	Small	Medium
1	Constant	648684**	1064651**	1344850*
2	COVID	-72,345	-2,00,228	-1,74,832
3	Year	-2,73,630**	-4,66,047*	-3,75,850
4	COVID*Year	-29,299	-1,992	-96,848

Table 2. Impact of COVID on income of farmers

Variable	Coefficients
Constant	7,39,211***
COVID	-19,164.3
Year	-3,18,982***
COVID*Year	-53540.5

* Significance at 10%
** Significance at 5%
*** Significance at 1%

and between COVID affected and not affected farmer respondents incomes (₹ 19,164.3), respectively and the difference of initial two differences, the estimate represented by this double difference was 53,540 per farm household per year. Numerically there is decline in income of farmers but COVID has more or less has shown no significant effect on the income of the farmers. The results are in line with the findings of Gatto and Islam (2020).

Determinants of farm income of farm household during a COVID year

The findings of the multiple linear regression show how important farm size and other socio-economic factors are to farm households' income during the COVID year. The COVID, farm size, livestock possession and yield were found significantly determine the income of the farm households. In this also yield was significant at 10 per cent, COVID was significant at 5 per cent, farm size and livestock possession were significant at 1 per cent level of significance. The non-significant variables include age, education, and membership in organization. ‘R^2’ value was 0.39 depict that all selected eight variables put together explained about 39 per cent variation in the impact of COVID on income of the farmer respondents. The results are in line with the findings of Yusuf *et al.* (2021); Tu *et al.* (2018); Asante-Addo *et al.* (2017); Mohammadi *et al.* (2015); Bansal (2021); Hara *et al.* (2020); Lin and Zhang (2020); Lynda *et al.* (2020) and Tran *et al.* (2020).

The significant reduction in income from crop, livestock and non-farm compared to off-farm in both COVID affected and not affected farmer respondents and we can also see that there is 50 and 43 per cent decline in the total income of the COVID affected and not affected respondents respectively in COVID year. The net income loss incurred by the farmers was 80 per cent and 70.50 per cent in COVID affected and not effected respondent farmers respectively in COVID year. Medium farm household lost an average of ₹ 96,848 per farm household per year, followed by marginal farmer with ₹ 29,299 and small farmers with ₹ 1,992 per household per year and total income of 53,540 per farm household per year. Numerically there is decline in income of farmers but COVID has more or less has shown no significant effect on the income of the farmers. The COVID, farm size, livestock possession and yield were found significantly determine the income of the farm households.

Table 3. Determinants of farm income of farm household during a COVID year

1	Constant	Intercept	174246.30	1,75,529	1.01^{NS}		
2	COVID	X_1	49035.55	-98,492	-2.01**		
3	Age	X_2	2413.20	-2,767	-1.15^{NS}		
4	Education	X_3	27283.10	21,781	0.80^{NS}		
5	Farm size	X_4	17138.39	95,735	5.43***	10.10***	0.39
6	Membership in org	X_5	57722.45	-45,286	-0.8^{NS}		
7	Livestock possession	X_6	53301.90	2,89,501	5.43***		
8	Yield	X_7	6.74	-12.70	-1.90*		

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SCREENING OF URDBEAN GENOTYPES AGAINST LEAF CRINKLE DISEASE UNDER FIELD CONDITIONS

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ABSTRACT

Among the viral diseases, Urdbean Leaf Crinkle Virus (ULCV) is one of the most serious disease in all urdbean growing areas The causal agent is reported to be transmitted by seed, sap, aphid and whitefly. However, there is limited work on the development of resistant cultivars to Urdbean Leaf Crinkle Disease (ULCD) due to the non-availability of the resistant sources. Hence the present investigation was carried out at RARS, Lam, Guntur district, Andhra Pradesh during 2021-22. Screening was conducted in RARS, Lam during *Rabi*, 2021-22 among 25 urdbean genotypes along with LBG 623 (Suceptible check) against ULCD under field conditions using 0-5 disease rating scale revealed that one genotype was found highly resistant, 10 genotypes were resistant, 9 genotypes were moderately resistant, 3 genotypes were moderately susceptible and 3 genotypes exhibited susceptible reaction to ULCV. While none of the urdbean genotypes were found to be highly susceptible to the disease.

KEYWORDS: Urdbean, ULCV, Resistance, Screening.

INTRODUCTION

Urdbean [*Vigna mungo* (L.) Hepper] also known as black gram, mash, mash kalai, black mapte *etc*., belongs to the family Leguminosae. It is the fourth most important short duration pulse crop grown in India. It is mainly consumed as 'dal' and in preparation of many dishes in diet. Urdbean has the ability to fix atmospheric nitrogen and thus helps in restoring the soil fertility. It has high amounts of total carbohydrates (60%) with protein content of 25%. Urdbean crop is infected by several viral diseases such as yellow mosaic virus, Urdbean leaf crinkle Virus (ULCV) and leaf curl. Under field conditions, ULCV is severe in urdbean than mungbean and other pulse crops (Biswas *et al.,* 2009; Rehman *et al.,* 2018).

Urdbean leaf crinkle disease was first reported in the year 1966 from Uttar Pradesh and Delhi by Williams *et al*., (1968). Later in 1967, the disease appeared in Tarai region of Uttar Pradesh (Kolte and Nene, 1970). These workers, named the disease as urdbean leaf crinkle disease, proved the infectious nature of the pathogen and designated it as urdbean leaf crinkle virus (ULCV). The symptoms of disease appear in the form of extreme crinkling, puckering, rugosity and curling of leaves, malformation of floral organs, stunting of plants causing heavy yield losses annually in major urdbean producing countries of the world and also pollen fertility and pod formation is also reduced severely in infected plants (Nene, 1972). ULCV infected plants produce barren flowers and a small number of pods (Bashir *et al*., 1991).

MATERIAL AND METHODS

Experimental layout

The present investigation was carried out Regional Agricultural Research Station (RARS), Lam, Guntur. Geographically the RARS, Lam is located at an altitude of 31.5 m above mean sea level with 16^0 2'N latitude and of 80^0 3'E longitude. The field experiment was laid out in Randomized Block Design (RBD) with two replications to evaluate all 25 urdbean genotypes. Infector row technique was used for disease evaluation. Each genotype was sown in two rows of 4 m length with spacing of 30×10 cm with a susceptible check (LBG 623). All the recommended package of practices were followed for raising good crop. Observations were recorded at 20, 40 and 60 DAS.

ULCV incidence was scored by counting the total number of plants infected in each row and per cent disease incidence was calculated by using the following formula:

Per cent Disease Incidence (PDI) =

$$\frac{\text{No. of plants infected in a row}}{\text{Total no. of plants in a row}} \times 100$$

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Table 1. List of urdbean genotypes used for field screening against ULCV

S. No.	Genotype	S. No.	Genotype	S. No.	Genotype
1.	LBG 933	10.	PU 31	19.	VBN 11
2.	LBG 944	11.	VBN 8	20.	VBG 12-110
3.	LBG 787	12.	GBG 1	21.	GBG 4
4.	GBG 12	13.	TBG 104	22.	LBG 645
5.	LBG 648	14.	LBG 884	23.	VBN 10
6.	LBG 932	15.	GBG 45	24.	TU 40
7.	LBG 941	16.	GBG 67	25.	TBG 129
8.	LBG 904	17.	LBG 918	26.	LBG 623 (Check)
9.	LBG 752	18.	LBG 685		

RESULTS AND DISCUSSION

Out of twenty five genotypes screened to ULCV during *rabi* 2021-22, VBN 10 was highly resistant with 0% incidence, ten genotypes *viz.*, TU 40, TBG 129, TBG 104, GBG 1, LBG 941, GBG 45, LBG 904, LBG 933, LBG 645 and LBG 932 were categorized under resistant with 1.26 to 10.05% incidence, nine genotypes *viz*., LBG 752, VBN 11, LBG 648, VBG 12-110, LBG 787, LBG 918, VBN 8, PU 31 and LBG 685 were categorized under moderately resistant with 11.44 to 19.23% incidence, three genotypes *viz*., GBG 4, LBG 944 and LBG 884 were found moderately susceptible with 21.1 to 22.57% incidence and rest of the two genotypes viz., GBG 12 and GBG 67 were found susceptible with 20.675 and 31.08% incidence of ULCV respectively. Check LBG 623 was also found susceptible with 32.25% incidence and none of the entries are found to be highly susceptible to Urdbean leaf crinkle infection (Fig 1).

Subba Rao (1984) screened 119 urdbean germplasm entries from Lam and NBPGR to blackgram leaf crinkle virus under natural epiphytotic conditions during *kharif* and found that none of the entries are found highly susceptible to ULCV, 23 genotypes showed moderately resistant reaction, 35 entries were resistant. Vijaykumar (1993) screened 40 genotypes against ULCV during 1992-93 and reported that four genotypes (PLU-807, MASA-69, LBG-667 and LBG-668) were moderately resistant, seven genotypes (PLU-290, PLU-429, PLU-1079, PLU-1146, NP-3, KL-270-41 and UG-407) were moderately susceptible and the remaining 23 genotypes were susceptible.

Rehman *et al.* (2018) screened eight urdbean genotypes (Arooj, 6065-3, 6036-21, 4em-716, ES-I, M-95, ARRIM-08 and ARRIM-16) against urdbean leaf crinkle virus and correlated with epidemiological factors (temperature, relative humidity). The overall results revealed that, among all these lines, one genotype (M-95) was susceptible, three genotypes (6065-3, 4em-716, ES-I) were moderately susceptible, three genotypes (6036-21, ARRIM-08, ARRIM-16) moderately resistant and only one genotype Arooj showed resistance response to urdbean leaf crinkle virus. Sravika *et al.* (2018) stated among the sixty nine blackgram genotypes screened thirty, twenty nine, five genotypes were fall under resistant (R), moderately resistant (MR) and susceptible (S) respectively.

TIME OF URDBEAN LEAF CRINKLE DISEASE OCCURRENCE

Among 26 urdbean genotypes screened for ULCV infection, the disease occurred at three weeks after sowing *i.e*., 25 DAS in fourteen genotypes *viz*., LBG 933, LBG 944, LBG 787, GBG 12, LBG 648, LBG 932, LBG 941, VBN 8, LBG 884, GBG 45, VBN 11, GBG 4, LBG 645, LBG 623. While in 24 genotypes *viz*., LBG 933, LBG 944, LBG 787, GBG 12, LBG 648, LBG 932, LBG 941, LBG 904, LBG 752, PU 31, VBN 8, GBG 1, TBG 104, LBG 884, GBG 45, GBG 67, LBG 918, LBG 685, VBN 11, VBG 12-110, GBG 4, LBG 645, TBG 129, LBG 623 the disease has appeared at five weeks after sowing *i.e*., 40 DAS (Table 3). Among all 26 genotypes, ten were resistant to ULCV infection *viz*., LBG 933, LBG 932, LBG 941, LBG 904, GBG 1, TBG 104, GBG 45, LBG 645, TU 40, TBG 129.

Table 2. Disease rating scale (0-5) for ULCV (AICRIP, MULLaRP)

Per cent infection	Disease grade	Reaction
All plants free of symptoms	0	HR
1-10% plants infected showing mild crinkling at the top, pods normal	1	R
11-20% plants infected showing crinkling and curling of top leaves, pods normal	2	MR
21-30% plants infected showing crinkling, puckering, malformation, shortening of pods	3	MS
31-40% plants infected showing all typical disease symptoms	4	S
More than 40% plants infected showing severe symptoms, few pods containing few seeds	5	HS

HR – Highly Resistant; R – Resistant; MR – Moderately resistant; MS – Moderately susceptible; S – Susceptible; HS – Highly susceptible

Table 3. Reaction of urdbean genotypes against urdbean leaf crinkle disease in *Rabi* 2021-22

Resistance level	Genotypes
HR	VBN 10
R	TBG 104, LBG 645, TU 40, TBG 129, GBG 1, LBG 933, GBG 45, LBG 932, LBG 941, LBG 904
MR	LBG 787, LBG 648,LBG 752, PU 31, VBN 8, LBG 918, LBG 685, VBN 11, VBG 12-110
MS	LBG 944, LBG 884, GBG 4
S	GBG 67, GBG 12, LBG 623 (Check)

The results were in agreement with Ashfaq *et al.* (2007) who observed incidence of ULCV 20 – 25 days after planting in urdbean and also with Kadian (1982) who recorded ULCV infection before 24 days old. Meanwhile, the results vary with the findings of Rehman *et al.* (2018) who identified disease occurrence early in one genotype at the first week after sowing, later the disease progressed with increase in the age of the plants.

In the present investigation, 26 genotypes were evaluated for their resistance to ULCD. Among the genotypes, VBN 10 recorded highly resistant reaction to ULCD. Genotypes *viz*., TBG 104, LBG 645, TU 40, TBG 129, GBG 1, LBG 933, GBG 45, LBG 932, LBG 941, LBG 904 were recorded as resistant reaction to ULCD. Hence, these genotypes can be utilized for the ULCD resistance breeding programme.

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EVALUATION OF ADVANCED BREEDING LINES OF GROUNDNUT (*Arachis hypogaea* L.) FOR YIELD AND YIELD ATTRIBUTES

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ABSTRACT

An experiment was conducted to evaluate performance of 36 groundnut genotypes for yield and yield attributes at Regional Agricultural Research Station, Tirupati, during *rabi* 2021-22 laid out in Alpha Lattice Design with two replications. Analysis of variance indicated significant differences among the genotypes for all the traits indicating the existence of ample amount of variability in the material for all the traits under consideration. TCGS 2233, TCGS 2223, TCGS 2347, UBEK 21-67, UBEK 21-70, UBEK 21-68, Rohini and UBEK 21-76 were found as promising genotypes and could be exploited for improvement of yield and yield attributes in the breeding programme as donors.

KEYWORDS: Groundnut, mean performance, evaluation, yield.

INTRODUCTION

Groundnut, a self-pollinated legume crop is one of the most important cash crop cultivated for edible oil, food and feed. Globally, it is cultivated in an area of 31.5 million hectares with production and productivity of 53.6 million tonnes and 1699 kg ha^{-1}, respectively (FAOSTAT, 2020). India ranks second among the groundnut producing countries in the world with an area of 6.09 million hectares, production of 10.21 million tonnes and productivity of 1676 kg ha^{-1}. In Andhra Pradesh, it is cultivated in an area of 0.87 million hectares with a production of 0.78 million tonnes and an average productivity of 894 kg ha^{-1} (Directorate of Economics and Statistics, Govt. of A.P, India, 2020-2021). With the ever-growing population, the constant need to increase productivity by developing elite high yielding genotypes is inevitable. Genetic improvement of yield is a primary concern for a plant breeder and yield being a complex and quantitative trait, it is important to evaluate components associated with yield. Thus, the present investigation mainly focused on identifying the genotypes with superior performance for yield and yield attributes.

MATERIAL AND METHODS

The field experiment was carried out with 36 advanced breeding lines of groundnut at Regional Agricultural Research Station, Tirupati during *rabi* 2021-22 in alpha lattice design with two replications. 36 genotypes were sown in each replication by randomization in four blocks each with nine genotypes. Recommended NPK (20 N + 40 P_2O_5 + 50 K_2O kg ha^{-1} & 500 gypsum kg ha^{-1}) fertilizers were applied as basal dose. Standard crop management and plant protection practices were followed during the crop stand. List of genotypes under study were presented in Table 1 along with pedigree and salient features observed. The observations were recorded on randomly selected five plants in each genotype in each replication for plant height, number of primary branches per plant, number of secondary branches per plant, number of mature pods per plant, number of immature pods per plant, harvest index, shelling percentage, pod yield per plant, kernel yield per plant, hundred pod weight, hundred kernel weight, number of sound mature kernel and sound mature kernel weight. Days to maturity was recorded on plot basis. Analysis of variance was carried out as suggested by Patterson and Williams (1976) using R packages (version 3.1.1).

RESULTS AND DISCUSSION

Analysis of variance indicated significant differences among the genotypes for all the traits indicating the existence of ample amount of variability in the material for all the traits under consideration. The *per se* performance for yield and yield components were furnished in Table 2. List of promising genotypes for each yield trait was presented in Table 3.

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1. Plant height (cm): Mean values for plant height ranged between 25.90 cm (TCGS 2233) to 44.60 cm (UBEK 21-74). Fifteen genotypes recorded short stature against the general mean of 36.86 cm.

2. Number of primary branches plant^{-1}: Number of primary branches plant^{-1} varied from 2.00 (UBEK 21-68, UBEK 21-35) to 6.00 (TCGS 2352). Twenty one genotypes recorded more number of primary branches than their general mean value (3.86).

3. Number of secondary branches plant^{-1}: Mean values for number of secondary branches plant^{-1} varied from 0.50 (Rohini, UBEK 21-40, UBEK 20-24, UBEK 21-35) to 4.50 (TCGS 2223). Fourteen genotypes recorded higher number of secondary branches plant^{-1} against general mean value (1.61).

4. Number of mature pods plant^{-1}: The character number of mature pods plant^{-1} is one of the most important yield components directly influencing the pod yield. Mean values for number of mature pods plant^{-1} ranged between 9.90 (UBEK 21-60) to 22.00 (TCGS 2348). Fifteen genotypes recorded more number of mature pods plant^{-1} against the general mean (15.14).

5. Number of immature pods plant^{-1}: Presence of immature pods is not desirable as they promote *Aspergillus flavus* contamination. Number of immature pods plant^{-1} varied from 1.60 (UBEK 21-60) to 6.00 (UBEK 21-74). Twenty one genotypes recorded lower number of immature pods plant^{-1} than the general mean (3.33).

6. Days to maturity: Mean performance for days to maturity ranged from 89.50 days (UBEK 21-40, UBEK 21-43) to 111.0 days (TCGS 2348). Twenty two genotypes exhibited earliness when compared to general mean (102.08 days). The genotypes *viz.,* TAG 24, TCGS 2339, TCGS 2326, UBEK 21-40, UBEK 21-43 and UBEK 21-74 came to maturity at 90 DAS. Therefore, these genotypes can be utilized in the hybridization programme as donor parents to develop short duration genotypes.

7. Harvest index (%): Harvest index (HI) is a measure of success in partitioning assimilated photosynthates. Very often high yields are associated with high harvest index. Understanding the HI in different genotypes would be very informative to select ideal genotypes for improving productivity. *Per se* performance for harvest index varied from 25.30% (UBEK 21-43) to 61.70% (UBEK 21-68). Twenty one genotypes recorded higher harvest index than the general mean of 46.93%.

8. Shelling percentage: Shelling percentage varied from 60.00% (TCGS 2233) to 78.00% (UBEK 21-74). Eighteen genotypes exhibited higher shelling percentage than the general mean of 70.50%.

9. Pod yield plant^{-1}: *Per se* performance of pod yield plant^{-1} ranged between 8.45g (UBEK 21-43) to 16.40 g (TCGS 2347). Sixteen genotypes recorded higher pod yield plant^{-1} against the general mean of 12.79 g.

10. Hundred pod weight: Hundred pod weight ranged from 70.00 g (UBEK 21-43) to 140.00 g (TCGS 2347). Seventeen genotypes recorded higher 100 pod weight than the general mean (100.03 g).

11. Hundred kernel weight: Mean values of 100 kernel weight ranged between 32.60 g (UBEK 21-43) to 58.60 g (TCGS 2347). Seventeen genotypes registered higher 100 kernel weight than the general mean (42.90 g).

12. Kernel yield plant^{-1}: Mean values for kernel yield plant^{-1} varied from 5.41 g (UBEK 21-43) to 12.83 g (TCGS 2347). Eighteen genotypes recorded higher kernel yield plant^{-1} when compared to the general mean of 9.04 g.

13. Number of sound mature kernel: *Per se* performance of number of sound mature kernel ranged from 77.00 (UBEK 20-32, TCGS 2326) to 95.00 (ISK-I-2021-8). Eighteen genotypes registered higher number of sound mature kernels than the general mean value (84.86).

14. Sound mature kernel weight: *Per se* performance of sound mature kernel weight ranged from 30.00 (TCGS 2347) to 54.30 (ISK-II-2020-12). Seventeen genotypes registered higher sound mature kernel weight than the general mean value (39.63).

To sum up the most relevant findings of the present study, genotypes *viz.,* TCGS 2347, TCGS 2233, UBEK 21-67, UBEK 21-70, UBEK 21-68 exhibited better performance for pod yield plant^{-1}. Among these lines, TCGS 2347 and UBEK 21-67 showed higher kernel yield plant^{-1} as well. In addition to these traits, TCGS 2347 exhibited superior performance for number of

Table 1. List of groundnut genotypes studied with their pedigree and salient features observed

S. No.	Entry	Pedigree	Salient features observed
1	TAG 24	TGS 2 × TGE 1	Early maturing, high yield
2	ROHINI	Tirupati 4 × TIR 45	Early maturing
3	TCGS 2223	Dharani × ICGV 06188	Moderately resistant to leaf spot
4	TCGS 2233	Dharani × ICGV 06100	Moderately resistant to leaf spot
5	TCGS 2339	TAG 24 × Dharani	High yield and early
6	TCGS 2347	TAG 24 × K. Harithandhra	High yield
7	TCGS 2348	TAG 24 × TCGS 1157	High yield
8	TCGS 2350	TAG 24 × Dharani	High yield, uniform maturity of pods
9	TCGS 2351	TAG 24 × Dharani	High yield
10	TCGS 2352	TAG 24 × Dharani	High yield
11	TCGS 2353	TAG 24 × Dharani	Early and High yield
12	TCGS 2354	TAG 24 × Dharani	High yield
13	TCGS 2357	TAG 24 × K. Amaravathi	High yield
14	UBEK 21-39	TAG 24 × TCGS 1694	High yield, light rose testa
15	UBEK 21-40	TAG 24 × TCGS 1694	Early and high yield, light rose testa and round kernels, tolerant to sucking pests
16	UBEK 21-43	TAG 24 × TCGS 1694	Early, high yield, compact plant type
17	UBEK 21-61	TAG 24 × TCGS 1694	High yield and moderately tolerance to leaf spots
18	UBEK 21-67	TAG 24 × TCGS 1694	High yield and moderately tolerance to leaf spots and sucking pests
19	UBEK 21-68	TAG 24 × TCGS 1694	High yield, uniform maturity of pods, lustrous seed coat
20	UBEK 21-70	TAG 24 × TCGS 1694	High yield and moderately tolerance to leaf spots
21	UBEK 20-32	TAG 24 × Dharani	High yield and early
22	UBEK 20-24	TAG 24 × Dharani	High yield and early
23	TCGS 2326	TAG 24 × Dharani	Early and high WUE
24	TCGS 2333	TAG 24 × TCGS 1173	High yield, early and moderately tolerance to leaf spots
25	JL 24	JL 86 × NcAc 343-75	Early, high yield and tolerant to *Sclerotium rolfsii (stem rot)*
26	UBEK 21-35	TAG 24 × TCGS 1694	High yield, light rose testa, round kernels
27	UBEK 21-38	TAG 24 × TCGS 1694	High yield, light rose testa, round kernels
28	UBEK 21-42	TAG 24 × TCGS 1694	High yield
29	UBEK 21-60	TAG 24 × TCGS 1694	High yield, light rose testa, round kernels
30	UBEK 21-74	TAG 24 × TCGS 1694	Early and High yield, light rose testa, round kernels
31	UBEK 21-76	TAG 24 × TCGS 1694	High yield, light rose testa, oblong kernels, tolerant to sucking pests
32	ISK-II-2020-4	Pedigree to be obtained from AICRP	High yield, compact plant type
33	SB-I-2021-7	Pedigree to be obtained from AICRP	High yield
34	ISK-I-2021-8	Pedigree to be obtained from AICRP	High yield
35	ISK-II-2020-12	Pedigree to be obtained from AICRP	High yield, tolerant to sucking pests
36	ISK-I-2021-21	Pedigree to be obtained from AICRP	High yield

Table 2. Mean Performance of 36 groundnut genotypes for yield and yield attributes

Genotypes	PH (cm)	PB	SB	MP	IMP	DM	HI (%)	SP	PYP (g)	HPW (g)	HKW (g)	KYP (g)	NSMK	SMK WT
TAG 24	32.45	4.00	1.00	15.59	3.41	91.00	47.07	66.00	10.85	92.00	40.00	7.15	84.00	37.60
ROHINI	32.40	4.00	0.50	14.18	2.82	100.00	48.12	76.50	14.95	111.00	44.60	11.42	91.00	44.90
TCGS 2223	35.50	4.00	4.50	15.75	2.26	109.50	58.93	73.00	14.00	126.00	53.90	10.21	87.00	49.20
TCGS 2233	43.60	4.50	2.00	18.80	2.21	110.50	48.66	60.00	17.05	116.00	49.70	10.23	83.00	45.10
TCGS 2339	38.75	3.50	2.50	13.52	3.49	91.50	37.36	67.00	12.60	80.50	38.40	8.43	78.00	32.70
TCGS 2347	41.45	5.00	2.00	14.02	2.49	109.50	55.40	72.00	17.75	140.00	58.60	12.83	82.00	54.30
TCGS 2348	40.85	5.00	1.50	22.04	2.46	111.00	54.31	66.50	15.80	115.50	50.90	10.49	83.00	43.30
TCGS 2350	42.00	4.00	1.00	20.75	4.25	100.00	44.46	76.50	14.45	111.50	47.50	11.07	94.00	42.60
TCGS 2351	38.60	4.50	3.00	14.88	3.62	99.50	39.44	70.50	11.05	108.50	45.10	7.78	84.00	44.30
TCGS 2352	37.90	6.00	2.00	13.20	3.31	99.00	49.72	70.00	12.90	105.00	44.80	9.04	85.00	39.40
TCGS 2353	42.95	4.00	1.00	16.17	4.83	100.50	43.51	68.50	11.60	107.00	48.00	7.94	84.00	37.30
TCGS 2354	39.45	3.50	1.00	13.37	3.63	101.00	45.50	73.50	13.55	103.20	45.50	9.97	92.00	36.80
TCGS 2357	43.35	5.00	2.00	12.30	2.70	100.50	41.48	75.00	9.65	100.00	40.00	7.24	86.00	35.20
UBEK 21-39	37.35	4.00	1.50	12.41	4.59	100.50	52.36	75.50	10.00	88.00	39.10	7.56	82.00	42.70
UBEK 21-40	33.20	4.00	0.50	18.06	3.94	89.50	47.21	64.00	12.15	85.50	34.40	7.79	78.00	39.60
UBEK 21-43	40.30	4.00	1.00	12.14	3.86	89.50	25.33	64.00	8.45	70.00	32.60	5.41	85.00	32.90
UBEK 21-61	41.85	4.00	1.00	14.80	3.70	101.00	55.97	77.00	14.65	97.20	45.10	11.29	89.00	39.10
UBEK 21-67	28.10	3.00	4.00	15.12	2.88	110.50	49.35	74.50	16.40	93.20	39.70	12.21	84.00	34.40
UBEK 21-68	35.85	2.00	2.00	18.72	2.78	109.50	61.65	63.00	16.25	118.60	46.20	10.26	86.50	40.00
UBEK 21-70	41.00	3.50	1.00	13.52	2.48	109.50	55.91	66.00	16.35	101.50	46.60	10.71	82.00	39.60
UBEK 20-32	44.60	3.50	1.00	15.55	3.45	110.50	33.93	70.50	11.25	101.70	49.50	7.94	77.00	44.10
UBEK 20-24	32.60	3.00	0.50	12.30	2.70	101.00	49.73	72.50	13.05	105.00	43.40	9.46	84.00	44.10

Cont...

Table 2. Cont...

Genotypes	PH (cm)	PB	SB	MP	IMP	DM	HI (%)	SP	PYP (g)	HPW (g)	HKW (g)	KYP (g)	NSMK	SMK WT
TCGS 2326	38.85	4.00	1.00	18.40	3.61	91.50	40.43	68.00	12.20	84.00	37.20	8.30	77.00	45.20
TCGS 2333	38.60	3.50	2.00	15.69	3.81	99.50	55.33	75.50	11.65	99.00	39.10	8.80	85.00	31.60
JL 24	45.40	3.50	1.00	11.96	2.55	100.00	35.44	65.00	8.85	92.80	38.90	5.75	88.00	37.30
UBEK 21-35	29.05	2.00	0.50	15.90	2.60	110.00	50.79	71.50	12.85	84.70	39.50	9.13	85.00	35.50
UBEK 21-38	35.10	5.00	1.00	15.38	3.62	99.50	51.78	77.00	13.20	97.00	41.60	10.16	86.50	47.80
UBEK 21-42	26.65	2.50	3.00	13.28	3.22	100.00	47.10	68.50	8.65	89.00	38.80	5.92	84.00	36.60
UBEK 21-60	25.90	2.50	1.00	9.94	1.57	109.50	33.51	71.00	11.50	89.40	37.50	8.21	85.00	33.70
UBEK 21-74	36.90	3.50	1.50	12.99	6.02	90.00	42.46	63.00	9.50	90.00	35.40	6.02	81.00	31.60
UBEK 21-76	33.70	3.00	1.00	16.02	2.49	109.00	57.63	78.00	14.85	102.60	46.30	11.58	88.00	41.90
ISK-II-2020-4	39.30	4.00	2.50	19.25	3.26	110.00	39.54	75.00	12.25	112.50	49.40	9.20	88.00	43.70
SB-I-2021-7	37.50	3.50	2.00	12.95	4.05	101.50	48.57	66.00	9.95	84.50	36.20	6.62	83.00	36.50
ISK-I-2021-8	34.10	5.00	1.00	15.42	4.08	99.00	54.47	74.00	14.15	113.10	42.10	10.43	95.00	40.10
ISK-II-2020-12	33.50	5.00	3.00	15.58	4.42	101.00	44.07	69.50	11.20	89.30	37.30	7.78	91.00	30.00
ISK-I-2021-21	28.15	4.00	1.00	15.30	2.70	109.50	42.96	74.00	14.75	96.20	41.60	10.93	78.00	36.00
General mean	**36.86**	**3.86**	**1.61**	**15.14**	**3.33**	**102.08**	**46.93**	**70.50**	**12.79**	**100.03**	**42.90**	**9.04**	**84.86**	**39.63**
Minimum	**25.90**	**2.00**	**0.50**	**9.90**	**1.60**	**89.50**	**25.30**	**60.00**	**8.45**	**70.00**	**32.60**	**5.41**	**77.00**	**30.00**
Maximum	**44.60**	**6.00**	**4.50**	**22.00**	**6.00**	**111.00**	**61.70**	**78.00**	**16.40**	**140.00**	**58.60**	**12.83**	**95.00**	**54.30**
C.D. 5%	**3.19**	**1.00**	**0.87**	**2.29**	**1.08**	**2.38**	**10.67**	**6.05**	**3.83**	**8.69**	**3.28**	**2.77**	**5.50**	**3.81**
S.E.(m)	**1.11**	**0.35**	**0.23**	**0.80**	**0.37**	**0.83**	**3.71**	**2.11**	**1.33**	**3.03**	**1.13**	**0.96**	**1.92**	**0.32**
C.V.(%)	**4.30**	**12.90**	**19.20**	**7.70**	**15.00**	**1.20**	**11.50**	**3.80**	**15.00**	**4.70**	**3.40**	**14.90**	**3.20**	**4.71**

PH: Plant height, **PB**: Number of primary branches plant^{-1}, **SB**: Number of secondary branches plant^{-1}, **MP**: Number of mature pods plant^{-1}, **IMP**: Number of immature pods plant^{-1}, **DM**: Days to maturity, **HI**: Harvest index, **SP**: Shelling percentage, **PYP**: Pod yield plant^{-1} (g), **HPW**: Hundred pod weight, **HKW**: Hundred kernel weight, **KYP**: Kernel yield plant^{-1} (g), **NSMK**: Number of sound mature kernels, **SMK WT:** Sound mature kernel weight.

Table 3. List of top five genotypes based on mean performance in groundnut

S. No.	Characters	Genotypes
1	Plant height (cm)	UBEK 21-60, UBEK 21-42, UBEK 21-67, ISK-I-2021-21, UBEK 21-35
2	Number of primary branches plant^{-1}	TCGS 2352, TCGS 2347, TCGS 2348, TCGS 2357, UBEK 21-38, ISK-I-2021-8, ISK-II-2020-12
3	Number of secondary branches plant^{-1}	TCGS 2223, UBEK 21-67, TCGS 2351, UBEK 21-42, ISK-II-2020-12
4	Number of mature pods plant^{-1}	TCGS 2348, TCGS 2350, TCGS 2233, UBEK 21-68, ISK-II-2020-4, UBEK 21-40, TCGS 2326
5	Number of immature pods plant^{-1}	UBEK 21-60, UBEK 21-76, UBEK 21-70, TCGS 2223, TCGS 2233, TCGS 2347, TCGS 2348
6	Days to maturity	UBEK 21-74, UBEK 21-40, UBEK 21-43, TAG 24, TCGS 2339, TCGS 2326
7	Harvest index (%)	UBEK 21-68, TCGS 2223, UBEK 21-76, UBEK 21-61, UBEK 21-70
8	Shelling percentage	UBEK 21-76, UBEK 21-38, UBEK 21-61, Rohini, TCGS 2350
9	Pod yield plant^{-1} (g)	TCGS 2347, TCGS 2233, UBEK 21-67, UBEK 21-70, UBEK 21-68
10	100 pod weight (g)	TCGS 2347, TCGS 2223, UBEK 21-68, TCGS 2233, TCGS 2348
11	100 kernel weight (g)	TCGS 2347, TCGS 2223, TCGS 2348, TCGS 2233, UBEK 20-32, ISK-II-2020-4
12	Kernel yield plant^{-1} (g)	TCGS 2347, UBEK 21-67, UBEK 21-76, Rohini, UBEK 21-61
13	Number of sound mature kernel	ISK-I-2021-8, TCGS 2350, TCGS 2354, Rohini, ISK-II-2020-12
14	Sound mature kernel weight	TCGS 2347, TCGS 2223, UBEK 21-38, TCGS 2326, TCGS 2233

primary branches plant^{-1}, 100 pod weight, sound mature kernel weight and 100 kernel weight. TCGS 2233 was also observed to be promising for number of mature pods plant^{-1}, 100 pod weight, 100 kernel weight whereas, UBEK 21-68 recorded higher harvest index, number of mature pods plant^{-1}, 100 pod weight and UBEK 21-70 recorded higher harvest index. UBEK 21-76, Rohini and UBEK 21-61 recorded higher kernel yield plant^{-1}. UBEK 21-61 performed better for shelling percentage and harvest index whereas, Rohini recorded higher mean performance for shelling percentage, number of sound mature kernel. genotypes *viz.,* UBEK 21-74, UBEK 21-40, UBEK 21-43, TAG 24, TCGS 2339 and TCGS 2326 recorded early maturity at 90 DAS. Among these genotypes, UBEK 21-40 and TCGS 2326 recorded more number of mature pods plant^{-1}.

From the current investigation, the genotypes *viz.,* TCGS 2233, TCGS 2223, TCGS 2347, UBEK 21-67, UBEK 21-70, UBEK 21-68, Rohini and UBEK 21-76 were found as promising genotypes and could be exploited for improvement of yield and yield attributes in the breeding programme as donors. UBEK 21-74, UBEK 21-40, UBEK 21-43, TAG 24, TCGS 2339 and TCGS 2326 were identified as early maturing genotypes. Their duration is to be confirmed in all the seasons in multilocations. Meanwhile, Rohini and UBEK 21-76 which are medium maturing genotypes could be utilized for improving yield and its contributing characters, along with maturity at the same time.

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NITROGEN UPTAKE AS INFLUENCED BY PRECISION NITROGEN MANAGEMENT IN *RABI* RICE (*Oryza sativa* L.)

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ABSTRACT

A field experiment was conducted during *rabi,* 2021-22 on sandy clay loam soils of Agricultural Research Station, Nellore, Andhra Pradesh to study the "Precision nitrogen management in *rabi* rice [*Oryza sativa* L.]". The experiment was laid out in Randomized Block Design and replicated thrice. The treatments included Control, Farmer's practice, Soil Test Based Nitrogen Fertilization, Recommended Dose of Nitrogen along with 2 LCC (Leaf color chart), based, 2 NDVI (Normalized difference vegetation index) based and 2 SPAD (Soil Plant Analysis Development) based N management with critical levels of LCC (4,5), NDVI (0.7, 0.8) and SPAD (35, 40). The variety NLR 3354 was tested in the present experiment. Among the different nitrogen management practices tried, higher yield and nutrient uptake was recorded with fixed time nitrogen management in FP and STBNF but was on par with LCC-5 (T_6), NDVI-0.8 (T_8) and SPAD-40 (T_{10}) with a saving of 45% and 27% of N respectively along with maintenance of high post-harvest soil nutrient status, while significantly lower values were recorded with control (without N) (T_1).

KEYWORDS: Farmer's practice, Soil Test Based Nitrogen Fertilization, Leaf color chart.

INTRODUCTION

Paddy (*Oryza sativa* L.) is the principal food crop of South East Asian countries and feeds more than half of the global population. Usually, paddy is grown under transplanted submerged condition over a large area.

In India, 45.76 m ha of area is occupied by rice crop with 124.36 m t of production and 2717 kg ha^{-1} of productivity. In Andhra Pradesh, 2.32 m ha of area is occupied with 7.8 m t of production and 4437 kg ha^{-1} of productivity. (*www.indiastat.com,* 2020).

Nitrogen is one of the most important and limited nutrient for rice production, and synthetic nitrogen fertilizer plays a critical role in increasing the yield. However, only 30 to 40% of the applied nitrogen is utilized by the crop resulting in significant losses of reactive nitrogen, which not only reduces production but also drains the national budget and pollutes the environment.

The various methods for fertilizer recommendation based on the analysis of soil and plants are tedious. To avoid the drudgery of the laboratory analysis, scientists have specialized crop sensor technology which gives information on the nitrogen need of a crop based on the leaf optical property. Chlorophyll or N content of leaf is closely related to photosynthetic rate and biomass production, and is an indicator of changes in crop N demand during the growing season. Keeping these in view the present study was formulated to find out the best N management practice.

MATERIALS AND METHODS

A field experiment entitled "Precision nitrogen management in *rabi* rice [*Oryza sativa* L.]" was conducted during *rabi*, 2021-22 at Agricultural Research Station, Nellore. It is geographically situated at 14°27' N latitude and 79.59'° E longitude and at an altitude of 20 m above MSL in the Southern Agro-climatic Zone of Andhra Pradesh. The present experiment was laid out in Randomized Block Design and replicated thrice. The treatments consisted of ten nitrogen management practices *viz.,* Control (without N) (T_1), Farmer's practice (200 kg N ha^{-1}) (T_2), Soil Test Based N fertilizer application (T_3), Recommended dose of N (120 kg ha^{-1}) + FYM @ 5 t ha^{-1}) (T_4), N application at LCC 4 scale (T_5), N application at LCC 5 scale (T_6), N application at NDVI Threshold 0.7 (T_7), N application at NDVI Threshold 0.8 (T_8), N application at SPAD Threshold of 35 (T_9) and N application at SPAD Threshold of 40 (T_{10}). The soil of the experimental field was sandy clay loam, neutral in soil reaction, low in organic carbon (0.46 %) and available nitrogen (202 kg ha^{-1}), high in available phosphorus (56 kg ha^{-1}) and available potassium (425 kg ha^{-1}). The crop was sown at 15 cm x 15 cm spacing.

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The variety Nellore dhanyarasi (NLR 3354) was sown on Nov-26. All the other recommended practices were adopted as per the crop requirement. The collected data was statistically analyzed following the analysis of variance for Randomized block design as given by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

Yield

The grain and straw yields were significantly influenced by different nitrogen management practices. Among them, higher yield of rice was recorded with the application of N through Soil Test Based N fertilizer application (T_3) and Farmer's practice (200 kg N ha^{-1}) (T_2), which were on par with precision nitrogen management practices i.e., LCC-5(T_6), NDVI-0.8 (T_8) and SPAD-40 (T_{10}) compared to RDN (T_4), which in turn maintained parity with LCC-4 (T_5) and NDVI-0.7(T_7). This was followed by SPAD-35 (T_9). Significantly lower grain and straw yield was obtained from control (T_1).

During this study, precision nitrogen management practice through LCC-5 (T_6), NDVI-0.8 (T_8) and SPAD-40 (T_{10}) supply nitrogen based on crop demand in several splits there by increasing the N uptake which showed favorable effect on cell-division and tissue organization that ultimately improved growth attributing characters like plant height, number of tillers, leaf area and higher SPAD values there by increasing the photosynthetic capacity and lead to higher dry matter production and its accumulation in different parts of plant which in turn lead to higher yield attributing characters like, number of panicles m^{-2}, grain weight panicle^{-1} and number of filled grains panicle^{-1} which directly or indirectly might have increased the yield equal to FP and STBNF in which N applied was at a higher rate. Lower yield was recorded with RDN, which maintained parity with LCC-4 (T_5) and NDVI-0.7 (T_7), might be due to less N uptake by the crop, as the indigenous N supply was low. No increase in the yield was observed in FP when compared to STBNF indicating the later to be the optimum dose. Among the precision nitrogen management practices the higher yields in case of LCC-5 (T_6), NDVI-0.8 (T_8) and SPAD-40 (T_{10}) compared to other critical levels is due to application of nitrogen in more number of splits which fulfills the crop requirement. These results are in conformity with Ghosh *et al*. (2013), Mohanty *et al*. (2015), Prabhudev *et al*. (2017) and Suresh *et al.* (2017).

Table 1. Grain and straw yield of rice as influenced by different nitrogen management practices

Treatments	Grain yield	Straw yield
T_1 : Control (without N)	2435	4140
T_2 : Farmer's practice (200 kg N ha^{-1})	6313	9040
T_3 : Soil Test Based N Fertilization	6384	8810
T_4 : Recommended dose of N (120 kg ha^{-1}) + FYM @ 5 t ha^{-1}	5696	7683
T_5 : N application at LCC 4 scale	5769	7533
T_6 : N application at LCC 5 scale	6291	8556
T_7 : N application at NDVI Threshold 0.7	5776	7549
T8 : N application at NDVI Threshold 0.8	6287	8551
T_9 : N application at SPAD Threshold of 35	4806	6234
T_{10} : N application at SPAD Threshold of 40	6279	8540
SEm±	168.9	251.2
CD (P = 0.05)	534	747

Table 2. Nutrient uptake (kg ha^{-1}) of rice at harvest as influenced by different nitrogen management practices

Treatments	Nitrogen uptake	Phosphorus uptake	Potassium uptake
T_1 : Control (without N)	50	20.3	97
T_2 : Farmer's practice (200 kg N ha^{-1})	132	37.7	151
T_3 : Soil Test Based N Fertilization	129	35.8	142
T_4 : Recommended dose of N (120 kg ha^{-1}) + FYM @ 5 t ha^{-1}	113	27.0	117
T_5 : N application at LCC 4 scale	105	28.3	120
T_6 : N application at LCC 5 scale	127	33.7	132
T_7 : N application at NDVI Threshold 0.7	106	28.0	121
T8 : N application at NDVI Threshold 0.8	125	32.7	134
T_9 : N application at SPAD Threshold of 35	86	24.0	107
T_{10} : N application at SPAD Threshold of 40	126	33.3	132
SEm±	3.3	0.93	4.1
CD (P=0.05)	10	2.8	12

Table 3. Post-harvest soil available nutrient status (kg ha^{-1}) as influenced by different nitrogen management practices inrice

Treatments	Available N	Available P_2O_5	Available K_2O
T_1 : Control (without N)	145	32.3	286
T_2 : Farmer's practice (200 kg N ha^{-1})	175	44.0	330
T_3 : Soil Test Based N Fertilization	164	44.3	335
T_4 : Recommended dose of N (120 kg ha^{-1}) + FYM @ 5 t ha^{-1}	178	42.3	342
T_5 : N application at LCC 4 scale	180	43.0	335
T_6 : N application at LCC 5 scale	176	51.9	380
T_7 : N application at NDVI Threshold 0.7	179	42.0	338
T8 : N application at NDVI Threshold 0.8	176	53.9	375
T_9 : N application at SPAD Threshold of 35	163	36.2	296
T_{10} : N application at SPAD Threshold of 40	177	53.9	382
SEm±	4.3	1.30	10.3
CD (P=0.05)	13	3.9	31

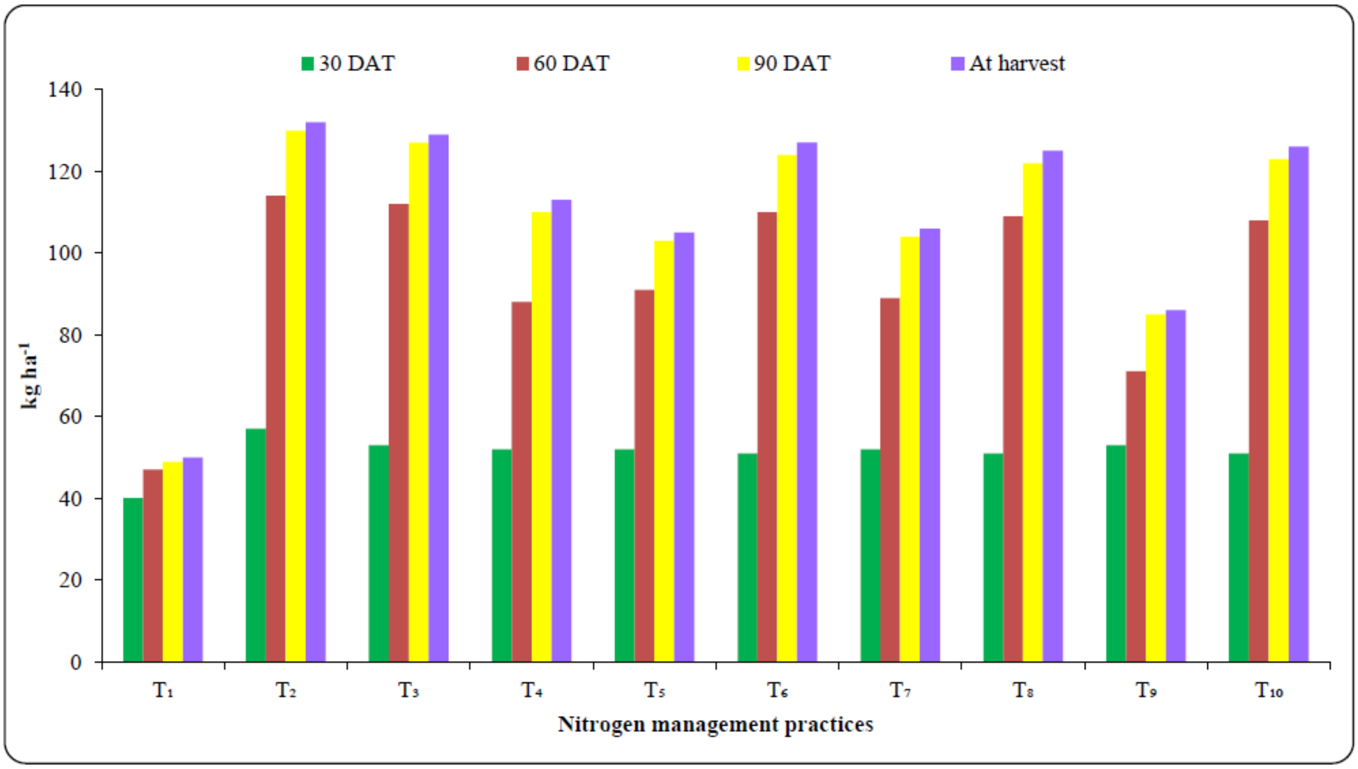

Fig. 1. Nitrogen uptake (kg ha^{-1}) of rice at different growth stages as influenced by different nitrogen management practices.

Nutrient uptake at harvest

During the study, among the treatments higher Nitrogen, phosphorus and potassium uptake was recorded with FP (T_2) and it was on par with STBNF and precision nitrogen management practices *i.e.*, LCC-5 (T_6), NDVI-0.8 (T_8) and SPAD 40 (T_{10}) compared to RDN, which maintained parity with LCC-4 (T_5) and NDVI-0.7 (T_7), followed by SPAD-35(T_9). Significantly lowest nutrient uptake was recorded with absolute control (T_1) without N. Nutrient uptake is a function of yield and nutrient concentrations in plant. Significant improvement in uptake of nitrogen might be attributed to the respective higher concentration in grain and straw and associated with higher grain and straw yields. Better availability of nitrogen in the soil under these treatments may influenced on higher degree of root proliferation, anchorage and deep penetration and in turn resulted in absorption of higher amount of nutrients from the rhizosphere and supplied to the crop. Even though precision N management practice through LCC-5(T_6), NDVI-0.8 (T_8) and SPAD-40 (T_{10}) received less amount of N than fixed time N management practice *i.e.*, FP and STBNF but the N uptake was comparable. This was mainly due to N application in more number of splits based on crop demand which reduces various losses such as leaching, volatilization and removal by the weeds there by increasing the crop uptake. Similar findings were also reported by Similar results were perceived by Shantappa *et al.* (2014), Das and Sahu (2015) and Reena *et al.* (2017)

Post-harvest soil nutrient status

Available nitrogen

During the study, the post-harvest soil available nitrogen status of precision N management practices were found to be comparable with each other except SPAD-35 (T_9) and were at par with FP and RDN but significantly superior than STBNF. Significantly lower N availability was observed with control (without N) (T_1). Adequate and timely supply of nitrogen to meet the crop demand along with increased microbial activity in these treatments might have hastened the process of mineralization during the crop growth period resulting in high accumulation of N in soil. These results strongly support the findings of Arvind *et al.* (2004) and Swamy *et al.* (2016).

Available phosphorus and potassium

Significantly higher phosphorus and potassium availability were observed with LCC-5 (T_6) NDVI-0.8 (T_8) and SPAD-40 (T_{10}), followed by RDN (T_4) which was comparable with all other treatments except SPAD-35 (T_9) and control (T_1). The lower available phosphorous and potassium were noticed in control which maintained parity with SPAD-35 (T_9). Application of nitrogen through LCC-5 (T6), NDVI-0.8 (T8) and SPAD-40 (T10) matches with the crop demand as it was applied in more splits in the form of urea which on nitrification forms hydrogen ions besides nitrate ions, thus modifies pH of the rhizosphere, due to this acidification of rhizosphere resulted in the solubilization of insoluble phosphates and release more orthophosphates in to the soil solution. Moreover, higher concentration of nitrates in the soil solution exchange for orthophosphate ions by anion exchange phenomenon. These results are in line with Krishnakumar and Haefele (2013).

Increased status of potassium might be due to enhanced mineralization owing to better root growth under LCC-5 (T_6) NDVI-0.8 (T_8) and SPAD-40 (T_{10}), which maintained parity with each other. Results of the present investigation strongly support the findings of Duttarganvi *et al*. (2011) and Rao *et al*. (2016).

It is concluded that the application of 30 kg N ha^{-1} as basal and 20 kg N ha^{-1} guided either by LCC-5 (T_6) or NDVI-0.8 (T_8) or SPAD -40 (T_{10}), proved to be most promising, feasible and economically viable nitrogen management practice for higher yield and economics in *rabi* rice for the Southern Agro-climatic Zone of Andhra Pradesh.

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