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EFFECT OF FOLIAR APPLICATION OF NANO UREA ON GROWTH AND YIELD OF FODDER MAIZE

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ABSTRACT

A field experiment entitled "Effect of foliar application of nano urea on growth and yield of fodder maize" was conducted at Dryland Farm, S.V. Agricultural College, Tirupati campus of Acharya N.G. Ranga Agricultural University, Andhra Pradesh, India during *rabi,* 2023-24. The experiment was laid down in the randomized block design and replicated thrice. Significantly higher values of plant height, leaf area index, green and dry fodder yields were recorded with application of 100% of RDN @120 kg N ha^{-1} + two sprays of nano urea @ 4 ml l^{-1} at knee high and tasselling stages, which was found to be on par with 100 % RDN through urea in three splits (33 % basal + 33 % KH + 33 % TS). Significantly lower values were realized with control.

KEYWORDS: Green fodder yield, Dry fodder yield, Knee high stage, Tasselling stage, Recommended dose of nitrogen.

INTRODUCTION

India feeds about 20 per cent of the world's livestock which means that a significant portion of the global livestock population relies on food resources from India's agricultural activities. The livestock population in India is increasing at a rate of 0.66 per cent per year. Additional pressure is put on the supply of fodder resources by this growth rate. Only 4 per cent of India's total arable land is currently dedicated to the production of fodder. Due to the insufficient amount of land set aside for the production of fodder, there may not be enough resources to support the increasing number of animals. The quantity and quality of the fodder that animals are fed have a significant impact on their health and production. In India, there is now a major shortage of feed supplies. There is 35.6 per cent scarcity of green fodder, 10.5 per cent shortfall of dry fodder and 44 per cent shortage of concentrate feed ingredients across the nation. This shortage shows that there is a gap between the supply and demand for fodder, which is problematic for livestock farmers. While there is a need to close the supply gap for fodder, the prospect of increasing the amount of land available for fodder cultivation is given weight.

Among the cultivated forage crops, maize (*Zea mays* L.), produces rich and nutritious green fodder which is a good source of carbohydrates. The green fodder is particularly suitable for silage making. Apart from having higher fodder yield, it is also tolerant to a wide range of climatic conditions. Maize crop is succulent, widely adaptable and fodder is highly palatable without any antinutritional factors throughout the growth period of the crop (Kashyap *et al*., 2023). As maize is an exhaustive crop, the nutritional requirement is very high. Due to continuous use of conventional urea, the quality of fodder is said to reduce in due course of time. Use of nanotechnology in fodder crops helps to increase the hay and silage quality thereby increasing the milk production in cattle.

Nanotechnology is the manipulation of matter on a near atomic scale to produce new structures, materials and devices. Conventional fertilizers when applied to crop will be subjected to different types of losses like photolysis, hydrolysis, leaching and degradation thereby reducing the availability of fertilizer (Ajithkumar *et al*., 2021). But use of nano fertilizers reduces the losses as they are very minute in size and can be made easily available at target sites. The present study was planned to investigate the effect of nano urea on growth and yield of fodder maize.

MATERIAL AND METHODS

A field experiment was conducted at Dryland farm, S.V. Agricultural College, Tirupati during *rabi,* 2023-24 on sandy loam soils. The soil was neutral in reaction, low in available nitrogen, high in available phosphorus and medium in available potassium status. The variety of fodder maize used in the experiment was African Tall. The present experiment was laid out in a randomized block design with nine treatments and replicated thrice. The treatments consisted of control (no application of N) (T_1), application of nano urea alone twice at KH and TS

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(T_2), 100 % RDN through urea in three splits (33 % basal + 33 % KH + 33 % TS) (T_3), RDN only basal (33 %) + two sprays of nano urea at KH and TS (T_4), RDN only basal (50 %) + two sprays of nano urea at KH and TS (T_5), 75 % of RDN (33 % basal + 33 % KH + 33 % TS) + two sprays of nano urea at KH and TS (T_6), 75 % of RDN (66 % basal + 17 % KH + 17 % TS) + two sprays of nano urea at KH and TS (T_7), 50 % of RDN (33 % basal + 33 % KH + 33 % TS) + two sprays of nano urea at KH and TS (T_8) and 100 % of RDN (33 % basal+ 33 % KH + 33 % TS) + two sprays of nano urea at KH and TS (T_9). Recommended dose of fertilizer used in the experiment was 120-50-40 N, P_2O_5 and K_2O kg ha^{-1}. Recommended dose of phosphorus and potassium were applied as basal to all the treatments. Nano urea was sprayed @ 4 ml l^{-1} during knee high and tasselling stages.

Plant height was recorded from five randomly tagged plants at different intervals *viz*., 20, 40, 60 DAS and at harvest. It was measured from the base of the plant to the tip of the longest leaf up to tasselling stage and later on it was measured from the base of the plant to the tip of the tassel and mean was expressed in cm. Five plants were selected outside the net plot area, leaving the extreme border row, for destructive sampling to generate data on leaf area at different stages of crop growth. Leaf area of five destructively sampled plants from border rows was measured at 20, 40, 60 DAS and at harvest by using LI-COR model, LT-300 leaf area meter with transparent conveyor belt and electronic digital display. After computing the leaf area (cm^2), leaf area index was calculated by using the following formula as suggested by Watson (1952).

$$\text{LAI} = \frac{\text{Leaf area (cm}^2\text{)}}{\text{Unitl and area (cm}^2\text{)}}$$

Crop was harvested at milky dough stage. Green fodder yield of fodder maize from the net plot area was harvested separately by leaving 5 cm stubbles from ground surface and expressed in t ha^{-1}. After harvesting, heaps were left in the field for one week for sun drying. Then dry fodder yield of maize from net plot area was weighed and total dry fodder yield was expressed in t ha^{-1}.

RESULTS AND DISCUSSION

Data pertaining to the plant height, leaf area index and yield as influenced by varied levels of nitrogen and foliar application of nano urea was discussed in different sections.

Plant height

Plant height of fodder maize recorded highest values with 75 % of RDN (66 % basal + 17 % KH + 17 % TS) + two sprays of nano urea at KH and TS (T_7) at 20 DAS. Whereas, taller plants at all the growth stages of observations *viz*., 40, 60 DAS and at harvest, were recorded with 100 % of RDN (33 % basal+ 33 % KH + 33 % TS) + two sprays of nano urea at KH and TS (T_9) but it was found to be on par with 100 % RDN through urea in three splits (33 % basal + 33 % KH + 33 % TS) (T_3). The shorter plants of fodder maize were associated with control (T_1). This might be due to greater availability of nitrogen at higher fertilizer doses *i.e*., 100 % RDN (T_9 and T_3) which might have improved protein synthesis and photosynthesis leading to rapid cell division and enlargement, which ultimately resulted in vigorous plant growth. Nano urea has been suggested to enhance various physiological processes in plants, such as photosynthesis, nutrient uptake and enzymatic activities. These improvements in plant physiology can contribute to better growth and development, potentially leading to increased plant height. The obtained results were in conformity with the findings of Lahari *et al*. (2021) and Navya *et al*. (2022).

Leaf area index

Leaf area index of fodder maize recorded highest values with 75 % of RDN (66% basal + 17% KH + 17% TS) + two sprays of nano urea at KH and TS (T_7) at 20 DAS. Higher leaf area index of fodder maize at 40, 60 DAS and at harvest was found with 100 % of RDN (33 % basal+ 33 % KH + 33 % TS) + two sprays of nano urea at KH and TS (T_9) which was on par with 100 % RDN through urea in three splits (33 % basal + 33 % KH + 33 % TS) (T_3). While the minimum leaf area index was associated with control (T_1). Application of 100 % recommended dose of N along with two foliar sprays of nano urea was found beneficial in increasing the leaf area of fodder maize at harvest compared to other treatments. This might be due to the fact that maize thrives on readily available nitrogen. Applying nitrogen through both soil and foliar methods creates a dynamic system. Soil application provides a base supply, while foliar sprays act like booster shots. This targeted approach ensures that nitrogen is available when it is most crucial for cell division and elongation in leaves. This results

Table 1. Plant height (cm) of fodder maize at different growth stages as influenced by varied levels of nitrogen and foliar application of nano urea

Treatments	20 DAS	40 DAS	60 DAS	At harvest
T_1 : Control (no application of N)	24.3	49.8	89	128
T_2 : Application of nano urea alone twice at KH and TS	25.6	55.8	112	150
T_3 : 100% RDN through urea in three splits (33% basal + 33% KH + 33% TS)	32.4	80.5	177	216
T_4 : RDN only basal (33%) + two sprays of nano urea at KH and TS	32.0	71.5	135	168
T_5 : RDN only basal (50%) + two sprays of nano urea at KH and TS	34.6	72.1	141	175
T_6 : 75% of RDN (33% basal + 33% KH + 33% TS) + two sprays of nano urea at KH and TS	31.5	76.0	158	196
T_7 : 75% of RDN (66% basal + 17% KH + 17% TS) + two sprays of nano urea at KH and TS	35.2	76.7	162	199
T_8 : 50% of RDN (33% basal + 33% KH + 33% TS) + two sprays of nano urea at KH and TS	28.3	72.4	145	178
T_9 : 100% of RDN (33% basal + 33% KH + 33% TS) + two sprays of nano urea at KH and TS	32.7	81.1	181	220
SEm±	0.61	1.14	4.1	5.0
CD (P = 0.05)	1.8	3.4	12	15

Table 2. Leaf area index of fodder maize at different growth stages as influenced by varied levels of nitrogen and foliar application of nano urea

Treatments	20 DAS	40 DAS	60 DAS	At harvest
T_1 : Control (no application of N)	0.12	0.80	1.34	1.62
T_2 : Application of nano urea alone twice at KH and TS	0.12	0.94	1.83	2.13
T_3 : 100% RDN through urea in three splits (33% basal + 33% KH + 33% TS)	0.21	1.40	3.23	4.13
T_4 : RDN only basal (33%) + two sprays of nano urea at KH and TS	0.21	1.09	2.32	2.69
T_5 : RDN only basal (50%) + two sprays of nano urea at KH and TS	0.28	1.11	2.39	2.81
T_6 : 75% of RDN (33% basal + 33% KH + 33% TS) + two sprays of nano urea at KH and TS	0.20	1.26	2.82	3.44
T_7 : 75% of RDN (66% basal + 17% KH + 17% TS) + two sprays of nano urea at KH and TS	0.30	1.27	2.85	3.55
T_8 : 50% of RDN (33% basal + 33% KH + 33% TS) + two sprays of nano urea at KH and TS	0.16	1.13	2.48	2.91
T_9 : 100% of RDN (33% basal + 33% KH + 33% TS) + two sprays of nano urea at KH and TS	0.22	1.41	3.25	4.20
SEm±	0.010	0.038	0.104	0.154
CD (P = 0.05)	0.03	0.12	0.31	0.46

Table 2. Green and dry fodder yields (t ha^{-1}) of fodder maize as influenced by varied levels of nitrogen and foliar application of nano urea

Treatments	Green fodder yield	Dry fodder yield
T_1 : Control (no application of N)	14.27	2.46
T_2 : Application of nano urea alone twice at KH and TS	20.14	3.84
T_3 : 100% RDN through urea in three splits (33% basal + 33% KH + 33% TS)	28.68	6.63
T_4 : RDN only basal (33%) + two sprays of nano urea at KH and TS	22.13	4.56
T_5 : RDN only basal (50%) + two sprays of nano urea at KH and TS	23.09	4.80
T_6 : 75% of RDN (33% basal + 33% KH + 33% TS) + two sprays of nano urea at KH and TS	25.55	5.67
T_7 : 75% of RDN (66% basal + 17% KH + 17% TS) + two sprays of nano urea at KH and TS	26.94	6.02
T_8 : 50% of RDN (33% basal + 33% KH + 33% TS) + two sprays of nano urea at KH and TS	23.50	4.96
T_9 : 100% of RDN (33% basal + 33% KH + 33% TS) + two sprays of nano urea at KH and TS	29.77	6.94
SEm±	0.654	0.150
CD (P = 0.05)	1.96	0.45

in significant increase in leaf area and overall vegetative growth. These results are in conformity with the findings of Rani *et al*. (2019) and Ajithkumar *et al*. (2021).

Green and dry fodder yields

Higher green and dry fodder yields of fodder maize were recorded with 100 % of RDN (33 % basal+ 33 % KH + 33 % TS) + two sprays of nano urea at KH and TS (T_9) which was on par with 100 % RDN through urea in three splits (33 % basal + 33 % KH + 33 % TS) (T_3). Significantly lower green fodder yield of fodder maize was recorded with control (T_1). The treatments with 100 % RDN (T_9 and T_3) recorded higher dry fodder yield. This was mainly because of superior performance in vegetative growth with respect to plant height, leaf area and leaf: stem ratio which ultimately resulted in higher dry matter accumulation. In the other treatments, substitution of conventional N with nano-urea (T_2, T_4, T_5, T_6, T_7 and T_8) might have significantly decreased the uptake of N by the plant. As fodder maize is an exhaustive crop, decreased uptake of nutrients by plant, affects cell division and elongation, formation of nucleotides and coenzymes, which led to decreased meristematic activity and photosynthetic area and in turn less production and accumulation of photosynthates yielding lower green and dry fodder. This corresponds to the results of Kumar (2023).

In conclusion, the present study revealed that application of 100 % of RDN (33 % basal+ 33 % KH + 33 % TS) + two sprays of nano urea at KH and TS is the most efficient nutrient management practice to obtain better growth and higher fodder yield in fodder maize.

LITERATURE CITED

Ajithkumar, K., Kumar, Y., Savitha, A.S., Ajayakumar, M.Y., Narayanaswamy, C., Raliya, R., Krupashankar, M.R and Bhat, S.N. 2021. Effect of IFFCO nanofertilizer on growth, grain yield and managing turcicum leaf blight disease in maize. *International Journal of Plant and Soil Science*. 33(16): 19-28.

Kashyap, S., Kumar, R., Ram, H., Kumar, A., Basak, N., Sheoran, P., Bhatacharjee, S., Biswal, B., Ali, G., Kumar, B and Bhakuni, K. 2023. Quantitative and qualitative response of fodder maize to use of bulk and nano-fertilizers in North Western Plains of India. *Agronomy*. *13*(7): 1889.

Kumar, A.M.R. 2023. Foliar application of nano urea for enhancing productivity and quality of fodder maize (Zea mays L.). *M.Sc. (Agri.) Thesis*. University of Agricultural Sciences, Bangalore, Karnataka, India.

Lahari, S., Hussain, S.A., Parameswari, Y.S and Sharma, S.H.K. 2021. Grain yield and nutrient uptake of rice as influenced by the nano forms of nitrogen and zinc. *International Journal of Environment and Climate Change*. 11(7): 1-6.

Navya, K., Kumar, S.R., Chaitanya, K.A and Sampath, O. 2022. Effect of nano nitrogen in conjunction with urea on growth and yield of mustard (*Brassica juncea* L.) in Northern Telangana Zone. *Biological Forum: An International Journal*. 14(3): 95-99.

Rani, B., Nirali, B., Zalawadia, N.M and Rushang, K. 2019. Effect of different levels of chemical and nano nitrogenous fertilizers on yield and yield attributes of sorghum crop (*Sorghum bicolor* L.). *International Journal of Current Microbiology and Applied Sciences*. 8(8): 2878- 2884.

Watson, D.J. 1952. The physiological basis of variation in yield. *Advances in Agronomy*. 6: 103-109.

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STUDIES ON EFFECT OF ANTIBIOTIC ON BIOLOGICAL PARAMETERS OF DIAMONDBACK MOTH, *Plutella xylostella* (Linnaeus)

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ABSTRACT

Diamondback moth larvae were reared on natural diet (cabbage) with three concentrations of Streptomycin sulphate (0.05, 0.1 and 0.2%) and without antibiotic (control). Mean larval developmental period was prolonged to 10.00, 11.00 and 12.00 days at 0.05, 0.1 and 0.2 per cent antibiotic respectively, compared to untreated natural diet (9.00 days). Among the concentrations of antibiotic tested, a dose of 0.2 per cent resulted in reduced pupal recovery (67.40%) with shortest pupal duration (4.23 days). Emergence of adults was drastically decreased from 85.80 per cent (control) with a higher number of females (1.5 f/m) to 57.80 per cent (0.2per cent antibiotic) with higher number of males (0.8 f/m). Females laid a greater number of eggs on untreated diet (151.70 eggs/female), with highest percent egg hatchability (82.16%), while a marked reduction was observed at 0.2 per cent antibiotic with 95.38 eggs/female and 58.25 per cent egg hatchability. Biological parameters of *Plutella xylostella* were negatively affected at all the three concentrations of Streptomycin sulphate and it was more obvious at 0.2 per cent antibiotic dose.

KEYWORDS: Diamondback moth, Streptomycin sulphate, Natural diet, biological parameter.

INTRODUCTION

Diamondback moth (DBM), *Plutella xylostella* (Linnaeus) (Lepidoptera: Plutellidae) is considered as the most universally distributed insect of all Lepidopteran insects and is a major pest of cruciferous vegetables (Paudel *et al*., 2022). It is a native of Mediterranean region or South Africa and then it had spread to Europe (Kfir*,* 1998). It is a cosmopolitan insect species found in most places wherever crucifers such as mustard, cabbage, cauliflower, radish, broccoli, turnip, rapeseed, brussels, knol-khol and kale are being grown (Badenes *et al.,* 2020). The change in the population of any insect pest depends on the nutritional status of their host plants, which influences growth, development and reproduction of insect population (Dumas *et al*., 2015). Antibiotic feeding to insects can negatively affect the biological parameters of insects. Among the antibiotics, rifampicin and aureomycin were the most commonly used antibiotics to treat aphids (Lal, 1971; Adams *et al*., 1996) and penicillin to *Spodoptera exigua* (Hubner) (Jung and Kim 2006). Raymond *et al*. (2009) reared *P. xylostella* on artificial diet with rifampicin for clearing gut bacteria. In this view, the present study was undertaken to study the effect of antibiotic on biological parameters of Diamondback moth.

MATERIAL AND METHODS

The studies on the effect of antibiotic on biological parameters of Diamondback moth, *Plutella xylostella,* were conducted during 2023-24 at Insectary, Department of Entomology, S. V. Agricultural College, Tirupati.

Rearing and maintenance of DBM on natural diet (Cabbage)

Egg mass and early instars of DBM were collected from the farmer's field and S.V. Agricultural College farm and brought to the insectary for the rearing and maintenance on cabbage.

Cabbage crop was grown at Insectary, Department of Entomology, S.V. Agricultural College, Tirupati by following Dr. YSRHU, package of practices except plant protection measures. The fresh leaves of cabbage were washed with distilled water, shade dried and cut into discs of uniform size and placed in petri plates. Neonates of Diamondback moth were transferred to Petri plates containing cabbage leaves. The fresh leaves were provided as feed for developing larvae at regular interval and left out material along with excreta were removed daily. The final instar larvae were separated and placed in separate rearing containers for pupation. Pupae were collected and placed in adult rearing cage (30×30×30 cm) for emergence of adult moths. After adult emergence the cages were provided with 10per cent honey solution on

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cotton swabs as adult food and 4-5 leaf stage mustard seedlings as ovipositional substrate

Testing of antibiotic using natural diet (Cabbage) through leaf disc method

An antibiotic (Streptomycin sulphate) was tested at three different concentrations of 0.05 per cent, 0.1 per cent and 0.2 per cent using cabbage as natural diet through leaf disc method. Leaf discs of cabbage leaves were surface sterilized with 75 per cent alcohol for 2 min, and then washed through distilled water to remove the external contamination. Disinfected leaf discs were picked with a needle and then dipped in antibiotic solutions of three different concentrations for 2 h. Antibiotic treated leaf discs were shade dried and were placed in petri dishes. Freshly hatched larvae of DBM were accessed to feed on treated leaf discs of cabbage separately. For each treatment, 30 larvae were released in three replications. Treated leaf discs were provided until pupation. Leaf discs without antibiotic treatment was also tested as control.

RESULTS AND DISCUSSION

The significant differences in biological parameters of *P. xylostella* were recorded among different treatments of natural diet (cabbage) are presented in the Table 1 (Fig. 1 and 2).

Significant differences were found in total larval period among different treatments of natural diet (cabbage), varied from 9.00 days (control) to 12.00 days (0.2% Streptomycin sulphate). At 0.05 per cent (NDS1) and 0.1 per cent (NDS2) of Streptomycin sulphate, the duration of larva was 10.00 and 11.00 days respectively, which were statistically on par with each other (Table 1).

The percentage of pupae resulted from larvae reared on natural diet (cabbage) treated with and without antibiotic was ranged from 67.40 (NDS3) to 81.47 per cent (NDC). Pupal recovery was significantly higher in control, which was on par with natural diet treated with 0.05 per cent antibiotic (76.66%). Percentage of pupal recovery on NDS2 and NDS3 were 72.22 per cent and 67.40 per cent at 0.1 per cent and 0.2 per cent antibiotic respectively (Table 1).

Pupal duration was shortest (4.23 days) on diet treated with 0.2 per cent antibiotic (NDS2) and on par with NDS1 (5.10 days). Whereas on diets; NDC (control) and NDS1 (0.05 per cent), pupal duration was relatively longer with 5.70-6.43 days, which is similar to the pupal duration of 5-7 days under natural conditions (Table 1).

The percentage of adult emergence from pupae resulted from different treatments of natural diet (cabbage) ranged between 57.81 per cent (0.2% antibiotic) to 85.80 per cent (control), which were significantly different from each other. Highest percentage of adult emergence (85.80%) was recorded on natural diet without antibiotic (NDC), whereas at 0.05 per cent and 0.1 per cent antibiotic, it was 76.56 per cent (NDS1) and 69.45 per cent (NDS2) respectively. Least percentage of adult emergence (57.81%) was recorded from the diet treated with 0.2 per cent antibiotic (NDS3) (Table 1).

There was a significant differences in sex ratio (females to males) among treatments of natural diet (cabbage) ranging from 0.8 to 1.5. It was observed that number of females were more than males when fed on natural diet without antibiotic (1.5), followed by 0.05 per cent antibiotic (1.16) and 0.1 per cent antibiotic (1.06). In contrast high proportion of males were produced at 0.2 per cent antibiotic with sex ratio of 0.8. Adult males from natural diet (cabbage) without antibiotic were lived up to 8.73 days, followed by 8.23 days on NDS1 (0.05% antibiotic). Duration from the diets treated with 0.1- 0.2 per cent antibiotic was 5.90-6.53 days (Table 1).

Adult males from natural diet (cabbage) without antibiotic were lived up to 8.73 days, followed by 8.23 days on NDS1 (0.05% antibiotic). Duration from the diets treated with 0.1- 0.2 per cent antibiotic was 5.90-6.53 days. The similar trend was observed in female adult longevity, in which longevity of adult female on natural diet without antibiotic (control) was longest with 10.70 days, and was found on par with NDS1 (0.05% antibiotic) with 9.60 days. Duration of adult female at 0.1 per cent antibiotic was 8.63 days. Longevity was shortest at 0.2 per cent antibiotic (NDS3) with 7.10 days, which were significantly different from control. It indicates that as the concentration of Streptomycin sulphate was increased in the diet, longevity of both male and female adults were decreased to 5.90 and 7.10 days respectively, at 0.2 per cent (NDS3) (Table 1).

Statistically significant differences were observed in egg production among different diets. The fecundity was highest (151.70 eggs/female) on natural diet without antibiotic (NDC). Fecundity at 0.05 per cent (NDS1) and 0.1 per cent antibiotic (NDS2) were 132.76 and 107.37 eggs/female, which are significantly different from control diet. Lowest fecundity was observed (95.38 eggs/female) in the diet treated with 0.2 per cent antibiotic (NDS3) (Table 1). An inverse relationship was observed between fecundity and concentration of antibiotic (Table 1).

Table 1. Biological Parameters of *Plutella xylostella* reared on natural diet (cabbage) with and without antibiotic

Parameter	Diet treatments				ANOVA
	NDS1	NDS2	NDS3	NDC	
Larval period (days)*	10.00^{ab} (1.00 ± 0.00)	11.00^{ab} (1.04 ± 0.57)	12.00^{b} (1.08 ± 0.57)	9.00^{a} (0.95 ± 0.00)	F = 10.00, df = (3, 8) P<0.01
Pupal recovery (%)**	76.66^{bc} (61.11 ± 0.64)	72.22^{ab} (58.19 ± 0.64)	67.40^{a} (55.18 ± 0.97)	81.47^{c} (64.50 ± 1.48)	F = 36.53, df = (3, 8) P<0.01
Pupal period (days)*	5.70^{bc} (0.76 ± 0.15)	5.10^{ab} (0.71 ± 0.05)	4.23^{a} (0.63 ± 0.14)	6.43^{c} (0.81 ± 0.23)	F = 33.97, df = (3, 8) P<0.01
Adult emergence (%)**	76.56^{c} (61.04 ± 0.38)	69.45^{b} (56.44 ± 0.58)	57.81^{a} (49.49 ± 1.32)	85.80^{d} (67.86 ± 1.04)	F = 167.00, df = (3, 8) P<0.01
Sex ratio (female/male)**	1.16^{b} (6.18 ± 0.03)	1.06^{ab} (5.90 ± 0.03)	0.8^{a} (5.13 ± 0.05)	1.5^{c} (7.03 ± 0.05)	F = 37.66, df = (3, 8) P<0.01
Adult male longevity (days)*	8.23^{bc} (0.92 ± 0.14)	6.53^{ab} (0.81 ± 0.08)	5.90^{a} (0.77 ± 0.05)	8.73^{c} (0.94 ± 0.12)	F = 156.09, df = (3, 8) P<0.01
Adult female longevity (days)*	9.60^{bc} (0.98 ± 0.05)	8.63^{b} (0.94 ± 0.08)	7.10^{a} (0.85 ± 0.05)	10.70^{c} (1.03 ± 0.47)	F = 39.22, df = (3, 8) P<0.01
Fecundity (eggs/female)*	132.76^{c} (2.12 ± 1.39)	107.37^{b} (2.03 ± 1.46)	95.38^{a} (1.98 ± 1.99)	151.7^{d} (2.18 ± 2.39)	F = 38.95, df = (3, 8) P<0.01
Egg hatch (%)**	75.65^{bc} (60.43 ± 1.40)	67.06^{b} (54.97 ± 0.97)	58.25^{a} (49.74 ± 1.72)	82.61^{c} (65.35 ± 1.45)	F = 55.61, df = (3, 8) P<0.01

With in a row, means followed by the same letter are not significantly different (α=0.05), (Tukey test; SPSS-25). Figures in the parenthesis are transformed values ± standard errors. *Log transformation, **Arc sine transformation. Where NDS1= Natural diet (Cabbage) with Streptomycin Sulphate @ 0.05 per cent; NDS2= Natural diet (Cabbage) with Streptomycin Sulphate @ 0.1 per cent; NDS3= Natural diet (Cabbage) with Streptomycin Sulphate @ 0.2 per cent; NDC= Natural diet (Cabbage) without antibiotic

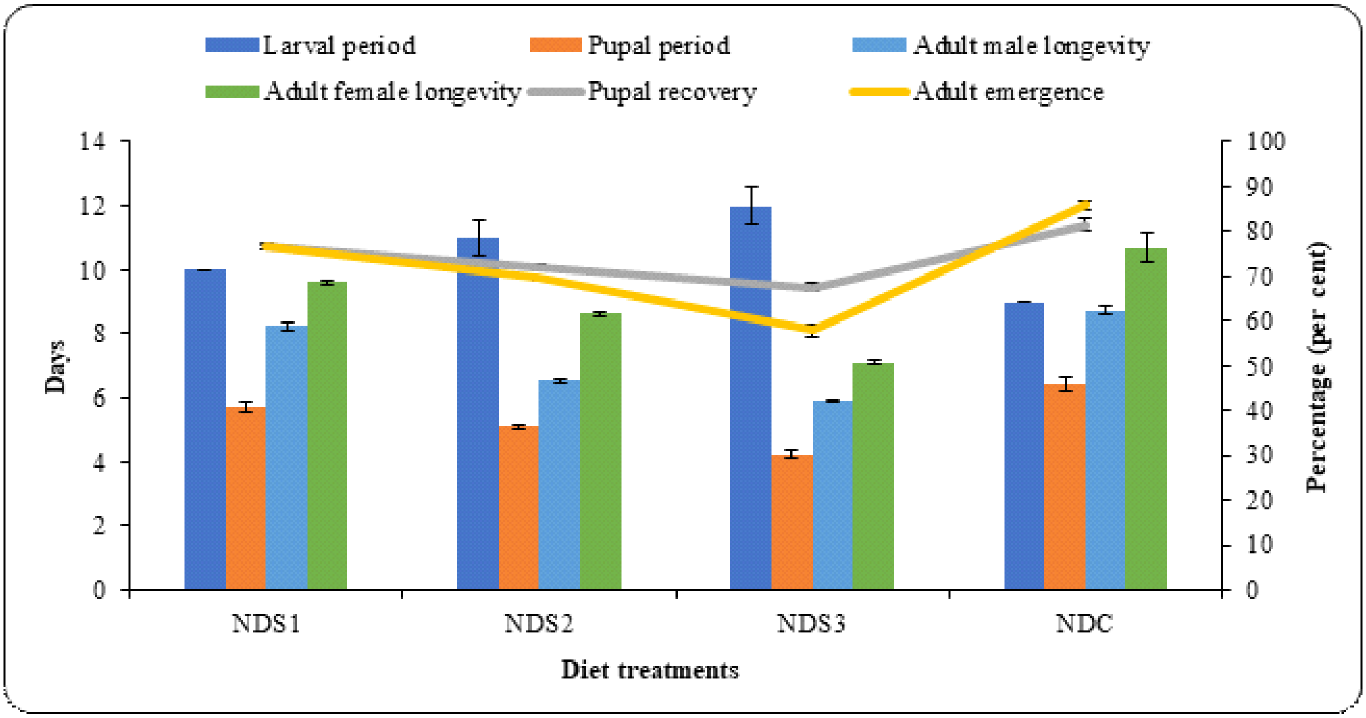

Fig. 1. Biological Parameters of *Plutella xylostella* reared on Natural diet (cabbage) with and without antibiotic.

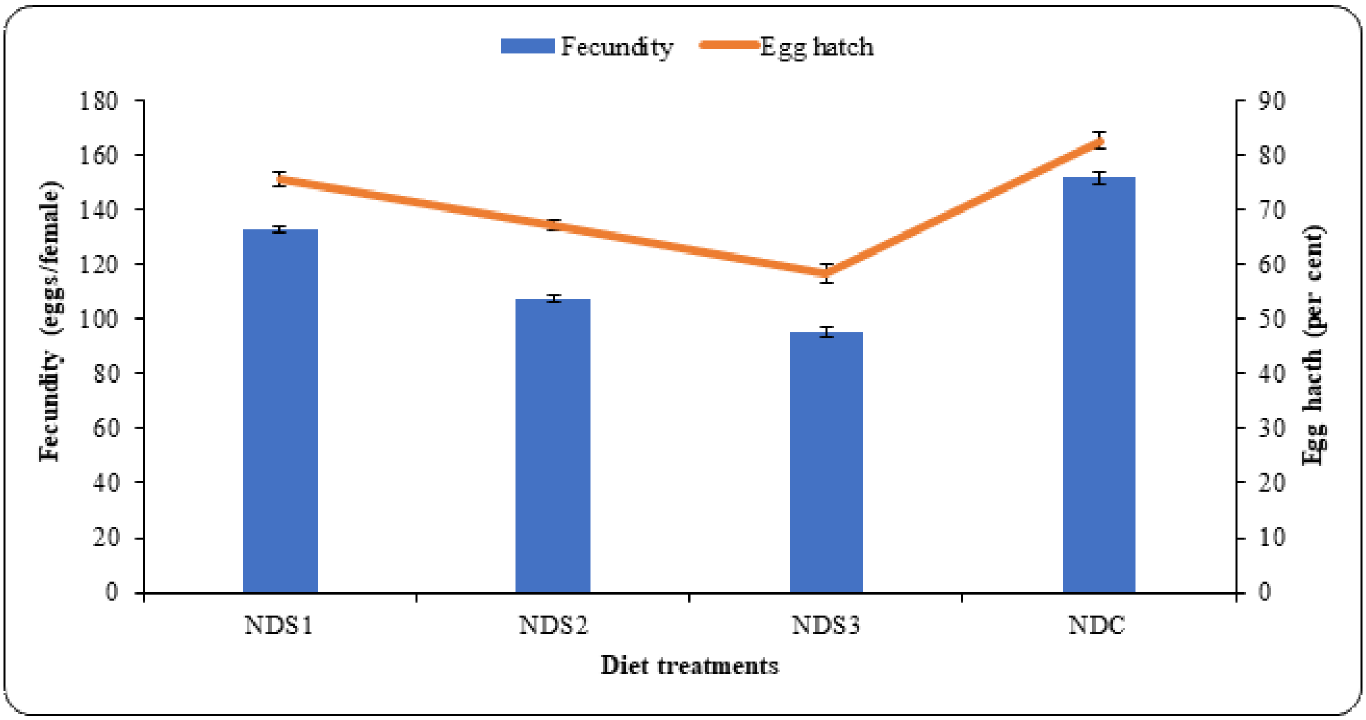

Fig. 2. Fecundity and fertility of *Plutella xylostella* reared on natural diet (cabbage) with and without antibiotic.

Percentage of egg hatch was highest (82.61%), on natural diet without antibiotic (NDC) followed in diet treated with 0.05 per cent antibiotic (75.65%). Whereas at 0.1 per cent antibiotic it was 67.06 per cent. Lowest percentage of egg hatch was observed at 0.2 per cent antibiotic (NDS3) with 58.25 per cent, which was significantly different from remaining diets (Table 1). Antibiotic treatment had showed detrimental effect on hatchability of eggs laid by females from diets treated at higher concentration of antibiotic (Table 1).

Mean larval period of DBM reared on natural diet (cabbage) treated with Streptomycin sulphate at three concentrations of 0.05, 0.1 and 0.2 per cent resulted in significant increase in larval duration from 9.00 (control) to 12.00 days (0.2 per cent antibiotic). The similar findings reported by Zhu *et al*. (2023), who found that the developmental duration of larvae fed on natural diet (radish) treated with 0.2 per cent of tetracycline, prolonged to 16.55 days, compared to 7.43 days on control. The highest pupal recovery was recorded on natural diet (cabbage) without antibiotic (81.47 per cent) and decreased to 67.40 per cent as the concentration of Streptomycin sulphate was increased to 0.2 per cent in natural diet, which were corroborated with Shen *et al*. (2018), who reported that larvae of *P. xylostella* fed on natural diet (radish) treated with antibiotic has declined pupation rates. Pupal period was reduced to 4.23 days in natural diet treated with 0.2 per cent of Streptomycin sulphate, when compared to 6.43 days in diet without antibiotic. Proportion of number of females were high in natural diet without antibiotic (1.5 f/m), whereas the number of females were reduced with slight increase in concentration of Streptomycin sulphate. It indicates that diets without antibiotic were suitable diets in favour of female sex ratio, which is an attribute of standard diet for insect rearing (Alam *et al*., 2024). Adult emergence was highest in natural diet without antibiotic (85.80%), while the emergence rate was decline to <60 per cent at 0.2 per cent Streptomycin sulphate. These results are in line with Thakur *et al*. (2016), who also reported that adult emergence of *Spodoptera litura* was decreased with increased concentrations of Streptomycin sulphate at 0.03 per cent, 0.07 per cent and 0.15 per cent, which resulted in poor emergence to <65.00 per cent compared to 85.00 per cent in control. Longevity of adult males and females of *P. xylostella* on natural diet without Streptomycin sulphate were lived up to 8.73 and 10.70 days respectively. Longevity of adult male were reduced from 8.23 to 5.90 days with increased concentration of Streptomycin sulphate from 0.05 to 0.2 per cent, similarly for adult females from 9.60 (0.05%) to 7.10 days (0.2%). Longevity of both male and female adults were slightly affected at 0.05 and 0.1 per cent, but at 0.2 per cent longevity was drastically affected. The present findings on adult longevity are in agreement with Zhang *et al*. (2022), who reported that larval feeding with ciprofloxacin shortened adult longevity of oriental fruit moth, *Grapholita molesta* (16.68 days) with slight increase in concentration of antibiotic by 0.0001 per cent, compared 17.86 days in control diet. Adult females of *P. xylostella* from natural diet without antibiotic laid highest number of eggs (151.70 eggs/female) with egg hatchability of 82.61 per cent, whereas from the diet treated with 0.2 per cent antibiotic; fecundity (95.38 eggs/female) and fertility (58.25%) were hugely affected. Zhang *et al*. (2022) also reported that larval feeding with a minimum concentration of ciprofloxacin (0.0001%), significantly affected larval growth, development and reproduction in *Grapholita molesta* which resulted in decreased fecundity (87.54 eggs/female) and egg hatchability (58.24%), compared to larval feeding without antibiotic, which resulted fecundity of 122.13 eggs/female and egg hatchability of 80.20 per cent.

Our results demonstrated that larvae of DBM reared on natural diet (cabbage) treated with Streptomycin sulphate at three concentrations significantly affected larval growth, development and reproduction, resulting in prolonged larval period, reduced pupal recovery with shortened pupal duration, decreased adult longevity with a greater number of males, and reduced fecundity and egg hatchability. Biological parameters of DBM were more negatively correlated with increasing concentration of Streptomycin sulphate.

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LITERATURE CITED

Adams, D., Wilkinson, T.L and Douglas, A.E. 1996. The aphid-bacterial symbiosis: a comparison between pea aphids and black bean aphids. *Entomologia Experimentalis et Applicata.* 80: 275–278.

Alam, A., Abbas, S., Ali, J., Liangzhu, W., Shakeel, M., Ullah, F., Xiao, F., Weibo, Q., Haichao, W., Jiali, L and Abbas, A. 2024. Diet suitability through biological parameters in *Ostrinia furnacalis* (Lepidoptera: Crambidae) clades. *Entomological Research*. 54(7): 12751.

Badenes, F.R., Gershenzon, J and Heckel, D.G. 2020. Plant glucosinolate content increases susceptibility to Diamondback moth (Lepidoptera: Plutellidae) regardless of its diet. *Journal of Pest Science*. 93(1): 491-506.

Dumas, P., Legeai, F., Lemaitre, C., Scaon, E., Orsucci, M., Labadie, K., Gimenez, S., Clamens, A.L., Henri, H., Vavre, F and Aury, J.M. 2015. *Spodoptera frugiperda* (Lepidoptera: Noctuidae) host-plant variants: two host strains or two distinct species. *Genetica*. 143: 305-316.

Jung, S and Kim, Y. 2006 Synergistic effect of *Xenorhabdus nematophila* K1 and *Bacillus thuringiensis subsp. aizawai* against *Spodoptera exigua* (Lepidoptera, Noctuidae). *Biological Control*. 39: 201–209.

Kfir, R. 1998. Origin of the diamondback moth (Lepidoptera: Plutellidae). *Annals of the Entomological Society of America*, 91(2): 164-167.

Lal, O.P. 1971. A New Approach to fight aphids with low concentrations of insecticides in combination with antibiotic and surfactant. *Entomologie*. 68: 314–321.

Paudel, A., Yadav, P.K and Karna, P. 2022. Diamondback Moth *Plutella xylostella* (Linnaeus, 1758) (Lepidoptera: Plutellidae); A Real Menace to Crucifers and Its Integrated Management Tactics. *Turkish Journal of Agriculture-Food Science and Technology*. 10(12): 2504-2515.

Raymond, B., Paul, R.J., Denis, J.W., Richard, J.E., Crickmore, N and Michael, B.B. 2009. A mid-gut microbiota is not required for the pathogenicity of *Bacillus thuringiensis* to Diamondback moth larvae. *Environmental Entomology*. 11: 2556–2563.

Shen, J., Wang, Q., Xia, X and You, M. 2018. Effect of antibiotics and gut bacteria on fitness of Diamondback moth *Plutella xylostella* (L.). *Acta Microbiologica Sinica*. (6): 1025-1035.

Thakur, A., Dhammi, P., Saini, H.S and Kaur, S. 2016. Effect of antibiotic on survival and development of *Spodoptera litura* (Lepidoptera: Noctuidae) and its gut microbial diversity. *Bulletin of Entomological Research*. 106(3): 387-394.

Zhang, X., Wang, X., Guo, Z., Liu, X., Wang, P., Yuan, X and Li, Y. 2022. Antibiotic treatment reduced the gut microbiota diversity, prolonged the larval development period and lessened adult fecundity of *Grapholita molesta* (Lepidoptera: Tortricidae). *Insects*. 13(9): 838.

Zhu, X., Zhang, L., Li, J., He, A., You, M and You, S. 2023. Effects of Antibiotic Treatment on the Development and Bacterial Community of the Wolbachia-Infected Diamondback Moth. *Evolutionary Bioinformatics*. 19(3): 69.

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ESTIMATION OF GENETIC VARIABILITY FOR YIELD AND YIELD ATTRIBUTING TRAITS IN SESAME (*Sesamum indicum* L.)

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ABSTRACT

One hundred and four sesame genotypes were evaluated for genetic variability parameters using 18 traits during *rabi* 2023-24 in dry land farm of S.V. Agricultural College, Tirupati, Andhra Pradesh. Analysis of variance revealed significant differences among the genotypes for all the traits except for 1000 seed weight and capsule length. High estimates of genotypic coefficient of variability (GCV) and phenotypic coefficient of variability (PCV) were recorded for the traits number of secondary branches per plant followed by seed yield per plant and number of capsules per plant. Heritability studies revealed that all the traits except plant height, number of primary branches per plant and capsule length showed high heritability. High heritability coupled with high genetic advance was exhibited by number of secondary branches per plant, seed yield per plant, plant height to first capsule number of capsules per plant, and 1000 seed weight indicating the prevalence of additive gene action in their inheritance.

KEYWORDS: Genetic variability, genetic advance as percent of mean, heritability, sesame.

INTRODUCTION

Sesame (*Sesamum indicum* L., 2n = 26), the most important prehistoric oilseed crop, belongs to the Pedaliaceae family and serves as a substitute cash crop for small land owners in developing countries due to its excellent adaptability to harsh environments. It is also called as "Queen of oil seeds" due to its high oil content (40 to 63 per cent), mild flavour, and pleasant edible oil. Sesame seeds are abundant in amino acids, proteins, vitamin B, E, minerals, and antioxidants including sesamin, sesamolin and γ-tocopherol. Sesame oil has resistance to oxidative deterioration, and a high level of unsaturated fatty acids (Pusadkar *et al*., 2015).

India occupies second position in area and production of oilseed crops in the World next to Myanmar. Yield is the most important trait for any crop improvement. Since, yield is a complex trait controlled by many genes, yield can be enhanced by improving the yield contributing traits.

Regardless of the numerous beneficial effects of sesame oil, the productivity is low due to its rainfed cultivation in marginal and sub marginal lands under poor management and input starved conditions, lack of synchronous maturity, shattering, yield instability and lack of high yielding cultivars. Therefore, it is essential to produce high yielding varieties with favourable features in order to overcome the low productivity and yield plateau in sesame.

The success of any crop improvement program depends upon the nature and magnitude of genetic variability present in the crop. The commencement of any systematic breeding programme, requires an understanding of the kind and amount of genetic variability existing in the gene pool. This is because a high level of genetic variability in the base material increases the likelihood of a desired plant type emerging. Keeping this in view, the present investigation was carried out to evaluate the genetic variability parameters among the sesame genotypes for yield and yield attributing traits.

MATERIAL AND METHODS

The present investigation was carried out during *rabi* 2023-24 on 100 sesame genotypes along with 4 checks collected from Regional Agricultural Research Station, Tirupati, Andhra Pradesh. The experiment was conducted in an unreplicated Augmented Block Design. Each genotype was sown in single row of four meters length with a spacing of 30 cm between rows and 15 cm between the plants. Eighteen yield contributing traits (qualitative and quantitative) were measured in five randomly selected plants from each genotype, to assess the magnitude of variability parameters among the sesame genotypes. The estimation of genetic parameters was done with the help of Grapes software.

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Genotypic and phenotypic coefficient of variation

The GCV and PCV were estimated by using the formula:

$$\text{Genotypic coefficient of variance} = \frac{\sigma_g}{\bar{X}} \times 100$$

$$\text{Phenotypic coefficient of variance} = \frac{\sigma_p}{\bar{X}} \times 100$$

Environmental coefficient of variance =

GCV and PCV were categorized into Low = Less than 10%; Moderate = 10-20%; High =More than 20%.

Broad sense heritability

The proportion of genotypic variance to the total variance of the population is referred to as heritability in broad sense [$h^2_{(b)}$] and was calculated by the formula given by Lush (1940).

$$h^2_{(b)}\,(\%) = \frac{\text{Genotypic variance}}{\text{Phenotypic variance}} \times 100$$

Genetic advance as percentage of mean

Genetic advance as percentage of mean was calculated by the following formula:

$$\text{GAM} = \frac{\text{Genetic advance}}{\text{General mean}} \times 100$$

GAM was categorized as < 10 per cent as low, 10-20 per cent as moderate, >20 per cent as high.

RESULTS AND DISCUSSION

The analysis of variance revealed significant variation among the genotypes for all the traits except 1000 seed weight and capsule length indicating the presence of considerable genetic variability among the experimental material under study (Table 1). Presence of variability in the initial breeding material ensures better chances of producing a desired genotype.

The study found that the phenotypic coefficient of variation (PCV) surpassed the genotypic coefficient of variation (GCV) for all traits, highlighting environmental influence on trait expression. This finding aligns with previous findings by Sasipriya *et al*. (2022). Mean, range, heritability, GCV, PCV and genetic advance as

Table 1. Analysis of variance for yield and yield attributing traits

ANOVA for twelve characters						
S. No.	**Characters**	**Mean sum of squares**				
		Entries (df = 103)	**Varieties (df = 99)**	**Checks (df = 3)**	**Blocks (df = 4)**	**Error (df = 12)**
1	Days to 50% flowering	2.00*	1.90*	3.40*	1.08	0.61
2	Days to maturity	13.80**	14.20**	3.80*	0.55	0.95
3	Plant height (cm)	105.40**	93.10**	458.20**	23.30**	41.20
4	Number of primary branches per plant	0.90*	0.80	4.40**	0.20	0.37
5	Number of secondary branches per plant	3.70**	2.10	19.90**	0.10	0.06
6	Plant height to first capsule	26.90**	25.80**	69.40**	4.03*	1.50
7	Number of capsules per plant	1427.00**	629.10**	1141.10**	14.40**	8.10
8	Number of seeds per capsule	58.20**	49.80**	346.9**	3.00	4.40
9	Capsule length (cm)	0.02	0.03	0.02	0.04	0.01
10	1000 seed weight (g)	0.20	0.20	0.60	0.03	0.03
11	Oil content (%)	19.9**	16.9**	126.01**	1.90	4.30
12	Seed yield per plant (g)	16.6**	16.4**	18.8**	1.09	1.06

Table 2. Genetic parameters of variability for yield and its attributing traits

S. No	Character	Grand mean	Range		Variance		Coefficient of		Heritability (broad sense)	Genetic advance (GA)	Genetic advance as per cent of mean
			Max	Min	Genotypic (σ^2) g	Phenotypic (σ^2) p	(GCV)	(PCV)			
1	Days to 50% flowering	34.77	39	31	1.35	1.96	3.35	4.03	68.99	1.99	5.73
2	Days to maturity	83.71	90	76	13.27	14.22	4.35	4.50	93.32	7.26	8.67
3	Plant height	89.20	110.6	62.50	51.89	93.10	8.07	10.81	55.73	11.09	12.44
4	Number of primary branches	4.31	7.80	2.40	0.49	0.86	16.25	21.54	56.91	1.08	25.29
5	Number of secondary branches	1.82	7.11	0	2.08	2.15	78.44	79.66	96.95	2.93	159.30
6	Plant height to first capsule	25.69	39.9	15.60	24.35	25.88	19.21	19.80	94.06	9.87	38.43
7	Number of capsules per plant	77.09	172.2	34.60	550.76	629.11	30.31	32.39	87.55	45.30	63.89
8	Number of seeds per capsule	72.35	96.08	56.32	45.43	49.89	9.31	9.76	91.05	13.26	18.33
9	Capsule length	2.49	3.00	2.02	0.02	0.03	4.91	6.80	52.38	0.18	7.34
10	1000 seed weight	3.29	4.20	2.20	0.16	0.20	12.30	13.65	81.07	0.75	22.85
11	Oil content (%)	45.49	52.52	33.57	12.63	16.93	7.81	9.04	74.61	6.32	13.90
12	Seed yield per plant	9.78	17.25	3.70	15.39	16.46	39.69	40.68	95.21	7.80	79.91

per cent of mean are presented in Table 2. High levels of GCV and PCV were observed for the traits number of secondary branches plant- 1 (GCV: 78.44%; PCV: 79.66%) followed by seed yield plant^{-1}, number of capsules plant^{-1}. This indicates the presence of sufficient amount of variation among the genotypes for these traits. The findings of this study are consistent with the results obtained by Kadvani *et al*. (2020), Sultana *et al*. (2019). Moderate levels of GCV and PCV were observed in plant height to first capsule (GCV: 19.21%; PCV: 19.8%) and thousand seed weight (GCV: 12.3%; PCV: 13.65%). The outcomes corroborate those obtained by Kadvani *et al*. (2020), Kalaiyarasi *et al*. (2019), Umamaheswari *et al*. (2019), and Bedawy *et al*. (2018). The lowest estimates of GCV and PCV were found for the traits number of seeds capsule^{-1} (GCV: 9.31%; PCV: 9.76%) and oil content (GCV: 7.81%; PCV: 9.04%), followed by capsule length, days to maturity, and days to 50% flowering. The findings align with the conclusions reached by Kadvani *et al*. (2020), Gautam *et a*l. (2023), Pavani *et al*. (2020), Kalaiyarasi *et al*. (2019), Sasipriya *et al*. (2023).

High estimates of heritability (broad sense) was observed for number of secondary branches plant^{-1} (96.95%) followed by seed yield plant^{-1} (95.21%), plant height to first capsule (94.06%), days to maturity (93.32%), number of seeds capsule^{-1} (91.05%), number of capsules plant^{-1} (87.55%), 1000 seed weight (81.07%), oil content (74.61%) and days to 50 % flowering (68.99%).

High estimates of genetic advance as percent of mean was recorded for number of secondary branches plant^{-1} (159.30%) followed by seed yield plant^{-1} (79.91%), number of capsules per plant (58.5%), plant height to first capsule (38.43%), number of primary branches plant^{-1} (25.29%) and 1000 seed weight (22.85%). This indicates the predominance of additive gene action and the desired results may be obtained through the simple selection. These results were in agreement with the findings of Pavani *et al*. (2020) for number of capsules plant^{-1}, plant height to first capsule. High heritability along with high genetic advance as percent of mean was recorded by number of secondary branches plant^{-1}, seed yield plant^{-1}, plant height to first capsule, number of capsules plant^{-1}, and 1000 seed weight. Similar type of results were found by Pavani *et al*. (2020) for number of capsules plant^{-1}, plant height to first capsule; Kiruthika *et al*. (2018) for number of secondary branches plant^{-1}, number of capsules plant-1 and 1000 seed weight.

The results of the variability study revealed that high to moderate estimates of GCV, PCV, high heritability and high genetic advance as percent of mean was recorded for the traits number of capsules per plant, seed yield per plant, plant height to first capsule and thousand seed weight This specified the dominance of additive gene action in expression of these traits. Therefore, simple selection might be fruitful for improvement of these traits in segregating generations.

LITERATURE CITED

Bedawy, I.M and Mohamed, N.E. 2018. Phenotypic and genotypic variability in a set of Sesame (*Sesamum indicum* L.) genotypes. *Egyptian Journal of Agronomy*. 40(3).

Gautam, S., Mishra, S.P., Gautam, S., Rao, S and Dwivedi, P. 2023. Morphological and biochemical characters studies in sesame (*Sesamum indicum* L.) varieties.

Kadvani, G., Patel, J.A., Patel, J.R., Prajapati, K.P and Patel, P.J. 2020. Estimation of genetic variability, heritability and genetic advance for seed yield and its attributes in sesame (*Sesamum indicum* L.). *International Journal of Bio-resource and Stress Management*. 11(3).

Kalaiyarasi, R., Lokeshkumar, K., Mohanraj, M., Priyadharshini, A and Rajasekar, R. 2019. Genetic variability parameters for yield and yield related traits in sesame (*Sesamum indicum* L.). *International Journal of Current Microbiology and Applied Sciences*. 8(8).

Kiruthika, S., Narayanan, S.L., Parameswari, C., Mini, M.L and Arunachalam, P. 2018. Genetic variability studies for yield and yield components in sesame (*Sesamum indicum* L.). *Electronic journal of plant breeding*. 9(4).

Pavani, K., Lal Ahamed, M., Ramana, J.V and Sirisha, A.B.M. 2020. Studies on genetic variability parameters in sesame (*Sesamum indicum* L.). *International Journal of Chemical Studies*. 8(4).

Pusadkar, P.P., Kokiladevi, E., Bonde, S.V and Mohite, N.R., 2015. Sesame (*Sesamum indicum* L.) importance and its high quality seed oil: a review. *TRENds in biosciences*. 8(15): 3900-3906.

Sasipriya, S., Parimala, K., Balram, M and Eswari, K.B. 2022. Variability and character association in sesame (*Sesamum indicum* L.). *The Pharma Innovation Journal*. 11(1).

Sultana, S., Mahmud, F and Rahim, M.A. 2019. Genetic variability studies for selection of elite germplasm in sesame (*Sesamum indicum* L.). Agronomski glasnik: Glasilo Hrvatskog agronomskog društva. 81(2): 87-104.

Umamaheswari, S., Suganthi, S., Sathiskumar, P and Kamaraj, A. 2019. Genetic variability, correlation and path analysis in sesame (*Sesamum indicum* L.).

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AN ECONOMIC ANALYSIS OF COMMUNITY HIRING CENTRES (CHCs) IN CHITTOOR DISTRICT OF ANDHRA PRADESH

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ABSTRACT

Mechanization is vital for enhancing agricultural efficiency and reducing production costs, yet small and marginal farmers face challenges such as high machinery costs and limited landholdings. Community Hiring Centres (CHCs) have emerged as a solution by offering farm machinery on a rental basis. This study, conducted in Chittoor district, Andhra Pradesh, analyzed the operational and economic aspects of CHCs. Data were collected from 30 CHC owners from three mandals: G D Nellore, Kuppam, and Punganur. Investment in CHCs ranged from ₹70,000 in smaller setups to ₹ 12,48,709 in larger Centres, with subsidies reducing costs by 32 per cent. Economic analysis revealed a Benefit-Cost ratio of 1.18, an Internal Rate of Return of 36 per cent, and a Net Present Worth of ₹ 10,51,083 from the CHCs. Payback periods varied from one to six years. Subsidies and diverse machinery ownership enhanced financial viability. Recommendations include optimizing subsidies, raising awareness, and providing technical training to CHC operators to enhance resource utilization and efficiency.

KEYWORDS: Community Hiring Centres (CHCs), Cost-Benefit Analysis, Economic Viability, Investment Pattern, Small and Marginal Farmers.

INTRODUCTION

Agriculture played a significant role in the Indian economy, contributing 17.6 per cent to the Gross Value Added (GVA) during the year 2023-24 (Agricultural Statistics at a Glance 2023, Ministry of Agriculture & Farmers Welfare, Government of India). Mechanization improved efficiency, but high costs and small landholdings hindered adoption. CHCs provided rental machinery to overcome these barriers. The study, titled *"An Economic Analysis of Community Hiring Centres (CHCs) in Chittoor District of Andhra Pradesh,"* aimed to evaluate the investment dynamics and economic viability in Chittoor district, Andhra Pradesh.

Rising livestock costs, declining draft animals, urbanization, and labor migration fueled mechanization, enhancing efficiency and reducing costs. CHCs provided rental machinery to small farmers, promoting resource-sharing, agri-entrepreneurship, and equitable access to affordable mechanized farming.

In Andhra Pradesh, a predominantly agrarian state, mechanization efforts were particularly noteworthy. In Chittoor district, where 92.94 per cent of agricultural holdings were owned by small and marginal farmers(Agricultural Statistics 2023-24, www.des.ap.gov.in), mechanization faced unique challenges. Between 2021 and 2023, the state established 10,663 CHCs, with 494 of these Centres located in Chittoor district alone. This initiative highlighted the Government's commitment to fostering mechanization and addressing the needs of smallholder farmers in the region.

MATERIAL AND METHODS

The study aimed to assess investment pattern and economic viability of Community Hiring Centres (CHCs) in Chittoor district of Andhra Pradesh state. The district was chosen purposively for its high CHC density and small farmer predominance (92.94% of holdings, 72.59% of farmland). Three mandalsG D Nellore, Kuppam, and Punganurwere selected based on CHC numbers. From each mandal 10 CHCs were randomly selected,totalling 30 CHCs for the study. Primary data was collected through structured schedulesform CHC owners, focusing on investment, expenses, and machinery use. Secondary data from the Department of Agriculture, Andhra Pradesh, complemented the primary data. Data were systematically coded, categorized, and analyzed using various analytical tools to assess operational efficiency and investment dynamics.

Descriptive Analysis

The descriptive analysis was used to analyse the investment pattern in the establishment of Community hiring centres.

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Discounted and undiscounted measures

Discounted and undiscounted measures were employed to know the economic viability of Community Hiring Centres. Payback period was the undiscounted measure used, which means the time taken for cumulative cash inflows to equal the initial investment, with shorter periods preferred. Discounted measures like NPV, B-C ratio and IRR were employed to know the economic viability of the CHC's.

(i) **Net present worth (NPW)**

It is also known as Net Present Value (NPV), representing the present value of the income stream generated by an investment.NPW was calculated using the following formula.

NPW = Discounted benefits – Discounted costs.

$$\text{NPW} = \sum_{t=1}^{n} \frac{B_t}{(1+r)^t} - \sum_{t=1}^{n} \frac{C_t}{(1+r)^t}$$

or

$$\text{NPW} = \sum_{t=1}^{n} \frac{B_t - C_t}{(1+r)^t}$$

where,

B_t is the Annual benefits

C_t is the Annual costs

t is the number of years

r is the rate of discount.

(ii) **Benefit - Cost Ratio ((BCR)**

BCR was derived by dividing the present value of benefits by the present value of costs, measuring the return per unit of cost. The formula to calculate the BCR was

$$\text{BCR or B-C Ratio} = \frac{\sum_{t=1}^{n} \frac{B_t}{(1+r)^t}}{\sum_{t=1}^{n} \frac{C_t}{(1+r)^t}} = \frac{\text{Discounted benefits}}{\text{Discounted costs}}$$

(iii) **Internal Rate of Return (IRR)**

IRR reflects the marginal efficiency of capital, indicating the return-generating capacity of an investment. It is the rate at which the NPW equals to zero, meaning the present value of returns equals the present value of costs. IRR can be calculated using the trial-and-error method.

$$\text{IRR} = R_1 + (R_2 - R_1)\left[\frac{\text{NPWR}_1}{|\text{NPWR}_1 - \text{NPWR}_2|}\right]$$

where,

R_1 = lower discount rate chosen

R_2= higher discount rate chosen

$NPWR_1$ = NPW at lower discount rate

$NPWR_2$ = NPW at higher discount rate

RESULTS AND DISCUSSION

The average age of sample CHC owners was 46 years, with an average farming experience of 15 years. Educational attainment varied, with 40.00 per cent completing high school, 30 .00 per cent primary education and 16.67 per cent being illiterate and 13.33 per cent college education. The average landholding size was 3.09 acres, with a mix of irrigated (43.05 per cent) and rainfed (56.95 per cent) lands.

Investment Pattern of Community Hiring Centres

The results presented in Table 1 revealed that average machinery cost incurred for establishment of CHC was ₹ 10,03,907 (85.98%), for construction of Shed it was ₹ 1,49,391, for purchasing of repairing tools ₹ 14,342 and the total investment cost for establishing the CHC stood at ₹ 11,67,640. After deducting the subsidy amount the investment cost dropped to ₹ 7,93,819.

In the total machinery cost, subsidies covered ₹ 3,73,821 (37.24%), while owners contributed ₹ 1,28,133 (12.76%), and the remaining ₹ 5,01,953 (50.00%) was

Table 1. Investment Costs of establishment of CHCs in Chittoor district (in ₹)

Particulars	Amount (₹)
Machinery cost	10,03,907 (85.98)
Construction cost of the shed	1,49,391 (12.79)
Cost of repairing tools	14,342 (1.23)
Total investment cost without subsidy	11,67,640 (100.00)
Total investment cost with subsidy	7,93,819

Note: Figures in parenthesis indicates percentages financed through bank loans. Larger CHCs owned more advanced machinery, including tractors and rotovators, while smaller ones focused on essential tools. Financial reliance on subsidies and loans made CHCs viable, especially for large-scale operations. For purchasing of machineries for CHC's subsidies up to 40.00 per cent subject to the subsidy limits stipulated under Annexure- IIC of CSS-SMAM were provided. Nagraj *et al.* (2020), Srinivas Rao *et al.* (2013), and Ranjith *et al*. (2020) highlighted subsidies' critical role in CHC establishment, reducing costs for farmers. Similarly, Singh *et al.* (2015) and Hiremath *et al.* (2014) assessed machinery investments, paralleling this study's focus on CHC investment patterns, ownership, and financial sustainability.

Economic Viability of Community Hiring Centres

The economic viability of Community Hiring Centres(CHCs) was assessed using the B-C ratio, NPW, IRR and Payback period.

Annual Cost Structure and Returns of Community Hiring Centres

The annual costs incurred by the Community Hiring Centres (CHCs) were analyzed and categorized into variable and fixed costs, with and without subsidies, alongside their respective contributions to the total cost and net returns.

The total variable costs for the CHCs amounted to ₹ 360,360, contributing to 48.27 per cent of the total annual cost. The breakdown of the total variable costs revealed that fuel Charges ₹ 156,114 (20.91%) contributes the more to the total variable costs, followed by salary to drivers ₹ 96,800, (12.97%), repairs and maintenance ₹ 100,391, (13.45%) and electricity charges ₹ 7,055 (0.95%).

Fixed costs excluding subsidies totalled to ₹ 3,86,157, accounting for 51.73 per cent of the total annual cost. Various component under fixed costs

Table 2. Annual costs and profitability analysis of community hiring centres

S. No.	Cost component	Amount (₹)	Percentage to total cost
I.	**Variable costs**		
1.	Salary to the drivers	96800	12.97
2.	Fuel charges	156114	20.91
3.	Repairs & maintenance	100391	13.45
4.	Electricity charges	7055	0.95
	Total variable cost	360360	48.27
II.	**Fixed costs**		
1.	Insurance premium	4767	0.64
2.	Rental value of shed	10900	1.46
3.	Depreciation	115330	15.45
4.	Interest on fixed capital	138396	18.54
5.	Apportioned establishment cost without subsidy	116764	15.64
6.	Apportioned establishment cost with subsidy	79372	
	Fixed costs without subsidy	386157	51.73
	Fixed costs with subsidy	348765	
III.	Total cost without subsidy	746517	100.00
IV.	Total cost with subsidy	709125	
V.	Gross returns	1082620	
VI.	Net returns without subsidy	336103	
VII.	Net returns with subsidy	373495	

Table 3. Economic viability indicators of community hiring centres

S. No.	Indicator	Without subsidy	With subsidy
1.	B-C ratio	1.18	1.32
2.	NPW @ 9% (₹)	10,51,083	16,25,431
3.	IRR (%)	36	55
4.	Pay back period (years)	4	3

include,interest on fixed capitalwhich were, ₹ 1,38,396 making up the largest fixed costs at 18.54 per cent; apportioned establishment costs ₹ 1,16,764 (15.64 %), depreciation ₹ 1,15,330, (15.45%), rental value of shed ₹ 10,900 (1.46%), and insurance premium ₹ 4,767 (0.64%). When subsidies applied, the apportioned establishment costs dropped to ₹ 79,372, hence thetotal fixed costs decreased to ₹ 3,48,765.

Finally, the total cost without subsidy amounting to ₹ 7,46,517 and including the subsidies it reduced to ₹ 7,09,125. The CHCs generated gross returns worth of ₹ 10,82,620 annually and the net returns without subsidy stood at ₹ 3,36,103 and with subsidy raised to ₹ 3,73,495. Because of subsidies there was a 11.13 per cent rise in net returns.

This analysis demonstrated the economic significance of subsidies in reducing fixed costs and increasing net profitability for CHCs. Among the variable costs, fuel expenses were predominant, while interest on fixed capital and depreciation were the largest components of fixed costs.

The study aligns with Chinnappa *et al.* (2018), Hiremath *et al.* (2014), Singh *et al.* (2015), and Srinivas *et al*. (2017). Subsidies improved net returns by 11.12 per cent, demonstrating their critical role in enhancing CHC profitability and economic sustainability.

The economic viability of the CHC's were evaluated using the discounted and undiscounted measures by assuming the life span of the CHC's as 10 years. The viability was assessed using the discounted measures like B-C ratio, NPW and IRR, and undiscounted measures like Payback Period and the results were presented in Table 3comparing efficiency indicators of the investment under two scenarios: Without Subsidy and With Subsidy.

The B-C ratio, which represented the return per rupee invested, was observed to be 1.18 without subsidy, and this improved to 1.32 when the subsidy was provided, indicating increased profitability. The Net Present Worth (NPW) at a 9 per cent discount rate was calculated to be ₹ 10,51,083 without subsidy, which increased to ₹ 16,25,431 with subsidy, reflecting enhanced financial benefits. The Internal Rate of Return (IRR), representing the annual return on investment, was found to be 36 per cent without subsidy and was elevated to 55 per cent with subsidy, demonstrating a significant improvement in profitability. The payback period, which denoted the time required to recover the investment, was determined to be 4 years without subsidy but was reduced to 3 years with subsidy, indicating faster recovery of the initial investment. It was concluded that the subsidy improved the financial viability of the project in all aspects. For Community Hiring Centres subsidy was provided under the Scheme "Sub Mission on Agricultural Mechanization (SMAM)".

The results confirmed the economic feasibility of CHCs, supported by a favorable B-C ratio and NPW, a high IRR, and a short payback period. These indicators highlighted the robustness of CHCs as a sustainable and profitable model for agricultural mechanization services. The results were in accord with the findings of Nagraj et al. (2020) and Anil et al. (2024).

The study highlighted the economic viability of the Community Hiring Centres. The study further highlighted the importance of bank loan in the form of 50 per cent of machinery cost in establishment of CHCs. Recommendations included raising awareness of CHC schemes, optimizing subsidies, providing training, and simplifying loan processes, highlighting CHCs as economically viable and instrumental in advancing mechanized farming practices.

LITERATURE CITED

Agricultural Statistics at a Glance. 2023-24. Directorate of Economics & Statistics, Planning Department, Government of Andhra Pradesh, www.des.ap.gov.in.

Agricultural Statistics at a Glance 2023-24. Ministry of Agriculture & Farmers Welfare, Economics & Statistics Division, Government of India.http://desagri.gov.in

The Agricultural Machinery Community Hiring Centres (CHC) Model Scheme byNABARD. 3.Community_Hiring_Centre.pdf (tnau.ac.in)

Anil, K., Jirli, B and Nandini, H. M. 2024. Economic analysis of Community hiring service centres in Tumakuru district of Karnataka. *International Journal of Agriculture Extension and Social Development.* 3(7): 50-55.

Chinnappa, B., Kiran Kumar R.P and Sowmya, H.S. 2018. Economic impact of Community Hiring Service Centres in maize cultivation: A case study from Karnataka. *Indian Journal of Agricultural Economics*. 73(4): 479-500.

Hiremath, G.M., Lokesh, G.B., Maraddi, G.N and Suresh, S. P. 2014. Accessibility of farm machinery to small and marginal farmers - A case study of Community Hiring Service Centres in Raichur District of Karnataka. *International Journal of Management Studies and Social Science Research*. 3(2): 897-907.

Nagaraj, B., Srilatha, C.H., Vikram, S., Venkatesh, M and Prameela, C.H. 2020. Establishing a model Community Hiring Centre: A feasibility study at Kandi Mandal. *International Journal of Current Microbiology and Applied Sciences*. 9(05): 1299-1307.

Ranjith Kumar, P.S., Prasanna Kumar P.S and Prem Jose Vazhacharickal 2020. Community Hiring Services in agriculture: An institutional economic study in eastern dry zones of Karnataka. *Trends in Biosciences*. 10(19):3432-3438.

Singh, D. J., Singh and Kumar, S. 2015. “Economic Viability of Agro Machinery Service Centres established by the Primary Agricultural Co-operative Societies in Punjab”. *Indian Journal of Economics and Development*. 11(3):743-750.

Srinivasarao, C., Dixit, S., Srinivas, I., Reddy, B. S., Adake, R.V and Borkar, S. 2013. Operationalization of Community hiring centres on farm implements in hundred villages in India. Central Research Institute for Dryland Agriculture, Hyderabad, Andhra Pradesh.

Srinivas, I., Rao, Ch. S., Reddy, K.S., Reddy, B.S., Adake, R.V., Dhimate, A.S., Osman, M., Prasad, J.V.N.S and Rao, C.A.R. 2017. “Up-scaling Farm Machinery Community Hiring Centres in India: A policy paper”, ICAR-Central Research Institute for Dryland Agriculture, Hyderabad:26.

Andhra Pradesh J Agril. Sci : 11(1): 23-30, 2025

DEVELOPMENT AND VALIDATION OF GC-ECD METHOD FOR DETERMINATION OF PROFENOPHOS IN PIGEONPEA

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ABSTRACT

A modified quick, easy, cheap, efficient, rugged, and safe (QuEChERS) method coupled to Gas Chromatography with Electron Capture Detection was developed for the determination of profenophos residues in pigeonpea standing crop. Extraction and cleanup parameters were optimized; thus, the original QuEChERS method was modified to minimize solvent usage. After optimization, the method was validated by evaluating the analytical curves, linearity, Limits of Detection (LOD) and Limits of Quantification (LOQ) and accuracy (recovery). Retention time was 22.018 minutes and minimum detectable and quantifiable limits were 0.05 and 0.15 µg mL^{-1}, respectively. Good linearity (R^2=0.9935) of the calibration curves was obtained over the range from 0.1 to 1 µg mL^{-1}. Good recovery in pigeonpea flower matrix was obtained with 90 to 98 per cent at 0.05 to 0.5 ppm with RSD value < 20% (0.93%). Results indicated that the developed method is rapid and easy to perform and making it applicable for analysis of profenophos in pigeonpea matrix. At 0 (2 hours) day after the insecticidal application an initial deposit of 0.72 mg kg^{-1} was recorded. The residues reached BDL on 7^{th} day, exhibiting cent per cent dissipation with the half-life of 2.4 days.

KEYWORDS: Profenophos, pigeonpea, GC-ECD, linearity, recovery, LOD, LOQ, RSD.

INTRODUCTION

Pigeonpea (*Cajanus cajan* L.) commonly known as red gram or tur. It is an important pulse or grain legume crop grown in semiarid and subtropical regions of the world (Chandrakala *et al*., 2022) and major pulse crop among the pulses grown in India. It is the world's fifth-most important pulse crop (Pratibha *et al*., 2015). Pigeonpeas crop is being attacked by more than 250 species of insects which belonging to 8 different orders and 61 different families (Lal and Katti, 1997). The major pests are gram pod borers whose infestation is in synchrony with flower initiation to pod maturity. The pigeonpea pod borer complex comprises of gram pod borer, *Helicoverpa armigera* Hubner; plume moth, *Exelastis atmosa* Walshingham, spotted pod borer, *Maruca vitrata* and pod fly, *Melanagromyza obtusa* Malloch *etc*. *H. armigera* alone contributes loss up to 50 per cent (Dodia *et al*., 2009). Hence, to reduce the substantial yield loss in pigeonpea, it is inevitable to manage these wide ranges of pest group effectively.

Profenophos is an organophosphorus insecticide, chemically called as O-4-bromo-2-chlorophenyl O-ethyl Spropyl phosphorothioate (IUPAC) and O-(4-bromo-2-chlorophenyl) O-ethyl Spropyl phosphorothioate (CAS). It is an extremely toxic and persistent chemical as per the toxicity classification. It is a non-systemic and acaricide with contact and stomach action and being extensively used for the control of lepidopteran group larvae, whitefly and mites on cotton, pigeonpea, chilli and vegetable crops (Sharma *et al*., 2018). Further, profenophos efficacy on flower borer and flower fly infesting pigeonpea was in the range of 25 to 85% when used as ovicide and larvicide (Srivastava and Mohapatra, 2003). The European Union limits (Maximum Residue Limitss) for profenophos in pigeonpea is 0.01 $mgkg^{-1}$. It was reported that, the initial deposits of profenophos was much higher in the tomato than the cypermethrin (Gupta *et al*., 2011) indicate its high persistence nature. Several reviews have examined persistence and dissipation of profenophos and residue analysis in fresh and edible crops such as tea leaves (Pramanik *et al*., 2005), okra (Paras *et al*., 2005), green and cured cardamom (Renuka *et al*., 2006), chillies (Reddy *et al*., 2007), brinjal (Nigam *et al*., 2009; Mukharjee *et al*., 2012. As most of the laboratories are not equipped with highly sensitive chromatography instruments like gas/liquid chromatography tandem mass spectrometry (GC-ms/ms and LC- ms/ms) for routine analysis and there is very scarce literature on analysis of profenophos in pigeonpea by GC-ECD, therefore, a sensitive analytical gas chromatographic method capable of estimating in microquantities is required. The objective of this study is to improve the extraction procedure and develop simple,

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sensitive method which can be conveniently used for the detection and determination method of profenophos.

MATERIAL AND METHODS

Instrument & Equipment

The following instrument and equipment were used for the study to carry out the sample extraction in the Pesticide Testing Laboratory, Institute of Frontier Technology, Tirupati. They were Balance (upto 0.02 mg and capacity- 6.0 kg), Blender MG-198 W. Homogenizer to pulverize, high volume centrifuge, Vertex, low volume centrifuge, Evaporator (Rapid Mini EC System, Crescent Scientific Company), Rapid mini EC system and Nitrogen air generator, Gas Chromatography- Electron Capture Detector (GC-ECD) were used to develop and validate a method in pigoenpea matrix.

Apparatus and Reagents

Centrifuge tubes (15 and 50 mL), Measuring cylinders, Micropipettes, Vials, Acetonitrile (HPLC analytical grade), Water (HPLC grade), Acetonitrile (HPLC grade), n-Hexane, Methanol (HPLC grade), Ethyl Acetate (HPLC grade), Saturated sodium chloride, Sodium Sulphate, Magnesium Sulphate ($MgSO_4$) anhydrous, Primary Secondary Amine (PSA) and Graphitised Carbon Black (GCB) were utilized for the sample extraction in the present study.

Preparation of standard solutions

Profenophos standard stock solution (1000 µg mL^{-1}) was prepared by weighing 10 mg (± 0.1) of certified reference material in a calibrated 10 mL volumetric flask and volume made up with solvent n-hexane. An intermediate standard solution of 100 µg mL^{-1} was prepared by pipetting out 1 mL of stock solution in to 10 mL volumetric flask and volume made up using n-hexane. A working standard of 1 µg mL^{-1} was prepared in n-hexane and further the calibration standard solution ranging from 0.05 to 1 µg mL^{-1} were prepared. The matrix match standards at the similar concentrations were prepared by using the control pigeonpea flower samples extract obtained through sample preparation by adding the rewuired volume of analyte.

Chromatographic Conditions

Gas Chromatography (GC Schimadzu 2010) was used to analyze profenophos using a column EB-5 (30m x 0.25mm x 0.25µm) coated with 1% phenyl-methylpolysiloxane (0.25 µm film thickness) and a 63Ni electron-capture detector (ECD). General operational conditions were as follows: The column temperature program was set to 50^0 C for 1 minute, then increased to 120^0C at 20^0C/min, held for 0 minute and raised to 280^0C at 50^0C/min for 13 minutes. The total programming time was 40 minutes, with an injection volume of 10 µL/min and a nitrogen flow rate of 0.79 mL/min. The carrier gas used was 99.99 percent pure N_2. For the elution of the seven test chemicals, injector port temperatures were maintained at 260^0C and detector temperatures at 280^0C. The analyte in the samples was identified by comparing the retention time of the matching matrix-matched calibration standard and quantification was done using external calibration curves created with a four-point matrix-matched calibration standard.

Feld Experiment

A filed experiment was conducted to study the dissipation pattern of profenophos in pigeonpea flowers at Dryland farm, S.V. Agricultural College, Tirupati during *rabi,* 2022-23. Profenophos spraying was done during 50 % flowering stage and the pigeonpea flower samples were collected on intervals of 1,3,5,7,10,15,20 and at harvest to study the dissipation patterns in pigeonpea flowers. Laboratory analysis was carried out at Pesticide residue testing Laboratory, Institute of Frontier Technoliogy, RARS, Tirupati.

Method Validation

The method was validated by evaluating analytical curves and linearity, limit of detection (LOD), limit of quantification (LOQ) and accuracy (recovery)

a) Analytical Curve and Linearity

The linearity of the instrument and the method was evaluated by analytical curves with the concentration levels from the LOQ of compound, that is, 0.05 to 1.0 mg/ mL with three replicate injections per concentration.

b) Limit of Detection and Quantification

The sensitivity of the method was determined using ratio between the estimated standard deviation of the linear coefficient and the slope of the analytical curve. The LOD and LOQ for profenophos were determined.

c) Recovery

The pigeonpea flower samples were collected from untreated control plots was brought to the laboratory and were homogenized using high volume homogenizer and each homogenized samples of 10 g was transferred to 50 mL centrifuge tubes. Extraction and clean up was done by QuEChERS method. The required quantity of intermediary standard prepared from CRM of respective standards were added to homogenized pigeonpea flower samples to get required fortification levels and each replicated thrice. These fortification levels were selected to know the suitability of the method to detect and quantify insecticides in pigeonpea samples below MRLs of Codex Alimentarius Commission (CAC). Then 10 mL of HPLC ice cold water and 15 mL of acetonitrile was added and homogenized the sample at 14000-15000 rpm for 3 minutes. To this, 6 g of sodium sulphate and 1.5 g of sodium acetate was added and centrifuged for 3 minutes at 4500 rpm to separate the organic layer. Then 12 mL of aliquot was transferred into 15 mL centrifuge tube containing 0.60 g magnesium sulfate and 0.2 g PSA (also add 10 mg of Graphitised Carbon Black to remove carotenoid content), vortexed for 30 seconds and centrifuged for 3 minutes at 2500- 300 rpm. A supernatant layer of 1 mL was taken into 15 mL tube for evaporation using rapid mini EC system (low volume concentrator using gentle stream of nitrogen at 350 C) and reconstituted with 2 mL n-hexane for analysis with GC-ECD.

d) Calculations

Residues (mg/kg)

$$\text{Residue}\left(\text{mg/kg}\right) = \frac{\text{Area of sample}}{\text{Volume of extract of the sample } \left(\text{g}\right)} \times \frac{\text{Concentration of standard } \left(\mu\text{g/ml}\right)}{\text{Area of standard}} \times \text{final weight}$$

$$\text{Recovery } \left(\%\right) = \frac{\text{Added concentration}}{\text{Obtained concentration}} \times 100$$

Dissipation (%)

$$\text{Dissipation}\left(\%\right) = \frac{\text{Initial deposit - Residuces at given time}}{\text{Initial deposit}} \times 100$$

Half-life (RL_{50})

RL_{50} is the time in days required to reduce the insecticide residues to half of its initial deposits.

Mathematically, it is

$$\text{RL50 or } t^{1/2} = \frac{Log}{K} = \frac{0.693}{K}$$

Where K is the dissipation rate constant

Prediction of approximate time required to dissipate the residue below maximum residue limit

The period allowed to except the residues to reach below the tolerance limit after treatment for use of the treated material will be calculated by using the formula (Blinn and Gunther, 1955).

$$Y = a + bX$$

where, Y = log of tolerance limit

a = log of initial deposit

b = slope of the regression line

X = intercept

Equation of first-order kinetics

$$Ct = C° \text{ x } ekt$$

The residue was calculated with the first-order equation

where, C_t is the concentration (mg/kg),

C_o is the initial concentration (mg/kg),

k is the dissipation rate constant,

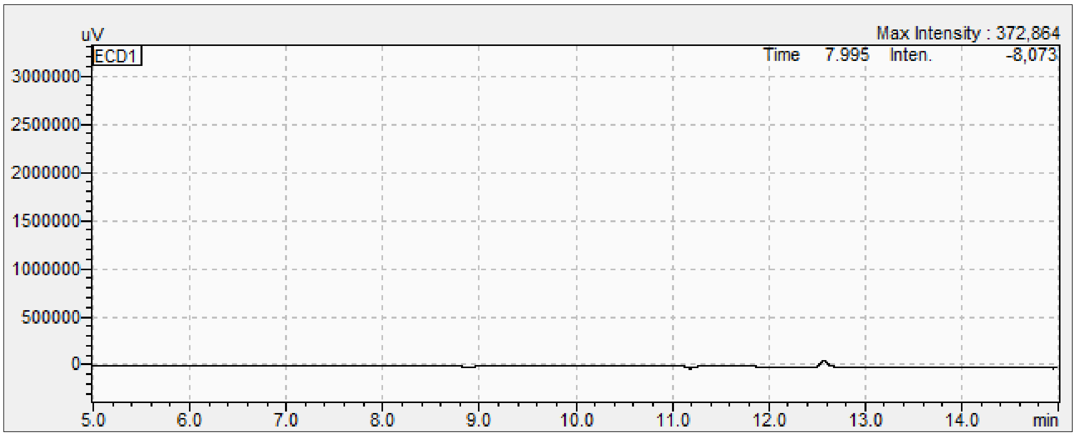
t is time (days) after application

RESULTS AND DISCUSSION

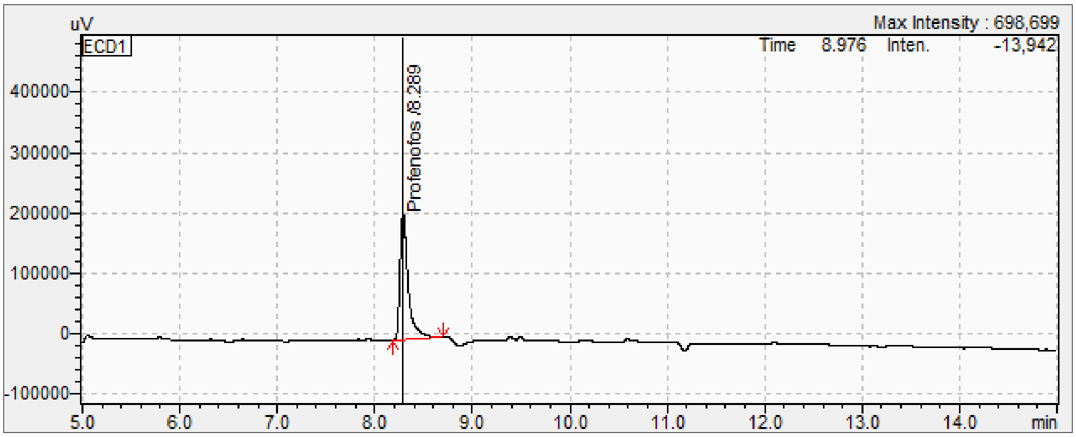
Under the optimised GC-ECD conditions, the retention time for profenophos was 22.018 minutes. N-hexane blank did not contain any residue.

Method validation for estimation of profenophos in pigeonpea flowers

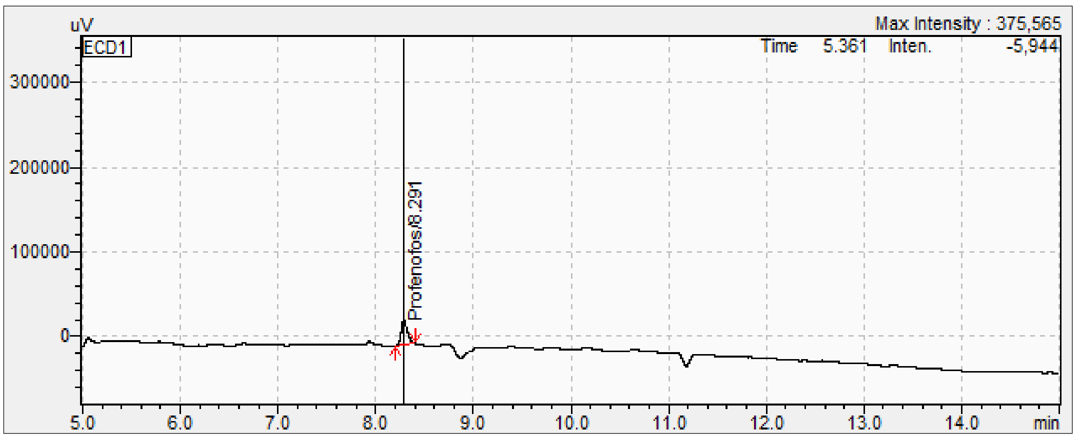
The analysis of profenophos residues in pigeonpea flowers was validated by calculating and assessing various performance parameters such as linearity, LOD (Limit od Detection), LOQ (Limit of Quantification) and recovery *etc.,* as per the SANTE/11813/2017 guidelines. The pigeonpea crop grown without application of insecticides was used for the spiking to establish LOD and LOQ method. The LOQ of the method for profenophos was 0.15 and LOD was 0.05 µg ml^{-1}. The mean recovery of profenophos from pigeonpea flower was within the acceptable range 70 to 120 per cent when spiked at 0.05



0.1 ppm



1 ppm



n-hexane blank

Fig. 1. GC- ECD Chromatograms for Profenophos.

Table 1. Details of GC-ECD operational parameters of profenophos

Gas Chromatograph	Shimadzu 2010 plus
Column	EB-5, 30 m × 0.25 mm × 0.25 µm
Column oven (°C)	50°C hold/1 min, to 120°C at 20°C/min hold for 0 min, to 280°C at 5°C/min hold for 13 min
Detector	Electron Capture Detector
Detector temp (°C)	280°C
Injector temp (°C)	260°C
Injection volume	1 µL
Carrier gas	Nitrogen (99% purity)
Colum flow (mL min^{-1})	6
Purge flow (mL min^{-1})	30
Retention time	Profenophos – 22.018
Total run time (min)	40

Table 2. Recoveries of profenophos from fortified pigeonpea flowers

Details	Recoveries of profenophos from fortified pigeonpea flowers					
	Fortified level (ppm)					
	0.05		0.1		0.5	
	Recovery (mg/kg)	Recovery %	Recovery (mg/kg)	Recovery %	Recovery (mg/kg)	Recovery %
R1	0.05	100.00	0.08	80.00	0.45	90.00
R2	0.05	98.00	0.10	100.00	0.49	98.00
R3	0.05	96.00	0.09	90.00	0.49	98.00
Mean		98.00		90.00		95.33
SD±		2.00		10.00		4.62
RSD		2.04		11.11		4.84

to 0.50 µg ml^{-1}. The recoveries of profenophos were in the range of 90 to 98 per cent for pigeonpea flowers. The precision in terms of repeatability was associated with recovery % and by calculating Relative Standard Deviation (RSD %) (Table 2). The RSD ranged from 12.29 to 20.06 per cent for profenophos with pigeonpea matrices. Linearity was achieved by four different concentrations (0.1 to 1.00 µg/ml) with calibration correspond to R^2=0.9935 as shown in Fig. 2 in flowers. Matrix effect was calculated from the data and was observed to be within the prescribed limits shown in Table 3.

Dissipation pattern of profenophos in pigeonpea flowers

At 0 (2 hours) day after the insecticidal application an initial deposit of 0.72 mg kg^{-1} was recorded and decreased to 0.32 mg kg^{-1} in flowers at 1 day after application. The same was dissipated to 89.14 per cent at 3 days after application showing residual amount of 0.08 mg kg^{-1}. The residual amount of 0.06 mg kg^{-1} was observed at 5th day. The residues reached BDL on 7th day, exhibiting cent per cent dissipation (Table 4). The half-life of 2.4 days was observed. The regression equation was with $y = -0.1695x + 0.7768$ with $R^2 = 0.8408$ and

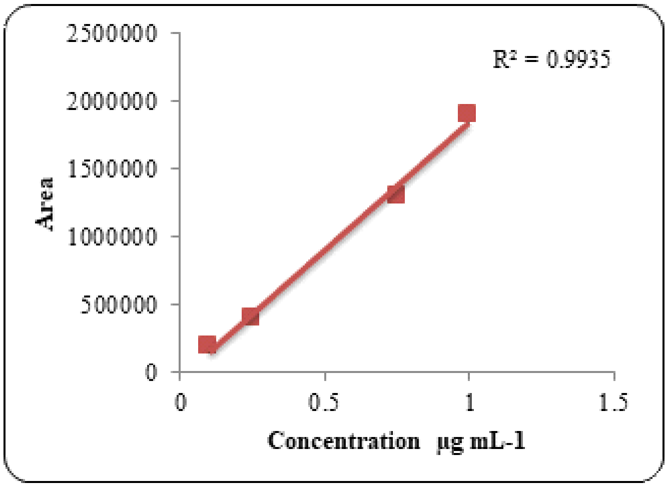


Fig. 2. Profenophos linearity in pigeonpea flower.

Table 3. Matrix effect (%) of profenophos in pigeonpea flowers

Concentration (µg mL^{-1})	Matrix effect %
0.10	7.00
0.25	1.05
0.75	4.15
1.00	2.98

the dissipation followed the first order kinetics C_t=0.827 $e^{-0.5894x}$ and R^2 = 0.9337 (Fig 3). The MRL values are not available for profenophos in pigeonpea flowers by either CAC or by FSSAI, hence the day at which the residues reached BDL (7 days) was considered as safe waiting period.

The present investigated results were in line with the recordings on dissipation pattern noticed in pigeonpea wherein profenophos dissipated quickly between 0-1 day in both the doses (Naik *et al.,* 2020). Mukherjee *et al*. (2012) who reported the initial deposits (2 hr after application) of profenophos on brinjal fruits were 0.575 and mg kg^{-1} for recommended. The residues dissipated with time and on the 7th day, residues were below determination limit at the recommended rate of application. Brar (2013) observed dissipation of profenophos on brinjal fruits and found the initial deposits of 1.966 mg kg-1 with half-life value of 1.5 days. In okra recorded the half-life of 1.35 days after the spray followed a biphasic dissipation pattern with faster dissipation in phase I (0-1 days) and manifesting slower rate of dissipation in phase II (1-15 days) as reported by Paras *et al*. (2005).

Table 4. Data on dissipation of profenophos in pigeonpea flowers during *rabi,* 2022-23

Days after insecticidal application	Residues of profenophos (mg kg^{-1})				Dissipation (%)
	R1	R2	R3	Mean	
0	0.69	0.75	0.73	0.72	0
1	0.31	0.34	0.32	0.32	55.42
3	0.08	0.08	0.08	0.08	89.14
5	0.06	0.05	0.06	0.06	91.68
7	BDL	BDL	BDL	BDL	100
10	BDL	BDL	BDL	BDL	100
15	BDL	BDL	BDL	BDL	100
20	BDL	BDL	BDL	BDL	100
At harvest	ND	ND	ND	ND	100
Regression equation	y = -0.1695x + 0.7768; R^2 = 0.8408				
First order kinetics	Ct= $0.827e^{-0.589x}$; R^2 = 0.9337				
Half-life	2.4 days				
FSSAI MRL	NA				

BDL: Below Detectable Level (< 0.05 mg/kg); NA: Not available; ND: Not Detected

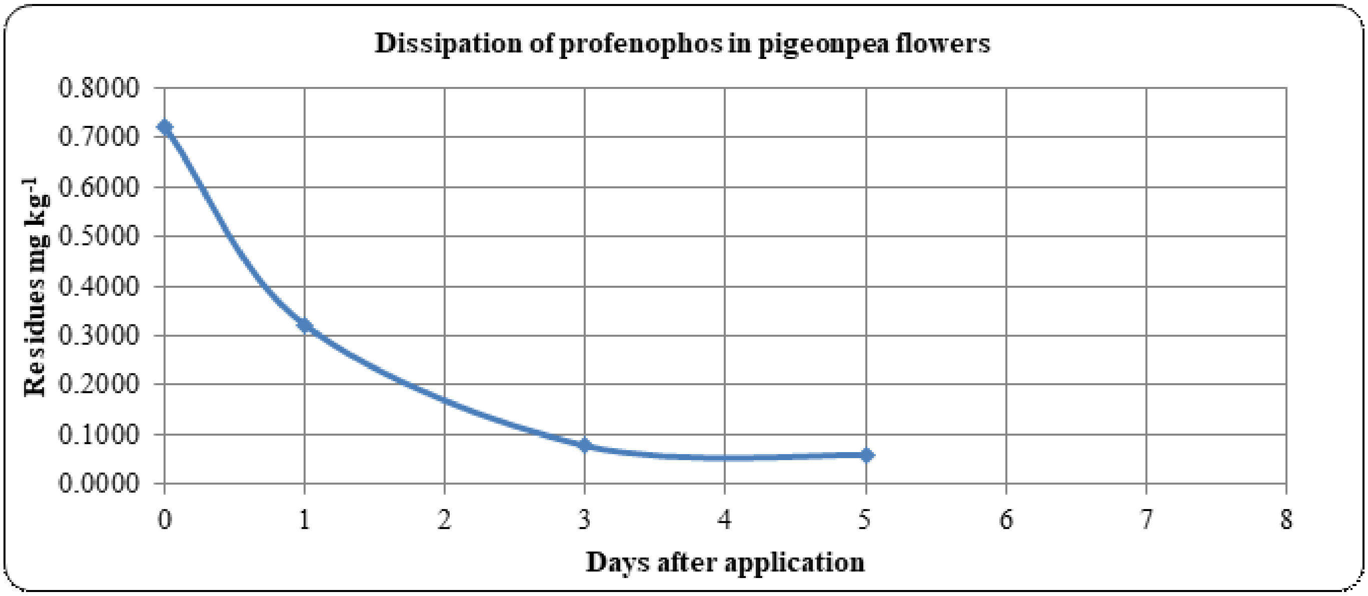


Fig. 4. Dissipation pattern of profenophos in pigeonpea flowers *rabi,* 2022-23.

Shashi *et al*. (2014) also reported the calculated half-life of profenophos in brinjal is 1.57 days. Gupta *et al*. (2011) reported that residues of profenophos dissipated with half-lifes of 2.2- 5.4 days and Sahoo *et al*. (2004) reported that profenophos spray on brinjal at 50% flowering stage and subsequently at 15 days intervals, resulted in to initial deposit of 1.37 mg kg^{-1} dissipating to BDL in 15 days. However, the studies conducted by various workers on dissipation on profenophos on different crops clearly indicate that when applied at recommended dose, the initial deposits are less than 3 mg kg^{-1} and dissipate to BDL in 7-10 days depending on the crop.

The proposed method showed acceptable repeatability and provides an alternative route to determine the profenophos compounds from flowers with a safer way with no compromise in sensitivity. Validation of the method has been shown with parameters of linearity, precision, LOD and LOQ, accuracy and specificity. The method gives more efficiency, reduced amount of chemicals and more sensitivity in comparison to earlier reported methods. The method can be applied to determine pesticide contamination in environmental samples.

LITERATURE CITED

Brar, G.S. 2013. Residue dynamics of acephate, profenophos and triazophos in brinjal (*Solanum melongena* L.). *M. Sc. Thesis*. Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan, H.P. India.

Chandrakala M.R., Srinivasan B.P., Niranjana K.V., Sujatha, K and Rajendra, H. 2022. Land suitability evaluation for pigeonpea in Semi-arid land, South Telangana plateau, India, using GIS, remote sensing and detailed survey. *Communications in Soil Science and Plant Analysis*. 53 (6): 675- 684.

Dodia, D.A., Prajapathi, B.G and Asharya, S. 2009. Efficacy of insecticides against pod borer, *H. armigera*, infesting pigeonpea. *Journal of Food Legumes*. 22(2): 35-38.

Gupta, S., Gajbhiye, V. T., Sharma, R. K and Gupta, R. K. 2011. Dissipation of cypermethrin, chlorpyriphos, and profenophos in tomato fruits and soil following application of pre-mix formulations. *Environmental Monitoring* and *Assessment*. 174: 337-345.

Lal, S.S and Katti, G. 1997. Podfly, *Melanagromyza obtusa* Malloch – A key pest of pigeonpea. *Indian Institute of Pulse Research*. Kanpur. 267.

Mukherjee, I., Kumar, A and Kumar, A. 2012. Persistence behaviour of combination mix crop protection agents in/on eggplant fruits. *Bulletin of Environmental Contamination and Toxicology.* 88: 338-343.

Naik, H.R., Rahul, C., Pallavi, M.S., Bheemanna, M., Rachappa, V., Pramesh, D., Anand, N and Udaykumar N. 2020. Determination of profenophos residues using LC-MS/MS and its dissipation kinetics in pigeonpea pods. *Legume Research - An International Journal*. 45 (11): 1372-1380.

Nigam, R.C., Pandaey, R.K., Yiwari, D.D and Katiyar, N.K. 2009. Persistence of endosulfan and profenophos in/on brinjal. *Pesticide Research Journal*. 21(2): 180-182.

Paras, N., Kumari, B., Yadav, P.R., Kathpal, T.S. 2005. Persistence and dissipation of ready mix formulations of insecticides in/on okra fruits. *Environmental Monitoring and Assessment*. 107(13):173-179.

Pramanik, S. K., Dutta, S., Bhattacharyya. J., Saha, T., Dey, P. K., Das, S., Bhattacharyya, A. 2005. Persistence of profenophos residue on tea under northeast Indian climatic conditions. *Bulletin of Environmental Contamination and Toxicology.* 74(4): 645-651.

Pratibha, G., Srinivas, I and Rao K.V. 2015. Impact of conservation agriculture practices on energy use efficiency and global warming potential in rainfed Pigeonpea-castor systems. *European Journal of Agronomy.* 66: 30–40.

Reddy, K.D., Reddy, K.N and Mahalingappa, P.B. 2007. Dissipation of fipronil and profenophos residues in chillies (*Capsicum annum* L.). *Pesticide Research Journal*. 19(1): 106- 107.

Renuka, S., Rajabaskar, D., Regupathy, A. 2006. Persistence and dissipation of profenophos 50 EC in cardamom. *Indian Journal of Plant Protection.* 34(2):165-167.

Sahoo, S.K., Kapoor, S.K and Singh, B. 2004. Estimation of residues of profenophos in/on tomato *Lycopersicon esculentum* Mill. *Bulletin of Environmental Contamination and Toxicology*. 72(5): 970-974.

Sharma, O. P., Rachappa, V., Suhas Y., Harischandra N., Gopali, J.B and Manish,R.S. 2018. Validation and implementation of principles of the Integrated Pest Management concept sustainability and current challenges in pest endemic pulse bowl of India. *Indian Journal of Agricultural Sciences.* 88(3): 474-81.

Shashi, B.V., Sreenivasa R.C., Swarupa R.S., Harinatha, R.A., Ravindranath, D., Aruna, M and Hymavathy, M. 2014. Dissipation dynamics and risk assessment of profenophos, triazophos and cypermethrin residues on brinjal for food safety. *International Journal of Research in Agricultural Sciences*. 2(2): 2348 – 3997.

Srivastava, C.P and Mohapatra, S.D. 2002. Field screening of pigeonpea genotypes for resistance to major insect pests. *Journal of Applied Zoological Research*. 13(2):202-203.

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ASSESSMENT OF SOIL MAJOR NUTRIENTS IN SCARCE RAINFALL ZONE OF ANDHRA PRADESH

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ABSTRACT

Six prominent cropping systems in scarce rainfall zone of Andhra Pradesh *viz*., groundnut-horsegram, cotton-fallow, fallow-bengalgram, groundnut monocropping, paddy-paddy and paddy-groundnut cropping systems were selected to study the chemical properties of soils. Twenty soil samples from each cropping system were collected at 0-15 cm (surface soil) and 15-30 cm (sub-surface soil) depth. The soils were processed and analysed for their chemical properties. The available nitrogen (206 and 180 kg ha^{-1}) and available phosphorus (63.10 and 43.51 kg ha^{-1}) were highest in paddy-groundnut cropping system in both surface and sub-surface soils, respectively. While the lowest available nitrogen (159 and 130 kg ha^{-1}) and available phosphorus (45.59 and 32.22 kg ha^{-1}) were observed in cotton-fallow cropping system in both surface and sub-surface soils, respectively. The highest available K (216 and 148 mg kg^{-1}) was recorded under paddy-paddy cropping system in both surface and sub-surface soils. However, the lowest available K (122 and 92 mg kg^{-1}) was recorded under groundnut monocropping system in both surface and sub-surface soils.

KEYWORDS: Scarce rainfall zone, Prominent cropping systems, Surface and Sub-surface soils.

INTRODUCTION

Soil is an exhaustible storehouse of plant nutrients. The successful agriculture requires the sustainable use of soil resources, because soil easily lose their quality and quantity within short period of time. Due to increasing population and acquisition of fertile land for urbanization the cultivable land for agriculture land is decreased day by day (Kumar *et al*., 2023). Therefore, assessment of nutrient constraints of soils being intensively cultivated with high yielding crops need to be carried out (Patil *et al*., 2016). Scarce rainfall zone of Andhra Pradesh faces significant challenges in agricultural productivity due to low and erratic rainfall, leading to soil moisture stress and reduced crop yields. It has been documented very well that dry land soils are not only thirsty but hungry too (Wani, 2008). However, intensive cropping systems and inadequate nutrient management practices have led to soil nutrient depletion, further exacerbating the challenges faced by farmers in these regions. Nitrogen, phosphorus and potassium are the major nutrients required by all the crops for their growth (Borkar *et al*., 2018). Understanding the soil nutrient content at different depths of soil is one of the most important aspects of crop management and information about the soil nutrient status of study area is very important for nutrient management programs (Amgain *et al*., 2023). Supplement of balanced nutrition is one of the important factors to improve the crop productivity.

MATERIAL AND METHODS

The present study was carried out in scarce rainfall zone of Andhra Pradesh. Scarce rainfall zone of Andhra Pradesh lies in between the northern latitudes of $13^{0}40'$ to $16^{0}18'$ and eastern longitudes of $76^{0}47'$ to $79^{0}34'$. The geographical area of Scarce rainfall zone 36,788 km^2. Out of 40 lakh ha of rainfed area, about 45% area is in scarce rainfall zone of Andhra Pradesh. The scarce rainfall zone of Andhra Pradesh received total annual rainfall during the year 2023-24 is 201.45 mm. Twenty soil samples at 0-15 cm (surface soil) and 15-30 cm (sub-surface soil) depth from each cropping system were collected from the scarce rainfall zone of Andhra Pradesh *viz*., groundnut-horsegram, cotton-fallow, fallow-bengalgram, groundnut monocropping, paddy-paddy and paddy-groundnut cropping systems. The collected soil samples were air dried in shade, ground with a wooden hammer, passed through the sieves of 2 mm and used for determination of various soil properties by following standard procedures.

Available nitrogen was determined by alkaline permanganate (0.32% $KMnO_4$) method (Subbiah and Asija, 1956); Available phosphorus was determined by extracting the soil P with 0.5 M $NaHCO_3$ from alkaline soil at pH 8.5. (Olsen *et al*., 1954); Available potassium was estimated by using neutral-normal-ammonium acetate (NH_4OAc, pH 7.0) (Jackson 1973).

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RESULTS AND DISCUSSION

Available nitrogen

The available nitrogen (Table 1) in surface soils varied from 103 kg ha^{-1} in cotton-fallow cropping system to 286 kg ha^{-1} in paddy-groundnut cropping system with mean values of 159 and 206 kg ha^{-1}, respectively. The available nitrogen of soils in groundnut-horsegram, cotton-fallow, fallow-bengalgram, groundnut monocropping, paddy-paddy and paddy-groundnut cropping systems was ranged from 125-165, 103-259, 116-263, 124-276, 111-262 and 127-186 kg ha^{-1}, respectively with mean values of 198, 159, 195, 202, 179 and 206 kg ha^{-1} respectively. The available nitrogen in surface soils varied from low to medium in status.

In sub-surface soils available nitrogen varied from 75 kg ha^{-1} in cotton-fallow cropping system to 276 kg ha^{-1} in paddy-groundnut cropping system with mean values of 130 and 180 kg ha^{-1}, respectively. The available nitrogen of soils in groundnut-horsegram, cotton-fallow, fallow-bengalgram, groundnut monocropping, paddy-paddy and paddy-groundnut cropping systems was ranged from 96-232, 75-206, 88-216, 105-236, 85-212 and 112-276 kg ha^{-1}, respectively with mean values of 161, 130, 151, 164, 140 and 180 kg ha^{-1}, respectively.

The maximum available nitrogen was observed in soils of paddy- groundnut cropping system in both surface and sub-surface soils. The minimum available nitrogen was observed in cotton-fallow cropping system in both the surface and sub-surface soils.

The available nitrogen of soils under paddy-groundnut cropping system and legume-based cropping systems was higher than that of other cropping systems. Several other workers have reported that legumes have the ability to fix and store more atmospheric N through their symbiotic association with rhizobium bacteria resulted more available nitrogen in soils (Kumar *et al*., 2020).

Regarding depth, available N decreased with increasing depth in all cropping systems. The increase in available nitrogen in surface soil is due to higher quantity of residue additions and their slow decomposition due to less soil disturbance might have caused higher available nitrogen concentrations in the surface layer (Du *et al*., 2010 and Dikgwatlhe *et al*., 2014).

Available Phosphorus

The available phosphorous (Table 2) in surface soils ranged from 15.48 kg ha^{-1} in cotton-fallow cropping system to 80.10 kg ha^{-1} in paddy-groundnut cropping system with mean values of 45.59 and 63.10 kg ha^{-1}, respectively. The available phosphorus of soils in groundnut-horsegram, cotton-fallow, fallow-bengalgram, groundnut monocropping, paddy-paddy and paddy-groundnut cropping systems was ranged from 32.40-74.26, 15.48-66.85, 25.49-72.45, 34.60-76.93, 25.44-68.43 and 35.67-80.10 kg ha^{-1}, respectively with mean values of 55.42, 45.59, 53.10, 57.27, 49.31 and 63.10 kg ha^{-1} respectively.

Available phosphorus in sub-surface soils ranged from 12.39 kg ha^{-1} in cotton-fallow cropping system to 68.23 kg ha^{-1} in paddy-groundnut cropping system with mean values of 32.22 and 43.51 kg ha^{-1}, respectively. The available phosphorus of soils in groundnut-horsegram, cotton-fallow, fallow-bengalgram, groundnut monocropping, paddy-paddy and paddy-groundnut cropping systems was ranged from 17.70-57.64, 12.39-52.56, 16.54-54.16, 18.42-57.99, 12.83-52.68 and 19.30-68.23 kg ha^{-1}, respectively with mean values of 38.00, 32.22, 34.61, 40.18, 33.85 and 43.51 kg ha^{-1}, respectively.

The maximum available phosphorus was recorded in soils of paddy-groundnut cropping system and the minimum available phosphorus was recorded in cotton-fallow cropping system in both surface and sub-surface soils. These soils were low to high in available phosphorus.

The available phosphorus of soils under paddy-groundnut cropping system was higher than that of other cropping systems. Crop rotations with legumes, can increase root colonization by mycorrhizae. Mycorrhizal associations have the greatest impact on increasing P availability in soils by colonizing root. This may be also due to higher available N in paddy-groundnut cropping system with BNF causes positive interaction between available N and P. The results are in accordance with the findings of Newton *et al*. (2011) and Smith *et al*. (2011).

The data further revealed that the soil available phosphorus decreased with increasing depth in all cropping systems. The increase in available phosphorus in surface soil which might be due to higher residue retention and higher organic carbon content that leads to favourable conditions for increasing nutrient availability

Table 1. Available nitrogen (kg ha^{-1}) of soils under prominent cropping systems in scarce rainfall zone of Andhra Pradesh

S. No.	Groundnut-Horsegram		Cotton-Fallow		Fallow-Bengalgram		Groundnut monocropping		Paddy-Paddy		Paddy-Groundnut	
	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
1	196	187	124	107	138	125	248	231	148	100	188	151
2	154	151	103	75	176	151	124	106	126	118	138	113
3	176	148	125	120	195	125	135	105	111	100	163	138
4	246	128	138	100	159	138	254	232	113	88	176	163
5	158	147	151	125	176	112	219	141	138	113	151	125
6	138	113	138	113	151	138	147	121	116	85	127	112
7	125	96	151	125	116	88	138	125	151	125	138	125
8	215	138	165	108	154	108	151	125	138	113	151	148
9	235	125	113	75	138	117	262	150	151	113	176	138
10	265	210	138	121	151	125	235	183	138	125	176	136
11	238	232	163	125	226	201	213	188	259	188	276	251
12	226	213	176	151	213	188	163	138	183	168	238	226
13	188	176	151	138	263	168	151	123	206	119	268	243
14	264	188	188	163	257	151	163	125	232	186	258	189
15	176	142	151	125	188	176	201	163	224	198	263	226
16	201	164	229	185	248	169	263	231	168	156	201	176
17	188	158	201	176	256	138	276	236	262	148	238	201
18	163	138	151	100	263	216	251	196	213	136	276	251
19	201	176	259	206	213	184	213	168	257	212	238	213
20	213	191	176	163	226	201	238	188	238	201	286	276
Min	**125**	**96**	**103**	**75**	**116**	**88**	**124**	**105**	**111**	**85**	**127**	**112**
Max	**265**	**232**	**259**	**206**	**263**	**216**	**276**	**236**	**262**	**212**	**286**	**276**
Mean	**198**	**161**	**159**	**130**	**195**	**151**	**202**	**164**	**179**	**140**	**206**	**180**
S. D	**40**	**35**	**38**	**35**	**47**	**35**	**51**	**44**	**53**	**40**	**54**	**52**
C.V	**20.12**	**21.96**	**23.82**	**26.66**	**24.28**	**23.48**	**25.12**	**27.15**	**29.61**	**28.56**	**26.27**	**29.00**

Table 2. Available phosphorus- P_2O_5 (kg ha^{-1}) of soils under prominent cropping systems in scarce rainfall zone of Andhra Pradesh

S. No	Groundnut-orsegram		Cotton-Fallow		Fallow-Bengalgram		Groundnut monocropping		Paddy-Paddy		Paddy-Groundnut	
	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
1	58.36	55.17	20.52	14.56	48.62	20.52	46.21	25.65	35.13	28.47	41.04	19.30
2	32.40	30.78	15.48	12.39	25.49	19.90	35.91	25.65	34.27	12.83	39.45	20.52
3	74.26	52.14	22.18	19.48	51.30	21.70	46.17	34.78	34.16	15.39	46.17	26.10
4	48.27	31.09	38.25	22.60	48.27	27.59	34.60	18.42	42.54	30.27	52.47	46.01
5	66.76	31.70	47.21	25.65	57.54	49.63	48.66	34.24	62.45	41.63	67.72	39.18
6	46.17	35.91	58.23	32.54	40.36	16.54	67.47	57.99	62.34	42.56	35.67	19.60
7	41.80	17.70	18.14	13.26	27.44	20.54	51.73	46.17	45.05	30.17	67.45	54.23
8	70.73	48.16	16.28	12.47	36.58	21.74	48.19	28.53	68.43	42.27	80.10	56.66
9	41.04	36.20	47.86	24.84	46.60	32.85	64.12	31.77	40.54	29.27	72.56	65.12
10	62.40	32.66	66.51	24.37	72.45	24.57	57.66	38.49	58.75	37.99	62.45	40.49
11	48.66	36.80	58.92	48.56	41.49	35.72	58.24	57.36	63.55	47.52	74.76	58.74
12	64.88	57.64	42.64	38.36	56.33	33.50	72.54	45.32	48.51	46.84	60.44	55.47
13	42.57	30.50	66.85	47.56	69.56	48.66	58.32	42.68	25.44	14.55	78.59	34.65
14	70.46	55.60	66.56	51.27	54.16	38.27	66.52	27.30	53.66	35.68	69.88	68.23
15	43.22	28.42	49.58	38.45	66.50	52.37	59.88	49.27	48.27	22.54	77.63	43.52
16	54.46	32.18	66.45	52.56	71.50	38.24	64.10	48.40	48.10	33.49	71.72	39.57
17	64.27	49.20	56.34	34.13	70.45	47.12	74.68	55.60	46.28	34.10	63.94	42.75
18	69.53	32.50	47.45	50.45	58.46	40.28	47.98	45.62	37.86	26.04	58.75	54.18
19	52.48	30.28	59.43	42.72	68.74	54.16	65.44	56.67	62.45	52.64	65.10	47.65
20	55.67	35.43	46.86	38.10	50.15	48.26	76.93	33.69	68.40	52.68	76.16	38.23
Min	**32.40**	**17.70**	**15.48**	**12.39**	**25.49**	**16.54**	**34.60**	**18.42**	**25.44**	**12.83**	**35.67**	**19.30**
Max	**74.26**	**57.64**	**66.85**	**52.56**	**72.45**	**54.16**	**76.93**	**57.99**	**68.43**	**52.68**	**80.10**	**68.23**
Mean	**55.42**	**38.00**	**45.59**	**32.22**	**53.10**	**34.61**	**57.27**	**40.18**	**49.31**	**33.85**	**63.10**	**43.51**
S. D	**12.13**	**10.97**	**18.06**	**13.96**	**14.25**	**12.46**	**12.08**	**12.03**	**12.70**	**11.95**	**13.62**	**14.54**
C.V	**21.89**	**28.87**	**39.61**	**43.33**	**26.84**	**36.00**	**21.09**	**29.94**	**25.76**	**35.30**	**21.58**	**33.42**

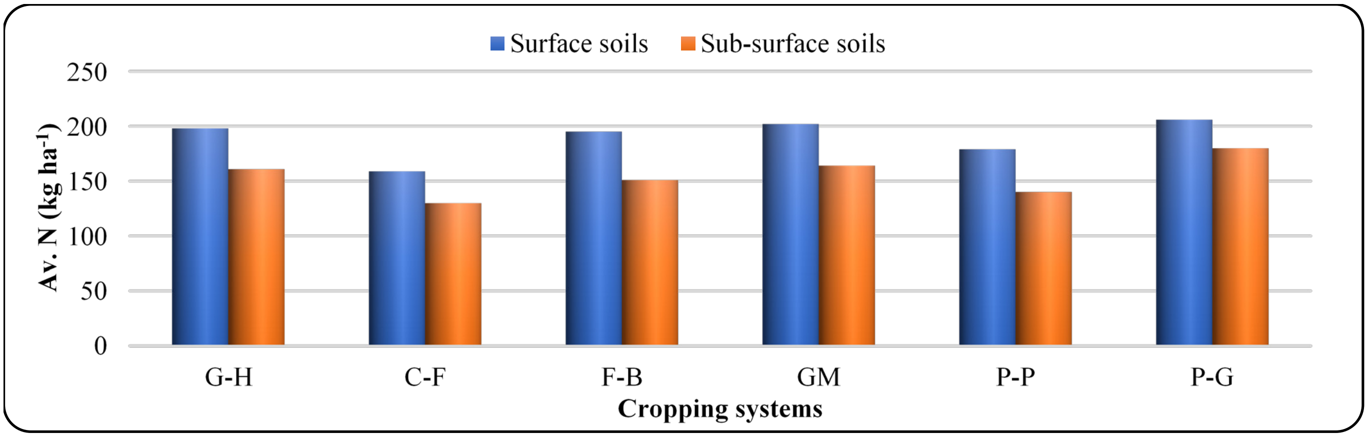

Fig. 1. **Available nitrogen (kg ha^{-1}) status of soils under prominent cropping systems in scarce rainfall zone of Andhra Pradesh.**

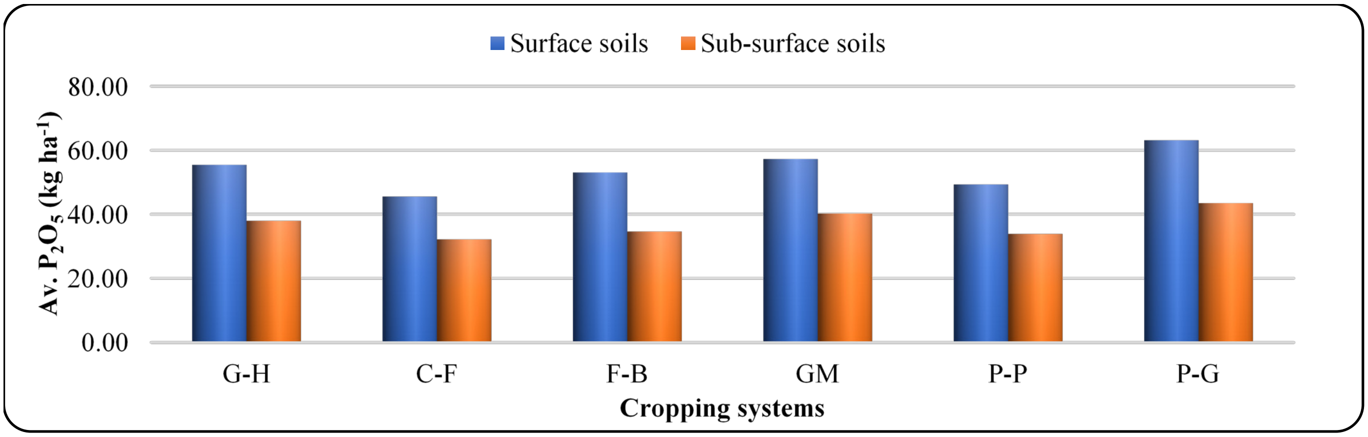

Fig. 2. **Available phosphorus (kg ha^{-1}) status of soils under prominent cropping systems in scarce rainfall zone of Andhra Pradesh.**

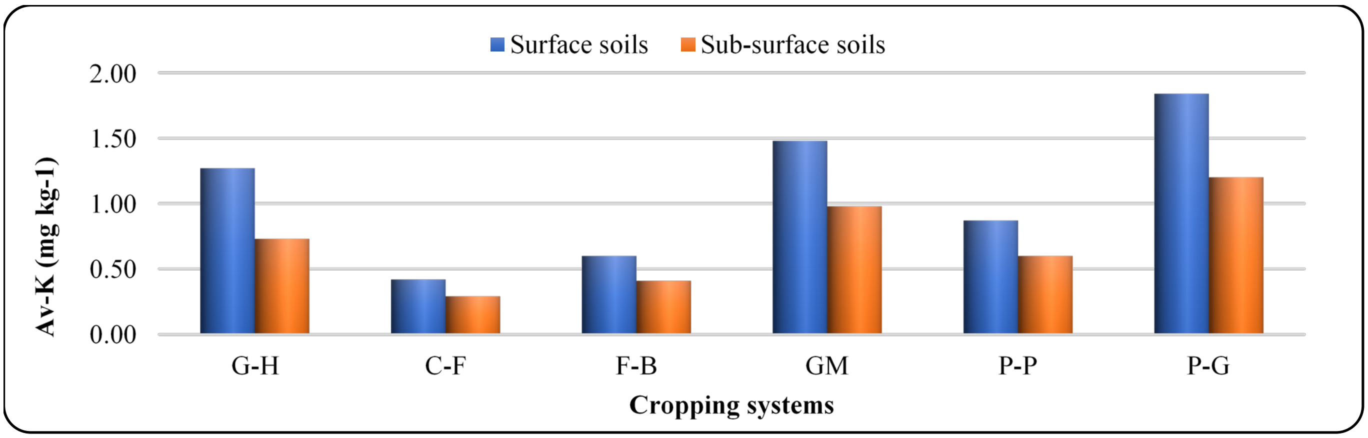

Fig. 3. **Available K (mg kg^{-1}) status of soils under prominent cropping systems in scarce rainfall zone of Andhra Pradesh.**

Note: **G-H: Groundnut-Horsegram; C-F: Cotton-Fallow; F-B: Fallow-Bengalgram; GM: Groundnut Monocropping; P-P: Paddy-Paddy; P-G: Paddy-Groundnut**

Table 3. Distribution of available potassium (mg kg^{-1}) under prominent cropping system in scarce rainfall zone of Andhra Pradesh

S. No	Groundnut-Horsegram		Cotton-Fallow		Fallow-Bengalgram		Groundnut monocropping		Paddy-Paddy		Paddy-Groundnut	
	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
1	156	130	85	70	197	134	147	104	229	189	127	112
2	140	125	152	132	149	112	76	61	161	143	279	150
3	108	98	145	66	152	118	108	101	208	168	282	130
4	122	114	123	109	135	122	73	66	118	89	113	72
5	128	108	135	122	173	137	113	64	143	120	146	77
6	82	60	108	80	153	126	138	104	256	244	101	92
7	134	96	136	63	167	133	80	72	241	138	284	226
8	121	59	154	76	183	126	113	73	191	129	160	129
9	85	69	85	67	145	122	141	83	127	122	134	85
10	93	80	118	123	139	117	83	58	268	142	110	74
11	147	66	224	150	143	116	84	68	201	110	230	124
12	135	124	237	146	189	130	191	128	289	172	272	146
13	157	126	191	161	153	141	125	134	273	156	247	166
14	188	125	157	87	156	114	91	59	203	121	200	117
15	177	130	278	125	98	70	134	112	217	136	220	176
16	167	108	149	62	249	140	82	74	274	166	206	166
17	143	112	145	128	213	131	184	134	230	176	234	125
18	182	92	223	166	282	210	131	69	205	145	246	158
19	213	146	246	184	174	132	175	144	263	153	249	184
20	152	112	264	150	157	139	179	133	220	150	219	176
Min	**82**	**59**	**85**	**62**	**98**	**70**	**73**	**58**	**118**	**89**	**101**	**72**
Max	**213**	**146**	**278**	**184**	**282**	**210**	**191**	**144**	**289**	**244**	**284**	**226**
Mean	**141**	**104**	**168**	**113**	**170**	**128**	**122**	**92**	**216**	**148**	**203**	**134**
S. D	**35**	**26**	**58**	**39**	**41**	**25**	**39**	**30**	**50**	**33**	**63**	**42**
C.V	**24.82**	**25.00**	**34.52**	**34.51**	**24.12**	**19.53**	**31.97**	**32.61**	**23.15**	**22.30**	**31.03**	**31.34**

at the surface layers (Jat *et al*., 2018 and Kavitha *et al*., 2019).

Available Potassium

The available potassium (Table no.3) content of surface soils varied from 73 mg kg^{-1} in groundnut monocropping system to 289 mg kg^{-1} in paddy- paddy cropping sytem with mean values of 122 and 216 mg kg^{-1}, respectively. The available potassium of soils in groundnut-horsegram, cotton-fallow, fallow-bengalgram, groundnut monocropping, paddy-paddy and paddy-groundnut cropping systems was ranged from 82-213, 85-278, 98-282, 73-191, 118-289 and 101-284 mg kg^{-1}, respectively with mean values of 141, 168, 170, 122, 216 and 203 mg kg^{-1}, respectively. The available potassium content in surface soils was varied from medium to high in status.

In sub-surface soils available potassium content varied from 58 mg kg^{-1} in groundnut monocropping system to 244 mg kg^{-1} in paddy- paddy cropping sytem with mean values of 92 and 148 mg kg^{-1}, respectively. The available potassium of soils in groundnut-horsegram, cotton-fallow, fallow-bengalgram, groundnut monocropping, paddy-paddy and paddy-groundnut cropping systems was ranged from 59-146, 62-184, 70-210, 58-144, 89-244 and 72-226 mg kg^{-1}, respectively with mean values of 104, 113, 128, 92, 148 and 134 mg kg^{-1}, respectively. The available potassium content in sub-surface soils was varied from medium to high in status.

The highest available potassium was observed in soils of paddy- paddy cropping system in both surface and sub-surface soils due to continuous application of potassic fertilizers. The lowest available potassium was recorded in groundnut monocropping system in both surface and sub-surface soils possibly due to less application of potassic fertilizers than crop needed or imbalanced fertilization in crop nutrition caused mining of its native pools (Charankumar *et al*., 2022).

The data further revealed that highest available potassium was observed in surface soils than in sub-surface soils in all cropping systems, which might be attributed to presence of vegetation or upward translocation of K from lower layers through capillary rise or ground water. (Lungmuana *et al*., 2014).

The results of this study indicated that the soils under prominent cropping systems in scarce rainfall zone of Andhra Pradesh were low to medium in available nitrogen, low to high in available phosphorus and medium to high in available potassium. In both surface and sub-surface soils, the available nitrogen and available phosphorus content in the prominent cropping systems were in the order of paddy-groundnut > groundnut monocropping > groundnut-horsegram > fallow-bengalgram > paddy-paddy > cotton-fallow. The available K in the prominent cropping systems waas in the order of paddy-paddy > paddy-groundnut > fallow-bengalgram > cotton-fallow > groundnut-horsegram > groundnut monocropping in both surface and sub-surface soils. Paddy-groundnut cropping system was found to be maintain sustainable soil health leading to improved crop productivity and profitability.

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LITERATURE CITED

Amgain, R., Khadka, D and Joshi, S. 2023. Soil macronutrient status in different depths after wheat harvest in the paddy-wheat cropping system of Rupandehi District of Nepal. *Nepal Agriculture Research Journal*. 15(1): 46-54.

Borkar, V.S., Gokhale, N.B., Dhopavkar, R.V., Khobragade, N.H., More, S.S and Kasture, M.C. 2018. Distribution of nutrients in different soil types in Konkan region of Maharashtra. *International Journal of Chemical Studies*. 6(1): 275-279.

Charankumar, G.R., Munaswamy, V., Krishna, T.G and Subramanyam, D. 2022. Dynamics of soil potassium under different cropping systems in YSR Kadapa district of Andhra Pradesh. *Environment and Ecology*. 40(2): 425-431.

Dikgwatlhe, S.B., Chen, Z., Lal, R., Zhang, H and Chen, F. 2014. Changes in soil organic carbon and nitrogen as affected by tillage and residue management under wheat–maize cropping system in the North China Plain. *Soil Tillage Research*. 144: 110-118.

Du, Z., Ren, T and Hu, C. 2010. Tillage and residue removal effects on soil carbon and nitrogen storage in the North China Plain. *Soil Science Society of America Journal*. 74(1): 196-202.

Jackson, M.L. 1973. *Soil Chemical Analysis*. Oxford IBH Publishing House, Bombay. 38.

Jat, H.S., Datta, A., Sharma, P.C., Kumar, V., Yadav, A.K., Choudhary, M., Choudhary, V., Gathala, M.K., Sharma, D.K., Jat, M.L and Yaduvanshi, N.P.S. 2018. Assessing soil properties and nutrient availability under conservation agriculture practices in a reclaimed sodic soil in cereal-based systems of North-West India. *Archives of Agronomy and Soil Science*. *64*(4): 531-545.

Kavitha, M., Vajantha, B., Naidu, M.V.S and Reddi Ramu, Y. 2019. Delineation and geographic information system (GIS) mapping of soil macronutrients status in sugarcane growing tracts of prudential sugar factory zone in Chittoor district, Andhra Pradesh. *International Journal of Chemical Studies*. 7(6): 11-16.

Kumar, A., Kumar, S., Gaur, A.S., Kumar, A., Singh, A and Prajpati, D. 2023. Effect of Physico-Chemical Properties of Soil under Various Depths on Different Cropping Systems in Ayodhya, India. *International Journal of Plant and Soil Science*. 35(18): 1484-1490.

Kumar, V., Singh, S.K., Singh, P., Tiwari, S., Nand, M.M., Chiranjeeb, K and Majhi, M. 2020. Effects of Cropping Systems on Soil Properties and Enzymatic Activities in Calcareous Soil. *International Journal of Current Microbiology and Applied Sciences*. 9(4): 2020.

Lungmuana., Bose, A., Ghosh, I., Ghosh, S.K and Patra, P.K. 2014. Distribution and variation of potassium in rice growing soils of red and laterite zone of West Bengal. *Journal of the Indian Society of Soil Science*. 62(1): 84-87.

Newton, Z.L., Kennedy, A.N and Chirwa, R.M. 2011. Grain legume impacts on soil biological processes in sub-Saharan Africa. *African Journal of Plant Science*. 5(1): 1-7.

Olsen, S.R., Cole, C.V., Watanabe, F.S and Dean, L.A. 1954. Estimation of available phosphorus in soils by extraction with sodium bicarbonate. *Circular of United States Department of Agriculture*. 939.

Patil, P.L., Kuligod, V.B., Gundlur, S.S., Katti, J., Nagaral, I.N., Shikrashetti, P., Geetanjali, H.M and Dasog, G.S. 2016. Soil fertility mapping in Dindur sub-watershed of Karnataka for site specific recommendations. *Journal of the Indian Society of Soil Science*. 64(4): 381-390.

Smith, S.E., Jakobsen, I., Gronlund, M and Smith, F.A. 2011. Roles of arbuscular mycorrhiza as in plant phosphorus nutrition: interactions between pathways of phosphorus uptake in arbuscular mycorrhizal roots have important implications for understanding and manipulating plant phosphorus acquisition. *Plant Physiology*. 156(3): 1050-1057.

Subbiah, B.V and Asija, C.L. 1956. A rapid procedure for the estimation of available nitrogen in soils. *Current Science*. 25: 32.

Wani, S.P. 2008. Taking soil science to farmers' doorsteps through community watershed management. *Journal of the Indian Society of Soil Science*. 56(4): 367-377.

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RESPONSE OF GROUNDNUT (*Arachis hypogaea* L.) TO VARIED LEVELS OF PHOSPHORUS AND NANO DAP

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ABSTRACT

A field experiment entitled "Response of groundnut (*Arachis hypogaea* L.) to varied levels of phosphorus and nano DAP" was conducted at Dryland Farm, S.V. Agricultural College, Tirupati campus of Acharya N.G. Ranga Agricultural University, Andhra Pradesh, India during *rabi,* 2023-24. The experiment was laid down in the randomized block design and replicated thrice. The results showed that significantly higher plant height, leaf area index, dry matter production, pod and haulm yield were recorded with application of 50 % RDP through DAP as basal + seed treatment with nano DAP @ 4 ml kg^{-1} + nano DAP spray @ 2 ml l^{-1} of water at 25 DAS, which was found to be on par with 50 % RDP through DAP as basal + nano DAP spray @ 2 ml l^{-1} of water at 25 DAS. Significantly lower values were recorded in control (No application of P).

KEYWORDS: Haulm yield, Nano DAP, Phosphorus, Pod yield, Seed treatment.

INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is known as king of vegetable oilseed crops and plays an important role in meeting the demand of edible oil across the world. Among the oilseed crops, groundnut is the 4th most predominant oilseed crop and 13th crucial food crop of the world. Groundnut seed contains 47-50% oil, 26% protein and 11.5% starch.

Groundnut is cultivated in almost all tropical and subtropical nations in the world. India is the top producing nation in the world accounting for 27.3% of production and 39.3 % area. It is grown over 4.9 million ha in India with the production of 9.25 million tonnes with an average productivity of 1893 kg ha^{-1}. Andhra Pradesh produces around 0.78 million tonnes from an area of 0.87 million ha with a productivity of 894 kg ha^{-1}. (Directorate of Economics and Statistics, Andhra Pradesh. 2022-2023).

Among various problems that hinder the productivity of groundnut nutrient management is the major problem. Nitrogen is a paramount element for plants since it is an essential for formation of amino acids which are building blocks of proteins and it is the limiting factor for crop growth, development and yield.

Phosphorus promotes biomass synthesis, stimulate root development and helps for partitioning of photosynthates between source and sink and low soil phosphorus levels significantly limit the growth and development of legume crops. However, phosphatic fertilizers are not only expensive, but their availability is also less than their demand.

Nano phosphatic fertilizers have the potential to significantly contribute to the endeavour to reduce the use of chemical fertilizers and to increase the phosphorus availability and other essential nutrients to the crops (Balachandrakumar *et al*. 2024 and Bakry *et al.* 2022). Reducing fertilizer particle size will boost the efficacy of amendments which in turn increase fertilizer contact with plants and thus increase nutrient uptake. As a result, it is crucial to consider strategies for preserving phosphatic fertilizers without sacrificing economic returns.

Application of bulk fertilizers like DAP and other associated fertilizers leads to losses from volatilization, leaching and runoff. Nano fertilizers dissolve more readily in water and may enhance fertilizer use by plants by increasing uptake and distribution. Seed treatment and foliar fertilization helps to increase the efficiency of applied fertilizer.

MATERIAL AND METHODS

A field experiment entitled "Response of groundnut (*Arachis hypogaea* L.) to varied levels of phosphorus and nano DAP" was conducted during *rabi*, 2023-24 in Dryland Farm of S.V. Agricultural College, Tirupati, Acharya N.G. Ranga Agricultural University, Andhra Pradesh. The present experiment was laid out in a randomized block design with eight treatments and three replications. The treatments comprised of Control (No application of P) (T_1), RDP through DAP as basal (40 kg P_2O_5 ha^{-1}) (T_2), 75 % RDP (30 kg P_2O_5 ha^{-1}) through DAP as basal + seed treatment with Nano DAP @ 4 ml

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kg^{-1} + Nano DAP spray @ 2 ml l^{-1} of water at 25 DAS (T_3), 50 % RDP (20 kg P_2O_5 ha^{-1}) through DAP as basal + seed treatment with Nano DAP @ 4 ml kg^{-1} + Nano DAP spray @ 2 ml l^{-1} of water at 25 DAS (T_4), 75 % RDP (30 kg P_2O_5 ha^{-1}) through DAP as basal + Nano DAP spray @ 2 ml l^{-1} of water at 25 DAS(T_5), 50 % RDP (20 kg P_2O_5 ha^{-1}) through DAP as basal + Nano DAP spray @ 2 ml l^{-1} of water at 25 DAS (T_6), Seed treatment with Nano DAP @ 5 ml kg^{-1} + Nano DAP spray @ 2 ml l^{-1} of water at 25 DAS (T_7) and Nano DAP spray @ 2 ml l^{-1} of water at 25 DAS (T_8). The soil of the experiment field was sandy loam in texture, neutral in soil reaction, low in organic carbon (0.27 %) and available nitrogen (157 kg N kg ha^{-1}), medium in available phosphorus (19.9 kg P_2O_5 ha^{-1}) and potassium (235 kg K_2O ha^{-1}). The test variety of groundnut used in present investigation was Vishista (TCGS-1694). Recommended dose of fertilizer used in the experiment was 30-40-50 N, P_2O_5, K_2O kg ha^{-1}. Recommended dose of nitrogen and potassium were applied as basal to all the treatments, where phosphorus was applied as per treatments. Seed treatment with nano DAP @ 4 ml kg^{-1} and @ 5 ml kg^{-1} and nano DAP was sprayed @ 2 ml l^{-1} of water at 25 DAS as per treatments. The crop was sown by hand dibbling with spacing of 30 cm between rows and 10 cm between plants. Five plants were randomly selected in each plot for taking observations on growth parameters at 25, 50, 75 DAS and at harvest. Yield was recorded in each plot by harvesting separately as per treatment and the values were converted into hectare basis and expressed in kg ha^{-1}. The data recorded on various parameters of groundnut during the course of investigation was statistically analyzed following the analysis of variance for randomized block design as suggested by Panse and Sukhatme (1985). Statistical significance was tested with 'F' value at five per cent level of probability. Critical difference (CD) for the significant sources of variation was calculated at five per cent level of significance. The treatmental differences those were non-significant were denoted by "NS".

Plant height was recorded from five randomly tagged plants and mean was expressed in cm. Five plants were selected outside the net plot area, leaving the extreme border row for destructive sampling to generate data on leaf area and dry matter production at different stages of crop growth. Leaf area of five destructively sampled plants from border rows was measured by using LI-COR model, LT-300 leaf area meter with transparent conveyor belt and electronic digital display. After computing the leaf area (cm^2), leaf area index was calculated by using the following formula as suggested by Watson (1952).

$$\text{LAI} = \frac{\text{Leaf area (cm}^2\text{)}}{\text{Unit land area (cm}^2\text{)}}$$

For dry matter production plants were shade dried and then dried in hot air oven at $60^{o}C$ to a constant weight and expressed as kg ha^{-1}.

The pods and haulm obtained from the net plot area of each treatment and five sampled plants were thoroughly sun dried, cleaned, weighed and expressed in kg ha^{-1}.

RESULTS AND DISCUSSION

Plant Height

The results of the experiment revealed that among different treatments, soil application of 50 % RDP through DAP as basal + seed treatment with nano DAP @ 4 ml kg^{-1} + nano DAP spray @ 2 ml l^{-1} of water at 25 DAS (T_4) recorded significantly higher plant height, which was in par with 50 % RDP through DAP as basal + nano DAP spray @ 2 ml l^{-1} of water at 25 DAS (T_6). The significantly higher plant height might be due to optimum soil application of conventional phosphorus and seed treatment along with foliar spray of nano DAP fertilizer with large permeability and high concentration of nanoparticles that might penetrate into plant leaves and play an important role in promoting plant growth parameters, where nitrogen has a positive role in increasing the activity of meristematic tissues and cell division and its importance in building amino acids such as tryptophan, which is the basis for building auxins that contribute to cell division and expansion which ultimately resulted in higher growth parameters. While lower plant height was recorded with control (No application of P) (T_1), this might be due to unavailability of required quantity of nutrients for growth and development of the plant. These results are in conformity with the findings of Kumar *et al.* (2022), Aziz *et al.* (2021) and Alqader *et al*. (2020).

Leaf Area Index

Significantly higher values of leaf area index were observed with 50 % RDP through DAP as basal + seed treatment with nano DAP @ 4 ml kg^{-1} + nano DAP spray @ 2 ml l^{-1} of water at 25 DAS (T_4), which was however at par with 50 % RDP through DAP as basal + nano DAP spray @ 2 ml l^{-1} of water at 25 DAS (T_6). Optimum phosphorus application may influence plant growth from cellular to the whole plant level and foliar application of nano DAP at the hour of need might have enabled the plants to maintain high chlorophyll content,

Table 1. Growth parameters and yield of groundnut as influenced by varied levels of phosphorus and nano DAP

Treatments		Plant height (cm)		Leaf area index		Dry matter production (kg ha^{-1})		Yield (kg ha^{-1})	
		75 DAS	Harvest	75 DAS	Harvest	75 DAS	Harvest	Pod yield	Haulm yield
T_1 :	Control (No application of P)	23.3	24.0	2.19	1.77	2606	4900	1917	2443
T_2 :	RDP through DAP as basal	27.1	28.9	2.57	2.09	3056	5800	2383	2900
T_3 :	75% RDP through DAP as basal + seed treatment with Nano DAP @ 4 ml kg^{-1} + Nano DAP spray @ 2 ml l^{-1} of water at 25 DAS	31.7	33.9	3.06	2.46	3743	7100	3016	3567
T_4 :	50 % RDP through DAP as basal + seed treatment with Nano DAP @ 4 ml kg^{-1} + Nano DAP spray @ 2 ml l^{-1} of water at 25 DAS	35.9	41.0	3.45	2.90	4216	8126	3643	4167
T_5 :	75% RDP through DAP as basal + Nano DAP spray @ 2 ml l^{-1} of water at 25 DAS	31.0	33.0	2.93	2.40	3587	6956	2890	3400
T_6 :	50% RDP through DAP as basal + Nano DAP spray @ 2 ml l^{-1} of water at 25 DAS	34.7	38.3	3.35	2.71	4160	7766	3403	4023
T_7 :	Seed treatment with Nano DAP @ 5 ml kg^{-1}+ Nano DAP spray @ 2 ml l^{-1} of water at 25 DAS	27.9	29.2	2.67	2.14	3198	6266	2497	3033
T_8 :	Nano DAP spray @ 2 ml l^{-1} of water at 25 DAS	23.9	25.3	2.28	1.86	2706	5100	2017	2567
	SEm±	0.89	1.03	0.082	0.069	103.5	196.9	93.6	99.5
	CD (P=0.05)	2.7	3.1	0.24	0.21	314	57	281	299

number of leaves plant^{-1} and ultimately higher leaf area index. Lower leaf area index recorded with control (No application of P) (T_1). This is in conformity with the works of Choudhary *et al.* (2022) and Rashmi and Prakash (2023).

Dry Matter Production

Application of 50 % RDP through DAP as basal + seed treatment with nano DAP @ 4 ml kg^{-1} + nano DAP spray @ 2 ml l^{-1} of water at 25 DAS (T_4) recorded significantly higher dry matter accumulation, which was at par with 50 % RDP through DAP as basal + nano DAP spray @ 2 ml l^{-1} of water at 25 DAS (T_6). The significant increase in dry matter production with soil application of 50 % RDP along with seed treatment and foliar nano DAP fertilization might be due to the fact that, tiny size of nano fertilizers might result in better absorption of nutrients and synergism between nitrogen and phosphorus helps to improve nutrient uptake leading to increased plant growth mechanisms, such as photosynthetic activity and chlorophyll synthesis resulting in higher plant height, photosynthetic area and vegetative growth, which ultimately reflected in the form of higher dry matter production. Similar observations were recorded by Maheta *et al.* (2023) and Sharma *et al.* (2022). The control (No application of P) (T_1) registered the least dry matter production.

Pod and Haulm Yield

The highest pod and haulm yield of groundnut was recorded with 50 % RDP through DAP as basal + seed treatment with nano DAP @ 4 ml kg^{-1} + nano DAP spray @ 2 ml l^{-1} of water at 25 DAS (T_4), which was comparable with 50 % RDP through DAP as basal + nano DAP spray @ 2 ml l^{-1} of water at 25 DAS (T_6). Higher pod yield might be due to increased yield components.

The optimum and balanced nutrient availability was ensured throughout the crop period, particularly during the critical stages of the crop, by applying conventional and nano fertilizers in combination. Increased uptake leads to optimal growth of plants and improved metabolic processes, such as photosynthesis, which increases the accumulation of photosynthates and their translocation to the economically productive parts of the plant. This process leads to higher growth parameters, yield attributing characters and yield by enhancing the translocation of assimilates to seeds all of which contribute to increased pod and haulm yield. Similar results were reported by Bhargavi and Sundari (2023) and Chinnappa *et al.* (2023). The lower pod yield recorded with control (No application of P) (T_1).

Higher growth parameters and yield were obtained with application of 50 % RDP through DAP as basal + seed treatment with nano DAP @ 4 ml kg^{-1} + nano DAP spray @ 2 ml l^{-1} of water at 25 DAS (T_4), which was comparable with 50 % RDP through DAP as basal + nano DAP spray @ 2 ml l^{-1} of water at 25 DAS (T_6). Application of nano DAP at right time and right quantity helped in better growth and yield of groundnut. Thus 50 % of phosphorus can be saved by seed treatment with nano DAP and foliar spray of nano DAP. The nano DAP fertilizers are new genera of fertilizers which even in small quantity are equal to large volume of conventional fertilizers and are having high surface area by which they are absorbed by the plant system and thereby improving growth and yield of groundnut.

LITERATURE CITED

Alqader Saleh, Al-jobourilaythmazin, Eshoaa H. 2020. Effect of nitrogenous and urea nano-hydroxyapatite fertilizer on growth and yield of two cultivars of broad bean (V*icia faba* L.). *Euphrates Journal of Agricultural Sciences*. 12(2): 598-618.

Aziz, B.R., Zrar, D.B. 2021. Effect of foliar application of nano-NPK fertilizer on growth and yield of bean (*Vicia faba* L.). *Journal of Pure Applied Science*. 33(4): 90-99.

Bakry, B.A., El-Nwehy, S.S., Afify, R.R., Ibrahim, O.M and El-Aziz, M.A. 2022. Preparation, characterization and evaluation of nano phosphorus foliar application on peanut production under sandy soil. *Asian Journal of Plant Sciences.* 423-431.

Balachandrakumar, V., Sowmiya, K., Shofiya, M., Gopika, K and Nithika, M. 2024. Impact of nano DAP and Zn EDTA on cowpea growth and yield. *International Journal of Plant and Soil Science*. 36(6): 317-326.

Bhargavi, G and Sundari, A. 2023. Effect of nano urea on growth and yield of rice (*Oryza sativa* L.) under SRI in the Cauvery delta zone of Tamil Nadu. *Crop Research*. 58(1&2): 12-17.

Chinnappa, S.A., Krishnamurthy, D., Ajayakumar, M.Y., Ramesha, Y.M and Ravi, S. 2023. Response of nano fertilizers on growth, yield and economics of *kharif* sorghum. *The Pharma Innovation Journal.* 12(9): 761-765.

Choudhary, P., Singh, D., Kaushik, M.K., Sharma, S.S., Jain, H.K., Saharan, V., Singh, D.P., Sharma, R.K. 2022. Production, productivity and quality of maize (*Zea mays* L.) as affected by foliar application of zinc-based nano-fertilizer and different fertility levels. *The Pharma Innovation Journal*. 11(2):1878-1882.

Directorate of Economics and Statistics, Planning Department, Government of Andhra Pradesh. 2022-2023. *Agricultural statistics at a glance.*

Kumar, N., Manuja, S., Sankhyan, N.K., Kumar, P., Kumar, A. and Sharma, T. 2022. Effect of application of Nano-DAP and conventional fertilizers on rice yield. *Sustainable Agricultural Innovations for Resilient Agri-Food Systems*. 373.

Maheta, A., Gaur, D and Patel, S. 2023. Effect of nitrogen and phosphorus nano fertilizers on growth and yield of maize (*Zea mays* L.). *The Pharma Innovation Journal.* 12(3): 2965-2969.

Panse, V.G and Sukhatme, P.V. 1985. *Statistical methods for Agricultural workers*. Indian Council of Agricultural Research, New Delhi. 187-202.

Rashmi, C.M and Prakash, S.S. 2023. Effect of nano phosphorus fertilizers on growth and yield of maize (*Zea mays* L.) in Central Dry Zone of Karnataka. *Mysore Journal of Agricultural Science.* 57(2): 286-293.

Sharma, S.K., Sharma, P.K., Mandeewal, R.L., Sharma, V., Chaudhary, R., Pandey, R and Gupta, S. 2022. Effect of foliar application of nano urea under different nitrogen levels on growth and nutrient content of pearlmillet (*Pennisetum glaucum* L.). *International Journal of Plant* and *Soil Science*. 34(20): 149-155.

Watson, D.J. 1952. The physiological basis of variation in yield. *Advances in Agronomy*. 6: 103-109.

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INFLUENCE OF ORGANIC MANURES AND ORGANIC FOLIAR SPRAYS ON GROWTH AND YIELD OF GROUNDNUT (*Arachis hypogaea* L.)

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ABSTRACT

A field experiment was conducted during *rabi*, 2023-24 at S.V. Agricultural College Farm, Tirupati. The experiment was laid out in a split-plot design and replicated thrice. The main plots contain four treatments *viz*., Control (M_1), 100 % RDN through farmyard manure (M_2), 100 % RDN through poultry manure (M_3) and 50 % RDN through farmyard manure + 50 % RDN through poultry manure (M_4) as organic manures and sub plots contain four treatments *viz.,* Control (S_1), Sea weed extract @ 1.0 % (S_2), Aerated panchagavya @ 3.0 % (S_3) and Fish amino acid @ 1.0 % (S_4) as foliar sprays at 20, 40, 60 DAS. The test variety of groundnut was 'Visishta'. Among the soil application of organic manures, 100 % RDN through poultry manure resulted higher in terms of growth and yield of groundnut. Among the organic foliar sprays, growth and yield of groundnut were higher with the application of sea weed extract @ 1 % however it was at par with aerated panchagavya @ 3% foliar spray.

KEYWORDS: Aearated panchagavya, Organic foliar sprays, Organic manures, Pod yield of Groundnut.

INTRODUCTION

Groundnut, also known as peanut, is a highly valuable oilseed and food crop due to its rich energy content. Approximately 50% of the groundnut produce is utilized for confectionery products such as roasted and salted peanuts, groundnut candy, and peanut butter (Rajagopal *et al*., 2000). Globally, groundnut is grown in an area of 327 lakh hectares, with a total production of 539 lakh tonnes and an average productivity of 1,648 kg per hectare (FAOSTAT, 2021). India leads in groundnut cultivation area, covering 54.2 lakh hectares annually, and is the second-largest producer worldwide with a production of 101 lakh tonnes and a productivity of 1,863 kg per hectare for the year 2021-22 (agricoop.nic.in). Groundnut is the most widely cultivated oilseed crop in India, accounting for over 40% of the total acreage and 60% of national production (Sridhar *et al*., 2020). In Andhra Pradesh, groundnut cultivation is in 8.23 lakh hectares, yielding about 5.19 lakh tonnes with a productivity of 625 kg per hectare for the year 2021-22 (des.ap.gov.in).

To maximize the soil biological activity and sustain long-term soil fertility, organic production emphasizes management techniques that focus on soil regeneration. This approach involves composting and utilization of organically accepted nutrient sources to nourish the soil and supply the plants with essential nutrients. Addition of organic manures to the soil not only improves it's physico-chemical properties, water and nutrient retention and both micro and macro nutrient availability, but also enhances the microbial activity. Integration of organic liquid products such as Panchagavya, Fish Amino Acid (FAA) and Seaweed Extract (SWE) with organic manures like Farmyard Manure (FYM) and Poultry Manure (PM) represents a cost-effective, eco-friendly and efficient method for nutrient management. These practices are advantageous for maintaining soil health and promoting plant growth. In contrast, conventional soil application of fertilizers often leads to low nutrient recovery, increased production costs and environmental pollution. Foliar application of nutrients offers a more efficient alternative, improving nutrient use efficiency and quality while reducing environmental impact by minimizing the amount of fertilizer applied to the soil. This method enhances nutrient absorption directly through plant leaves, thus optimizing growth and reduces the pollution.

MATERIAL AND METHODS

The field experiment was conducted at S.V. Agricultural College, Tirupati campus of Acharya N.G. Ranga Agricultural University, Andhra Pradesh during *rabi*, 2023-24. The soil of the experimental site was sandy loam in texture, neutral in reaction, low in organic carbon (0.27%) and nitrogen (148 kg ha^{-1}), high in available phosphorus (29 kg ha^{-1}) and medium in available potassium (192 kg ha^{-1}). The experiment was laid out in a split-plot design and replicated thrice. The treatments consisted of soil application of organic manures (4) *viz.,* Control (M_1), 100 % RDN through FYM (M_2), 100 % RDN through Poultry manure (M_3)

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and 50 % RDN through FYM + 50 % RDN (M_4) through Poultry manure which were assigned to main plots and organic foliar sprays (4) at 20, 40 and 60 DAS *viz.,* Control (S_1), Sea weed extract @ 1.0 % (S_2), Aerated panchagavya @ 3.0 % (S_3) and Fish amino acid @ 1.0 % (S_4) which were allotted to sub plots. The test variety used in the present experiment was Visishta by adopting a spacing of 22.5 cm x 10 cm.

RESULTS AND DISCUSSION

Growth parameters as influenced by Organic manures and Organic foliar sprays.

Growth parameters *viz.,* plant height, leaf area index and dry matter production were significantly influenced by organic manures and organic foliar nutrition in groundnut during *rabi* 2023-24. However, interaction was found to be non-significant.

Among the organic manures, soil application of 100% RDN through poultry manure resulted in higher plant height, leaf area index and dry matter production of groundnut and in case organic foliar sprays, application of sea weed extract @ 1% recorded higher plant height, leaf area index and dry matter production which was on par with aerated panchagavya @ 3%.

The steady supply of nutrients for plant metabolism and photosynthetic activity with application of poultry manure might have triggered the production of higher number of leaves with more leaf size which in turn resulted in the higher leaf area index as reported by Chaudhri *et al*. (2017). Maximum dry matter production noticed with poultry manure was mainly due to subsequent supply of adequate quantity of nutrients, which in turn enhanced the overall growth of plant that resulted in increased plant height and leaf area and thus the higher dry matter

Table 1. Growth parameters of groundnut as influenced by organic manures and organic foliar sprays

Treatments	Plant height (cm)	Leaf area index	Dry matter production (kg ha^{-1})
Soil application of organic manures			
M_1 : Control	16.9	1.65	6558
M_2 : 100% RDN through FYM	20.3	1.91	7040
M_3 : 100% RDN through poultry manure	25.1	2.51	8059
M_4 : 50% RDN through FYM + 50 % RDN through poultry manure	22.7	2.21	7580
SEm±	0.65	0.072	156.4
CD (P = 0.05)	2.2	0.25	469
Organic foliar sprays at 20, 40 and 60 DAS			
S_1 : Control	17.0	1.60	6735
S_2 : Sea weed extract @ 1.0%	24.4	2.40	7721
S_3 : Aerated panchagavya @ 3.0%	23.3	2.25	7680
S_4 : Fish amino acid @ 1.0%	20.4	2.03	7232
SEm±	0.65	0.071	141.9
CD (P = 0.05)	1.9	0.20	414
Interaction			
M at S			
SEm±	1.29	0.143	291.4
CD (P = 0.05)	NS	NS	NS
S at M			
SEm±	1.30	0.143	283.8
CD (P = 0.05)	NS	NS	NS

Table 2. Pod and haulm yield (kg ha^{-1}) of groundnut as influenced by organic manures and organic foliar sprays

Treatments	Pod yield	Haulm yield
Soil application of organic manures		
M_1 : Control	2050	2565
M_2 : 100% RDN through FYM	2653	3125
M_3 : 100% RDN through poultry manure	3288	3808
M_4 : 50% RDN through FYM + 50 % RDN through poultry manure	3005	3521
SEm±	63.2	74.4
CD (P = 0.05)	218	257
Organic foliar sprays at 20, 40 and 60 DAS		
S_1 : Control	1963	2435
S_2 : Sea weed extract @ 1.0%	3261	3783
S_3 : Aerated panchagavya @ 3.0%	3156	3687
S_4 : Fish amino acid @ 1.0%	2616	3115
SEm±	59.8	70.8
CD (P = 0.05)	174	206
Interaction		
M at S		
SEm±	121.3	143.6
CD (P = 0.05)	372	440
S at M		
SEm±	119.6	141.7
CD (P = 0.05)	349	413

production. This corroborates the findings of Chaudhari and Bhanwaria (2018) and Chaudhari and Choudhary (2022).

Sea weed extract is a condensed source of plant hormones and gives rise to nutrient mobilization as well as cell growth and enlargement, growth of a strong root-system, increased chlorophyll content and leaf area and senescence retardation in the plant system which might have resulted in increased plant height. These results are in conformity with Shekh *et al*. (2018). Higher leaf area index observed with sea weed extract might be attributed to the fact that auxins content in the seaweed extract have an effective role in cell division and enlargement. These findings are similar with those of Zidubule (2021). The higher dry matter was noticed with sea weed extract may be ascribed due to the presence of various growth regulators such as cytokinins, auxins, gibberellins, and betaines as well as macro-nutrients like Ca, K, P, and micro-nutrients like Fe, Cu, Zn, B, Mn, Co and Mo which in turn have increased the plant growth, resulting in higher dry matter production. These observations were similar to the findings of Shankar *et al.* (2020) and Bahekar *et al.* (2024).

Aerated panchagavya spray was known to produce bioactive substances secreted by beneficial microorganisms like *Pseudomonas*, *Azatobacter* and *Phosphobacteria*. These growth promoting secretions might have contributed to improved growth which in turn increase the dry matter production of groundnut. These results are in agreement with the findings of Anusha *et al.* (2018) and Chandra and Mehera (2022).

Pod and haulm yield as influenced by organic manures and organic foliar sprays

Biological yield (pod yield and haulm yield) was significantly influenced by organic manures and organic foliar nutrition and their interaction in groundnut during *rabi*, 2023-24.

Among the organic manures, soil application of 100 % RDN through Poultry manure resulted in higher pod and haulm yield of groundnut and in case organic foliar sprays, application of sea weed extract @ 1 % recorded higher pod and haulm yield. However, it was on par with aerated panchagavya @ 3%.

Table 2a. Pod yield (kg ha^{-1}) of groundnut as influenced by interaction between organic manures and organic foliar sprays

Main\Sub	S_1	S_2	S_3	S_4	Mean
M_1	1442	2395	2333	2031	2050
M_2	1980	3112	2925	2595	2653
M_3	2403	3800	3738	3213	3288
M_4	2027	3737	3627	2628	2628
Mean	1963	3261	3156	2616	
M at S			S at M		
SEm±		121.3	SEm±		119.6
CD (P = 0.05)		372	CD (P = 0.05)		349

Table 2b. Haulm yield (kg ha^{-1}) of groundnut as influenced by interaction between organic manures and organic foliar sprays

Main\Sub	S_1	S_2	S_3	S_4	Mean
M_1	1952	2877	2888	2542	2565
M_2	2386	3602	3403	3111	3125
M_3	2891	4335	4286	3719	3808
M_4	2511	4316	4170	3089	3521
Mean	2435	3738	3687	3115	
M at S			S at M		
SEm±		143.6	SEm±		141
CD (P = 0.05)		440	CD (P = 0.05)		413

Significantly higher pod yield was recorded with the application poultry manure might be due to adequate supply of nutrients through organic sources enhanced the biological nitrogen fixation which might facilitates better root proliferation and increased the pod yield. Poultry manure improves the number of pods per plant, pod yield in groundnut. Higher economical and biological yields in poultry manure might be due to ammonium-N (NH_4-N) is a significant part of total N in poultry manure, which additionally contains uric acid. Uric acid metabolizes rapidly to NH_4-N in most soils, and the net result of the high NH_4-N and uric acid contents in poultry waste is that a large percentage of N can be converted to nitrate-N (NO_3-N) within a few weeks. These results are in conformity with Nagaraj *et al.* (2018) and Pareek *et al.* (2024).

Among the organic foliar sprays, sea weed extract resulted in higher pod yield. The positive response of sea weed extract suggest the role of phyto-hormones and plant growth regulators like gibberellins, auxins and cytokinins. Yield increases in seaweed-treated plants are thought to be associated with the hormonal substances present in the extracts, especially cytokinins. Cytokinins in vegetative plant organs are associated with nutrient partitioning; whereas in reproductive organs, high levels of cytokinins may be linked with nutrient mobilization. Additionally, seaweed sap contains a lot of potassium and phosphorus. Within a few hours of the application when used as a foliar spray, it is immediately assimilated by crop leaves. The maximum improvement in economical and biological yield with aerated panchagavya spray might be associated with increased yield attributes due to concomitant increase in dry matter accumulation, chlorophyll content, nitrate reductase activity and supply of all the plant nutrients. The maximum improvement in economical and biological yield with aerated panchagavya spray might be associated with increased yield attributes due to concomitant increase in dry matter accumulation, chlorophyll content, nitrate reductase activity and supply of all the plant nutrients. Similar results were reported by Selvam and Sivakumar (2014), Choudhary *et al.* (2018) and Bahekar *et al.* (2024).

Significant and higher haulm yield was recorded with poultry manure. As poultry waste contains a high concentration of nutrients, addition of small quantity of it in an integrated nutrient management system could meet the shortage of FYM to some extent. The increment in supply of essential nutrients to plant and their availability, acquisition, mobilization and influx into the plant tissue increased and thus enhances yield components and finally the yield. Similar results were reported by Nagaraj *et al.* (2018), Reddy and Singh (2018) and Pareek *et al.* (2024).

Among the organic foliar sprays, sea weed extract recorded higher haulm yield, which was on par with aerated panchagavya. The easy transfer of nutrients to plant through foliar spray with aerated panchagavya, which contains several nutrients *viz*., macronutrients like nitrogen, phosphorus, potassium and micronutrients required for the growth and development of plants, various amino acids, vitamins and growth regulators like auxins, gibberellins might have influenced the necessary growth and development in plants which lead to higher pod yield and haulm yield. Mavarkar *et al.* (2016), Anusha *et al.* (2018) and Bahekar *et al.* (2024).

Interaction between the organic manures and organic foliar sprays was found to be significant. Soil application of 100 % RDN through poultry manure (M_3)

along with foliar spray of sea weed extract @ 1.0 % (S_2) and aerated panchagavya @ 3.0 % (S_3) registered significantly higher pod and haulm yield of groundnut. The lowest values were noticed with both the controls (M_1) (S_1).

In conclusion, soil application of 100% RDN through poultry manure along with foliar spray of sea weed extract @ 1 % at 20, 40 and 60 DAS resulted higher growth parameters *viz.,* plant height, leaf area index, dry matter production and pod and haulm yield in groundnut followed by soil application of 100% RDN through poultry manure along with foliar spray of aerated panchagavya @ 3 % at 20, 40 and 60 DAS.

LITERATURE CITED

agricoop.nic.in 2021-22.

Anusha, O., Reddy, G.K., Sumathi, V., Reddy, P.V and Reddy, A.P. 2018. Organic approach for sustained productivity of *rabi* groundnut (*Arachis hypogaea* L.). *Andhra Pradesh Journal of Agricultural Sciences.* 4(1): 56-61.

Bahekar, K., Singh, K and Dawson, J. 2024. Effect of sulphur and seaweed (*Kappaphycus alvarezii*) extract spray on growth and yield of groundnut. *International Journal of Plant & Soil Science*. 36(6): 183-187.

Chandra, C.S.B and Mehera, B. 2022. Effect of foliar application of liquid organic manures and sulphur on growth and yield of groundnut (*Arachis hypogaea* L.). *The Pharma Innovation Journal*. 11(5): 1737-1740.

Chaudhari, R and Bhanwaria, R. 2018. Influence of organic manures and iron on growth and yield of groundnut (*Arachis hypogaea* L.). *Trends in Biosciences*. 11(9): 1945-1949.

Chaudhari, R and Choudhary, R. 2022. Effect of integrated nitrogen management and foliar spray of iron on nutrient content and uptake of groundnut (*Arachis hypogaea* L.). *The Pharma Innovation Journal*. 11(2): 1091-1093.

Chaudhri, R., Choudhary, R and Choudhary, R.S. 2017. Impact of different sources of nutrients on growth and yield attributes of groundnut (*Arachis hypogaea* L.). *International Journal of Bio-resource and Stress Management*. 8(1): 047-050.

Choudhary, K.M., Man, M.K., Jat, R.D., Singh, L.K., Rolaniya, L.K., Devi, S and Kumar, A. 2018. Foliar application of panchagavya and leaf extracts of endemic plants on performance and quality of groundnut (*Arachis hypogaea* L.). *International Journal of Chemical studies*. 6(3): 2677-2682.

des.ap.gov.in, 2021-22.

FAOSTAT, 2021.

Mavarkar, N.S., Naik, T.B., Naik, K.P.S and Sharanappa, H.G. 2016. Effect of organic source of nutrients on groundnut (*Arachis hypogaea* L.) under southern transitional zone of Karnataka. *International Journal of Tropical Agriculture*. 34(3): 0254-8755.

Nagaraj, R., Hanumanthappa, M and Kamath, S. 2018. Effect of integrated nutrient management in groundnut on yield, nutrient uptake, availability of secondary nutrients and microbial activity in soil at coastal zone of Karnataka. *Journal of Pharmacognosy and Phytochemistry*. 7(5): 3028-3031.

Pareek, D., Debbarma, V., Kumar, R and Karnot, M.K. 2024. Response of nitrogen management on growth and yield of groundnut (*Arachis hypogea* L.). *Journal of Advances in Biology & Biotechnology*. 27(7): 257-263.

Rajagopal, K., Chandran, K., Mishra, J.B., Bhalodia, P.K and Mathur, R.S. 2000. Evaluation of bold seeded groundnut accessions for confectionary attributes. *International Arachis Newsletter*. 20: 18–20.

Reddy, G.N and Singh, R. 2018. Effect of integrated nitrogen management on the growth and yield of mustard (*Brassica juncea* L.). *Journal of Pharmacognosy and Phytochemistry*. 7(3): 617-619.

Selvam, G.G and Sivakumar, K. 2014. Influence of seaweed extract as an organic fertilizer on the growth and yield of (*Arachis hypogea* L.) and their elemental composition using SEM–Energy Dispersive Spectroscopic Analysis. *Asian Pacific Journal of Reproduction*. 3(1): 18-22.

Shankar, T., Malik, G.C., Banerjee, M and Ghosh, A. 2020. Influence of sea weed extracts on the growth, quality and productivity of sesame (*Sesamum indicum*) in the red and lateritic belt of West Bengal. *International Journal of Bioresource Science*. 7(1): 05-09.

Shekh, M.A., Mathukia, R.K., Sagarka, B.K and Chhodavadia, S.K. 2018. Evaluation of some cow-based bio-enhancers and botanicals for organic cultivation of summer groundnut. *International Journal of Economic Plants*. 5(1): 43-45.

Sridhar, N., Nongmaithem, D., Tzudir, L and Singh, A.P. 2020. Weed management in groundnut with diclosulam herbicide. *Indian Journal of Weed Science*. 53(3): 305-306.

Sujatha, K., Anand, R., Ragupathi, K.P and Ahamed, A.S. 2016. Effect of organic foliar nutrition on growth and yield attributes of kodo millet (*Paspalum scrobiculatum* L.). *American International Journal of Research in Formal, Applied & Natural Sciences.* 16(1): 23-27.

Zidubule, S. 2021. Use of biostimulants to assess the production of the underutilised legume, Bambara groundnut (Doctoral dissertation, Stellenbosch: Stellenbosch University).

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NUTRIENT UPTAKE, POST-HARVEST SOIL AVAILABLE NUTRIENT STATUS AND YIELD AS INFLUENCED BY VARIETIES AND PLANT GEOMETRIES OF REDGRAM

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ABSTRACT

A field experiment was conducted at wetland farm, S. V. Agricultural College, Tirupati, Acharya N.G. Ranga Agricultural University, Andhra Pradesh, India during *rabi* season of 2023-24 to study the seed yield, post harvest soil available nutrient status and nutrient uptake of ultra short duration redgram varieties under different plant geometries. The field experiment was laid out in a split pot design with three replications. The treatments consists of four varieties *viz.,* ICPV 21333, ICPV 21444, ICPV 21777 and ICPV 21888 as main plots and three plant geometries *viz.,* 30 cm × 10 cm, 45 cm × 10 cm and 60 cm × 10 cm as sub plots. ICPV 21333 recorded significantly higher seed yield and nutrient uptake where as, ICPV 21444 registered higher post harvest soil available nutrient status among the varieties tested. Plant geometry of 60 cm × 10 cm resulted in higher post harvest soil available nutrient status and 45 cm × 10 cm resulted in higher seed yield where as, plant geometry of 30 cm × 10 cm recorded higher nutrient uptake.

KEYWORDS: Nutrient uptake, Plant geometries, Redgram, seed yield and Ultra short duration varieties.

INTRODUCTION

Redgram (*Cajanus cajan L.*) also known as pigeonpea or arhar or tur is the second most important pulse crop after chickpea in India. It is a good source of protein (20-22 per cent), vitamins (thiamine, riboflavin, niacin and choline) and minerals such as iron, iodine, calcium, phosphorus, sulphur and potassium. In addition to its primary use as a dal, it's immature green seeds and pods are consumed as vegetable (Yadav *et al*., 2021). In India, redgram is cultivated in an area of 47.24 lakh hectares with a production of 43.16 lakh tonnes and a productivity of 914 kg ha^{-1}. Whereas, in Andhra Pradesh, it is grown under rainfed conditions in an area of 2.31 lakh hectares, with an annual production of 8.38 lakh tonnes and a productivity of 363 kg ha^{-1} during 2020-21 (*www.indiastat.com*, 2020-21). Under changing climate scenario, ultra short duration genotypes of redgram contribute to a greater harvest index. The advent of these ultra-short duration redgram varieties that matures in 100-110 days makes it possible to explore redgram cultivation during the off-season and non-traditional niches, with the goal of increasing the national pulse production pool. Ultra short duration varieties also display photo insensitivity, synchronous maturity, hardiness and adaptability to diverse cropping systems (Saxena *et al.,* 2019). However, there is a need to find out the suitable ultra-short duration redgram cultivar that fit in diverse cropping systems for enhanced productivity.

Choice of a suitable geometry for a particular genotype is one of the important factors among the different agronomic practices limiting the yield of redgram. Adaptation of proper planting geometry to a particular genotype will go a long way in making efficient use of limited growth resources and thus to stabilize yield. Ultra short duration varieties of redgram having determinate and indeterminate growth habits respond very well to crop geometry. Therefore, there is a need to identify the suitable crop geometry for ultra short duration redgram varieties for higher productivity.

MATERIAL AND METHODS

The present investigation was carried out at wetland farm, S.V. Agricultural College, Tirupati of Acharya N.G. Ranga Agricultural University which is geographically situated at 13.5°N latitude and 79.5°E longitude with 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 include four varieties *viz.*, ICPV 21333 (V_1), ICPV 21444 (V_2), ICPV 21777 (V_3) and ICPV 21888 (V_4) as main plots and three plant geometries *viz.,* 30 cm × 10 cm, 45 cm × 10 cm and 60 cm × 10 cm as sub plots. Recommended dose of fertilizers (20:50:0 kg N, P_2O_5 and K_2O ha^{-1}), were applied as basal in the form of urea and single super phosphate.

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The experimental field was sandy clay loam in texture with low organic carbon (0.46%). The soil is neutral in reaction (pH 7.8), low in available N (215.9 kg ha^{-1}), medium in available phosphorus (31.2 kg ha^{-1}) and potassium (243.1 kg ha^{-1}). A total rainfall of 378.6 mm was received in 15 rainy days during the crop growing period. All the other recommended practices were adopted as per the recommendations.

RESULTS AND DISCUSSION

Data pertaining to the yield, N, P and K uptake by redgram and post-harvest available soil nutrient status at harvest as influenced by varieties and plant geometries is discussed in different sections.

Effect of varieties on yield, N, P and K uptake and post-harvest soil available nutrient status of redgram

The highest seed yield of redgram was recorded in ICPV 21333 (V_1). The next best variety was ICPV 21888 (V_4) which was significantly superior to that of ICPV 21777 (V_3) (Table 1.). Significantly lower seed yield was recorded in ICPV 21444 (V_2) (Table 1.). The differences in yield among the varieties could be attributed to their genetic potential to utilize and translocate photosynthates from source to sink. The superiority of the redgram variety ICPV 21333 (V_1) in terms of growth, yield attributes *i.e.,* number of pod bearing branches plant^{-1}, number of pods plant^{-1} and number of seeds pod^{-1} have positively impacted on seed yield of redgram. Similar results were reported by Rajani *et al*. (2018), Deepika (2020), Shruthi (2020), Deva *et al*. (2021) Kumar *et al*. (2021) and Devi *et al.* (2022).

With regard to the varieties tested, significantly higher nutrient (nitrogen, phosphorus and potassium) uptake at harvest by redgram was recorded with the variety ICPV 21333 (V_1). This might be due to the elevated growth stature coupled with higher dry matter accumulation. Similar findings were reported by Devi

Table 1. Seed yield and nutrient uptake by redgram at harvest as influenced by varieties and plant geometries

Treatments	Seed yield (kg ha^{-1})	Nitrogen uptake (kg ha^{-1})	Phosphorus uptake (kg ha^{-1})	Potassium uptake (kg ha^{-1})
Main plots - Varieties (V)				
V1 : ICPV 21333	1079	85	20.0	79
V2 : ICPV 21444	760	61	14.4	56
V3 : ICPV 21777	853	68	16.0	63
V4 : ICPV 21888	969	74	17.6	69
SEm±	23.1	1.6	0.36	1.5
CD (P = 0.05)	80	6	1.3	5
Sub-plots - Plant Geometries (G)				
G1 : 30 cm × 10 cm	931	81	19.1	75
G2 : 45 cm × 10 cm	1031	73	17.3	68
G3 : 60 cm × 10 cm	784	62	14.7	58
SEm±	17.8	1.2	0.29	1.1
CD (P = 0.05)	53	4	0.9	3
Varieties (V) × Plant Geometries (G)				
G at V				
SEm±	35.6	2.31	0.57	2.15
CD (P = 0.05)	NS	NS	NS	NS
V at G				
SEm±	53.6	3.69	0.85	3.42
CD (P = 0.05)	NS	NS	NS	NS

Table 2. Post-harvest soil available N, P_2O_5 and K_2O as influenced by varieties and plant geometries in redgram

Treatments	Available N (kg ha^{-1})	Available P_2O_5 (kg ha^{-1})	Available K_2O (kg ha^{-1})
Main plots - Varieties (V)			
V1 : ICPV 21333	144	23.3	206
V2 : ICPV 21444	181	29.4	259
V3 : ICPV 21777	170	27.5	243
V4 : ICPV 21888	156	25.2	223
SEm±	3.0	0.49	4.2
CD (P = 0.05)	11	1.7	14
Sub-plots - Plant Geometries (G)			
G1 : 30 cm × 10 cm	151	24.5	216
G2 : 45 cm × 10 cm	161	26.0	230
G3 : 60 cm × 10 cm	176	28.6	252
SEm±	2.8	0.44	3.9
CD (P = 0.05)	8	1.3	12
Varieties (V) × Plant Geometries (G)			
G at V			
SEm±	5.49	0.89	7.78
CD (P = 0.05)	NS	NS	NS
V at G			
SEm±	7.60	1.23	10.61
CD (P = 0.05)	NS	NS	NS

(2022). The next best redgram variety was ICPV 21888 (V_4) which was significantly superior to that of ICPV 21777 (V_3) except for the nitrogen uptake where they were on par with each other. Significantly lower nutrient uptake by with ICPV 21444 (V_2).

Higher post-harvest soil available nitrogen, phosphorus and potassium were recorded with ICPV 21444 (V_2) followed by ICPV 21777 (V_3) and ICPV 21888 (V_4) in the order of descent with significant difference between each other except for the post harvest soil available nitrogen which was on par with that of ICPV 21777 (V_3). The variety ICPV 21333 (V_1) registered significantly lower soil available nitrogen, phosphorous and potassium. Higher growth parameters *viz.,* plant height, leaf area, maximum dry matter production and better root system with the redgram variety ICPV 21333 (V_1) might have led to better uptake of nutrients and increased nutrient use efficiency, which in turn reflected on lower soil nutrient status after harvest. These results are in conformity with that of Deva *et al*. (2021) and Devi (2022).

Efffect of plant geometries on yield, N, P and K uptake and post-harvest soil available nutrient status of redgram

Redgram with the plant geometry of 45 cm × 10 cm (G_2) resulted in significantly higher seed yield compared to 30 cm × 10 cm (G_1). Yield reduction at higher plant density is due to less number of pods plant^{-1} in the indeterminate plants (Reddy and Reddy, 2010). Higher seed yield with 45 cm × 10 cm (G_2) might be due to optimum plant population with better availability of growth resources to individual plants and their maximum utilization throughout the growth period compared to that of other plant geometries tried 30 cm × 10 cm (G_1) and 60 cm × 10 cm (G_3). This might have resulted in higher stature of yield attributes and hence the seed yield of redgram. These findings are in conformity with the observations of Abhishek *et al.* (2023), Ammaiyappan *et al.* (2021) and Sujathamma *et al*., (2022). Significantly lower seed yield of redgram was recorded with the plant geometry of 60 cm × 10 cm (G_3).

Among the plant geometries tested, 30 cm × 10 cm (G_1) resulted in significantly higher nutrient uptake. The next treatment was 45 cm × 10 cm (G_2) which was significantly superior to that of 60 cm × 10 cm (G_3). Higher nutrient uptake at 30 cm × 10 cm (G_1) geometry might be due to higher plant population unit area^{-1} coupled with removal of higher amount of nutrients from the soil. These results were in accordance with the findings of Sangeetha *et al*. (2011) and Venkanna *et al*. (2013). Higher post harvest soil available nitrogen, phosphorus and potassium were recorded with redgram at a plant geometry of 60 cm × 10 cm (G_3) which was significantly superior to the rest of the plant geometries tested. This might be due to maintenance of lesser plant population unit area^{-1} which have reduced the uptake of nutrients and increased the post harvest soil available nitrogen, phosphorus and potassium. The next best spacing that recorded higher post harvest soil nutrient status was 45 cm × 10 cm (G_2). Redgram with the plant geometry of 30 cm × 10 cm (G_1) recorded significantly lower post harvest soil available nitrogen, phosphorus and potassium. These results are in accordance with the findings of Prathibha (2017) and Dathamma (2023).

LITERATURE CITED

Abhishek, K., Kumar, A.N., Naseeruddin, R and Sandhyarani, P. 2023. Influence of high density planting on yield parameters of super early and mid early varieties of redgram (*Cajanus cajan* (L.) Millsp.). *Andhra Pradesh Journal of Agricultural Sciences.* 9(4): 267-270.

Ammaiyappan A., Paul, R.A.I., Veeramani, A. and Kannan, P. 2021. Effect of agronomic manipulations on morpho-physiological and biochemical responses of rainfed redgram [*Cajanus cajan* (L.) Millsp.]. *Legume Research*. DOI: 10.18805/LR-4650.

Dathamma, B.V. 2023. Optimization of sowing window and spacing for enhanced seed production in dhaincha (*Sesbania aculeata* L.). *M.Sc. (Ag.)* Thesis. Acharya N.G. Ranga Agricultural University, Guntur, Andhra Pradesh, India.

Deepika, G. 2020. Physiological evaluation of super early and mid early pigeonpea (*Cajanus cajan* (L.) Millsp.) genotypes for delayed *kharif* sowing. *M.Sc. (Ag.)*. *Thesis*. Acharya N.G. Ranga Agricultural University, Guntur, India.

Deva, S., Rao, V.C.H., Lakshmi, P.V and Rao, P.G.M.V. 2021. Short duration varieties of pigeonpea perform better under late sown conditions in rainfed areas. *Journal of Krishi Vigyan*. 9(2): 225-228.

Devi, M.U. 2022. Performance of super early varieties of redgram [*Cajanus cajan* (L.) Millsp.] under graded levels of nutrients. *M.Sc. (Ag.) Thesis*. Acharya N.G. Ranga Agricultural University, Guntur, Andhra Pradesh.

Devi, M.U., Naseeruddin, R., Nagamani, C and Reddy, Ch.B.R. 2022. Growth and yield of super early varieties of redgram [*Cajanus cajan* (L.) Millsp.] under different nutrient levels. *Andhra Pradesh Journal of Agricultural Sciences.* 8(1): 53-57.

Kumar, M.N., Ramya, V., Kumar, C.V.S., Raju, T., Kumar, N.M.S and Seshu, G. 2021. Identification of pigeonpea genotypes with wider adaptability to rainfed environments through AMMI and GGE biplot analysis. Indian Journal of Genetics. 81(1): 63-73.

Prathibha, S.K. 2017. Effect of sowing dates, spacing and topping on sunhemp (*Crotalaria juncea* L.) seed production. *M.Sc. (Ag.) Thesis*. Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharastra.

Ranjani, M.S., Vanniarajan, C., Kumar, C.V.S., Saxena, R.K., Sudhagar, R and Hingane, A.J. 2018. Genetic variability and association studies for yield and its attributes in super-early pigeonpea (*Cajanus cajan* (L.) Millsp.) genotypes. *Electronic Journal of Plant Breeding*. 9(2): 682-691.

ities during *rabi* season. *Journal of Research*, ANGRAU. 39(4): 57-58.

Sangeetha, R., Yakadri, M., Srinivasulu, M and Sairam, A. 2011. Seed yield of dhaincha (Sesbania aculeata) as influenced by sowing dates and plant densities during rabi season. Journal of Research, ANGRAU. 39(4): 57-58.

Saxena, K., Choudhary, A.K., Srivastava, R.K., Bohra, A., Saxena, R.K and Varshney, R.K. 2019. Origin of early maturing pigeonpea germplasm and its impact on adaptation and cropping systems. *Plant Breeding*. 138(3): 243-251.

Shruthi, H.B., Hingane, A.J., Reddi, M.S., Kumar, S.C.V., Prashanthi, L., Reddy, B.B.V., Sudhakar, P., Srivarsha, J., Bhosle, T.M., Kumar, A.V and Rathore, A. 2020. Genetic divergence for yield, physiological and quality traits in super-early pigeonpea (Cajanus cajan (L.) Millsp.). *International Journal of Current Microbiology and Applied Sciences.* 9(1): 2422-2433.

Sujathamma, P., Nedunchezhiyan, M and Naik, B.S.K. 2022. Response of super early varieties of pigeonpea to crop geometry under rainfed conditions. *Indian Journal of Agricultural Research*. DOI: 10. 18805/ IJARe.A-5978.

Reddy, T.Y and Reddy, G.H.S. 2010. Principles of Agronomy. (4th edition), Kalyani Publishers, Ludhiana, Punjab.

Venkanna, B., Joseph, B., Devi, K.S and Sankar, A.S. 2013. Influence of row spacing and phosphorus levels on seed production of dhaincha (*Sesbania aculeata* L.). *The Journal of Research ANGRAU.* 41(3): 124-128.

www.indiastat.com, 2020-21

Yadav, K., Shukla, D.K., Singh, V.K., Agrawal, A., Singh, R and Durgude, S.A. 2021. Effect of nutrients and genotypes on growth and yield of pigeonpea (*Cajanus cajan* (L.) Millsp). *Journal of Pharmacognosy and Phytochemistry*. 10(2): 753-756.

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EFFECT OF VIGOUR LEVELS ON SEED QUALITY ATTRIBUTES OF GROUNDNUT VARIETIES

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ABSTRACT

A laboratory experiment entitled was conducted at Laboratory department of Seed Science and Technology, S.V. Agricultural College, Tirupati campus of Acharya N.G. Ranga Agricultural University, Andhra Pradesh, India during *rabi,* 2023-24. Vigour tests were conducted for ten different groundnut varieties and the results showed that significant differences were observed among different varieties with respect to vigour tests. Among all the varieties Kadiri-6 has shown highest performance in the laboratory studies and considered more vigorous whereas Kadiri Amaravathi have shown less vigour.

KEYWORDS: Vigour tests, Vigorous, Seed quality attributes.

INTRODUCTION

Groundnut (*Arachis hypogaea L.*) is an important oilseed crop, belonging to the family Leguminosae. chromosome number (2n=40). This crop is widely cultivated and consumed in various tropical and subtropical countries around the world. One of its unique characteristics is that it is geotropically positive, meaning its seeds develop underground. Groundnut is believed to be the native of Brazil. China is the world's leading producer of groundnut, followed by India, the United States, and Argentina.

Globally, groundnut is grown in an area of 30.5 million hectares with a production and productivity of 54.2 million tonnes and 1776 kg ha^{-1}, respectively. In India, groundnut is grown in an area of 5.7 million hectares with a production and productivity of 10.1 million tonnes and 1777 kg ha^{-1}, respectively (FAO, 2024).

Before seeds are sown, effective screening of high-quality seeds for planting is crucial to improve the quality of crop yield. Since perfect conditions are rare, we need alternative methods to estimate how seeds will fare under less favourable circumstances. If seeds encounter harsh environmental conditions, their ability to function properly (physiological potential) can be severely weakened.

In simpler terms, seed health is determined by two main factors: germination success (how many seeds will sprout) and seedling strength (how well the sprouted seeds grow). These factors affect how well seeds perform, even under challenging conditions. Among many factors affecting the yield and quality of peanut seed vigor plays a crucial role. Germination potential of seed is associated with seedling vigour (Maurya *et al*. 2006). Vigorous seeds lead to better germination, faster emergence, and stronger seedlings, ultimately establishing a healthy and uniform crop stand. Germination tests are a valuable tool for initial assessment of seed quality. When field conditions are favourable (optimal temperature, moisture, etc.), germination test results tend to closely correlate with field emergence. However, when conditions are unfavourable, the test might overestimate actual emergence.

The present study was initiated to predict the field performance of groundnut (*Arachis hypogaea* L.) varieties through various vigour tests.

MATERIAL AND METHODS

The present experiment was conducted at laboratory department of Seed Science and Technology, S.V. Agricultural College, Tirupati. Popular groundnut varieties viz., Narayani, Dharani, Dheeraj, TCGS-1694 and Nithya Haritha released from RARS, Tirupati, Kadiri-9, Kadiri Amaravathi, Kadiri-6 and Kadiri-1812 from ARS, Kadiri and TAG-24 from BARC, Trombay were collected and multiplied the seed. The harvested seed was used for conducting different vigour tests for prediction of field performance like germination test, speed of germination, seedling vigour index-I, seedling vigour index-II, accelerated ageing test, electrical

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conductivity of seed leachates by adopting completely randomized design with four replications. Observations were recorded under laboratory conditions including gerimination percentage which was conducted by employing between paper method as prescribed by ISTA in a germinator maintained at 25 ± 2°C and the number of normal seedlings obtained was recorded on final count *i.e.,* 10^{th} day and expressed in percentage.

Number of normal seedlings emerged was counted every day till the end of the test period and was calculated using the formula suggested by Maguire (1962). The speed of emergence was calculated.

Speed of emergence = n1/d1+n2/d2+n3/d3+ ---

where, n is the number of emerged seedlings, d is the number of days.

Seed vigour index-I and seed vigour index-II were computed by adopting the following formula as suggested by Abdul-Baki and Anderson (1973) and was expressed in whole number.

Seed vigour index-I = Germination (%) x Mean seedling length (cm) Seed vigour index II = Germination (%) x Mean seedling dry weight (g)

Table 1. Effect of vigour levels on germination percentage, root length, shoot length, seedling length of groundnut varieties

Varieties	Germination percentage (%)	Root length (cm)	Shoot length (cm)	Seedling length (cm)
Narayani	72.10 (59.11)	15.37	11.38	26.74
Dharani	58.80 (51.07)	13.83	9.13	22.96
Dheeraj	69.85 (57.70)	15.16	10.50	25.66
Nithya Haritha	61.93 (52.90)	14.25	9.75	24.00
TCGS-1694	68.72 (57.00)	15.00	10.01	25.01
Kadiri-6	75.35 (61.23)	16.50	11.50	28.00
Kadiri-1812	71.14 (58.50)	15.25	10.63	25.88
Kadiri-9	53.20 (47.83)	13.50	8.80	22.30
Kadiri Amaravathi	44.27 (42.71)	12.25	8.00	20.25
Tag-24	66.92 (55.89)	14.74	9.87	24.61
Mean	64.23 (54.27)	14.59	9.96	24.54
S.Em. ±	3.57	0.65	0.27	0.66
C.D. (0.05)	10.33	1.90	0.79	1.92
C.V (%)	11.14	9.04	5.53	5.51

Figures in parenthesis indicates arcsine transformed values

The seeds were subjected to 42°C ±1°C temperature and 95 per cent relative humidity (RH) by keeping them in monolayer on a wire gauge / mesh for a period of four days (Delouche and Baskin, 1973). Accelerated aged seed samples were drawn after four days and subjected for germination test. Then germination percentage after accelerated ageing was recorded. Electrical conductivity test was conducted in four replications of five gram seeds which were weighed and the seeds were rinsed twice in distilled water and then soaked in 25ml of distilled water and incubated at 25 ± 1°C temperature for 24 hours (Presley, 1958). Electrical conductivity of seed leachate was measured in digital conductivity meter with a cell constant 1.0 and the mean values were expressed in µS cm^{-1}.

The following observations were recorded after performing vigour tests. Germination percentage, Root length, shoot length, seedling length, root dry weight, shoot dry weight, seedling dry weight, seedling vigour index-I, seedling vigour index-II, EC of seed leachates (µS cm^{-1}). At the time of germination count, ten normal seedlings were selected at random and used for measuring the root length, shoot length, seedling length of seedlings. The same seedlings were taken in the brown paper bags and kept in hot air oven at 70± 2^0C for 24 hr after cooling root and shoot were separated and root dry weight shoot dry and seedling dry weight was measured.

The mean data obtained from the experimentation was statistically analysed and subjected to the Analysis of variance by adopting appropriate statistical methods as outlined by Panse and Sukhatme (1985). The critical differences were calculated at five percent and one percent level of probability. The percentage data of germination and germination percentage after accelerated ageing were transformed into arc sine root transformation before analysis.

RESULTS AND DISCUSSION

In the present experiment, 10 different groundnut varieties were used to conduct laboratory based seed vigour tests. Based on the results obtained, significantly higher initial seed germination was recorded in Kadiri-6 (75.35%) followed by Narayani (72.10%) and the least value for germination was observed in Kadiri Amaravati (44.27%) followed by Kadiri-9 (53.20%) (Table 1). The results indicated that varieties showing higher germination on the first count day also showed higher final germination percentage. Similar observations were

Table 2. Effect of vigour levels on speed of germination, root dry weight, shoot dry weight, seedling dry weight of groundnut varieties

Varieties	Speed of germination	Root dry weight (g)	Shoot dry weight (g)	Seedling dry weight (g)
Narayani	9.50	0.063	0.254	0.317
Dharani	7.29	0.052	0.175	0.227
Dheeraj	8.94	0.062	0.248	0.310
Nithya Haritha	8.00	0.053	0.164	0.217
TCGS-1694	8.72	0.063	0.182	0.245
Kadiri-6	13.13	0.100	0.352	0.452
Kadiri-1812	9.20	0.058	0.245	0.303
Kadiri-9	6.30	0.053	0.142	0.195
Kadiri Amaravathi	3.56	0.052	0.142	0.194
Tag-24	8.44	0.054	0.181	0.235
Mean	8.31	0.061	0.209	0.270
S.Em. ±	0.63	0.003	0.01	0.011
C.D. (0.05)	1.82	0.009	0.029	0.031
C.V (%)	5.51	10.573	9.228	7.776

recorded in cotton (Shinde and Dadlani, 2012), pigeon pea (Kanakadurga *et al.,* 2012).

Maximum root length (cm) was recorded by Kadiri-6 (16.50 cm) followed by Narayani (15.37cm). Minimum root length was recorded by Kadiri Amaravathi (12.25cm) followed by Kadiri-9 (13.50cm) (Table 1.). Maximum shoot length (cm) was recorded by Kadiri-6 (11.50cm). followed by Narayani (11.38cm). Minimum shoot length was recorded by Kadiri Amaravthi (8.00cm) followed by Kadiri-9 (8.80cm) (Table 1**)**. The above results are in correlation with findings of Vanangamudi (1987). Seedling length was also highest for Kadiri-6 (28.00cm) and lowest seedling length was recorded in Kadiri Amaravathi (20.25cm) (Table 1.). Among different groundnut varieties Kadiri-6 showed the maximum root length, shoot length and seedling length.

Similarly, highest speed of germination was recorded by Kadiri-6 (13.13) followed by Narayani (9.50). Lowest speed of germination was recorded with Kadiri Amaravathi (3.56) followed by Kadiri-9 (6.30) (Table 2.). High speed of germination is noticed by varieties having higher germination percentage and vice-versa. Similar results were noticed by Rana and Biridarpatil (2019) that speed of emergence showed significant relationship with varied vigour levels of seed lots. Highest root dry weight was recorded in kadiri-6 (0.100g) and lowest in Kadiri Amaravathi and Dharani (0.052g) (Table 2.). Highest shoot dry weight was recorded by Kadiri-6 (0.352g) while, lowest shoot dry weight was recorded by Kadiri Amaravathi and Kadiri-9 (0.142g) (Table 2.), Seedling dry weight was recorded by Kadiri-6 (0.452g) followed by Narayani (0.317g). Lowest seedling dry weight was

Table 3. Effect of vigour levels on germination percentage after accelerated ageing, seedling vigour index-I, seedling vigour index-II, electrical conductivity of seed leachates of groundnut varieties

Varieties	Germination percentage after Accelerated ageing (%)	SVI-I	SVI-II	EC of seed leachates (µS cm^{-1})
Narayani	60.17 (51.86)	1928	22.86	143.75
Dharani	53.25 (47.86)	1350	13.35	302.25
Dheeraj	59.10 (51.24)	1792	21.65	145.00
Nithya Haritha	54.46 (48.56)	1486	13.44	177.00
TCGS-1694	58.47 (50.87)	1719	16.84	225.00
Kadiri-6	61.37 (52.57)	2110	34.06	95.00
Kadiri-1812	59.55 (51.50)	1841	21.56	151.00
Kadiri-9	51.83 (47.04)	1186	10.37	337.50
Kadiri Amaravathi	40.85 (44.19)	896	8.59	345.00
Tag-24	56.34 (49.64)	1647	15.73	185.00
Mean	55.53 (49.52)	1595.50	17.85	210.65
S.Em. ±	2.01	95.41	1.25	7.92
C.D. (0.05)	5.81	275.57	3.62	22.99
C.V (%)	7.17	11.96	13.72	7.42

Figures in parenthesis indicates arcsine transformed values recorded by Kadiri Amaravathi (0.194g) followed by Kadiri-9 (0.195g) (Table 2).

Kadiri-6 recorded highest seedling vigour index- I (2110) followed by Narayani (1928) Lowest seedling vigour index- I was recorded with Kadiri Amaravathi (896) and was least vigorous among the varieties followed by Kadiri-9 (1186) (Table 3.). The results of the study are in line with that of Manjunath (1993) who reported that high vigour seeds with higher initial germination had greater vigour index. Similar trend of response with respect to seedling vigour index-II was observed with highest value of Kadiri-6 (34.06) followed by Narayani (22.86). Lowest seedling vigour index- II was recorded with Kadiri Amaravathi (8.59) followed by Kadiri-9 (10.37) with 53.20 germination percent (Table.3.). Significantly higher germination percentage after accelerated ageing was recorded with Kadiri-6 (61.37%) with initial germination of 75.35% followed by Narayani (60.17%) which was having initial germination of 72.10%. Kadiri Amaravathi with initial germination of 44.27% followed by Kadiri-9 with initial germination of 53.20 % reduced to 40.85, 51.83 (%) respectively after accelerated ageing (Table 3.). Similar results were reported by Ravindar and vanga (1990), Narayanaswamy and Reddy (1996) where there is reduction in germination percent by accelerated ageing in all the cultivars. Electrical conductivity of different varieties ranged from 95.00(µS cm^{-1}) to 345.00(µS cm^{-1}).

Significantly higher electrical conductivity was recorded with Kadiri Amaravathi (345 µS cm^{1}) followed by Kadiri-9 (337.50µS cm^{-1}). Least value of electrical conductivity was observed for Kadiri-6 (95 µS cm^{-1}) followed by Narayani (143.75 µS cm^{-1}) were considered to be more vigorous (Table 3.).

In Conclusion, the present study revealed that seeds of groundnut varieties having high germination percentage, speed of germination, root length, shoot length, seedling length, root dry weight, shoot dry weight, seedling dry weight, seedling vigour index-I, seedling vigour index-II and low electrical conductivity were considered more vigorous. Kadiri-6 was found highly vigorous while Kadiri Amaravathi exhibited lower level of vigour.

LITERATURE CITED

Abdul-Baki, A.A and Anderson, J.D. 1973. Vigor determination in soybean seed by multiple criteria 1. *Crop science*. *13*(6): 630-633.

Delouche, J.C. and Baskin, C.C. 1973. Accelerated ageing techniques for predicting the relative storability of seed lots. *Seed Science and Technology*. 1: 427-452.

http://faostat.fao.org/.

Kanakadurga, K., Kesavulu, K., Jyothi, M., Ankaiah, R and Ganesh, M. 2012. Effect of accelerated ageing on germination and vigour in pigeonpea (*Cajanus cajan*). *Seed Research*. 40: 34-40.

Maguire, J.D. 1962. Speed of germination-aid in selection and evaluation for seedling emergence and vigor. 2: 176-77.

Manjunath, T. 1993. Effect of seed vigour levels on field performance and yield of TMV-2 groundnut (*Arachis hypogaea* L.). *M.Sc. (Agri.) Thesis. University of Agricultural Sciences, Bangalore*.

Maurya, C.l., Khan, A.A., Singh, P and Yadav, V. K.S. 2006. Studies of various vigour test and their correlation with field emergence in oat (*Avena sativa* L.). *Farm Science Journal*. 15(1): 73-74.

Narayanaswamy, S and Reddy, R.K. 1996. Accelerated ageing effect on seed quality of field bean (*Lablab purpureus* L. Sweet). *Seed Research*. 24(2): 163-165.

Nations. World Agricultural Production, Rome, Italy.

Panse, V.G and Sukhatme, P.V. 1985. Statistical Methods for Agricultural Workers. Indian Council of Agricultural Research. New Delhi. 150-157.

Presley, J.T. 1958. Relations of protoplast permeability to cotton seed viability and predisposition to seedling disease. *Plant Disease Reporter*. 42: 852.

Rana, S and Biradarpatil, N.K. 2019. Effect of vigour levels on growth parameters of groundnut (*Arachis hypogaea* L.). *International Journal of Chemical Studies*. *7*(3): 157-162.

Ravindar, V. 1990. Studies on the effect of accelerated ageing on germination, vigour and yield of sunflower (*Helianthus annuus* L**.**). *Phd Diss., Acharya N.G Ranga Agricultural University Rajendranagar, Hyderabad.*

Shinde, P.Y and Dadlani, M. 2012. Correlation between vigour tests and field emergence in cotton. *Seed research*. 40(2): 186-189.

Vanangamudi, K. 1987. Evaluation of seed vigour tests in bajra. *Madras Agricultural Journal*. 74(1): 18-20.

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WILD RELATIVES OF AGROFORESTRY SPECIES FOUND IN INDIA

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ABSTRACT

Agroforestry practices are traditional method for providing livelihood and sustainable management of resources. It is a management of trees and crops for light, water and nutrients in favour of farmer. Cultivation of indigenous trees with high-value products enhances profitability and provides economic security. Wild relatives of crops are genetic resources of desirable characters which may be utilized in the plant breeding for increase in productivity, disease resistance, management insect and pest, etc. In present study, 98 crops with their wild relatives of agroforestry species are enumerated. This may be utilized for plant breeding programmes.

KEYWORDS: Agroforestry, Wild relatives, Genetic resources, Plant breeding.

INTRODUCTION

Agroforestry involves cultivation of trees with agricultural crop and/or animal husbandry. Usually, woody perennials (tree, shrubs etc.) are grown in association with herbaceous plants (crops, pastures) or livestock in spatial arrangement. Basically, it keeps both ecological and economic benefits together. The land and time management options increase livelihood security and reduce vulnerability to climate and environmental change. It is a traditional method of resource management, pollen records suggested existence for at least 1300 years, the agroforestry systems may potentially provide options for improvement in livelihoods through simultaneous production of food, fodder and firewood as well as mitigation of the impact of climate change (Brookfield and Padoch, 1994; Lundgren, 1982). In agroforestry, productivity of cultivation increased due to the capture of more light and water. It will increase more if cash crop will be introduced in intercropping (Tokey, 1997). It also conserve soil on arable land because trees are soil binders especially when planted on terrace risers, terrace edges , field bunds as intercrops and as alley cropping in the shape of hedge row plantation (Singh, 1988). Agroforestry enhance water use efficiency through a combination of mulching and water conservation, trees in agro-ecosystems may directly enhance crop yields of coarse grains (Kumar et al. 1998). In the areas experience high wind or sand movement, the trees (i.e. *Acacia nilotica* and *Dalbergia sissoo*) are act as shelterbelts (Venkateshwaralu, 1993; Fanish and Priya, 2012).

Germplam is the basic material for crop improvement programme, it includes both cultivated and wild species and their relatives. The future of agriculture is dependent on agricultural biodiversity, however, bio-diversity are depleting at the global, regional and local levels. The plant genetic resources are the raw materials to improve the capacity of crops to respond to new pathogens, climate change and change in physiological conditions. Further, threat of climate change is severe on farming and creating unique and difficult challenges for agriculture. Therefore, it is necessary to secure wild relatives of crops and intensive plant breeding programme must be initiated to tackle food insecurity and environment protection. (Halewood *et al.,* 2018).

The enlisting of agro-forestry species and their wild relatives will offer new genes and allelic variability, as well as several other economic and environmental benefits that may be harnessed with their conservation and cultivation.

METHODOLOGY

The list of species used in agroforestry and their wild relatives has been compiled from the relevant literatures like, Inventory of cultivated plants species and their wild relatives in India (Singh et al., 2013), Wild relatives of Crop plants in India: collection and conservation (Pandey et al., 2005), Wild relatives of crop plants in India (Arora and Nayar, 1984). Scientific names of the species have been updated with help of online databases such as https://plants.usda.gov/, https://powo.science.

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Table 1. Agroforestry species and their wild relatives

S. No.	Scientific name	Family
1	*Acacia concinna* (Willd.) DC.	Fabaceae
2	*Acacia donaldii* Haines	Fabaceae
3	*Acacia eburnea* (L.f.) Willd.	Fabaceae
4	*Acacia farnesiana* (L.) Willd.	Fabaceae
5	*Acacia jacquemontii* Benth.	Fabaceae
6	*Acacia leucophloea* var. *leucophloea* (Roxb.) Willd.	Fabaceae
7	*Acacia mearnsii* De Wild.	Fabaceae
8	*Acacia nilotica* subsp. *indica* (Benth.) Brenan	Fabaceae
9	*Acacia senegal* (L.) Willd.	Fabaceae
10	*Acer acuminatum* Wall. ex D.Don	Sapindaceae
11	*Acer oblongum* Wall. ex DC.	Sapindaceae
12	*Acer sikkimense* var. *serrulatum* Pax	Sapindaceae
13	*Adansonia digitata* L.	Malvaceae
14	*Agathis robusta* (C.Moore ex F.Muell.) F.M.Bailey	Araucariaceae
15	*Ailanthus excelsa* Roxb.	Simaroubaceae
16	*Albizia chinensis* (Osb.) Merr.	Fabaceae
17	*Albizia kalkora* (Roxb.) Prain	Fabaceae
18	*Albizia lebbeck* (L.) Benth.	Fabaceae
19	*Albizia orissensis* Sahni & Bennet	Fabaceae
20	*Albizia procera* (Roxb.) Benth.	Fabaceae
21	*Albizia thompsonii* Brandis	Fabaceae
22	*Albizia thompsonii* var. *galbana* Haines	Fabaceae
23	*Alstonia venenata* R.Br.	Apocynaceae
24	*Anogeissus latifolia* (Roxb. ex DC.) Wall. ex Bedd.	Combretaceae
25	*Anogeissus pendula* Edgew.	Combretaceae
26	*Anogeissus sericea* var. *nummularia* King ex Duthie	Combretaceae
27	*Azadirachta indica* A. Juss.	Meliaceae
28	*Barringtonia acutangula* (L.) Gaertn.	Lecythidaceae
29	*Barringtonia racemosa* (L.) Spreng.	Lecythidaceae
30	*Bauhinia acuminata* L.	Fabaceae
31	*Bauhinia purpurea* L.	Fabaceae
32	*Bauhinia racemosa* Lam.	Fabaceae
33	*Bauhinia tomentosa* L.	Fabaceae
34	*Bauhinia vahlii* Wight & Arn.	Fabaceae
35	*Bauhinia variegata* L.	Fabaceae
36	*Betula utilis* D. Don	Betulaceae
37	*Bridelia retusa* A. Juss.	Phyllanthaceae
38	*Bridelia stipularis* Blume	Phyllanthaceae
39	*Butea monosperma* (Lam.) Taub.	Fabaceae
40	*Caesalpinia pulcherrima* (L.)Swartz	Fabaceae
41	*Caesalpinia crista* L.	Fabaceae
42	*Caesalpinia decapetala* (Roth) Alston	Fabaceae
43	*Caesalpinia sappan* L.	Fabaceae
44	*Callicarpa macrophylla* Vahl.	Lamiaceae
45	*Cassia fistula* L.	Fabaceae
46	*Casuarina equisetifolia* L.	Casuarinaceae
47	*Cedrus deodara* (Roxb. ex Lamb.) G.Don	Meliaceae
48	*Cordia obliqua* Willd.	Boraginaceae
49	*Dalbergia lanceolaria* L.f. subsp. *paniculata* (Roxb.) Thoth.	Fabaceae

Cont...

Table 1. Cont...

S. No.	Scientific name	Family
50	*Dalbergia latifolia* Roxb.	Fabaceae
51	*Dalbergia sissoo* Roxb. ex DC.	Fabaceae
52	*Dalbergia wattii* C.B.Clarke	Fabaceae
53	*Delonix elata* (L.) Gamble	Fabaceae
54	*Delonix regia* (Bojer ex Hook.) Raf.	Fabaceae
55	*Dendrocalamus giganteus* Clump.	Poaceae
56	*Erythrina variegata* L.	Fabaceae
57	*Eucalyptus citriodora* Hook.	Myrtaceae
58	*Eucalyptus globulus* Labill	Myrtaceae
59	*Falcataria moluccana* (Miq.) Barneby & J W Grimes	Fabaceae
60	*Garcinia andamanica* King var. *andamanica*	Clusiaceae
61	*Garcinia mangostana* L.	Clusiaceae
62	*Hardwickia binata* Roxb	Fabaceae
63	*Hibiscus cannabinus* L.	Malvaceae
64	*Hopea glabra* Wt and Arn.	Dipterocarpaceae
65	*Hopea parviflora* Bedd.	Dipterocarpaceae
66	*Hopea shingkeng* (Dunn) Bor	Dipterocarpaceae
67	*Hopea wightiana* Wall.	Dipterocarpaceae
68	*Jacaranda acutifolia* Humb. & Bonpl.	Bignoniaceae
69	*Litsea lancifolia* Roxb. var. *alternifolia* Meissn	Lauraceae
70	*Madhuca diplostemon* (C.B. Clarke) van Royen	Sapotaceae
71	*Mesua ferrea* L.	Calophyllaceae
72	*Olea dioica* Roxb.	Oleaceae
73	*Olea ferruginea* Royle	Oleaceae
74	*Olea gamblei* C. B. Clarke	Oleaceae
75	*Olea glandulifera* Wall. ex G. Don	Oleaceae
76	*Pinus kesiya* Royle ex Gordon	Pinaceae
77	*Pinus roxburghii* Sarg.	Pinaceae
78	*Pinus sylvestris* L.	Pinaceae
79	*Pithecellobium dulce* (Roxb.) Benth.	Fabaceae
80	*Polyalthia fragrans* (Dalz.) Bedd	Annonaceae
81	*Pongamia pinnata* (L.) Pierre	Fabaceae
82	*Prosopis juliflora* (Sw.) DC.	Fabaceae
83	*Putranjiva roxburghii* Wall.	Putranjivaceae
84	*Salix radinostachya* Schneider	Salicaceae
85	*Salix stomatophora* Floderus	Salicaceae
86	*Salix wallichiana* Anderss.	Salicaceae
87	*Salvadora oleoides* Decae	Salvadoraceae
88	*Salvadora persica* L.	Salvadoraceae
89	*Sapindus trifoliatus* L.	Sapindaceae
90	*Senna montana* (Roth) V.Singh	Fabaceae
91	*Sesbania bispinosa* (Jacq.) W. Wight	Fabaceae
92	*Sesbania cannabina* (Retz.) Pers.	Fabaceae
93	*Sesbania concolor* Gillett	Fabaceae
94	*Sesbania sesban* (L.) Merr.	Fabaceae
95	*Tecomella undulata* (Sm.) Seem.	Bignoniaceae
96	*Tectona grandis* L.	Lamiaceae
97	*Terminalia alata* Herb. Madr. ex Wall	Combretaceae
98	*Ulmus wallichiana* Planch.	Ulmaceae

kew.org/ and http://www.tropicos.org/. The families of respective species are according to the APG IV system of classification.

RESULTS AND DISCUSSION

A total 98 taxon has been documented in the present study, it includes 90 species, 2 subsp. and 6 varieties (table 1). The family Fabaceae is represented by 45 taxon, followed by Combretaceae, Dipterocarpaceae, Oleaceae, Sapindaceae (4 taxon each), Pinaceae, Salicaceae (3 taxon each), Bignoniaceae, Clusiaceae, Lamiaceae, Lecythidaceae, Malvaceae, Meliaceae, Myrtaceae, Phyllanthaceae, Salvadoraceae (2 taxon each), Annonaceae, Apocynaceae, Araucariaceae, Betulaceae,

Boraginaceae, Calophyllaceae, Casuarinaceae, Lauraceae, Poaceae, Putranjivaceae, Sapotaceae, Simaroubaceae and Ulmaceae (1 taxon each) (Fig. 1).

The agroforestry trees valuable resources for timber, fuel, nitrogen fixation (legumes), fruits, etc. however, some of species like *Ailanthus excels, Alstonia venenata, Azadirachta indica, Betua utilis, Callicarpa macrophylla* and *Erythrina variegata* are medicinally important whereas, *Acacia nilotica* subsp. *Indica*, *Albizia chinensis*, *Albizia procera, Sesbania bispinosa, Sesbania cannabina* and *Sesbania sesban* have very high fodder value.

LITERATURE CITED

Arora, R.K and Nayar, E.R. 1984. Wild relatives of crop plants in India. Wild relatives of crop plants in India.

Brookfield, H and Padoch, C. 1994. Agrodiversity. Environment. 36(5): 7-11, 37-45

Fanish, S.A and Priya, R.S. 2012. Review on benefits of agro forestry system. *International Journal of Education and Research.* 1: 80-91.

Halewood, M., Chiurugwi, T., Sackville Hamilton, R., Kurtz, B., Marden, E., Welch, E., Michiels, F., Mozafari, J., Sabran, M., Patron, N and Kersey, P. 2018. Plant genetic resources for food and agriculture: opportunities and challenges emerging from the science and information technology revolution. *New Phytologist*. 217(4): 1407-1419.

Lundgren, B .1982. Introduction (editorial). *Agroforestry Systems.* 1: 1-12.

Pandey, A., D. Bhandari, K. Bhatt, S. Pareek, A. Tomer and B. Dhillon. 2005. Wild relatives of Crop plants in India: collection and conservation. *National Bureau of Plant Genetic Resources*: New Delhi, India.

Singh, A. 1988. Hydrological behaviour of experimental watersheds. Annual Report, ICARRC for NEH Region, Barapani, Meghalaya, 169-171.

Singh, A.K., R.S. Rana, B. Mal, B. Singh and R.C. Agrawal. 2013. Inventory of cultivated plants species and their wild relatives in India. Protection of Plant Varieties and Farmers' Right Authority (PPV & FRA), Ministry of Agriculture, Government of India, New Delhi.

Toky, O.P. 1997. Poplar an economy booster and eco-friendly agroforestry tree. Agroforestry News Letter, NRC for Agroforestry 9: 2-3.

Venkateswarlu, J. 1993. Problems and prospects in desertification control: Role of Central Arid Zone Research Institute. In: Desertification and its Control in the Thar, Sahara and Sahel Regions (Sen, A.K. and Kar, A. Eds.). pp. 249-267. Jodhpur, India: Scientific Publishers.

Research Note

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SURVEY FOR THE OCCURRENCE OF YELLOW MOSAIC DISEASE IN MAJOR PIGEON PEA GROWING AREAS IN ANDHRA PRADESH

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ABSTRACT

The reasons for sudden outbreak of yellow mosaic disease of pigeon pea in isolated patches in Andhra Pradesh during Kharif 2021 was not known. It may be due to association of more than one begomovirus with YMD of pigeon pea or variations in virus or climatic factors or vector biotypes in symptomatology was not known. Roving survey of yellow mosaic disease in pigeon pea was conducted from major growing districts of Andhra Pradesh during December-2022 to January -2023. The symptomology of yellow mosaic disease in redgram was characterized by small yellow diffused spots on the leaves which gradually enlarged to form broad yellow patches. The percent disease incidence ranged from 2-23%. The overall incidence of YMD of Pigeon pea was very low though enough population of whiteflies were observed in the fields and source of inoculums was present on weeds and other pulses grown where the incidence goes upto 100%. Understanding the severity of a disease is crucial for advancing research and gaining valuable insights for further studies..

KEYWORDS: Yellow mosaic disease, begomovirus, survey, percent disease incidence.

INTRODUCTION

The Pigeon pea (*Cajanus cajan*) is a perennial legume from the Fabaceae family. It is significant drought resistant leguminous food crop, used both for dhal and also for vegetable purpose (Manjunatha *et al*. 2015). India is the leading country in both redgram production and consumption. Redgram is a staple meal that is high in protein. It has a protein content of roughly 22%, which is nearly three times that of grains. Redgram is ingested as split pulse known as dal, which is a crucial addition to a diet rich in grains (Khairnar *et al*. 2019). Red gram covers up around 11.8% of the nation's total pulse area and 17% of its overall pulse production.

India is the world's major producer of redgram, with 42.8 lakh tonnes grown on 48.24 lakh hectares in 2020–21 with the yield of 887 kg/hectare on average. Redgram was grown on 2.31 lakh hectares in Andhra Pradesh, yielding 0.83 lakh tonnes (ANGRAU Crop outlook report of Andhra Pradesh 2021). The productivity of pigeon pea can be impacted by different diseases including wilt, pigeon pea sterility mosaic disease, stem blight, stem rot, etc.

Williams *et al*. (1968) provided the first report of the yellow mosaic disease of pigeon pea's occurrence. Later Nene *et al*. (1971) reported based on white fly (*Bemisia tabaci*) transmission and symptomatology, the mung bean yellow mosaic virus (MYMV) was responsible for the yellow mosaic of pigeon pea. Raj *et al*., (2005) reported Tomato leaf curl virus with YMD of red gram from Lucknow. Manjunatha *et al*. (2015) reported association of Horsegram YMV (HgYMV) with pigeon pea YMD in Karnataka based on full length sequence. Severe incidence in isolated patches exhibiting typical bright yellow mosaic symptoms with stunting was observed in redgram fields located at KVK farm, Anantapur. The total DNA was isolated from infected plants, PCR amplified, cloned and sequencing revealed the association of HgYMV with redgram YMD in Andhra Pradesh (Chaitanya *et al.* 2021). YMD is a severe disease in summer and late rabi seasons that affect pulse crops caused by whitefly transmitted begomoviruses belonging to the Geminiviridae family. Recently new species of begomovirus named as *Cajanus scarabaeoides* YMV (CsYMV) was reported with wild relative of pigeonpea (*C.scarabaeoides*) from Chhattisgarh state (Dokka et al., 2023).

The majority of begomoviruses are icosa-hedral twin virion particles with a bipartite genome made up of circular, covalently closed single strand DNA molecules (DNA-A and DNA-B) that are each typically 2.6–2.8kb (Harrison *et al.* 1977). Symptoms consisting of yellow mosaic, mottling, shortening of leaves and stunting occur in most pigeon pea growing areas at a low incidence.

These begomoviruses have a bipartite genome and contain two single stranded covalently closed circular DNA as their genetic material. These are named as DNA-A and DNA-B, each of approximately 2.7Kb in

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size. DNA-A encodes six open reading frames (ORFs), AC1(Replication protein), AC2(Transcriptional activator protein), AC3 (Replication enhancer Protein), AC4(May determine Symptom expression) and AV1(Coat Protein), AV2(Pre coat protein) involved in replication, transcription and packaging, whereas DNA-B encodes two protein ORFs, BC1(movement protein) and BV1(nuclear shuttle protein) involved in viral movement.

Recently high incidence of yellow mosaic and severe stunting of Pigeon pea plants were observed at KVK farm, Reddipalli and other places in Anantapur district during Kharif-2021.The reasons for sudden outbreak of yellow mosaic disease of Pigeon pea in isolated patches in Anantapur district of Andhra Pradesh during Kharif 2021 was not known.

MATERIAL AND METHODS

Roving survey was conducted to record the incidence of yellow mosaic disease in major pigeon pea growing areas of Andhra Pradesh during December-2022 to January -2023. The districts covered under this study are Anantapur, Kadapa, Guntur and Prakasam from Andhra Pradesh.

I. Symptoms

In order to study the symptoms of the disease, healthy plants and yellow mosaic disease infected plants of Pigeon pea are compared during roving survey from different locations. The symptoms exhibited by the diseased plants.

II. Per cent disease incidence (PDI)

The incidence of the disease was recorded during the survey on naturally infected plants by using following equation as suggested by Wheeler (1969). The zigzag pattern is followed to collect required data in which randomly selected plants were evaluated at each location.

Table 1. Survey details of yellow mosaic disease of pigeon pea in Andhra Pradesh

District	Village	Mandal	Total Number of plants	Number of Infected plants	Percentage of disease incidence
Anantapur	Kadiri	Kadiri	74	12	16
	Motukupalli	Kadiri	43	4	9
	Nallamada	Nallamada	61	5	8
	Kurumala	Nallamada	72	8	11
	Malakavaripalli	Obuladevarecheruvu	97	11	11
Kadapa	Thollaganganapalle	Vallur	78	15	19
	Nallaguttapalle	Ramapuram	41	9	21
	Chitluru	Ramapuram	86	11	12
	Kothagaripalle	Pendlimarri	55	13	23
	Rachapalle	Ramapuram	84	6	7
	Jammalpalle	Chinthakomma dinne	64	6	9
	Ganganapalle	Pendlimarri	89	13	14
Prakasam	Unaguravaya palem	Buchannaplem	51	3	5
	Annavaram	Podili	63	4	6
Guntur	Chandavanam	Nadendla	68	2	2
	Narasaropeta	Narasaraopet	89	3	3
	Satuluru	Nadendla	57	2	3
	Narnepadu	Muppalla	48	4	8

$$PDI = \frac{\text{Total number of plants infected}}{\text{Total number of plants observed}} \times 100$$

RESULTS AND DISCUSSION

i. Symptomotology

The typical symptoms of YMD observed are mottle mosaic which are small, irregular greenish yellow patches intermixed with green patches. Due to severe infection, there is a stunted in plant growth and reduction in leaf size and internodal length (Fig. 1).

ii. Incidence of yellow mosaic disease

The disease incidence recorded in four districts of Andhra Pradesh is presented in Table 1. The disease incidence in five mandals in Anantapur district ranged from 8-16%, 7-23 % in seven mandals of YSR Kadapa district, 5-6% in two mandals of Prakasam district and 2-8% in four mandals of Guntur district of Andhra Pradesh. The overall incidence of YMD of pigeon pea was very low as compared to YMV on other pulses like urdbean and mungbean where the incidence goes upto 100%. Though enough population of whiteflies were observed in the fields and source of inoculums was present on weeds and other pulses grown at RARS, Tirupati and elsewhere, still the incidence of disease on pigeon pea was very low. It is worth to study the factors like weather, vector, seasons, genotype characters etc., that are responsible for low incidence in several districts surveyed in Andhra Pradesh. Dokka *et al.* (2023) observed upto 46% disease incidence in *Cajanus scaraaeboides*- a wild relative of pigeon pea present on bunds of urdbean, munbean and pigeonpea fields in 22 districts of Chattisgarh state during survey carried out from 2017 to 2019.

Based on the above data, it was found that several pigeon pea fields, the plants displayed moderate to low level of incidence showing yellow mosaic symptoms across the fields during survey. The range of disease incidence is observed upto 2-23% in different locations of Andhra Pradesh. The overall incidence of YMD of Pigeon pea was very low as compared to YMV on other pulses like urdbean and mungbean where the incidence goes upto 100%. Though enough population of whiteflies were observed in the fields and source of inoculums was present on weeds and other pulses grown.

Fig. 1. Typical symptoms of pigeon pea yellow mosaic disease

Fig. 2. Healthy plant

Because of this reason, further investigation is need to study the factors like weather, vector, seasons, genotype characters etc., that are responsible for low incidence in several districts surveyed in Andhra Pradesh.

LITERATURE CITED

Acharya N.G. Ranga Agricultural University Crop Outlook Reports of Andhra Pradesh REDGRAM (January to December 2021).

Chaithanya, B.H., Reddy, B.B., Prasanthi, L and Devi, R.S.J. 2021. Molecular characterization of virus species causing yellow mosaic disease of redgram in Andhra Pradesh. *Ecology, Environment and Conservation.* 28(5): 300-305.

Dokka N, Marathe A, Sahu B, Kaushal P, Ghosh PK, Sivalingam PN. 2023. *Cajanus Scarabaeoides* Yellow Mosaic Virus, a New Bipartite Begomovirus Causing Yellow Mosaic Disease in *Cajanus scarabaeoides* in India. *Plant Disease.* 107(10):2924-2928.

Harrison, B.D., Barker, H., Bock, K.R., Guthrie, E.J., Meredith, G and Atkinson, M. 1977. Plant viruses with circular single-stranded DNA. *Nature*. *270*(5639):760-762.

Khairnar, K.Y., Pokharkar, V.G., Yadav, D.B and Kadam, S.A. 2019. Economic impact of red gram production technology on farm productivity and income in western Maharashtra. *Journal of Pharmacognosy and Phytochemistry*. 8(3):3005-3009.

Manjunatha, N., Noorulla, H., Anjaneya, R., Archana, S and Manjunath, S.H. 2015. Molecular Detection and Characterization of Virus Causing Yellow Mosaic Disease of Redgram [*Cajanus cajan* (L.) Millsp] in Karnataka. *International Journal of Pure and Applied Bioscience*. 3(4):258-264.

Nene, Y.L., Naresh, J.S and Nair, N.G. 1971. Additional hosts of mung bean yellow mosaic virus. *Indian phytopathology.* 24:415-417.

Raj, S.K., Khan, M.S and Singh, R. 2005. Natural occurrence of a begomovirus on pigeonpea in India. *Plant Pathology*. 54(6):809.

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

Williams, F.J., Grewal, J.S and Amin, K.S. 1968. Serious and new diseases of pulse crops in India in 1966. *Plant Disease Reporter*. 52(4):300-304.

Research Note

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CONSUMER PERCEPTION TOWARDS VALUE ADDED NUTRI-CEREAL PRODUCTS IN HYDERABAD CITY

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ABSTRACT

The study, "Consumer Perception Towards Value-added Nutri-cereal Products in Hyderabad City," explored how consumers in Hyderabad perceive these products and the factors influencing their perceptions. Conducted with a purposive approach, the research utilized a sample of 124 consumers, primarily aged 26-40, with a majority holding a graduation degree and working in the private sector. Data was collected through personal interviews and analyzed using statistical techniques such as percentage analysis, Likert scale analysis, and factor analysis. The findings indicated that consumers highly valued nutritional attributes, *viz.,* "Rich in vitamin content" and "High in protein" being most positively perceived, while "Lower fat" was less favored. Special attributes like "Nutritional value" and "Packaging" were prioritized, and "Convenience" was the top benefit in diet and lifestyle. The perception of value for money was predominantly "Good." The study identified that "preservation and time saving" were key factors influencing purchase motives, with other significant factors including "augmentation," "convenience," and "influential factors." Overall, consumers prioritize nutritional value, convenience, and packaging in their perception of value-added nutri-cereal products..

KEYWORDS: Nutri-cereal products, Consumer, Perception, Factors.

INTRODUCTION

Nutri-cereals, are recognized by the Food Safety and Standards Authority of India (FSSAI) and include major crops like sorghum and pearl millet, along with minor crops such as foxtail and little millet. Despite their historical significance, these grains have been over shadowed by staple crops like wheat and rice in Indian cuisine. India and China are the leading millet producers, but millets role in the diet has diminished due to the popularity of wheat and rice, which are restricted to specific climatic zones. Millets, designated as "Nutri-cereals" by the Indian government in 2018, offer excellent nutritional benefits including fiber, minerals, and vitamins. They are adaptable to diverse climates and require minimal irrigation, thriving in dry and hilly regions. The Indian government has declared 2023 the International Year of Millets to boost global awareness and adoption of these grains. In 2022, the packaged food market for nutri-cereals in India was valued at US$ 37.7 million, with a projected Compound Annual Growth Rate (CAGR) of 9.2 per cent from 2022 to 2032. Despite their potential, research on millets has been limited, and the value chain has been restricted to basic processing. However, recent efforts to revitalize millet cultivation and processing are underway, with increasing recognition in the processed food industry. The market faces challenges, including limited consumer awareness and misconceptions about high costs. Addressing these through effective promotional campaigns and pricing strategies presents opportunities for new market entrants. With India's growing population and nutritional needs, millets could enhance food security and farmer incomes, supported by government initiatives to promote these ancient grains.

METHODOLOGY

The study was conducted purposively in Hyderabad because it is one of the metropolitan cities in South India and also the city is undergoing rapid and dynamic changes due to urbanization. This area is particularly selected in order to understand consumer perception, factors influencing perception, and market entry opportunities for value-added nutri-cereal products. A total number of 124 customers were interviewed and data was collected. Primary data regarding consumer perception and factors influencing perception towards value-added nutri-cereal products were collected by personally interviewing the respondents using a structured schedule. The data collected were subjected to the appropriate set of statistical analysis using SPSS program, mean, percentages and Likert scale. The total

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Table 1. Consumer perception towards value added Nutri-cereal products (Health benefits)

S. No.	Particulars	Strongly agree		Agree		Neutral		Disagree		Strongly disagree		Total score	Mean	Rank
		NR	S	NR	S	NR	S	NR	S	NR	S			
1	Improved health	19	95	48	192	22	66	18	36	17	17	406	3.27	3
2	Weight management	32	160	31	124	45	135	11	22	5	5	446	3.59	1
3	Improved digestion	27	135	16	64	27	81	53	106	7	7	393	3.16	4
4	Energy booster	9	45	44	176	34	102	23	46	14	14	383	3.08	5
5	Better immunity	25	125	55	220	17	51	16	32	11	11	439	3.54	2

NR: No. of Respondents ; S: Score

Table 2. Consumers perception towards value-added Nutri-cereal products (Nutritional Benefits)

S. No.	Particulars	Strongly agree		Agree		Neutral		Disagree		Strongly disagree		Total score	Mean	Rank
		NR	S	NR	S	NR	S	NR	S	NR	S			
1	Lower fat	29	145	59	236	17	51	13	26	6	6	464	3.74	3
2	High in protein	47	235	38	152	25	75	8	16	6	6	484	3.90	2
3	Rice in vitamin content	7	35	20	80	55	165	34	68	8	8	356	2.87	4
4	High in fibre	64	320	33	132	9	27	12	24	6	6	509	4.10	1

NR: No. of Respondents ; S: Score

Table 3. Consumer perception towards value-added Nutri-cereal products (Special attributes)

S. No.	Particulars	Strongly agree		Agree		Neutral		Disagree		Strongly disagree		Total score	Mean	Rank
		NR	S	NR	S	NR	S	NR	S	NR	S			
1	Nutritional value	57	285	41	164	11	33	8	16	7	7	505	4.07	1
2	Freshness	23	115	30	120	51	153	11	22	9	9	419	3.38	4
3	Taste and Flavour	24	120	65	260	17	51	9	18	9	9	458	3.69	3
4	Packaging	55	275	34	136	21	63	8	16	6	6	496	4.00	2

NR: No. of Respondents ; S: Score

Table 4. Consumer perception towards value-added Nutri-cereal products (Diet and Lifestyle)

S. No.	Particulars	Strongly agree		Agree		Neutral		Disagree		Strongly disagree		Total score	Mean	Rank
		NR	S	NR	S	NR	S	NR	S	NR	S			
1	Health supplement	29	145	55	220	17	51	14	28	9	9	453	3.65	3
2	Convenience	58	290	30	120	19	57	9	18	8	8	493	3.98	1
3	Dietary diversity	48	240	36	144	19	57	13	26	8	8	475	3.83	2
4	Staple food	12	60	21	84	49	147	33	66	9	9	366	2.95	4

NR: No. of Respondents ; S: Score

score is calculated by assigning points to responses as follows: "Strongly Agree" is given 5 points, "Agree" is given 4 points, "Neutral" is given 3 points, "Disagree" is given 2 points, and "Strongly Disagree" is given 1 point. The mean score is then calculated by dividing the total score by the total number of respondents. This approach provided a detailed and nuanced understanding of the dataset.

RESULTS AND DISCUSSION

I. Consumer perception towards value added nutri-cereal products

The data presented in the Table 1 revealed that weight management is the most positively perceived benefit, with the highest mean score of 3.92, followed by better immunity with a mean score of 3.45. Improved health ranks third with a mean score of 3.13. Improved digestion is less favored, with a mean score of 2.98, and energy booster is perceived least favorably, with a mean score of 2.88. These rankings highlight that while weight management and immunity are top priorities, other benefits like digestion and energy boosting are less influential in consumer perception. Similar results were reported by Raju and Rukmani (2012).

The data presented in the Table 2 revealed that rich in vitamin content is the most positively perceived attribute, ranking first with a mean score of 4.10. High in protein follows closely, ranking second with a mean score of 3.90. High in fiber also scores well, with a mean of 3.74, securing the third position. Lower fat content is perceived less favorably, ranking fourth with a mean score of 2.87. These results indicate that consumers prioritize vitamin and protein content in value-added nutri- cereal products, with fiber being important but lower fat content being less of a concern.

The data presented in the Table 3 revealed that nutritional value is the top-rated attribute, with the highest mean score of 4.07, followed by packaging with a mean score of 4.00. Taste and flavor rank third with a mean of 3.69, indicating positive consumer perception. Freshness is perceived moderately, ranking fourth with a mean score of 3.38. These findings suggest that while consumers highly value the nutritional content and packaging of nutri-cereal products, taste and freshness are also important but slightly less prioritized. Similar results were reported by Barratry and Rajapushpam (2018) and Kapoor *et al.*(2023).

The data presented in the Table 4 revealed that convenience is the most positively perceived benefit, ranking first with a mean score of 3.98. Dietary diversity follows closely in second place with a mean score of 3.83. The health supplement attribute is also positively perceived, ranking third with a mean score of 3.65. However, staple food is viewed less favorably, ranking fourth with a mean score of 2.95. These findings highlight that consumers value convenience and dietary diversity in nutri-cereal products, with less emphasis placed on their role as a staple food.

II. Factors influencing the consumer perception towards value added nutri-cereal products

The data presented in Table 5 revealed that the highest mean score (3.15) was obtained for preservation and time-saving factors like they remain fresh for longer periods of time, longer shelf life, saving time in meal preparation, followed by augmentation factors (3.01) like for their consistent and reliable flavour, taste of dishes, texture of the dishes, influential factors (2.96) like they are promoted in favourite cooking shows telecasted on TV shows, attracted to the display of products by retailers,

Table 5. Factors influencing the perception of sample consumers

S. No.	Factors	Mean score	Rank
1	Preservation and time-saving factor	3.15	1
2	Augmentation factor	3.01	2
3	Influential factor	2.96	3
4	Convenience factor	2.85	4
5	Quality factor	2.77	5

promoted by trusted brand ambassadors, suggested by neighbours/friends/relatives, convenience factors (2.85) like due to affordability, ease of availability, available in customer- preferred sizes, and quality factors (2.77) like due to the quality of ingredients used for the preparation of products, non-addition of colours and other adulterated ingredients, ingredient transparency is known . Thus, preservation and time-saving factors were very important factors influencing consumer perception of sample consumers towards value-added nutri-cereal products. Similar results were reported by Indumathy and Jeyalakshmi (2014) and Mohan *et al.* (2021).

LITERATURE CITED

Barratry, D and Rajapushpam, R. 2018. A study on perception of millet products among houshold consumers in Salem District. *IOSR Journal of Business and Management*. 20(8): 67-76.

Indumathy, M and Jeyalakshmi, D. 2024. Consumer perception towards millets among households in Coimbatore city.

Kapoor, C., Sondhi, A., Jamir, C and Kumar, C. 2023. Consumption and perceptions associated with Nutri-cereals: Major, minor, and pseudo millets—A study of urban households in Delhi, India. *Journal of Drug Research in Ayurvedic Sciences*. 8(Suppl 1): S140-S147.

Mohan, A.R., George, A and George, G. 2021. Consumer perception and factorsinfluencing consumption of millets. *Journal of Tropical Agriculture*. 59(2).

Raju, S.S and Rukmani, A. 2022. Factors influencing consumer buying behavior towards organic millets and pulses in Hyderabad city–a study. *International Journal of Economic Perspectives*. 16(1): 32-44.

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