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Influence of Integrated Nutrient Management on the Productivity of *kharif* Redgram (*Cajanus cajan* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A field experiment was conducted during *kharif* season of 2021-22 at Agricultural Research Station, Tandur, Vikarabad, Professor Jayashankar Telangana State Agricultural University (PJTSAU) under deep black soils to study the effect of integrated nutrient management on the growth and yield of *kharif* redgram (*Cajanus cajan* L.). The experiment was laid out in Randomized block design with 9 treatments in 3 replications. Treatments comprised of T_1: Control, T_2: 50% RDF (10:25:0 NPK kg ha^{-1}) + 50% FYM (2.5 t ha^{-1}), T_3: 75% RDF (15:37.5:0 NPK kg ha^{-1}) + 25% FYM (1.25 t ha^{-1}), T_4: 100% RDF (20:50:0 NPK kg ha^{-1}), T_5: 50% RDF + FYM @ 5 t ha^{-1} + *Rhizobium*

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(Seed treatment) + PSB (Seed treatment), T_6: 75% RDF + FYM @ 5 t ha^{-1} + *Rhizobium* (Seed treatment) + PSB (Seed treatment), T_7: 100% RDF + FYM @ 5 t ha^{-1} + *Rhizobium* (Seed treatment) + PSB (Seed treatment), T_8: 100% RDF + *Rhizobium* (Seed treatment) + PSB (Seed treatment) and T_9: FYM @ 5 t ha^{-1} + *Rhizobium* (Seed treatment) + PSB (Seed treatment). Among the treatments, application of 100% RDF, FYM @ 5 t ha^{-1}, *Rhizobium* and PSB recorded significantly higher seed yield (1898 kg ha^{-1}) and stalk yield (6275 kg ha^{-1}).

Keywords: Integrated nutrient management; redgram; fertilizer; FYM; rhizobium; phosphate solubilizing bacteria (PSB).

1. INTRODUCTION

Redgram, also known as pigeon pea (*Cajanus cajan* L.), stands as the fifth most prominent grain legume crop globally and holds second position in India after chickpea. It holds a significant position in the agricultural landscape as a vital pulse crop due to its nutritional value and economic importance. It is a perennial legume from the family leguminosae, which has high market price for its nutritive value, dietary fibre and capacity to fix atmospheric nitrogen, enhancing the fertility of the land and supplying it with nutrients. Redgram is mainly consumed in the form of split pulse as dal, green leaves are used as quality fodder and dry stems make an excellent fuel wood.

“Globally, redgram is grown in an area of 63.57 lakh hectares with a production of 54.75 lakh tonnes and productivity of 861.25 kg ha^{-1}” [1]. “India ranks first in redgram production globally with 42.2 lakh tonnes cultivated under 49.0 lakh hectares with productivity of 861 kg ha^{-1}” [2].

“As the global population continues to grow, the demand for protein rich food sources, such as redgram, escalates. However, the challenge lies in maintaining and increasing its yield amidst changing climatic conditions and depleting soil fertility. The unregulated use of synthetic fertilizers has resulted in detrimental consequences including, soil contamination, water basin pollution, microbial and insect destruction, heightened vulnerability to diseases, and reduced soil fertility. The use of organic manure and biofertilizers is economical, eco-friendly, more efficient, productive and accessible to marginal and small farmers over chemical fertilizers” [3,4]. Although these manures and biofertilizers often fall short in fully replacing the rapid nutrient supply provided by chemical fertilizers, hence Integrated Nutrient Management (INM) offers a comprehensive approach by synergistically blending these methods, optimizing nutrient availability, promoting sustainable growth and minimizing negative ecological consequences. This integrative approach not only optimizes nutrient availability but also addresses the concerns regarding environmental sustainability and soil health.

“The interactive benefits of combining organic and inorganic nutrient sources along with biofertilizers have shown to be more effective compared to using each component separately” [5]. “Organic manure on the other side, provide a good substrate for the growth of the microorganism and maintain a favourable nutrient supply environment to the crop. The use of *rhizobium* and phosphate solubilizing microorganism with organic manure may prove a viable option for sustaining crop production. As a result, the integrated approach of supplying nutrients through chemical fertilizers alongside organic manure and biofertilizers is gaining importance” [6]. Keeping these considerations in view, the present study was undertaken to estimate the effect of integrated nutrient management practices on the productivity of redgram.

2. MATERIALS AND METHODS

The field experiment was conducted at Agricultural Research Station, Tandur, Vikarabad (Dist.), Professor Jayashankar Telangana State Agricultural University, during *kharif* season, 2021-22. The farm is geographically situated at an altitude of 350 m above mean sea level at 17° 22ˊ N latitude, 77° 58ˊ E longitude, in the Southern Agro-climatic zone of Telangana. The soil of experimental site had a pH of 7.48, EC of 0.36 dS m^{-1}containing 0.44% organic carbon, low available nitrogen (174.5 kg ha^{-1}), medium in available phosphorus (19.4 kg ha^{-1}) and high in available potassium (362.9 kg ha^{-1}). Total rainfall received during the crop season was 460 mm. The experiment was laid out in randomized block design comprising 9 treatments i.e., T_1: Control, T_2: 50% RDF (10:25:0 NPK kg ha^{-1}) + 50% FYM (2.5 t ha^{-1}), T_3: 75% RDF (15:37.5:0 NPK kg ha^{-1}) + 25% FYM (1.25 t ha^{-1}), T_4: 100% RDF (20:50:0 NPK kg ha^{-1}), T_5: 50% RDF + FYM @ 5 t ha^{-1} + *Rhizobium* (Seed treatment) +PSB (Seed treatment), T_6: 75% RDF + FYM @ 5 t ha^{-1} + *Rhizobium* (Seed treatment) + PSB (Seed treatment), T_7: 100% RDF + FYM @ 5 t ha^{-1} + *Rhizobium* (Seed treatment) + PSB, T_8: 100% RDF + *Rhizobium* (Seed treatment) + PSB (Seed treatment) and T_9: FYM @ 5 t ha^{-1} + *Rhizobium* (Seed treatment) + PSB (Seed treatment).

Nitrogen and phosphorus fertilizers were applied as per the treatment details just before sowing using urea and diammonium phosphate, respectively as basal. FYM was applied to the soil before land preparation as per the treatment details and properly mixed with the soil. *Rhizobium* and PSB were inoculated to soil by seed treatment @ 20 g kg^{-1} seed. The redgram variety TDRG-59 (Telangana Kandi-3), was sown at a spacing of 150 cm x 20 cm using seed rate of 10 kg ha^{-1}. The gross plot size was 7.2 x 7 m.

Regular observations were made for recording the data related to growth and yield attributes. Five random plants from each plot were assessed for characteristics such as plant height, primary and secondary branches per plant, leaf area, dry matter, number of pods per plant, number of seeds per pod. For test weight, treatment wise seed samples were drawn at random and the weight of 100 counted seed was determined and expressed in grams. Seed yield is obtained from the harvested plants of net plot area, where plants are dried to constant weight, threshed and winnowed. Stalk/ haulm yield is obtained by from the net plot after harvest to ground level at each treatment and allowing them to dry for at least a week in the respective plots. Harvest index is the ratio of seed yield to the total dry matter (seed + stalk yield) and expressed as percentage. It was calculated by the formula as given below.

$$\text{Harvest Index (\%)} = \frac{\text{Economic yield (kg ha}^{-1})}{\text{Biological yield (kg ha}^{-1})} \times 100$$

The mean values of collected data are statistically analyzed using Fischer's method of analysis of variance, as outlined by Gomez and Gomez [7]. When the treatment differences were found to be statistically significant based on the F-test, critical differences were calculated at a five percent probability level.

3. RESULTS AND DISCUSSION

Results of the experimental data indicated the integrated nutrient management practices had a significant impact on the growth, yield attributes and yield of redgram.

3.1 Growth Parameters

Data presented in Table 1 revealed that there was a significant variation in growth parameters due to the effect of different integrated nutrient management practices. Among the growth parameters, application of 100% RDF + FYM @ 5 t ha^{-1} + *Rhizobium* + PSB resulted in significantly highest plant height (148.3 cm), number of primary and secondary branches (3.06 and 13.9 respectively), leaf area (6031.5 cm^2 $plant^{-1}$) and dry matter (6873 kg ha^{-1}), which was on par with the application of 75% RDF + FYM @ 5 t ha^{-1} + *Rhizobium* + PSB. Lowest values of growth parameters were obtained in control. All the treatments had shown significantly higher yields than control.

The improvement in plant growth might be due to the quick supply of nutrients by fertilizers, enhanced soil structure fostering optimal root growth and improved nutrient uptake FYM and biofertilizers. Beneficial effect of combined use of organic and inorganic nutrients along with biofertilizers increased the rate of photosynthetic and symbiotic activity, which stimulated better growth of the crop resulting in higher plant height, number of branches, which in turn expanded leaf area and increased dry matter accumulation in the plant. Similar results were obtained by Goud et al. [8], Pandey et al. [6] and Kumar et al. [9].

3.2 Yield Parameters and Yield

From the data presented in Table 2, it is clear that performance of redgram was better with application of 100% RDF + FYM @ 5 t ha^{-1} + *Rhizobium* + PSB resulted in significantly highest number of pods $plant^{-1}$ (243.1), seed yield (1898 kg ha^{-1}) and stalk yield (6445 kg ha^{-1}) which was on par with the application of 75% RDF + FYM @ 5 t ha^{-1} + *Rhizobium* + PSB. Lowest results were observed in control. Similar findings were given by Arabhanvi et al. [10], Mittoliya et al. [11] and Rathod et al. [12].

This appreciable increase in pod yield can be attributed to improved nutrient availability and balanced nutrition, which enhance flowering, fertilization, and seed development. Additionally, the optimized plant health, hormonal balance and resource allocation facilitated by INM contribute to higher pod formation and improved seed setting within the pods, ultimately leading to greater pod yield. Seeds per pod and test weight being a genetical character, it was not

Table 1. Influence of nutrient management practices on the growth parameters of *kharif* redgram

Treatments	Plant height (cm)	No. of primary branches plant^{-1}	No. of secondary branches plant^{-1}	Leaf area (cm^2 plant^{-1})	Dry matter (kg ha^{-1})
T_1: Control	113.1	2.2	9.8	3834.5	2703
T_2: 50% RDF + 50% FYM	124.1	2.5	11.6	4156.1	3711
T_3: 75% RDF + 25% FYM	130.0	2.6	12.1	4426.3	3941
T_4: 100% RDF	136.5	2.8	12.5	4569.4	4467
T_5: 50% RDF + FYM @ 5 t ha^{-1} + *Rhizobium* + PSB	133.2	2.7	12.2	4480.6	4225
T_6: 75% RDF + FYM @ 5 t ha^{-1} + *Rhizobium* + PSB	145.1	3.0	13.3	4701.2	5072
T_7: 100% RDF + FYM @ 5 t ha^{-1} + *Rhizobium* + PSB	149.3	3.1	14.2	4885.6	5473
T_8: 100% RDF + *Rhizobium* + PSB	140.3	2.9	12.9	4640.2	4799
T_9: FYM @ 5 t ha^{-1} + *Rhizobium* + PSB	120.9	2.4	11.2	4101.4	3372
SEm±	1.8	0.05	0.39	67.2	143
CD (P=0.05)	5.4	0.14	1.16	201.4	428

Table 2. Influence of nutrient management practices on the yield attributes of *kharif* redgram

Treatments	No. of pods plant^{-1}	No. of seeds pod^{-1}	Test weight (g)	Seed yield (kg ha^{-1})	Stalk yield (kg ha^{-1})	HI (%)
reT_1: Control	125.0	3.07	9.72	839	2790	23.3
T_2: 50% RDF + 50% FYM	167.1	3.40	9.86	1122	3767	23.2
T_3: 75% RDF + 25% FYM	189.3	3.60	9.92	1271	3905	24.6
T_4: 100% RDF	207.2	3.83	10.02	1351	4443	23.4
T_5: 50% RDF + FYM @ 5 t ha^{-1} + *Rhizobium* + PSB	195.2	3.70	9.95	1311	4220	23.8
T_6: 75% RDF + FYM @ 5 t ha^{-1} + *Rhizobium* + PSB	229.5	3.84	10.10	1541	5049	23.5
T_7: 100% RDF + FYM @ 5 t ha^{-1} + *Rhizobium* + PSB	243.1	3.92	10.12	1632	5460	23.0
T_8:100% RDF + *Rhizobium* + PSB	215.5	3.77	10.08	1447	4801	23.3
T_9: FYM @ 5 t ha^{-1} + *Rhizobium* + PSB	154.2	3.57	9.83	1035	3430	23.2
SEm±	6.6	0.20	1.31	35	159	0.60
CD (P=0.05)	19.8	NS	NS	132	679	NS

significantly influenced by the application of different nutrient management practices.

Higher seed yield might be attributed to an increase in the availability of all essential plant nutrients and increased microbial activity in root nodules, symbiotic nitrogen which in term resulted in greater transformation of photosynthates towards the sink. Enhanced stalk yield can be attributed to improved vegetative growth and greater dry matter accumulation as a result of the availability of all essential plant nutrients and improved soil physico-chemical and biological properties. Nutrient management practices are found to show no significant effect on harvest index. The results collaborated the experimental findings of Mittoliya et al. [11], Pandey et al. [7] and Goud et al. [8].

4. CONCLUSION

From the experimental results it is concluded that performance of redgram was better with combined application of inorganic fertilizers, FYM and biofertilizers i.e., 100% RDF, FYM @ 5 t ha^{-1}, *Rhizobium* and PSB.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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