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G Veeranna
Regional Agricultural Research Station, Warangal, PJTSAU, Hyderabad, India

Ch. Ramulu
Regional Agricultural Research Station, Warangal, PJTSAU, Hyderabad, India

P Raghu Rami Reddy
Regional Agricultural Research Station, Warangal, PJTSAU, Hyderabad, India

P Jagan Mohan Rao
Regional Agricultural Research Station, Warangal, PJTSAU, Hyderabad, India

Correspondence
G Veeranna
Regional Agricultural Research Station, Warangal, PJTSAU, Hyderabad, India

Maximizing Yield and Economics of Pigeonpea through Integrated Agronomic Management in Black Soil under Rainfed Condition

G Veeranna, Ch. Ramulu, P Raghu Rami Reddy and P Jagan Mohan Rao

Abstract
The experiment was conducted at Regional Agricultural Research Station, Warangal during kharif, 2013 to 15 on redgram with an objective to study the effect of various management techniques experiment are seed treatment with Rhizobium + Pseudomonas bacteria + Plant growth promoting Rhizobium were common to all treatments except control (Farmers practice). *viz*; INM-integrated nutrient management (Vermi composting @ 2.5 t/ha + RDF *i.e.*, 20 N, 50 P, 0 K, 50 S and 25 Zn kgha^{-1}), IWM-integrated weed management (Pendimethalin 0.75 kg/ha on 3 days after sowing + Imazethapyr @ 100 g a.i ha^{-1} on 10-15 days after weeds emergence + one hand weeding on 50 days after sowing), IPM-integrated pest management (Indoxacarb 15.8% EC at the time of flowering @ 375 ml ha^{-1} + one systemic insecticide spray 15 days after 1st spray, INM + IWM, INM + IPM, IWM + IPM, INM + IWM + IPM and were compared with control (Farmers practice). The results revealed that INM + IWM + IPM recorded higher biometric characters, yield attributes (number of pods plant^{-1} (123.8), number of seeds pod^{-1}(3.84), less number of borer infested pods plant^{-1} (4.27) and grain yield (1649 kgha^{-1}) with higher soil organic carbon content (0.26 per cent) and available N (291.5 kg ha^{-1}). The B:C ratio (1.64) was also recorded higher under the same treatment followed by INM + IWM and INM (grain yield 1327 kg ha^{-1} and 1230 kg ha^{-1}, respectively); and were compared with control/farmers practice (1283 kg ha^{-1}).

Keywords: Agronomic Management, kharif, Rhizobium, Pseudomonas bacteria.

1. Introduction
The redgram is the most important pulse crop in India. India is the largest producer (81 per cent) and consumer (90 per cent) of redgram in the world. In 2025 A.D India's food grain requirement is 301 million tonnes. But at national level the average productivity is very low (675 kgha^{-1}). There are several constrains in the redgram cultivation. One of them is application of fossil based inputs like imbalance chemical fertilization, pesticides and herbicides. In Telangana State, redgram is often grown on marginal lands and is generally supplied with sub optional doses of fertilizers in local varieties leading to low productivity of the crop. Pulses improve the health of soil to benefit farmers with small holdings. Recognizing the importance of pulses in enhancing food security and the income of small farmers, transfer of technology to the door step of every small farmers in the country is the priority for increasing the area cultivation and productivity of pulses and making them more competitive and attractive to farmers. There is growing awareness and concern over their adverse effects on soil productivity and environmental quality. The high cost of chemical fertilizers, the low purchasing power of small and marginal farmers and their adverse effect on environment has led to look for some alternative strategies. Sharma *et al* (2007) [1] reported the inoculation of pulses with PGPR and Rhizobium causes' growth stimulation of plant and enhances crop yields. Hence the present experiment has been carried out with the main is to quantity the incremental effect of various management techniques on redgram growth, yield and soil properties under black soil and to find out the economic viability of the different agronomic practices.

Material and Methods
The present investigation was carried out during kharif season of 2013-14 at Regional Agricultural Research Station, Warangal. The experimental material consist of redgram WRG-65. The experiment was laid out in randomized block design with three replications. The initial soil nutrient status are low in soil Organic carbon (0.20 per cent), low in soil available nitrogen (278 kgha^{-1}), medium in soil phosphorus (11 kg ha^{-1}) and high available potassium (315 kg ha^{-1}). The treatments *viz*; T_1: INM-integrated nutrient management (Vermi composting @ 2.5 t ha^{-1} + RDF i.*e*., 20 N, 50P, OK, 50S and 25 Zn kg ha^{-1}). T_2: IWM-Integrted weed management

(Pendimethalin 0.75 kg ha^{-1} on 3 days after sowing + Imazethapyr @ 100 g a.i ha^{-1} on 10-15 days after weeds emergence + one hand weeding on 50 days after sowing). T_3: IPM-Integrated pest management (Indfoxacarb 15.8%, EC at the time of flowering @ 375 M/ha^{-1} + one systemic insecticides spray 15 days after 1st spray). T_4: INM+IWM, T_5:INM+IPM, T_6:IWM+IPM, T_7:INM+IWM+IPM and T_8: Farmer practices (control). The seed treated with Rhizobium + Pseudomonas bacteria + Plant growth promoting Rhizobium were common to all treatments except control (Farmers practice). The crop was raised under rainfed condition with 120 cm as inter row spacing and 20 cm is followed as intra row spacing. The crop was harvested after 160 days. Data were recorded on biometrical characters *viz*; plant height (cm), number of branches $plant^{-1}$, number of pods $plant^{-1}$, number of seeds pod^{-1}, test weight (g), Stover yield and seed yield (kg ha^{-1}), post harvest nutrient status and economics were worked out, the statistical analysis was done with AGRES package.

Results and Discussion

Growth and yield attributes: All the treatment applications had no significant effect on plant height, yield attributes and yield, except number of branches $plant^{-1}$ and number of seeds pod^{-1}. Number of branches $plant^{-1}$ was recorded significantly higher (9.87) under management practices of three combinations of INM + IWM + IPM which was at par (8.40) with two combinations of INM + IWM. The lowest number of branches $plant^{-1}$ was recorded in IPM practice (5.67), due to without application of fertilizers and weed control reduced branches $plant^{-1}$ in IPM. In management practices IWM + IPM recorded significantly higher number of seeds pod^{-1} (4.0) which was at par with combination of INM + IWM (3.9), reason of increase higher number of seeds pod^{-1} was proper/timely management of insect hosts weeds and pest control, and fallowed by balanced fertilization through bio fertilizer.

Numerically recorded higher mean values of plant height (204.7 cm), number of pods $plant^{-1}$ (123.8), test weight (9.86 g), Stover yield (2224 $kgha^{-1}$) and seed yield (1649 $kgha^{-1}$), and less number of borer infested pods $plant^{-1}$ (4.27) in the three combination of INM + IWM + IPM management practices fallowed by INM + IWM (1327 $kgha^{-1}$) and were compared with control farmers practices (1283 kg ha^{-1}). Reddy *et al*., (2011) [2] found the similar result by the integrated nutrient management for increase in yield attributes because of increase in nutrient up take correspondingly increase the yield attributes.

Post-harvest nutrient status of soil: Based on the first year experiment it was observed that, INM and INM + IWM + IPM both management practices were significantly superior soil available N (291.5 and 289.5 $kgha^{-1}$, respectively) and organic carbon % (0.26 and 0.24 respectively) followed by INM + IWM practices (285.3 N $kgha^{-1}$ and OC 0.23%). The increase in yield with the addition of Rhizobium is possibly due to higher nitrogen availability as it improves grows, quality and yield of field crops. Jat and Ahlawat (2004) also reported that combined application of various organic and inorganic sources is capable of sustaining higher production by improving soil physical condition and soil productivity.

Economics: The net income Rs. 44012 was obtained from the INM + IWM + IPM management practices and benefit: Cost ratio 1.94 was obtained from the IWM + IPM followed by INM practice (Net income Rs. 34191 and B: C ratio 1.83). This indicates that the above mentioned management practices is more effective and economical with higher benefit: cost ratio in pigeonpea. Reddy *et al*; (2011) [2] also confirm the similar kind of results.

Conclusion

Redgram can be profitably adopted, Integrated Nutrient Management (Vermi composting @ 2.5 t ha^{-1} + RDF i.*e*., 20 N, 50P, OK, 50S and 25 Zn kg ha^{-1}). Integrated Weed Management (Pendimethalin 0.75 kg ha^{-1} on 3 days after sowing + imazethapyr @ 100 g a.i ha^{-1} on 10-15 days after weeds emergence + one hand weeding on 50 days after sowing) + Integrated Pest Management (Indfoxacarb 15.8%, EC at the time of flowering @ 375 M/ha^{-1} + one systemic insecticides spray 15 days after 1st spray) were the best combination with seed treatment Rhizobium Psendomonas bacteria + PGPR cultures @ 200 g kg^{-1} seed just before sowing for getting higher productivity and quality with maximum net returns.

Yield attributes, yield, economics, organic carbon and soil available N of pigeonpea as influenced by different agronomic management practices

Table 1.

Treatment	Plant height (cm) at harvest	No. of branches /Plant	No. of pods/ plant	No. of borer pods / plant	No. of seeds /pod	100 seed weight (g)	Seed yield (kg/ha)	Stover yield (kg/ha)	Net Returns (Rs/ha)	B:C ratio	OC %	Soil available N (kg/ha)
INM	201.4	7.27	118.0	7.27	3.77	9.56	1230	1960	34191	1.83	0.24	289.5
IWM	202.4	6.07	100.9	6.67	3.64	8.99	948	1849	23360	1.34	0.20	272.5
IPM	202.4	5.67	91.2	5.07	3.67	8.80	722	1543	17167	1.24	0.18	268.0
INM + IWM	204.4	8.40	121.8	5.70	3.90	9.78	1327	2113	32502	1.33	0.23	285.3
INM + IPM	200.4	7.40	117.0	5.0	3.76	9.45	1205	2141	30781	1.46	0.24	284.0
IWM + IPM	204.0	7.07	116.7	5.14	4.00	8.94	1015	1891	23906	1.94	0.21	270.0
INM + IWM + IPM	204.7	9.87	123.8	4.27	3.84	9.86	1649	2224	44012	1.64	0.26	291.5
Farmer Practice (Control)	202.0	7.60	118.2	3.6	3.74	9.40	1283	2085	34078	1.62	0.21	275.5
SEm ±	0.99	0.75	18.87	1.07	0.23	0.34	230	165	-	-	0.01	1.4
CD (P=0.05)	NS	2.3	NS	NS	0.09	NS	NS	NS	-	-	0.02	3.0
CV (%)	0.85	17.6	28.82	34.5	3.85	6.23	34.0	14.5	-	-	-	-

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