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Productivity and Profitability of Baby Corn-hyacinth Bean Cropping System as Influenced by Nutrient Management Practices

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A B S T R A C T

A field experiment was conducted at Horticultural Research Station, Adilabad during *kharif* and *rabi* seasons of 2015-16 and 2016-17 to study the effect of integrated nutrient management practices on system productivity, profitability and economics of baby corn-hyacinth bean cropping system. The experiment was laid out in a randomized block design for baby corn during *kharif*, 2015 season with seven treatments comprised of 100% Recommended dose of fertilizer (RDF- 150:60:60 N, P_2O_5, and K_2O kg ha^{-1}) 25% N supplemented through Farm Yard Manure (FYM) or vermicompost (VC) + 75% RDF with or without soil application of *Azospirillum* and *Bacillus megaterium*@ 5 kg ha^{-1} each, in addition to control (no fertilizer application) and replicated thrice. Manures and inorganic fertilizers, P_2O_5 and K_2O (single super phosphate and muriate of potash) incorporated into the soil before sowing as per the treatments. Nitrogen (urea) was applied in three splits at 10, 25 and 40 DAS. Each main treatment was divided into four sub plots and the treatments of 100% RDF and 75% RDF with or without *Bradyrhizobium* @ 500 g ha^{-1} (seed treatment) were imposed for hyacinth bean in *rabi*season and data of *kharif*, 2016 and *rabi*, 2015-16 and 2016-17 was analysed in split plot design. Integrated use of 25% N through VC, bio-fertilizers and 75% RDF (inorganic) during *kharif* to baby corn and 100% RDF along with *Bradyrhizobium* seed treatment to hyacinth bean during *rabi* realized higher system productivity, gross returns, net returns, system profitability over rest of the treatments of 100% RDF with or without bio-fertilizers, 25% N through FYM with or without bio-fertilizers and 75% RDF, 25% N through VC + 75% RDF and unfertilized control during *kharif* followed by 75% RDF with or without seed treatment with *Bradyrhizobium* and 100% RDF alone to *rabi* hyacinth bean.

Introduction

Adilabad is bestowed with good amount of rainfall, cotton and soybean are the important rainy season crops along with tomato, brinjal in this region. Growers mostly follow cultivation of cotton or soybean as mono-cropping and leave the field follow for remaining part of the year. Productivity of rainfed mono-cropping system in Northern Telangana Zone is very low and it is a high economic risk activity.

Intensive natural resources mining, continuous degradation of natural resources (soil, water, vegetation) and practice of mono-cropping under conventional agricultural practice will not ensure farm productivity and food security (Ghosh *et al.,* 2010). Emphasis needs to be given for increasing productivity levels besides diversification towards high value crops. Poor recycling of organic sources, application of high analysis fertilizers caused deficiency of several micro nutrients in soil and also lead to environmental pollution (Kumar, 2008).

In Northern Telangana Zone, maize is one of the main *kharif* crops. In recent times efforts were made to popularize baby corn – speciality maize because of its nutritive value, demand in hotels. Baby corn is a potential crop that could improve the economic status of the farmers in India (Das *et al.,* 2008) through earning foreign exchange as well as meeting local needs. Application of chemical fertilizers may assist in obtaining maximum production of baby corn but is leading to hazardous effect on the environment (Ranjan *et al.,* 2013, Mahajan *et al.,* 2007 and Dadarwal *et al.,* 2009).

Dolichos bean is a legume crop which fits up well in the multiple cropping systems, which has multiple uses and also restores soil fertility. It is one of the main *rabi* crop in Karimnagar and Jagtial districts of Northern Telangana Zone. The extensive research on INM in different crops and cropping system has emphasized its importance in achieving production, economic and environmental sustainability. Addition of multiple cropping systems needs more nutrients for proper growth and development of each crop in sequence. For a sustainable crop production system, chemical nutrients removed by the crop must be replenished and physical condition of the soil maintained.

Balanced application of nutrients through any source is most important in increasing the agricultural productivity. Fertilizers have played a major role in replenishing the soil fertility and increasing the yield. But their escalating costs, stagnation in yields and the injudicious use is compelling to look for other alternatives. Secondly the use of chemical fertilizers (mainly NPK fertilizers) alone is leading to the deficiency of other nutrients particularly, the micronutrients. On the other hand, organics alone cannot meet the nutritional requirement of the crops as the nutrient contents in these are very low. Therefore, for sustained yields and to maintain the soil health, the integration of organic and inorganic is the viable alternative. However, due to the adverse effects of chemicals on ecosystem / environment and quality of produce, the concept of pure organic farming has also come up. However, organic farming can only be practiced in high value crops at selected places to improve their quality.

Keeping the above facts in view, the present investigation was undertaken to assess the productivity and economics of baby corn-hyacinth bean cropping system with integrated use of manures, microbial cultures and inorganic fertilizers.

Materials and Methods

The experiment was conducted at horticultural research station farm, Adilabad during *kharif,* 2015 and 2016 and *rabi* seasons of 2015-16 and 2016-17. The experimental site is situated at an altitude of 264 meters above mean sea level on 79^{o} 56’ 03” E longitude and 19^{o}08’ 09” N latitude. The experimental soil was sandy clay loam in texture, neutral in reaction, medium in available nitrogen, phosphorous and potassium. The soil belongs to the order Alfisol of shallow to medium depth. The

experiment was laid out in a randomized block design for baby corn during *kharif*, 2015 season with seven treatments comprised of 25% N supplemented through farm yard manure (FYM) or vermicompost (VC) + 75% Recommended dose of fertilizer, (100% RDF; 150:60:60 N, P_2O_5 and K_2O kg ha^{-1}) with or without soil application of *Azospirillum* and *Bacillus megaterium*@ 5 kg ha^{-1} each, and control (no fertilizer application), replicated thrice. Each main treatment was divided into four sub plots and the treatments 100% RDF, 75% RDF, 100% RDF + *Bradyrhizobium* @ 500 g ha^{-1} (seed treatment) and 75% RDF + *Bradyrhizobium* @ 500 g ha^{-1} (seed treatment) were imposed in *rabi*. Experimental Design for *rabi*, 2015-16, *kharif*, 2016 and *rabi*, 2016-17 was split plot.

Babycorn

Manures and fertilizers were applied as per the treatment. *Azospirillum* (nitrogen fixing bacterial formulation) and *Bacillus megaterium* (phosphorus solubilizing bacterial formulation) @ 5 kg ha^{-1} was utilized for baby corn as per the treatments. G-5414 variety of baby corn which grows to height of 180-200 cm and matures within 50-55 days was selected for testing. The crop was sown on 22nd and 3rd July in 2015 and 2016, respectively. Two seeds were dibbled $hill^{-1}$ at a depth of 3-4 cm with a spacing of 60 cm x 15 cm. Gap filling was done on 7th day after sowing and thinning was done on 14th day after sowing. Atrazine @1.0 kg a.i ha^{-1} was applied two days after sowing to control the weeds. The field was maintained weed free condition by hand weeding at 15 and 30 DAS. Harvesting of the ears was done after observing 2-3 cm long silk emergence. Harvesting was continued from 58 to 68 DAS plot wise and yield in each plot at each harvest was recorded treatment wise. In all, three pickings were done in 11 days and summed up to work out yield ha^{-1}.

Hyacinth bean

Bradyrhizobium (nitrogen fixing bacterial formulation) @ 500 g ha^{-1} was utilized for seed dressing of hyacinth bean as per the treatments. Fertilizers were applied as per the treatment. Arka Jay variety, vegetable type bean with excellent cooking quality was selected for testing. The crop was sown on 10th and 6th October in 2015 and 2016, respectively. One seed was dibbled $hill^{-1}$ at a depth of 3-4 cm with a spacing of 45 cm x 20 cm. Gap filling was done on 7th day after sowing. The fresh pods were harvested at 80, 100and 127 DAS. In all there were three pickings during *rabi*, 2015-16 and 2016-17.

Baby corn equivalent yield (BEY) and system productivity was calculated as detailed below:

$$BEY = \frac{\text{Hyacinth bean yield x sale price of hyacinth bean}}{\text{Sale price of baby corn}}$$

System productivity (kg ha^{-1} $year^{-1}$) = BEY + Baby corn yield (kg ha^{-1})

System productivity (kg ha^{-1} day^{-1}) =

$$\frac{\text{BEY + Baby corn yield (kg ha}^{-1}\text{)}}{365}$$

To find out the economic viability of the system, the cost of cultivation, gross returns, net returns and system profitability were worked out. The expenditure incurred from field preparation to harvest of baby corn and hyacinth bean was worked out and expressed as ₹ ha^{-1}

The crop yield was computed ha^{-1} and the total income was worked out based on the market rate which was prevalent during the time of study. The following local prices were

considered for computing gross monitory returns.

$$\text{System profitability (Rs. ha}^{-1}\text{ day}^{-1}\text{)} = \frac{\text{System net returns (Rs. ha}^{-1}\text{)}}{365}$$

The data on observations were analyzed statistically by applying the technique of analysis of variance as outlined by Panse and Sukhatme (1978) for Randomized Block Design and for Split Plot design as suggested by Gomez and Gomez (1984). Statistical significance was tested by F test. Critical difference for treatment means was evaluated at 5 per cent level of probability (P=0.05).

Results and Discussion

Production potential of baby corn-hyacinth bean cropping system

System productivity

The economic yields of baby corn, hyacinth bean were converted into baby corn equivalent yields to compare different treatments. The baby corn equivalent yields were significantly influenced by the treatments given to *kharif* baby corn and succeeding hyacinth bean but not for their interactions.

Significantly higher system productivity of 3918 kg ha^{-1} yr^{-1} and 10.73 kg ha^{-1} day^{-1}(pooled mean data of two years) was realized due to application of 75% RDF in conjunction with 25% N through VC and bio fertilizer (*Azospirillum* and *Bacillus megaterium*) to baby corn in *kharif* and due to residual effect on hyacinth bean during *rabi*. Least system productivity of 2272 kg ha^{-1} yr^{-1} and 6.22 kg ha^{-1} day^{-1} was realized in unfertilized control treatment (Table 1).

Substitution of 25% of inorganic fertilizer N with organic manures (VC or FYM) showed higher system productivity over 100% RDF with or without bio fertilizer. Substitution of 25% RDN through VC or FYM might have supplied major nutrients as well as micro nutrients ensuring balanced plant nutrition, besides improving soil physical (Anil Kumar *et al.,* 2002), chemical properties (Singh *et al.,* 1980) and biological properties (Santhy*et al.,* 1998) of soil resulting in favourable conditions for crop growth and development thereby resulting in higher cob and baby corn equivalent yield (Table 1) over other treatments.

Bio fertilizer (*Azospirillum* and *Bacillus megaterium*) when integrated with 25% N through organic manures and 75% RDF or applied along with 100% RDF realized higher system productivity over the treatments in which the bio-fertilizer was not combined. The promising effect of bio-fertilizers may be attributed to production of biologically active substances like vitamins, nicotinic acid, Indole-acetic acid, gibberellins *etc*., in better germination, root and shoot growth and fixation of atmospheric nitrogen. Secretion of growth promoting substances of *Azospirillum* and increased bacterial efficiency by *Bacillus megaterium* (Datta and Banik, 1997) combined together might have increased yield of baby corn and ultimately the system productivity.

Among the organic manures, use of VC along with 75% RDF with bio-fertilizers realized higher system productivity over FYM along with 75% RDF with or without bio fertilizer treatments (Table 1). Synergistic effect of VC along with bio-fertilizer may be attributed to promoting effect of micronutrient and growth regulators present in VC (Ranjan*et al.,* 2013).

Economics of baby corn-hyacinth bean cropping system

Gross and net returns

The gross and net returns were significantly influenced by the direct and residual effect of

treatments imposed to *kharif* baby corn and succeeding hyacinth bean but not by the interactions. Perusal of the pooled mean data of two years of economics of baby corn-hyacinth bean cropping system revealed that, integration of 25% N through VC with 75% RDF along with bio-fertilizers resulted in an increase of gross and net returns to the tune of 23.97% and 26.91% over 100% RDF and 72.61% and 91.41% over un-fertilized control (Table 2).

Combined use of 100% RDF and bio-fertilizer resulted in an increase of gross and net returns (7.24% and 9.32%) over 100% RDF and (49.32% and 64.88%) over unfertilized control.

Significantly higher gross and net returns (Rs. 3,58, 595 and Rs. 2,70, 250) were realized with the application of 75% RDF integrated with 25% N through VC in conjunction with the bio-fertilizers (*Azospirillum* and *Bacillus megaterium*) over rest of the treatments of 100% RDF with or without bio-fertilizers, 25% N through FYM or VC integrated with 75% RDF and unfertilized control and was at par with 25% N through FYM integrated with 75% RDF along with bio-fertilizers (Table 2). All the treatments imposed recorded significantly higher gross and net returns over un-fertilized control.

Substitution of 25% N through organic manures (VC and FYM) resulted in significantly higher gross and net returns over application 100% RDF through inorganic sources and un-fertilized control during both the years of study. Among the organic manures, use of VC resulted in higher gross and net returns over FYM.

Use of bio-fertilizers along with 100% RDF resulted in the realization of significantly higher gross and net returns over 100% RDF alone and unfertilized control.

System profitability

The system profitability was highest (Rs. 740.4 ha^{-1} day^{-1}) with application of 75% RDF in conjunction with 25% N through VC and bio-fertilizer, due to direct and residual effect of the treatment imposed to baby corn during *kharif* and hyacinth bean during *rabi* (Table 2).

Lowest system profitability of Rs. 386.8 ha^{-1} day^{-1} was realized with unfertilized control. All the organic treatments (25% N through FYM or VC) integrated with 75% RDF with or without bio-fertilizers realized higher system profitability over the use of 100% recommended dose of inorganic fertilizers with or without use of bio-fertilizer and unfertilized control.

Among the organic treatments use of 25% N through VC integrated with 75% RDF with or without use of bio-fertilizer realized higher system profitability over respective use of FYM in place of VC. Use of bio-fertilizer (*Azospirillum* and *Bacillus megaterium*) along with 100% RDF realized higher system profitability over 100% RDF alone and unfertilized control.

Higher system profitability is due to significant higher economic yields, higher gross returns and net returns.

Based on the above results it can be concluded that, conjunctive use of 25% N through VC and 75% RDF along with soil application of bio-fertilizers (*Azospirillum* and *Bacillus megaterium*) @ 5 kg ha^{-1} for baby corn and application of 100% RDF with *Bradyrhizobium* seed treatment to hyacinth bean during *rabi* found better for realization of maximum yield, maximum monetary returns and higher system productivity and profitability.

Table.1 Effect of integrated nutrient management practices on system productivity (kg ha^{-1} year^{-1} and kg ha^{-1} day^{-1}) of baby corn-hyacinth bean cropping system

Treatments	Pooled Mean data of two years (2015-16 and 2016-17)			
	Baby corn yield (kg ha^{-1})	BEY (kg ha^{-1})	System Productivity (kg ha^{-1} year^{-1})	System Productivity (kg ha^{-1} day^{-1})
Main treatments- (*Kharif*-Baby corn)				
T_1- 25% N through FYM + 75% RDF	1549	1954	3502	9.60
T_2- 25% N through FYM + 75% RDF + *Azospirillum* and *Bacillus megaterium* @ 5 kg ha^{-1} each	1700	1996	3696	10.13
T_3- 25% N through VC + 75% RDF	1701	1921	3622	9.92
T_4- 25% N through VC + 75% RDF + *Azospirillum* and *Bacillus megaterium* @ 5 kg ha^{-1} each	1970	1948	3918	10.73
T_5- 100% RDF	1507	1629	3135	8.59
T_6- 100% RDF + *Azospirillum* and *Bacillus megaterium* @ 5 kg ha^{-1} each	1680	1697	3377	9.25
T_7- Control (No fertilizer application)	786	1486	2272	6.22
S.Em±	40	26	44	0.12
C.D. (P=0.05)	123	81	134	0.37
Sub-treatments– (*Rabi*- hyacinth bean)				
S_1-100% RDF	1589	1841	3431	9.40
S_2-75% RDF	1501	1682	3183	8.72
S_3-100% RDF + *Bradyrhizobium* @ 500 g ha^{-1}Seed treatment	1611	1912	3523	9.66
S_4-75% RDF + *Bradyrhizobium* @ 500 g ha^{-1} Seed treatment	1522	1784	3305	9.06
S.Em±		21	22	0.06
C.D. (P=0.05)		61	64	0.17

BEY: Baby corn equivalent yield

Table.2 Effect of integrated nutrient management practices on gross returns, CoC, net returns and system profitability (Rs ha^{-1} day^{-1}) of baby corn-hyacinth bean cropping system

Treatments	Pooled mean data of two years (2015-16 and 2016-17)			
	Grossreturns (Rs ha^{-1})	CoC (Rs ha^{-1})	Netreturns (Rs ha^{-1})	SystemProfitability (Rs ha^{-1} day^{-1})
Main treatments- (*Kharif*-Baby corn)				
T_1- 25% N through FYM + 75% RDF	318453	84119	234335	642.0
T_2- 25% N through FYM + 75% RDF + *Azospirillum* and *Bacillus megaterium* @ 5 kg ha^{-1} each	336243	85145	251099	687.9
T_3- 25% N through VC + 75% RDF	330957	86832	244126	668.8
T_4- 25% N through VC + 75% RDF + *Azospirillum* and *Bacillus megaterium* @ 5 kg ha^{-1} each	358595	88346	270250	740.4
T_5- 100% RDF	289254	76303	212952	583.4
T_6- 100% RDF + *Azospirillum* and *Bacillus megaterium* @ 5 kg ha^{-1} each	310219	77423	232797	637.8
T_7- Control (No fertilizer application)	207749	66560	141190	386.8
S.Em+	3714		3714	10.2
C.D. (P=0.05)	11445		11445	31.4
Sub-treatments– (*Rabi*- hyacinth bean)				
S_1-100% RDF	319205	80877	232480	636.95
S_2-75% RDF	306743	80340	211934	580.65
S_3-100% RDF + *Bradyrhizobium* @ 500 g ha^{-1}Seed treatment	324659	81077	240032	657.65
S_4-75% RDF + *Bradyrhizobium* @ 500 g ha^{-1} Seed treatment	315175	80405	222245	608.9
S.Em+	1811		1811	4.965
C.D. (P=0.05)	5169		5169	14.15

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