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Influence of Integrated Nutrient Management Practices on Dry Matter Production and Nutrient Uptake of Baby Corn in Baby Corn (*Zea mays*. L) - Hyacinth Bean (*Lablab purpureus* var *typicus*) Cropping System

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A B S T R A C T

A field experiment was conducted at Horticultural Research Station, Adilabad during *kharif*, 2015 and 2016 to study the effect of integrated nutrient management practices on dry matter production and nutrient uptake by baby corn in 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 25% N supplemented through FYM or vermicompost + 75% RDF (Recommended dose of fertilizer150:60:60 N, P_2O_5 and K_2O ha^{-1}) with or without *Azospirillum* and *Bacillus megaterium* @ 5 kg ha^{-1} each and control (no fertilizer application) and replicated thrice. 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 to hyacinth bean in *rabi* season and data of *kharif*, 2016 was analyzed in split plot design. Application of vermicompost (25% N) in combination with 75% RDF along with bio-fertilizers recorded significantly higher DMP over rest of the treatments at all growth periods of study during both the years except that 15 DAS in which it was on par with other treatments. Use of bio-fertilizers to baby corn in conjunction with 100% or 75% RDF integrated with 25% N through FYM and 75% RDF integrated with 25% N through vermicompost resulted in significantly higher DMP at 30 and 45 DAS over un-fertilized control, 100% RDF and 75% RDF integrated with 25% N through FYM during both the years of study. Combined application of 75% RDF and 25% N through vermicompost in-additions bio-fertilizers incorporation showed significantly higher N, P and K uptake over integration of 75% RDF with 25% N through vermicompost, integration of 75% RDF with 25% N through FYM with or without bio-fertilizer, 100% RDF with or without bio-fertilizer and un-fertilized control.

Introduction

Maize is classified into different types or groups based on the endosperm of kernels and among which baby corn is grown for vegetable purpose. Baby corn is the shank with un-pollinated silk. It is a delicious and nutritive vegetable which provide

carbohydrate, protein, fat, sugar, minerals and vitamins. 100 g of baby corn contain 89.1% moisture, 1.9 g protein, 0.2 g fat, 0.06 g ash, 8.2 mg carbohydrate, 28 mg calcium, 86 mg phosphorus and 11 mg ascorbic acid (Thavaprakash *et al.,* 2005). Recently baby corn has gained popularity in Delhi, UP, Haryana, MH, Karnataka, Telangana and Andhra Pradesh. Pickles and canned baby corns have great potential for export in European and American markets.

Lablab bean or hyacinth bean is one of the most ancient among the cultivated legumes and the crop is indigenous to India, grown all over the country. The crop is put to multipurpose uses such as pulse, vegetable, fodder and green manure. The dwarf, bushy types are determinate, photo insensitive and can be cultivated throughout the year. Dwarf varieties (determinate or bush-type) have a potential for more extensive cultivation of the crop, because of the plants require no support system, the pods mature uniformly and the crop is amenable to mechanical harvesting which will reduce cost and labour.

Fertilizer is by and large the most important resource affecting the production and productivity of any cropping system. In maize based cropping system, indiscriminate use of fertilizer is practiced to enhance productivity and profitability. The imbalanced and indiscriminate use of chemical fertilizer in intensive cropping system has resulted in deterioration of soil health and decline in factor productivity (Kumar *et al.,* 2008). The application of indiscriminate use of chemical fertilizers is posing several problems, although its application assist in obtaining maximum production, but keeping in view of the hazardous effect on environmental health as well as growing production cost, judicious use of organic and inorganic sources in conjunction with bio-fertilizers will maintain the environment at sustainability for generations without affecting the environmental health (Ranjan *et al.,* 2013, Dadarwal *et al.,* 2009, Kumar *et al.,* 2014). Keeping these view's a study was conducted to evaluate the efficiency of organic manures (FYM and vermicompost) in conjunction with microbial cultures (*Azospirillium and Bacillus megaterium)* and inorganic fertilizer on dry matter production and uptake of nutrients by baby corn in baby corn-hyacinth bean cropping system.

Materials and Methods

The experiment was conducted at Horticultural Research Station farm, Adilabad during *kharif,* 2015 and 2016. 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 electrical conductivity of the soil indicated that the soil is non-saline with EC value of 0.03 and was found to be optimum for arable crop production. The soil belongs to the order Alfisol of shallow to medium depth. The experiment was laid out in a randomized block design during *kharif,* 2015 season with seven treatments comprised of 25% N supplemented through FYM or vermicompost + 75% RDF (Recommended dose of fertilizer, 150:60:60 N, P_2O_5 and K_2O ha^{-1}) with or without *Azospirillum* and *Bacillus megaterium*@ 5 kg ha^{-1} each, and control (no fertilizer application) for baby corn and replicated thrice. Each main treatment was divided into four sub plots and the treatments 100% RDF and 75% RDF with or without *Bradyrhizobium* @ 500 g ha^{-1} (seed treatment), were imposed to hyacinth bean in *rabi*seasonand data of *kharif,* 2016 was analyzed in split plot design.Manures (FYM and vermicompost) and fertilizers (urea, SSP and muriate of potash) were applied as per the

treatment. Manures, P and K as basal at the time of sowingand N in three splits at 4,8 and 12 leaf stages.*Azospirillum* (nitrogen fixing bacterial formulation) and *Bacillus megaterium* (phosphorus solubilizing bacterial formulation) @ 5 kg ha^{-1} each was applied to soil after incubation with 50 kg FYM for baby corn as per the treatments. G-5414 variety of baby corn (50-55 days duration) 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 (DAS). Atrazine @1.0 kg a.i ha^{-1} applied two DAS and hand weeding at 15 and 30 DAS to maintain the fields weed free condition.The field was irrigated immediately after sowing. Subsequent need based irrigation were given as and when required.

Five plants from net plot area were used for estimating leaf area were separately sun dried and later oven dried at 65°C, till constant weight was obtained and the weights were recorded at 15, 30, 45 DAS and at harvest and expressed as kg ha^{-1}. Nitrogen content (%) in plant sample was estimated by the micro-kjeldhal method (AOAC, 1965). The P content in the tri-acid digest was determined by vanadomolybdo phosphoric acid yellow colour method (Piper, 1966). The intensity of yellow colour developed was measured by using spectrophotometer at 420 µm wave length. The potassium in the tri-acid digest was determined by using flame photometer (AOAC, 1965). The N, P and K uptake was calculated using the formula as shown below and is expressed in kg ha^{-1}.

$$\text{N, P or K uptake (kg ha}^{-1}\text{)} = \frac{\text{N, P or K content (\%) x DMP (kg ha}^{-1}\text{)}}{100}$$

The data on observations were analyzed statistically by applying the technique of analysis of variance 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

Dry matter production

There was significant variation in dry matter production (DMP) at different periods among the treatments and the interaction between main and sub treatments were not significant during both the years of study (*kharif*,2015 and 2016). Dry matter production went on increasing with advancement of age of the crop upto harvest, but magnitude of increase was not uniform. The increase was more than double from 15 to 30 DAS and 30 to 45 DAS (Table 1).

During 2015, the DMP ranged from 300 to 337 kg ha^{-1} at 15 DAS and reached maximum at harvest ranging from 3796 kg ha^{-1} in control to 6992 kg ha^{-1} in integration of vermicompost (25% N) and microbes along with 75% RDF. During 2016, the range of DMP was from 282 to 360 kg ha^{-1} at 15 DAS and showed increasing trend upto harvest which ranged from 3459 to 6483 kg ha^{-1} recording lowest with control and highest with vermicompost and bio-fertilizers integrated with chemical fertilizer treatment. Significantly lower DMP was recorded with control in both the years over rest of the treatments at different periods of observation. Application of vermicompost (25%) in combination with 75% RDF along with bio-fertilizers recorded significantly higher DMP over rest of the treatments at all growth periods of study during both the years except that at 15 DAS in which it was on par with other treatments except control.

Use of bio-fertilizers to baby corn in conjunction with 100% RDF or 75% RDF integrated with 25% N through FYM and 75% RDF integrated with 25% N through vermicompost resulted in significantly higher DMP at 30 and 45 DAS over un-fertilized control, 100% RDF alone and 75% RDF integrated with 25% N through FYM during both the years of study. At harvest, integration of 75% RDF with 25% N through vermicompost and 100% RDF in conjunction with bio-fertilizer resulted in significantly higher DMP during 2015 over un-fertilized control and 75% RDF integrated with 25% N through FYM. These results corroborates with the findings of Syahmi *et al.,* 2015, Kolari *et al.,* 2014, Bunker *et al.,* 2013, KanuMurmu *et al.,* 2013.Vermicompost in combination with 75% RDF was better in improving the DMP than FYM. Use of vermicompost in conjunction with bio-fertilizer, apart from improving soil physical, chemical and biological properties might have also released adequate quantities of nitrogen and phosphorous to boost up the growth of the crop there by increasing the dry matter production. Beneficial effect of vermicompost may also be attributed to the fact that, it contains appreciable quantities of magnesium apart from other plant nutrients, which might have helped in synthesis of chlorophyll.

The observations of this study also confirm the statement as indicated by nutrient uptake by the crop (Table 2). These results are also in line with findings of Oktem *et al.,* 2010 and Khadtare *et al.,* 2006.

Application of bio-fertilizers either with organics in conjunction with 75% RDF or with 100% RDF improved the DMP than respective treatments without bio-fertilizers. Similarly, application of FYM or vermicompost along with 75% RDF resulted in higher DMP than 100% RDF. Application of bio fertilizers might have resulted in besides fixing nitrogen secreted growth promoting substances such as IAA, GA3 and Cytokines which favoured for better growth of babycorn.

Residual effect of 100% or 75% RDF alone or with bio-fertilizers applied to hyacinth bean significantly influenced the DMP of baby corn at all periods of data recorded. Seed treatment to hyacinth bean crop with *Bradyrhizobium* along with 100% RDF during preceding *rabi* resulted in significantly higher DMP of succeeding baby corn crop during *kharif* over rest of the treatments at all periods of study except at harvest where in it was on par with 100% RDF applied to hyacinth bean. Significantly lower residual effect was observed with 75% RDF applied to hyacinth bean than 100% RDF applied alone or with *Bradyrhizobium* seed treatment.

Nutrient uptake

Nitrogen uptake (kg ha^{-1})

Significant variation was noticed among different treatments in the nitrogen uptake during both the years of study (*kharif*, 2015 and 2016). The nitrogen uptake ranged from 39.84 kg ha^{-1} and 34.94 kg ha^{-1} in control treatment to 136.80 kg ha^{-1} and 124.07 kg ha^{-1} during 2015 and 2016 respectively in integration of 75% RDF with 25% N through vermicompost in-conjunction with bio-fertilizers (*Azospirillum* and *Bacillus megaterium*). The interaction between main and sub treatments was not significant.

Combined application of 75% RDF and 25% N through vermicompost in-additions bio-fertilizers incorporation showed significantly higher N uptake over integration of 75% RDF with 25% N through vermicompost, integration of 75% RDF with 25% N through FYM with or without bio-fertilizer, 100% RDF with or without bio-fertilizer and un-

fertilized control (Table 2). The higher uptake of N might be due to higher availability of nitrogen due to application of vermicompost. Sharma and PabitraBanik, 2014 and AshishShivran *et al.,* 2015, reported similar results of higher N uptake with integration of in-organic sources of nutrition with organic manures (vermicompost).

Incorporation of organic manure (FYM @ 25% N) integrated with 75% RDF recorded significantly higher N uptake over un-fertilized control and was at par with 100% RDF during both the years of study.

Combined application of 75% RDF with 25% N through vermicompost showed significantly higher N uptake over 100% RDF, integration of 75% RDF with 25% N through FYM and un-fertilized control during both the years of study but was at par with 100% RDF in conjunction with the use of bio-fertilizer and integration of 75% RDF with 25% N through FYM in conjunction with the use of bio-fertilizer during *kharif,* 2015 and 2016.

Application of 100% RDF to hyacinth bean crop during preceding *rabi* resulted in significantly higher N uptake of baby corn in the succeeding *kharif* over 75% RDF with or without seed treatment with *Bradyrhizobium* and was at par with 100% RDF with *Bradyrhizobium* seed treatment.

Phosphorus uptake (kg ha^{-1})

The phosphorus uptake ranged from 4.31 kg ha^{-1} and 3.78 kg ha^{-1} in control treatment to 14.81 kg ha^{-1} and 13.47 kg ha^{-1} during the years of 2015 and 2016 respectively in integration of 75% RDF with 25% N through vermicompost in-conjunction with bio-fertilizers (*Azospirillum* and *Bacillus megaterium*). The interaction between main and sub treatments was not significant.

Application of 75% RDF along with 25% N through vermicompost in conjunction with bio-fertilizers (*Azospirillum* and *Bacillus megaterium*) resulted in significantly higher phosphorus uptake during both the years of study (*kharif,* 2015 and 2016) over rest of the treatments (Table 2).

Use of 75% RDF along with 25% N through FYM reported significantly higher phosphorus uptake over un-fertilized control and was at par with 100% RDF during both the years of study. Integration of 75% RDF with 25% N through FYM in conjunction with the use of bio-fertilizer showed significantly higher phosphorus uptake over 100% RDF, integration of 75% RDF with 25% N through FYM during both the years of study and was at par with integration of 75% RDF with 25% N through vermicompost and 100% RDF along with bio-fertilizer.

Residual effect with application of 100% RDF (chemical fertilizers) to preceding hyacinth bean crop during *rabi,* 2015-16 resulted in significantly higher phosphorus uptake in succeeding baby corn over 75% RDF with or without seed treatment with *Bradyrhizobium* and was at par with 100% RDF along with seed treatment with *Bradyrhizobium*. These results corroborates the findings of AshishShivran *et al.,* 2015, and Dadarwal *et al.,* 2009 who reported higher phosphorus uptake with integration of vermicompost with chemical fertilizers.

Potassium uptake (kg ha^{-1})

Perusal of data presented in Table 2 indicated that there was significant variation among the treatments mean due to different treatments imposed and the potassium uptake varied from 53.94 kg ha^{-1} to 184.94 kg ha^{-1} during *kharif,* 2015 and 47.42 kg ha^{-1} to 167.54 kg ha^{-1} during *kharif,* 2016. The interaction between main and sub treatments was not significant.

Table.1 Effect of integrated nutrient management practices on dry matter production (kg ha^{-1}) of baby corn at different stages during *kharif*, 2015 and 2016

Treatment given to *kharif* baby corn	2015				2016			
	15 DAS	30 DAS	45 DAS	Harvest	15 DAS	30 DAS	45 DAS	Harvest
T_1- 25% N through FYM + 75% RDF	328	1585	4397	5609	314	1521	4232	5532
T_2- 25% N through FYM + 75% RDF + *Azospirillum* and *Bacillus megaterium* @ 5 kg ha^{-1} each	330	1680	4942	5959	323	1606	4761	5762
T_3- 25% N through Vermicompost + 75% RDF	333	1689	4987	6078	339	1629	4910	5750
T_4- 25% N through Vermicompost + 75% RDF + *Azospirillum* and *Bacillus megaterium* @ 5 kg ha^{-1} each	337	2107	5514	6992	360	1859	5330	6483
T_5- 100% RDF	326	1576	4301	5620	309	1507	4174	5717
T_6- 100% RDF + *Azospirillum* and *Bacillus megaterium* @ 5 kg ha^{-1} each	329	1668	4912	6061	321	1588	4719	5831
T_7- Control (No fertilizer application)	300	558	1913	3796	282	695	2185	3459
S.Em±	5	24	140	126	18	16	113	78
C.D. (P=0.05)	15	73	432	388	56	48	347	239
Treatment given to *rabi* crop (hyacinth bean)								
S_1- 100% RDF					316	1492	4346	5659
S_2- 75% RDF					295	1447	3841	5222
S_3-100% RDF + *Bradyrhizobium* @ 500 g ha^{-1} (Seed treatment)					359	1529	4895	5776
S_4- 75% RDF + *Bradyrhizobium* @ 500 g ha^{-1} (Seed treatment)					314	1477	4238	5362
S.Em±					10	15	83	74
C.D. (P=0.05)					28	44	237	211
Interaction								
Bean treatment means at same level of baby corn INM treatments								
S.Em±					26	41	220	196
C.D. (P=0.05)					NS	NS	NS	NS
INM treatment means of baby corn at same level of bean treatments								
S.Em±					29	39	221	186
C.D. (P=0.05)					NS	NS	NS	NS

Table.2 Effect of integrated nutrient management practices on nutrient uptake (kg ha^{-1}) of baby corn during *kharif*,2015 and 2016

Treatment given to *kharif* baby corn	Nutrient Uptake (kg ha^{-1})					
	2015			2016		
	N	P	K	N	P	K
T_1- 25% N through FYM + 75% RDF	82.48	8.94	129.15	80.76	8.76	126.36
T_2- 25% N through FYM + 75% RDF + *Azospirillum* and *Bacillus megaterium* @ 5 kg ha^{-1} each	102.78	11.15	160.72	97.64	10.61	152.28
T_3- 25% N through Vermicompost + 75% RDF	101.69	11.02	137.28	94.46	10.27	127.24
T_4- 25% N through Vermicompost + 75% RDF + *Azospirillum* and *Bacillus megaterium* @ 5 kg ha^{-1} each	136.80	14.81	184.94	124.07	13.47	167.54
T_5- 100% RDF	81.16	8.80	109.59	82.43	8.94	111.35
T_6- 100% RDF + *Azospirillum* and *Bacillus megaterium* @ 5 kg ha^{-1} each	95.79	10.40	129.15	91.78	9.97	123.71
T_7- Control (No fertilizer application)	39.84	4.31	53.94	34.94	3.78	47.42
S.Em+	3.09	0.33	4.77	2.08	0.22	2.97
C.D. (P=0.05)	9.53	1.03	14.70	6.40	0.69	9.17
Treatment given to *rabi*crop (hyacinth bean)						
S_1- 100% RDF				91.14	9.89	128.94
S_2- 75% RDF				84.71	9.19	119.93
S_3-100% RDF + *Bradyrhizobium* @ 500 g ha^{-1} (Seed treatment)				88.12	9.58	124.06
S_4- 75% RDF + *Bradyrhizobium* @ 500 g ha^{-1} (Seed treatment)				82.36	8.95	116.16
S.Em+				1.56	0.17	2.24
C.D. (P=0.05)				4.46	0.48	6.39
Interaction						
Bean treatment means at same level of baby corn INM treatments						
S.Em+				4.13	0.44	5.92
C.D. (P=0.05)				NS	NS	NS
INM treatment means of baby corn at same level of bean treatments						
S.Em+				4.14	0.44	5.93
C.D. (P=0.05)				NS	NS	NS

Among the various treatments imposed, integration of 75% RDF with 25% N through FYM or vermicompost in conjunction with bio-fertilizers recorded significantly higher potassium uptake over 100% RDF with or without use of bio-fertilizer, integration of 75% RDF with 25% N through FYM or vermicompost and unfertilized control (Table 2). AshishShivran *et al.,* 2015, Sharma and PabitraBanik 2014 and Dadarwal *et al.,* 2009 reported similar results of higher potassium uptake with integration of vermicompost with chemical fertilizers.

Integration of 75% RDF with 25% N through FYM showed significantly higher potassium uptake over 100% RDF and un-fertilized control during both the years of study and was at par with 100% RDF along with the use of bio-fertilizer.

Application of 100% RDF to preceding hyacinth bean crop during *rabi*, 2015-16 resulted in significantly higher uptake of potassium in succeeding *kharif*, 2016 over 75% RDF with or without seed treatment with *Bradyrhizobium* but was at par with 100% RDF along with seed treatment with *Bradyrhizobium*.

Higher dry matter production might have laid to higher uptake of nitrogen and in general when the uptake of nitrogen is more, the crop would have a tendency to absorb more phosphorus and potassium. The built up of vigorous growth and higher photosynthetic rate might have laid to better uptake of nutrients by the crop. Improvement of nutrient uptake due to organic manures was also reported by Cooperband *et al.,* 2002 and with bio fertilizer usage by Singh and Totawat (2002).

In conclusions, application of vermicompost (25%N) in combination with 75% RDF along with bio-fertilizers is recommended for higher plant growth and nutrient uptake followed by integration of 75% RDF with 25%N through vermicompost, integration of 75% RDF with 25% N through FYM in conjunction with bio-fertilizers and 100% RDF in-conjunction with bio-fertilizers over 100% RDF or unfertilized control.

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