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SOIL SCIENCE

Integrated Nutrient Management in Baby Corn and its Residual Effect on Green Gram Under Rainfed Ecosystem of Odisha

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ABSTRACT

Experimental results revealed that **i**ntegrated application of 75% RDF + vermicompost @ 2.5 t/ha + mixed bio-fertilizers (*Azosirillum + Azotobacter* + phosphorus solubilizing bacteria) significantly augmented the baby corn yield attributes along with baby corn (1.50 t/ha) and green forage (26.03 t/ ha) yield. The conjunctive use of 75% RDF + FYM @ 5 t /ha + mixed bio fertilizers applied to preceding baby corn recorded the maximum seed yield (620 kg/ha) and stick yield (950 kg/ha) in green gram being at par with residual effect of 75% RDF + vermicompost @ 2.5 t/ha + mixed bio fertilizers. The system yield was enhanced with application of 75% RDF + vermicompost @ 2.5 t/ha + mixed bio-fertilizers applied to baby corn producing the baby corn equivalent yield (2.20 t/ha) being remained at par with 75% RDF + FYM @ 5 t /ha + mixed bio-fertilizers. Application of 75% RDF + vermicompost @ 2.5 t/ha + mixed bio-fertilizers registered the highest gross return (₹ 159131/ha) in baby corn green gram system when green gram was grown under residual fertility condition. But the combined use of 75% RDF + 5 t FYM/ha + mixed bio fertilizer in preceding baby corn incurred the maximum net return (₹ 102269/ha) and benefit cost ratio of 2.82 in baby corn -green gram sequence.

Highlights

- System yield and gross return was enhanced with application of 75% NPK + vermicompost @ 2.5 t/ ha + mixed bio fertilizers.
- 75% RDF + 5 t FYM/ha + mixed bio-fertilizer in preceding baby corn incurred the maximum net return and benefit cost ratio in babycorn -green gram sequence

Keywords: baby corn-green gram system, integrated nutrient management

Baby corn is a delicious and nutritive vegetable rich in carbohydrates, protein, fat, sugar, minerals and vitamins in palatable, wholesome, hygienic and digestible form. Baby corn finds a prominent place in most of the intensive cropping systems due to its short duration, wider adaptability, high yielding ability and fast growing habit enabling it a potential alternative for diversification and value addition. Integrated nutrient management as one of the production technology contributes substantially towards higher productivity and maintenance of soil fertility. The productivity of cropping system depends on efficient utilization of residual and cumulative nutrients. Judicious combination of organics like FYM, vermicompost and green manures with bio-fertilizers and chemical fertilizers will facilitate profitable and sustainable production. In addition to NPK, sulphur is becoming a limiting factor in crop production due to it's deficiency by use of high yielding varieties and sulphur free fertilizers along with low or no use of organic source of nutrients in intensive cropping systems thereby needs prioritization in plant nutrition (Nader and Nadia 2011**)**. Among the micronutrients,

zinc deficiency appears to be the most widespread owing to intensive agricultural practices, use of high purity NPK fertilizers and limited or no application of Zinc by farmers (Rakshit *et al.* 2017; Meena *et al*. 2013). Boron is essential for the development of reproductive tissues and its deficiency results in low grain set. Pulses are considered as rich source of protein for vegetarian people and maintain soil fertility through biological nitrogen fixation. Green gram grown both as a catch crop in between two main seasons can be suitably grown after baby corn in residual soil moisture and fertility condition under rainfed ecosystem. The information related to integrated nutrient management in baby corn and its residual effect on green gram is scanty .Therefore, the present investigation was undertaken with an objective to find out the effect of integrated nutrient management on growth and yield of baby corn and it's residual effect on green gram under rainfed ecosystem in Odisha.

MATERIALS AND METHODS

The experiment was conducted in the Agronomy Main Research Station, College of Agriculture, Orissa University of Agriculture and Technology, Bhubaneswar, Odisha. The experimental soil was acidic (pH-5.1) sandy loam in texture, low in organic carbon (0.45 %) and low in available N (126.46 kg /ha), K (114.7 kg /ha), S (18.24 kg/ha), Zn(1.84 kg/ ha) and B (1.24 kg/ha) and medium in available P (14.57 kg/ ha), The field experiment was laid out in factorial randomized block design with 20 treatment combinations in the plot size of 5.4 m x 4.5 m. The baby corn variety, VL Baby Corn 1 and green gram variety, Durga were the test varieties in baby corn – green gram cropping sequence. The experiment was conducted in 2012 and 2013 with twenty treatments combination comprised of fertility levels of recommended dose of fertiliser (120:60:60 N: P_2O_5: K_2O Kg /ha), 75% recommended dose of fertiliser + 5 t FYM/ha + *Azospirillum* + *Azotobacter* + Phosphorus solubilizing bacteria,75% recommended dose of fertiliser + vermicompost @ 2.5 t/ha + *Azosirillum* + *Azotobacter* + Phosphorus solubilizing bacteria and 75% recommended dose of fertilizer + green manuring with sunhemp + *Azosirillum* + *Azotobacter* + Phosphorus solubilizing bacteria and secondary and micronutrient levels of no secondary and micronutrient, 5 kg Zn/ha, 40 kg S/ha, 40 kg S/ha + 5 kg Zn /ha and 40 kg S/ha + 5 kg Zn/ha + 2.5 kg B/ ha. After harvest of baby corn, the green gram was sown on under residual environmental condition. The biometric observations were recorded on baby corn and green gram at harvest. The economics of cultivation was computed basing upon the prevailing market prices of the local area.

RESULTS AND DISCUSSION

Effect of Fertility levels on yield and yield attributes of baby corn

The data depicted in Table 1 indicated that application of integrated nutrient management practice's exerted the significant effect on pooled yield attributes and green forage yield of baby corn along with baby corn yield during 2012 and 2013 as well as it's pooled value. The combined application of 75% RDF + organic manure as vermicompost @ 2.5 t/ha with + mixed biofertilizer (*Azotobacter* + *Azospirillum* + Phosphorous solubilizing bacteria) markedly augmented the yield attributes like number of cobs /plant (2.82), length of baby corn (9.28 cm), girth of baby corn (4.99 cm) and baby corn weight (8.45 g). It corroborated with the findings of Thavaprakash *et al*. (2015). Integrated use of 75% RDF + vermicompost @ 2.5 t/ha with mixed bio fertilizers increased the baby corn yield during both the years and pooled yield of baby corn (1.50 t/ha) and green forage (26.03 t/ha). It was in agreement with the findings of Thavaprakash *et al*. (2015); Dadarwal *et al.* (2009) and Rasool *et al.* (2015). The said treatment was found to remain at par with 75% RDF + FYM @ 5 t/ha with mixed bio-fertilizers and 100% RDF. The favorable effect of integrated nutrient supply in improving the yield components of baby corn was resulted in enhancement of baby corn yield. Increase in yield and its attributes observed with integrated application of inorganic, organic and bio -fertilizer is ascribed to better translocation, utilization of applied nutrients which increased sink capacity and partitioning of photosynthates.

Effect of secondary and micronutrient levels on yield and yield attributes of baby corn

The pooled yield attributes of baby corn such as number of cobs/plant (2.88), length of baby corn (9.32 cm), girth of baby corn (5.01 cm) and baby corn weight (8.53 g) and pooled baby corn yield (1.54 t/

Table 1: Effect of integrated nutrient management on yield and yield attributes of baby corn (Average value of two years)

Treatments	Baby corn / plant	Baby corn length (cm)	Baby corn girth(cm)	Baby corn weight (g)	Baby corn yield (t/ha)			Green forage yield (t/ha)
					2012	2013	Pooled	
Fertility levels								
RDF (120:60:60 N:P_2O_5:K_2O Kg/ha)	2.76	9.17	4.84	8.23	1.29	1.58	1.44	25.59
75% RDF + 5 t FYM/ ha+ Azs + Azb + PSB	2.79	9.24	4.89	8.27	1.31	1.64	1.48	25.65
75 % RDF + 2.5 t VC /ha + Azs + Azb+ PSB	2.82	9.28	4.99	8.45	1.33	1.65	1.50	26.03
75 % RDF + GM (Sunhemp) + Azs + Azb+ PSB	2.66	8.76	4.61	7.99	1.18	1.47	1.32	24.66
SEm±	0.03	0.07	0.06	0.07	0.03	0.04	0.02	0.30
CD (P=0.05)	0.08	0.22	0.18	0.21	0.09	0.13	0.07	0.88
Secondary and Micronutrient levels								
No nutrient	2.50	8.68	4.63	7.82	1.06	1.43	1.24	24.65
5 kg Zn/ha	2.79	9.17	4.88	8.18	1.27	1.61	1.42	25.64
40 kg S/ha	2.73	9.16	4.77	8.15	1.25	1.58	1.43	25.13
40 kg S/ha+ 5 kg Zn/ha	2.88	9.23	4.87	8.51	1.37	1.65	1.52	25.83
40 kg S/ha+ 5 kg Zn/ha +2.5 kg B/ha	2.88	9.32	5.01	8.53	1.44	1.66	1.54	26.17
SEm±	0.03	0.08	0.07	0.08	0.03	0.04	0.03	0.33
CD (P=0.05)	0.09	0.24	0.20	0.23	0.10	0.15	0.08	0.99
Interaction(FxM)								
SEm±	0.06	0.16	0.13	0.16	0.07	0.09	0.05	6.71
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS

RDF- Recommended dose of fertilizer, FYM- Farm yard manure, VC- Vermicompost , GM- Green manuring, Azs- Azospirillum, Azb- Azotobacter, PSB- Phosphorus solubilizing bacteria.

ha) as well as green fodder yield (26.17 t/ha) were the highest with application of 40 kg S/ha + 5kg Zn/ha + 2.5 kg B/ha (Table 1). The increased yield attributes due to sulphur and zinc nutrition resulted in chlorophyll formation which had positive effect on photosynthesis, translocation of metabolites and growth regulating substances, oxidation and metabolic activities, there by augmented the yield attributes and yield. The favourable effect of applied S, Zn and B had positive influence on physiological and metabolic process of plant which ultimately augmented baby corn and fodder yield. This result was in pipeline with earlier work done by Kumar and Bhora (2014).

Residual effect of fertility levels on yield and yield attributes of green gram

The mean yield attributing characters and yield in 2012 and 2013 along with pooled stover yield of green gram were significantly affected by carry over effect of integrated use of inorganic and organic sources of nutrients along with mixed bio fertilizers (Table 2). Application of 75% RDF + FYM@ 5 t/ha + mixed bio fertilizers applied to preceding baby corn recorded the maximum number of branches/ plant (3.61), pods/plant (6.71), seeds/pod (16.52) and 1000 seed weight (34.01 g) consequently increased the seed yield (620 kg/ha) and stover yield (950 kg/ ha). It was followed by residual effect of 75% RDF + vermicompost @ 2.5 t/ha + mixed bio fertilizers with respect to yield attributes and yield. It was possible due to favourable carry over effect of INM treatment in increasing the crop growth which in turn boosted the yield components there by enhanced the yield. The higher residual availability of nutrients under the treatments receiving the organic sources in

Table 2: Residual effect of integrated nutrient management in corn on yield and yield attributes of green gram (Average value of two years)

Treatments	Branches / plant	Pods/plant	Seeds/pod	1000 seed weight (g)	Seed yield (kg/ha)			Stover yield (t/ha)
					2012	2013	Pooled	
Fertility levels								
RDF (120:60:60 N:P_2O_5:K_2O Kg/ha)	3.39	6.25	15.45	33.68	514	531	523	802
75% RDF + 5 t FYM/ ha+ Azs + Azb + PSB	3.61	6.71	16.52	34.01	595	645	620	950
75 % RDF + 2.5 t VC/ha + Azs + Azb+ PSB	3.56	6.57	16.09	33.86	577	642	609	930
75% RDF + GM (Sunhemp) + Azs + Azb+ PSB	3.43	6.43	15.84	33.73	566	636	601	896
SEm±	0.03	0.06	0.11	0.31	10.2	7.1	7.8	13
CD(P=0.05)	0.09	0.19	0.34	0.91	29.3	20.2	23	38
Secondary and Micronutrient levels								
No nutrient	3.44	6.05	15.41	33.21	508	569	539	818
5 kg Zn/ha	3.46	6.37	15.77	33.30	549	594	571	875
40 kg S/ha	3.49	6.49	16.12	33.97	572	614	593	908
40 kg S/ha+ 5 kg Zn/ha	3.53	6.73	16.25	34.20	584	636	610	924
40 kg S/ha+ 5 kg Zn/ha +2.5 kg B/ha	3.55	6.80	16.33	34.41	602	653	627	949
SEm±	0.03	0.07	0.13	0.34	11.5	7.9	8.7	14
CD(P=0.05)	NS	0.21	0.38	1.02	32.8	22.7	26.0	42
Interaction (F×M)								
SEm±	0.06	0.14	0.26	0.69	22.9	15.8	17.4	28.8
CD(P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS

RDF- Recommended dose of fertilizer, FYM- Farm yard manure, VC- Vermicompost , GM- Green manuring, Azs- Azospirillum, Azb- Azotobacter, PSB- Phosphorus solubilizing bacteria.

the form of FYM, vermicompost was possible due to addition of organic matter serving as the store house of nutrients. Similar positive residual effect of organic sources of nutrient applied to previous crop in increasing the yield and yield attributes of green gram was evidenced from the work of Meena *et al*. (2012).

Residual effect of secondary and micronutrient levels on yield and yield attributes of green gram

The combined application of 40 kg S/ha + 5 kg Zn/ha + 2.5 kg B/ha to baby corn exerted significant effect in increasing the yield components like number of branches /plant (3.55), number of pods /plant (6.80), number of seeds/pod (16.33) and test weight (34.41 g) along with seed (627 kg/ha) and stover (949 kg/ha) yield of green gram grown under residual fertility (Table 2). The favourable carry over effect of secondary and micronutrients resulted in increasing the yield attributes which reflected seed yield of green gram. Similar favourable residual effect of RDF with FYM or vermicompost + zinc sulphate + ferrous sulphate applied to baby corn had positive effect on chickpea in increasing the yield and yield attributing characters reported earlier by Asoka *et al.* (2008).

Baby corn – green gram system yield

System yield in baby corn – green gram system expressed in baby corn equivalent yield (BEY) was significantly influenced by adoption of integrated nutrient management practices (Table 3). The pooled system yield was augmented with 75% RDF + vermicompost @ 2. 5 t/ha + mixed bio fertilizers applied to baby corn producing the BEY (2.20 t/

Table 3: System yield and pooled economics as influenced by integrated nutrient management in baby corn and its residual Effect on green gram in baby corn- green gram sequence (Average value of two years

Treatments	System yield in baby corn equivalent yield (t/ha)			Cost of cultivation (₹/ha)	Gross Return (₹/ha)	Net Return (₹/ha)	Benefit- cost ratio
	2012	2013	pooled				
Fertility levels							
RDF (120:60:60 N:P_2O_5:K_2O Kg/ha)	1.89	2.20	2.05	55054	149288	94234	2.71
75% RDF + 5 t FYM/ha+ Azs + Azb + PSB	2.00	2.39	2.19	56019	158288	102269	2.82
75% RDF + 2.5 t VC/ha + Azs + Azb + PSB	2.01	2.40	2.20	57029	159131	102102	2.79
75% RDF + GM (Sunhemp) + Azs + Azb+ PSB	1.84	2.21	2.03	54779	147100	92321	2.68
SEm±	0.03	0.04	0.03	—	1626	1626	0.02
CD(P=0.05)	0.09	0.13	0.08	—	4813	4813	NS
Secondary and Micronutrient levels							
No nutrient	1.65	2.09	1.87	53844	137823	83979	2.56
5 kg Zn/ha	1.91	2.30	2.10	54904	152675	97771	2.78
40 kg S/ha	1.92	2.30	2.11	55569	152610	97041	2.75
40 kg S/ha+ 5 kg Zn/ha	2.05	2.39	2.22	56810	160002	103192	2.82
40 kg S/ha+ 5 kg Zn/ha +2.5 kg B/ha	2.15	2.42	2.28	57475	164151	106676	2.86
SEm±	0.03	0.05	0.03	—	1818	1818	0.03
CD(P=0.05)	0.10	0.14	0.09	—	5381	5381	0.10
Interaction(FxM)							
SEm±	0.10	0.14	0.06		3636	3636	0.07
CD(P=0.05)	NS	NS	NS		NS	NS	NS

RDF- Recommended dose of fertilizer, FYM- Farm yard manure, VC- Vermicompost , GM- Green manuring, Azs- Azospirillum, Azb- Azotobacter, PSB- Phosphorus solubilizing bacteria.

ha) being remained at par with 75% RDF + FYM @ 5t/ha + mixed bio fertilizers when green gram was grown with carryover effect. It was possible due to conjunctive use of organic manure and inorganic NPK sources of nutrient mixed with bio fertilizers applied to baby corn enhanced the yield of baby corn and succeeding green gram under residual condition which ultimately increased the system productivity. It was in agreement with the findings of Meena *et al.* (2012). Application of 40 kg S + 5 kg Zn/ha + 2.5 kg B/ha remarkably increased the system yield in terms of BEY (2.28 t/ha) when green gram succeeded baby corn with residual fertility condition. The judicious use of S + Zn + B in balanced manner increased the efficiency of NPK and added secondary and micronutrient in deficient soil resulted in enhancement of system yield which as reported alike by Shukla (2011).

Economics in Baby corn – green gram system

Integrated use of 75 % RDF + vermicompost @ 2.5 t/ha + mixed bio fertilizers registered the highest gross return (₹ 159131/ha) but use of 75 % RDF + 5 t FYM/ha + mixed bio fertilizer gave maximum net return (₹ 102269/ha) and benefit cost ratio (B:C) of 2.82 (Table 3). Application of 40 kg S/ha + 5 kg Zn/ha + 2.5 kg B/ha gave the highest gross return (₹ 164151/ha), net return (₹ 106676/ha) and benefit-cost ratio of 2.86. This was mainly attributed to the higher system yield obtained through improvement in soil health by judicious integrated nutrient management approach using 75% inorganic NPK with organic manure (FYM or vermicompost) and mixed bio fertilizers along with combination of secondary nutrient (S)+ micro nutrients (Zn and B). Similar favourable effect of inorganic and organic nutrient applied to baby corn and potato and green

gram grown under residual fertility condition in baby corn – potato - green gram sequence was recorded by Meena *et al*. 2012. Asoka *et al*. 2008 also obtained the maximum system economics with combined use of RDF + vermicompost / FYM + zinc sulphate + ferrous sulphate applied to baby corn and chickpea was grown in residual soil fertility in baby corn – chickpea system.

CONCLUSION

It is concluded that integrated application of 75% recommended dose of NPK + FYM @ 5 t/ha or vermi compost @ 2.5 t/ha + mixed bio fertilizer along with combination of 40 kg S/ha + Zn @ 5 kg/ha + B @ 2.5 kg/ha applied to preceding baby corn was found suitable in increasing the yield and economics of baby corn and green gram when green gram was grown under residual fertility condition under baby corn- green gram sequence.

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