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Residual Effect of Integrated Nutrient Management on Growth, Yield and Quality of Vegetable Clusterbean

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Abstract: A field experiment was conducted at Horticulture Farm, College of Agriculture, Bikaner (Rajasthan) to evaluate the residual effect of organic and inorganic sources of nutrients on growth, yield and quality of vegetable clusterbean var. Pusa Navbhar. The results showed that among different growth parameters viz. average plant height (17.41 cm) was maximum under vermicompost. Among different levels of organic manures, 21 t ha^{-1} recorded maximum plant height (20.17 cm). Among different fertilizer doses, application of 100% recommended doses (RD) recorded maximum average plant height (17.26 cm). Similarly with respect to yield attributing parameters, average pod length (8.40 cm), pod yield (41.03 q ha^{-1}) were maximum under vermicompost. Among different levels of organic manures, 21 t ha^{-1} produced maximum average pod length (8.78 cm), average pod weight (8.99 g), pod yield (42.21 q ha^{-1}). Among different fertilizer doses, maximum average pod length (8.17 cm), average pod weight (7.94 g), pod yield (41.43 q ha^{-1}) were recorded under the treatment of 100% RD. Quality parameters viz. nitrogen in pod (1.94%), protein (12.12%) and fibre (9.61%), iron (87.86 ppm), copper (6.81 ppm) and zinc (32.68 ppm) were maximum under vermicompost and phosphorous content was maximum (0.29%) under PROM. However, potassium content showed non-significant differences with respect to different sources of organic manures. Among its various levels, treatment consisting of 21 t ha^{-1} recorded highest nitrogen (1.96%), phosphorous (0.28%), potassium (0.21%), iron (88.71 ppm), copper (6.82 ppm) and zinc (32.45 ppm) in pods of clusterbean.

Key words: Clusterbean, organic sources, integrated nutrient management, residual effect, FYM, PROM.

Clusterbean is mainly grown for fodder and gum and very less for vegetable purpose. However, tender green pods of vegetable guar (clusterbean) are important source of nutrition to human beings and animals as it provides protein and fibre. It is a hardy crop and its cultivation is suitable in arid areas. Hence, there is need to promote clusterbean cultivation as a vegetable. Brinjal and vegetable clusterbean rotation can be beneficial for vegetable growers under arid irrigated condition of Bikaner. Clusterbean grown on residual nutrient of applied organic manures and chemical fertilizers after brinjal can give more profit to the marginal vegetable growers. There is a trend to integrate inorganic fertilizers with organic manures to harvest sustained high yields with better quality (Raina and Jaggi, 2008). The ecofriendly approach goes a long way in improving the soil health also. FYM and vermicompost are the most common and important organic manures used in agriculture. Vermicompost also contains biologically active substances such as plant growth regulators (Krishnamoorthy and Vijranablaiah, 1986). Recently a fortified organic manure PROM (Phosphate Rich Organic Manure) has been brought forth through R&D endeavors of Rajasthan State Mine and Minerals Limited (RSMML, Bikaner) which possesses the potential of replacing phosphatic fertilizer and has been recognized by APEDA as organic manure.

Multiple cropping is a practice of growing two or more crops either together or in succession in a year or in an appropriate span of time on the same piece of land. Recent developments in the field of soil management like frequency and method of tillage, residue management, use of fertilizers and other agro

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chemicals have also made multiple cropping feasible. Leguminous vegetable crops included in the cropping sequences, not only upgrade the protein status of the farm produce but also enhance soil fertility. To improve the productivity, balanced plant nutrition can be an option (Srivastava *et al*., 2009). Keeping the above facts in mind, the present investigation was planned to study the effectiveness of integrating various organic sources with chemical fertilizers in sustainable production of different crops of brinjal-clusterbean cropping system.

Materials and Methods

The field experiment was conducted at Horticulture Farm (28°01'N, 73°22' and 234.7 m above mean sea level), College of Agriculture, Bikaner, Rajasthan. The soils of the site was sandy loam with low fertility and productivity level having bulk density of 1.54 Mg m^{-3}, pH of 8.2, organic carbon content of 0.09%, available N 61.85 kg ha^{-1}, available P 20.91 kg ha^{-1} and available K 178 kg ha^{-1}. The experiment included three different sources of organic manures viz. Farm Yard Manure (FYM) M_1, vermicompost M_2 and Phosphorous Rich Organic Manure (PROM) M_3 as main plot treatments. The nutrients composition of all three organic sources is given in Table 1.

Four levels viz. control (L_0), 7 t ha^{-1} (L_1), 14 t ha^{-1} (L_2) and 21 t ha^{-1} (L_3), of each organic source constituted sub plot treatments. Levels of inorganic fertilizers that included control (F_o), 50% of recommended dose (F_1) and 100% of recommended dose (F_2) served as sub-sub plot treatments. The experiment consisted of 36 treatments combinations, laid out in split plot design with three replications. All organic manures were applied on 15% moisture content basis. Organic manures were applied by hand 21 days before transplanting of brinjal and were incorporated in soil. The recommended fertilizer doses (80:80:60 NPK kg ha^{-1}, respectively) were calculated at 0, 50, and 100% and incorporated 2 days before transplanting as per treatments through urea, single super phosphate and muriate of potash. The treatments were applied to brinjal crop whereas clusterbean crop was raised on the residual fertility of these treatments.

Clusterbean crop was sown on the same field after brinjal. Seeds of clusterbean variety Pusa Navbahar were purchased from National Seeds Corporation and treated with 0.02% thiram to check the infection of damping off. Seeds were sown keeping 30 cm distance between rows. Regular watering, hoeing, weeding, plant protection measures etc. were done from time to time as per standard agronomic practice.

Protein (%) content was calculated by multiplying the per cent nitrogen content in fruit with a constant factor 6.25 (AOAC, 1965) wherein estimation of nitrogen was done by colorimetric method using Nessler's reagent (Snell and Snell, 1939). Fibre content (%) was determined by the standard method in fat free material (AOAC, 1965). Phosphorus content was determined by "Vanadomolybdo phosphoric acid" yellow color method after digestion of the sample using tri-acid mixture (Jackson, 1967). Potassium content in samples was determined in tri-acid digested material using flame photometer (Jackson, 1967). Estimation of Fe, Cu and Zn in fruits was determined by Atomic Absorption Spectrophotometer. Economics of the treatments were computed on the basis of prevailing market rates of produce and agro-inputs. The data collected from the experimental field and laboratory analysis were subjected to statistical analysis by adopting Fischer's method of analysis of variance (Fisher, 1950). The level of significance used in 'F' and 't' test was P=0.05. Critical difference was calculated wherever 'F' test was significant.

Results and Discussion

Data presented in Table 2 revealed that plant height (7.14 cm) was maximum under vermicompost. Among its various levels, 21 t ha^{-1} (7.11 cm) and among fertilizer doses, 100% RD (6.91 cm) recorded maximum plant height in the succeeding crop (vegetable guar).

Table 1. Nutrient composition of various organic manures

Treatments	N (%)	P (%)	K (%)	Fe (ppm)	Cu (ppm)	Zn (ppm)	Mn (ppm)
FYM	0.46	0.19	0.50	900	40	70	278
Vermicompost	1.90	0.89	1.10	1500	42	85	370
PROM	0.45	2.29	0.60	1100	35	73	285

Table 2. Residual effect of conjoint use of organic manures and inorganic fertilizers on growth yield and quality of clusterbean

Treatments	Plant height (cm)	Pod length (cm)	Pod weight (g)	Plot yield (kg)	Yield ha^{-1} (q)	Protein cont. (%)	Fiber cont. (%)
Organic sources							
FYM (M_1)	15.76	7.09	7.49	2.756	38.28	11.35	8.61
VC (M_2)	17.41	8.40	7.65	2.954	41.03	12.12	9.61
PROM (M_3)	16.47	7.62	7.69	2.899	40.26	11.30	9.05
C.D. (5%)	0.96	0.35	NS	0.115	1.60	0.48	0.57
Levels							
Control (L_0)	12.97	6.49	6.35	2.710	37.64	10.95	8.02
7 t ha^{-1} (L_1)	14.96	7.35	7.15	2.801	38.90	11.37	8.87
14 t ha^{-1} (L_2)	18.08	8.18	7.94	2.929	40.68	11.76	9.56
21 t ha^{-1} (L_3)	20.17	8.78	8.99	3.039	42.21	12.27	9.92
C.D. (5%)	1.11	0.41	0.50	0.133	1.84	0.55	0.66
Fertilizers							
Control (F_0)	15.85	7.18	7.17	2.744	38.11	11.09	8.64
50% RD (F_1)	16.53	7.76	7.71	2.882	40.03	11.69	9.08
100% RD (F_2)	17.26	8.17	7.94	2.983	41.43	11.98	9.56
C.D. (5%)	0.46	0.09	0.18	0.083	1.15	0.21	0.38

Treatments	N cont. (%)	P cont. (%)	K cont. (%)	Fe cont. (ppm)	Cu cont. (ppm)	Zn cont. (ppm)	Net return (Rs. ha^{-1})	B:C ratio
Organic sources								
FYM (M_1)	1.82	0.258	0.193	84.39	6.42	30.81	5245.25	1.18
VC (M_2)	1.94	0.260	0.199	87.86	6.81	32.68	7717.75	1.26
PROM (M_3)	1.81	0.289	0.197	85.08	6.56	31.84	7028.25	1.24
C.D. (5%)	0.08	0.014	NS	3.21	0.27	1.29		
Levels								
Control (L_0)	1.75	0.258	0.179	83.11	6.28	31.29	4669.33	1.16
7 t ha^{-1} (L_1)	1.82	0.265	0.193	85.10	6.46	31.38	5803.00	1.20
14 t ha^{-1} (L_2)	1.88	0.274	0.201	86.19	6.81	31.97	7402.67	1.25
21 t ha^{-1} (L_3)	1.96	0.279	0.211	88.71	6.82	32.45	8780.00	1.30
C.D. (5%)	0.09	0.016	0.008	3.70	0.32	NS		
Fertilizers								
Control (F_0)	1.77	0.254	0.189	84.04	6.28	30.91	5092.25	1.17
50% RD (F_1)	1.87	0.271	0.197	85.92	6.70	31.64	6820.00	1.23
100% RD (F_2)	1.92	0.283	0.202	87.37	6.81	32.78	8079.00	1.28
C.D. (5%)	0.03	0.013	0.007	1.71	0.20	0.99		

Increased values of growth parameters with 21 t ha^{-1} of organic manure and 100% RD of fertilizers might be due to increased availability of nitrogen, phosphorous and potassium to plants initially through chemical fertilizers and then by organic sources thereby matching the need of plants in the successive cropping season. These findings are in agreement with those by Kumar and Sirvastava (2006) in okra-pea-tomato cropping system and Kumar and Sharma (2004) in cabbage-tomato cropping sequence.

Average pod length, plot yield ha^{-1} exhibited increase due to residual effect of organic manures and inorganic fertilizers (Table 2). However, pod weight did not vary significantly due to application of different sources of organic manure. Average pod length and yield ha^{-1} were maximum with vermicompost among different sources of organic manures. Among levels, 21 t ha^{-1} and among fertilizer doses, 100% RD resulted in maximum values of these. It may be due to the cumulative effect of increased plant growth parameters and yield attributes due to highest levels of application of organic and inorganic sources. Sidhu and Sekhon (2000) reported beneficial effect of organic sources of fertilizer in terms of all macro and micro nutrients and also reported improved physico-chemical and biological properties of soil that enabled plant roots to proliferate leading to better uptake of nutrients. The application of NPK probably favored the metabolic and auxin activity which might accelerate the photosynthetic rate and in turn increase the supply of carbohydrates to different plant parts accounting for increase in fruit size, number of fruits per plant, average fruit weight, yield per plant and yield per hectare (Everaarts and Boou, 2000).

Positive residual effect of conjoint application of organic manures and inorganic fertilizers was observed on parameters such as average pod length, mean fruit weight and yield in okra and pea crops in brinjal-pea-okra cropping system (Srivastava *et al.*, 2009). Thind *et al*. (2007) also reported the residual effect of integrated nutrient application on the yield of sunflower rotation.

Quality parameters were also influenced significantly under the residual effect of different manures and fertilizers treatments (Table 2). Many of these were found maximum with the residual effect of the maximum dose of organic manure and inorganic fertilizers in the preceding brinjal crop. Crude protein, crude fiber, NPK and trace element (Fe and Cu) contents of pods were found maximum under maximum level of vermicompost application i.e. 21 t ha^{-1} and with 100% RD of inorganic fertilizers. However, zinc content did not vary significantly for increasing levels of organic manures but it was significantly superior with 100% RD of inorganic fertilizer. The significant residual effect of NPK fertilization and organic manure on content of nitrogen in fruits appeared to be due to increased availability of NPK being rich sources of these essential plant nutrients thus providing better nutritional environment, both in root zone and and to overall plant system as also reported by (Khankhane and Yadav, 2003). Kumar and Sharma (2004) also reported increased nutrient content of fruits due to residual fertility in tomato cabbage-tomato cropping system.

The net return and B:C ratio calculated on the inputs in brinjal revealed that vermicompost application was most expensive having net return of Rs. 80625.19 ha^{-1} with B:C ratio of 2.53 compared to Rs. 83104.55 ha^{-1} and 2.95 obtained in FYM and Rs. 66954.96 ha^{-1} and 2.17 obtained in PROM, respectively (Chhipa, 2011). However, in succeeding vegetable clusterbean crop, the trend was reversed and vermicompost application gave maximum net returns (Rs. 7717.75 ha^{-1}) and B:C ratio (1.26) as compared to Rs. 5245.25 ha^{-1} and 1.18 under application of FYM and in PROM Rs. 7028.25 ha^{-1} and 1.24, respectively. Superiority of vermicompost leading to maximum returns at 9 t ha^{-1} application with a B:C ratio of 4.89 compared to RD of NPK with B:C ratio of 4.66 in the succeeding radish crop under okra-radish cropping system was also earlier reported (Choudhary and Chandra, 2006). Thus, vermicompost application could be advocated in a brinjal-clusterbean cropping system.

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