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Sustainable soil health management for Dolichos bean cultivation in organic way by application of bulk and concentrated organic manures on post harvest nutrient status of soil, crop yield and economics benefits to the farmers

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Abstract

The experiment was conducted to standardize the quantity of bulky and concentrated organic manures for Dolichos Bean to substitute the inorganic fertilizers. The experiment was laid out in a randomized block design with 14 treatments in 3 replications. The treatment schedule included various levels of bulky (25 and 75 % N) and concentrated organic manures (25 and 75 % N), inorganic fertilizers along with an absolute control. The bulky organic manures used were FYM and vermicompost and the concentrated manures used were neem cake and groundnut cake. The nutrient content of bulky and concentrated organic manures used in the study were FYM (0.80, 0.41 and 0.74 % NPK), vermicompost (1.60, 2.20 and 0.67 % NPK), poultry manure (3.47, 1.33 and 3.1 NPK), neem cake (5.2, 1.0 and 1.4 % NPK) and castor cake (4.1, 1.9 and 1.4 % NPK). Quantity of organic manures required was computed on the basis of nitrogen equivalent to substitute the recommended dose of chemical fertilizer (32:72 kg NP ha-1) in garden bean. Among the organic manures and concentrated oil cakes applied, 75 per cent N supplied through vermicompost @ 2.41 t ha-1 along with 25 per cent N supplied through neem cake @ 0.22 t ha-1 followed by 75 percent N supplied through poultry manure @ 0.61 t ha-1 along with neem cake @ 0.22 t ha-1 were identified. Which recorded the maximum level of post-harvest nutrient status of soil, yield attributes and economics of Garden bean.

Keywords: Dolichos Bean, bulk and concentrated organic manures, post-harvest nutrient status of soil, yield and economics

Introduction

For improving the soil health, bulky organic manures should be necessarily applied. FYM, vermicompost, poultry manure and pressmud are some of the commonly available organic manures which are widely used by the farmers. Organic manures which are tried in the present investigation are FYM, poultry manure, oilcakes and vermicompost. Among the varied organic inputs, Farm yard manure is considered as a repository of plant nutrients. The role of FYM is multidimensional, varying from building up of organic matter, good soil aggregation, permeability of soil and related physical properties to long lasting supply of several macro and micronutrients, besides, improving cation exchanging capacity of soil (Gupta *et al*., 1983) [2]. Vermicompost produced using earthworm is another rich and recognized source of macro and micro-nutrients and contributes much towards improving the fertility of soil. Vermicompost contains major and minor nutrients in available form along with enzymes, antibiotics, vitamins, beneficial microorganisms and other plant hormones and have definite advantage over other organic manures in respect of quality and shelf life of produce (Meerabai and Raj, 2001) [6]. Kale *et al*., (1992) [3] found that the application of vermicompost to fields improved the chemical and biological properties of soil.

Material and Methods

The seeds of Dolichos bean cv. Konkan Bushan were dibbled singly at a spacing of 30 x 60 cm apart. The first irrigation was given immediately after sowing followed by life saving irrigation and subsequent irrigations were given once in a week. Incidence of sucking pests were managed by spraying with Neem seed kernal extract at 5%. Weeding was done where and when found necessary. Quantity of organic manures required was computed on the nitrogen equivalent basis. Recommended dose of N (36 kg ha^{-1}) was supplied in two different combinations like supply of 25% and 75% N through Bulky and 25% and 75%N through concentrated organic manures. The bulky organic manures used were FYM, Poultry Manure and vermicompost (VC) and the concentrated manures used were neem cake (NC) and castor cake (GC). 25 and 75 per cent N was calculated as 0.84 and 2.25 t ha^{-1} of FYM; 0.8 and 2.41 t ha^{-1} of VC; 0.25 and 0.61 t ha^{-1} of poultry manure; 0.22, and 0.78 t ha^{-1} of NC; 0.20 and 0.65 t ha^{-1} of CC to substitute the recommended dose of N (36 kg ha^{-1}). Bulky organic manures were applied as basal and concentrated cakes were top dressed in 2 split doses. First application was done at 20 days after sowing. The second was applied on 45^{th} day of sowing. Recommended dose of inorganic fertilizers were applied only in the conventional farming treatment.

Experimental design and treatment details

The experiment was laid out in a Randomized Block Design with three replication and fourten treatments, viz.,

T_1 - Control

T_2 - Inorganic fertilizers (36:72 kg NP ha $^{-1}$)

T_3 - 25 % N as Farm Yard Manure (0.84 t ha $^{-1}$) +75 % N as Neem cake (0.78 t ha $^{-1}$)

T_4 - 75 % N as Farm Yard Manure FYM (2.52 t ha $^{-1}$)+ 25 % N as Neem cake(0.22 t ha $^{-1}$)

T_5 - 25 % N as Farm Yard Manure (0.84 t ha $^{-1}$) + 75 % N as Castor cake (0.65 t ha $^{-1}$)

T_6 - 75 % N as Farm Yard Manure (2.52 t ha $^{-1}$) +25 % N as Castor cake (0.20 t ha $^{-1}$)

T_7 - 25 % N as Vermicompost (0.80 t ha $^{-1}$) +75 %N as Neem cake (0.78 t ha $^{-1}$)

T_8 - 75 % N as Vermicompost (2.41 t ha $^{-1}$)+25 % N as Neem cake (0.22 t ha $^{-1}$)

T_9 - 25 % N as Vermicompost (0.80 t ha $^{-1}$) +75 % N as Castor cake (0.65 t ha $^{-1}$)

T_{10} - 75 % N as Vermicompost (2.41 t ha $^{-1}$) +25 % N as Castor cake (0.20 t ha $^{-1}$)

T_{11} - 25 % N as Poultry manure (0.25 t ha $^{-1}$) +75 % N as Neem cake(0.78 t ha $^{-1}$)

T_{12} - 75 % N as Poultry manure (0.61 t ha $^{-1}$) +25 % N as Neem cake (0.22 t ha $^{-1}$)

T_{13} - 25 % N as Poultry manure (0.25 t ha $^{-1}$) +75 % N as Castor cake (0.78 t ha $^{-1}$)

T_{14} - 75 % N as Poultry manure (0.61 t ha $^{-1}$) + 25 % N as Castor cake(0.22 t ha $^{-1}$)

Results

Post-harvest soil nutrient status

Available nitrogen in soil

The Nitrogen in available form after harvest differed significantly among all the treatments when compared with control. The treatment T_2 (inorganic fertilizer) recorded the highest soil available nitrogen of 208.89 kg ha^{-1}. The next best value was exhibited in the treatment T_8 (200.26 kg ha^{-1}) followed by T_{12} (193.12 kg ha^{-1}). The treatment T_4 and T_3 were however on par with each other. The lowest soil available nitrogen was recorded in T_1 which served as control (Table 29).

Available phosphorus in soil

The available phosphorus in post harvest soil differed significantly among all the treatments. The highest value was recorded in the treatment T_2 (60.14 kg ha^{-1}) which was followed by T_8 (58.51 kg ha^{-1}) and T_{12} (55.91 kg ha^{-1}). The lowest value for this parameter was recorded in control T_1 (25.84 kg ha^{-1}) as presented in the table 29.

Available potassium in soil

The available potassium after harvest varied significantly among all the treatments when compared with control. The value for this parameter was the highest in T_2 (260.18 kg ha^{-1}) and was followed by T_8 (254.52 kg ha^{-1}). The treatment T_2 however did not exhibit significant difference with T_8. The value for this parameter was lowest in T_1 (201.52 kg ha^{-1}) the control as shown in the table 1.

Table 1: Effect of bulky and concentrated organic manures on post harvest soil nutrient status in garden bean

Treatments	Available soil nutrient (kg ha^{-1})		
	Nitrogen	Phosphorus	Potassium
T_1 - Control	128.01	25.84	201.52
T_2 - Inorganic fertilizers (36:72 NP kg ha^{-1})	208.89	60.14	260.18
T_3 - FYM @ 10 t ha^{-1} + NC @ 2.25 t ha^{-1}	135.12	30.10	208.12
T_4 - FYM @ 15 t ha^{-1} + NC @ 1.50 t ha^{-1}	135.62	31.25	210.32
T_5 - FYM @ 10 t ha^{-1} + CC @ 2.0 t ha^{-1}	130.12	27.01	204.12
T_6 - FYM @ 15 t ha^{-1} + CC @ 1.50 t ha^{-1}	132.43	28.41	206.10
T_7 – VC @ 5 t ha^{-1} + NC @ 2.25 t ha^{-1}	185.06	53.17	245.16
T_8 - VC @ 7.5 t ha^{-1} + NC @ 1.50 t ha^{-1}	200.26	58.51	254.52
T_9 - VC @ 5 t ha^{-1} + NC @ 2.0 t ha^{-1}	167.43	46.95	236.42
T_{10} - VC @ 7.5 t ha^{-1} + NC @ 1.5 t ha^{-1}	176.14	50.45	239.05
T_{11} - PM @ 7.5 t ha^{-1} + NC @ 2.25 t ha^{-1}	177.02	50.93	240.25
T_{12} - PM @ 10 t ha^{-1} + NC @ 1.5 t ha^{-1}	193.12	55.91	248.23
T_{13} - PM @ 7.5 t ha $^{-1}$ + NC @ 2.0 t ha^{-1}	159.65	43.22	231.38
T_{14} - PM @ 10 t ha^{-1} + NC @ 1.5 t ha^{-1}	151.63	40.45	228.94
S.ED	0.73	0.36	0.67
CD (P=0.05)	1.50	0.77	1.38

Pod yield per hectare

The pod yield per hectare has shown significant difference among all the treatment when compared with control (Table 2). The pod yield was highest (6.46 t ha^{-1}) in T_2 which was followed by T_8 (5.50 t ha^{-1}) and T_{12} (5.35 t ha^{-1}). The treatment T_3 and T_4 were however, on par with each other. The treatment, T_1 recorded the lowest pod yield of 2.72 tonnes per hectare. Table 2.

Table 2: Effect of bulky and concentrated organic manures on yield per plot and hectare in garden bean

Treatments	Pod yield per hectare in tonnes
T_1 - Control	2.72
T_2 - Inorganic fertilizers (36:72 NP kg ha^{-1})	6.46
T_3 - FYM @ 10 t ha^{-1} + NC @ 2.25 t ha^{-1}	3.63
T_4 - FYM @ 15 t ha^{-1} + NC @ 1.50 t ha^{-1}	3.64
T_5 - FYM @ 10 t ha^{-1} + CC @ 2.0 t ha^{-1}	3.01
T_6 - FYM @ 15 t ha^{-1} + CC @ 1.50 t ha^{-1}	3.21
T_7 – VC @ 5 t ha^{-1} + NC @ 2.25 t ha^{-1}	5.26
T_8 - VC @ 7.5 t ha^{-1} + NC @ 1.50 t ha^{-1}	5.50
T_9 - VC @ 5 t ha^{-1} + NC @ 2.0 t ha^{-1}	4.43
T_{10} - VC @ 7.5 t ha^{-1} + NC @ 1.5 t ha^{-1}	5.08
T_{11} - PM @ 7.5 t ha^{-1} + NC @ 2.25 t ha^{-1}	5.10
T_{12} - PM @ 10 t ha^{-1} + NC @ 1.5 t ha^{-1}	5.35
T_{13} - PM @ 7.5 t ha $^{-1}$ + NC @ 2.0 t ha^{-1}	4.32
T_{14} - PM @ 10 t ha^{-1} + NC @ 1.5 t ha^{-1}	4.13
S.ED	0.02
CD (P=0.05)	0.05

Economics of various treatment combinations

It was found out that the treatment T_2 (Inorganic fertilizer in recommended dose) recorded the highest gross income (1,08,086) as well as net income (69,741). The return per rupee invested was also observed to be higher (2.8) in this treatment combination. The next best treatment was T_8 with the value of 2.6 as return per rupee invested. T_1 (control) recorded the least (1.3) return per rupee invested when compared to all the other treatments as shown in table 3.

Table 3: Benefit cost ratio

Treatments	Cost of cultivation (Rs)	Gross Income (Rs)	Net Income (Rs)	BCR
T_1 - Control	14400	18720	4320	1.3
T_2 - Inorganic fertilizers (36:72 NP kg ha^{-1})	38745	108086	69741	2.8
T_3 - FYM @ 10 t ha^{-1} + NC @ 2.25 t ha^{-1}	38425	76850	38425	2.0
T_4 - FYM @ 15 t ha^{-1} + NC @ 1.50 t ha^{-1}	38425	76850	384252`0	2.0
T_5 - FYM @ 10 t ha^{-1} + CC @ 2.0 t ha^{-1}	38240	68832	30592	1`8
T_6 - FYM @ 15 t ha^{-1} + CC @ 1.50 t ha^{-1}	38240	72656	34416	1.9
T_7 – VC @ 5 t ha^{-1} + NC @ 2.25 t ha^{-1}	38745	92988	54243	2.4
T_8 - VC @ 7.5 t ha^{-1} + NC @ 1.50 t ha^{-1}	38745	100737	61992	2.6
T_9 - VC @ 5 t ha^{-1} + NC @ 2.0 t ha^{-1}	38425	84535	46110	2.2
T_{10} - VC @ 7.5 t ha^{-1} + NC @ 1.5 t ha^{-1}	38425	88377	49952	2.3
T_{11} - PM @ 7.5 t ha^{-1} + NC @ 2.25 t ha^{-1}	38993	89683	50690	2.3
T_{12} - PM @ 10 t ha^{-1} + NC @ 1.5 t ha^{-1}	38745	96862.5	58117.5	2.5
T_{13} - PM @ 7.5 t ha $^{-1}$ + NC @ 2.0 t ha^{-1}	38425	80892.5	42467	2.1
T_{14} - PM @ 10 t ha^{-1} + NC @ 1.5 t ha^{-1}	38425	80692	42267	2.1

Discussion

Significant variation was observed among the treatments for the trait, post harvest nutrient status of soil. The maximum availability of nitrogen, phosphorus and potassium were obtained with application of vermicompost @ 10.03 t ha^{-1} along with neem cake @ 0.73 t ha^{-1}. This might be due to the fact that vermicompost was found to enhance the number of nitrogen fixing bacteria and symbiotic microbial association thereby contributing to increase in nitrogen, phosphorus and potassium in soil. This is in line with the work of Kale *et al.* (1987) [4] and Loquet *et al.* (1977) [5]. Another reason may be the higher amount of total and mineral nitrogen level as ammonia in the vermicompost that could be rapidly converted to nitrate thus minimizing the loss of N from soil reported by Kale *et al.* (1992) [3]. Application of vermicompost increased the proportion of mineral nitrogen available for plants at any given time, although nitrogen was immobilized in the initial stage as reported by Umamaheshwari (2009) [11], an increased availability of nitrogen in soil by the application of vermicompost compared to poultry manure and FYM is due to mineralization of native 'N' by higher bacterial population. Rao *et al.*, (1996) [8] stated that, higher levels of available potassium were recorded with vermicompost application due to earth worm activity. Further, presence of more organic matter in vermicompost amended soil might have enhanced the nutrient retention in post harvest soil as earlier reported by Arancon *et al.* (2006) [1]. Since the nutrient content in neem cake is greater, the availability of soil nutrients was also higher. The influence of neem cake in increasing the rhizosphere micro flora was also discussed earlier by Subramanian and Rao (1974) [10]. The microbiological properties of soil could influence in decomposition of organic matter and enzymatic activities in soil (Nannipieri *et al.*, 1990) [7]. This also might be the reason for increasing the availability of nutrients. The lower loss of nutrients due to the slow release in the manure amended plots may be responsible for an increase in available nutrients in soil when compared to inorganic manures as reported by Umamaheswari (2009) [11]. In any management technology, the benefit cost analysis need to be focussed to assess its suitability for adoption. Considering the sale of garden bean and cultivated through inorganic manure at Rs.35 per kg and the organic tomato (CIKS organic outlet, Salem), the highest return per rupee invested was obtained through application of inorganic fertilizers due to higher yield statistics. Among the organic manure treatments, application of vermicompost @ 10.50 t ha^{-1}

with neem cake @ 0.73 t ha^{-1} recorded the highest income and benefit cost ratio followed by poultry manure @ 2.16 t ha^{-1} with neem cake @ 0.73 t ha^{-1}. (Siddeswaran and Shanmugam. 2013) also have reported higher returns due to organically grown vegetables.

Conclusion

The soil post harvest nutrient status, yield and cost benefit analysis of garden bean under different treatments imposed with bulky and concentrated organic manures showed that the treatment combination of 75 per cent N supplied through vermicompost 10.73 t ha^{-1}along with 25 percent N supplied through 0.73 t ha^{-1} of neem cake followed by 75 per cent N supplied through poultry manure @ 2.16 t ha^{-1} along with 25 per cent N supplied through 0.73 t ha^{-1} of neem cake are recognized for valuable returns and were forwarded for further studies in garden bean.

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