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Effect of Organic and Inorganic Sources of Nutrients on Growth and Yield of Bottle Gourd (*Lagenaria siceraria* (Mol.) Standl.) in Bihar

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A field experiment was conducted at Nalanda College of Horticulture, Noorsarai, Nalanda during *summer* 2017 to assess the effect of complementary and sole applications of organic and inorganic fertilizers on the growth and yield of bottle gourd under onion-onion-bottle gourd crop sequence. The experiment consists of seven treatments *viz.*,T_1-Inorganic fertilizers (120 Kg N: 60 Kg P_2O_5 and 40 Kg K_2O); T_2-50% NPK through inorganic fertilizer + 50%N through FYM; T_3-50% N through FYM + 50% N through VC; T_4-1/3 of N through FYM + VC + Neemcake; T_5-50% N through FYM + PSB + Azotobactor; T_6-T_3 + PSB + Azotobactor and T_7-T_4 + PSB + Azotobactor. These seven treatments were replicated thrice in Randomized Block Design. Results revealed that T_1-100% NPK through inorganic fertilizer recorded 225.7 q ha^{-1} fruit yield, which was statistically at par with T_2 and T_6 producing (211.8 and 209.5 q ha^{-1}). Vine length differed significantly at all the growth stages. T_1 recorded maximum vine length (51.8, 370.3 and 464.7 cm) at 30, 60 and 90 DAS, which was significantly higher over T_5 at 30 DAS, over T_4 and T_5 at 60 DAS and over T_5 at 90 DAS. Among organics, T_6 recorded longest vine, while T_5 recorded shortest. No. of branches were found non-significant at 30 DAS but it become significant at 60 and 90 DAS and found significantly highest in T_6 over all the treatments. After completion of the cropping system; onion-onion-bottle gourd, soils were subjected to analysis. pH differed significantly, while non-significant difference were observed

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in EC and soil Org-C. Similarly, available N and P concentration were also found non-significant due to different fertilizer sources, but the concentration of available K differed significantly and found highest in T_1 which was at par with T_2. T_1-100% inorganic fertilizer sources recorded highest gross return, net return and B: C ratio followed by T_2. On the basis of result it has been concluded that T_2 having 50% NPK through inorganic fertilizer + 50% N through FYM may found suitable for sustainable bottle gourd production as it performed at par with T_1 in respect to crop growth and yield.

Keywords: Bottle gourd; FYM; vermicompost; neemcake; inorganic fertilizer.

1. INTRODUCTION

Fertilizers as a source of plant nutrients and pesticides as plant protection measures are being used to increase crop production. However, imbalance and frequent use of these agro-chemicals have polluted the environment to a great extent. Concern is growing that vegetables produced under such farm management may not be safe or of good quality [1]. Bottle gourd (*Lagenaria siceraria* (Molina) Standl.) is one of the most important summer season vegetable, but growing throughout the year in different part of the country. In India, it is grown extensively in the state of Bihar, Uttar Pradesh, Haryana, Madhya Pradesh, Chhattishgarh, Odisha and Punjab in large scale. Bihar is the leading state in both area (40.3 thousand hectare) and production (631.60 thousand tonnes.) with the productivity of 25.4 tonnes ha^{-1} [2]. The fruit contain 0.2% protein, 2.9% carbohydrate, 0.5% fat and 11 mg vitamin C of per 100 g fresh weight [3]. The effect of organic and inorganic fertilizers is complementary to each other in terms of soil fertility improvement and sustainable agriculture. Researches on various aspects of its production technology have been carried out worldwide, but limited number of works has been done on different organic sources of nutrients. Microorganisms increase the nutrient bioavailability through nitrogen fixation and mobilization of key nutrients (phosphorus, potassium and iron) to the crop plants while remediate soil structure by improving its aggregation and stability. Success rate of such inoculation under field conditions depends on their antagonistic or synergistic interaction with indigenous microbes or their inoculation with organic fertilizers [4,5]. Among the various factors involved in bottle gourd production, nutrient supply is an important for realizing higher crop yield. Experimental evidences showed that the response of bottle gourd is high to nitrogen application and moderate to phosphorus application, as results revealed that length of main vine and per cent fruit set were the maximum under application of 110 kg N + 70 kg P_2O_5 ha^{-1} as compared to 110 kg N + 50 kg P_2O_5 ha^{-1} [6]. Soil management practices have recently been changed as farmers utilising huge amount of synthetic fertilizers and pesticides to increase crop yield. However, the cultivation of crop requires balance supply of plant nutrients. Vegetables are important components of the human diet involved in most of the reactions occurring in the body. Like fertilizers, pesticides are considered a vital component of modern farming and in high-input intensive agricultural production systems the widespread use of pesticides has emerged as a dominant feature [7], causing nutrient imbalance, increased soil acidity, degradation in soil physical properties and loss of organic matter [8,9]. Pesticides are agrochemicals used in agricultural lands, public health programs, and urban green areas in order to protect plants and humans from various diseases. However, due to their known ability to cause a large number of negative health and environmental effects, their side effects can be an important environmental health risk factor [10,11]. Hence, the tendency to supply all plant nutrients through chemical fertilizer must be reconsidered because of the deleterious effect on soil productivity on a long-term basis. Considering the demand of organic market, it is time to emphasize research towards organic sources because, residual effect of chemical substances used in the crop fields causes health hazards and environmental degradation. Organic manure and inorganic fertilizers have paramount importance in ameliorating the yield and soil sustainability [12]. Fertility of a particular soil is determined by the presence of organic matter, therefore, organic matter is needed to restore in soil either by supplying nutrient through organic source or through residue management. Considering the above factors, the present experiment was undertaken with the following objectives; to determine the suitable source and optimum dose of organic

fertilizer for better growth and yield of bottle gourd.

2. MATERIALS AND METHODS

This experiment was conducted at Nalanda College of Horticulture, Noorsarai, Nalanda during summer 2017 to assess the suitable source and optimum dose of organic fertilizer for better growth and yield of bottle gourd in onion-onion-bottle gourd crop sequence. The soil of the experimental plot was clay loam with 7.47 pH, 0.21 EC and 0.62% organic carbon, 262, 14.60 and 142 kg ha^{-1} available N, P and K respectively. The experiment consists of seven treatments *viz.,*T_1-100% inorganic fertilizer sources (120 Kg N: 60 Kg P_2O_5 and 40 Kg K_2O); T_2-50% NPK through inorganic fertilizer sources + 50% N through FYM; T_3-50% N through FYM + 50% N through VC; T_4-1/3 of N through FYM + VC + Neem cake; T_5-50% N through FYM + PSB + Azotobactor; T_6-T_3 + PSB + Azotobactor and T_7-T_4 + PSB + Azotobactor. These seven treatments were replicated thrice in Randomized Block Design. These organic sources *viz.,* FYM, vermicompost, neemcake and biofertilizers (15 ml per plot of 15 m^2) namely Azotobactor and PSB were applied as per treatment. Recommended agronomical package of practices were followed excluding fertilizer treatments. Organic fertilizers were applied in standing crop 25 days after sowing. It was uniformly spread in the plots and incorporated into the soil manually as inter-cultural operations. Irrigation was given as per crop demand. Weeding was done manually as per crop need. Harvesting of matured fruit started as they attain maturity in each experimental plot on treatment basis, and observations such as vine length, number of branches and number of fruits, fruit length and width, fruit weight per plot and yield per hectare were measured. After harvesting, soil samples were taken from each plot for routine laboratory analysis. Soil pH and EC (described by Chopra and Kanwar, [13]), organic carbon determined by Walkley and Black's rapid titration method [14]. The determination of available nitrogen was done by alkaline permanganate method [15], available phosphorus by Olsen's [16] method (as described Houba et al., [17]), and potassium by flame photometer described by Jackson [14]. The data collected on different aspect of experimentation, were analyzed with the analysis of variance technique given by Gomez and Gomez [18].

3. RESULTS AND DISCUSSION

3.1 Plant Growth and Yield

Vine length and number of branches (Table 1) are an important parameter in bottle gourd that determines the highest performance of fruit yield. Vine length differed significantly at 30, 60 and 90 DAS. T_1 recorded maximum vine length (51.8, 370.3 and 464.7 cm) at 30, 60 and 90 DAS, which was significantly higher over T_5 at 30 DAS, over T_4 and T_5 at 60 DAS and over T_5 at 90 DAS. Among organics, T_6 recorded longest vine, while T_5 recorded shortest. Number of branches didn't differed significantly at 30 days after sowing, although at 60 and 90 days after sowing significant difference have been observed in number of branches. It has clearly observed from the Table-1 that, as the plant growth progressed, the number of branches found increased in organic treatments (T_6 and T_7). At 90 days after sowing highest number of branches was recorded in T_6-T_3+biofertilizers (4.8) which was significantly higher over T_2 and T_5, while rest of the treatments were at par with each other.

3.2 Yield and Economics

Fruit yield differed significantly due to different inorganic and organic fertilizer sources. Results revealed that T_1-100% inorganic fertilizer sources, recorded maximum (225.7 q ha^{-1}) fruit yield, followed by T_2-50 % NPK through inorganic fertilizer + 50% N through FYM (211.18 q ha^{-1}). Among organic fertilizer sources T_6-T_3 + PSB + Azotobactor recorded (209.5 q ha^{-1}) which was at par with T_1 and T_2. Singh et al. [19] reported that application of vermicompost with 50% recommended dose of chemical fertilizer had a significant effect on growth and yield parameters of bottle gourd. Natsheh and Mousa [20] found that compost application is the best management for increasing soil fertility yield and decrease the cost of mineral nitrogenous fertilizers in cucumber. Highest gross return (lakh ha^{-1}), net return (lakh ha^{-1}) and B:C ratio was recorded in T_1-100% inorganic fertilizer sources (Rs. 1.58, Rs. 1.18 and 2.93 respectively, followed by T_2-50% NPK through inorganic fertilizer + 50% N through FYM (Rs. 1.48, Rs. 1.03 and 2.27). Among organic, T_6-T_3 + biofertilizers recorded highest gross return (Rs 1.47 lakh ha^{-1}) followed by T_3-50% N through FYM + 50% N through VC (Rs. 1.33 lakh ha^{-1}) and T_7-T_4 + biofertilizer (Rs.1.33 lakh ha^{-1}). Likewise, T_6 recorded highest net return (Rs. 0.90 lakh ha^{-1}) over T_3-50% N

through FYM + 50% N through VC (Rs. 0.80 lakh ha^{-1}), T_4-1/3 each through FYM + VC + Neemcake (Rs. 0.78 lakh ha^{-1}), T_5-50% N through FYM + biofertilizers (Rs. 0.40 lakh ha^{-1}), and T_7-T_4 + biofertilizers (Rs. 0.78 lakh ha^{-1}). Highest net return was observed in T_1 and T_2 might be due to less cost of cultivation of fertilizers through inorganic sources and the less B:C ratio in organically treated plots is due to comparatively more cost of cultivation.

3.2 Soil Chemical Properties

The effect of different treatments on soil chemical properties like pH, EC, OC, available N, P and K after harvesting of bottle gourd shown in the Table-2. The maximum reduction in pH was less over initial value in the plots receiving chemical fertilizers. The higher reduction in pH of soil in the plots receiving organic manures may be due to production of organic acids, during decomposition of organic manures which neutralize the sodium salts present in the soil and increase the hydrogen ions concentration. Maurya and Ghosh, [21]; Swarup and Singh [22] also reported decrease in the soil pH by 0.3 to 0.9 unit after continuous application of chemical fertilizer along with green manure and FYM. The highest reduction over its initial value of the EC was recorded in the treatment T_5, T_6 and T_7. However, the reduction in EC was less over initial values in the plots receiving chemical fertilizers alone. Similar finding was also observed by Chaudhary et al., [12]; Chaudhary et al. [23]. Kumar and Yadav [24] also reported that organic plus chemical fertilizer treatments decrease EC at faster rate than inorganic fertilizers alone. Application of chemical fertilizer alone did not increase organic carbon content of the soil over its initial content, while, significant build-up was observed where, organic fertilizer were applied alone or along with bio-fertilizers. The maximum build-up of organic carbon (0.66%) was noticed in T_6 receiving 50% N through FYM+50% N through VC + PSB+ Azotobactor while, lowest (0.62%) was measured with the treatment T_1-100% inorganic fertilizers. The improved organic matter content of soil in the treatment having organic manure is attributed to direct incorporation of the organic matter in the soil. Soil organic carbon reported by Swarup and Yaduvanshi, [25] significantly lower in inorganic fertilizer treatments as compared to the treatments involving fertilizer with organic sources.

3.3 Change in Available Nitrogen, Phosphorus and Potassium

Manure contains many nutrients needed for crop production. Of these, nitrogen is one of the most important and is the most common added to soil for higher yield. Nitrogen undergoes many transformations in soil as it is used, re-used, and made available by soil microbes. Maximum available N (270.04 kg ha^{-1}) was measured in the treatment T_6 receiving 50% N through FYM + 50% N through VC+ biofertilizers followed by T_2-50% NPK through inorganic fertilizer sources + 50% N through FYM (269.13 kg ha^{-1}) It may be due to application of FYM and Vermicompost. Since organic manures are rich in organic matter that increased N content in those treatments where FYM and vermicompost were added. Similar finding were also observed by Bhandari et al., (1992), Kumar and Yadav [24] and Sharma and Ghosh [26]. The availability of N in soil decreased in the treatments (T_1) because of chemical fertilizer application that may be loss and uptake by crop in the soil after crop harvest.

Lowest available phosphorus (Table 2) was noticed in T_5-50% N through FYM + PSB + Azotobactor (32.83 kg ha^{-1}) while highest P was observed in all those treatment where biofertilizers were applied along with organic manure such as FYM, Vermicompost and Neem cake. The maximum build-up of available phosphorus (43.13 kg ha^{-1}) was observed under the treatment T_7-T_4 + biofertilizers. Increased availability of phosphorus in soil under treatments may be by increased solubility due to production of organic acids. Similar finding was also observed by Bhandari et al. (1992); Kumar et al. [27]. The inorganic fertilizer treated plot recorded significantly higher amount of available K (170.26 kg ha^{-1}), while lowest (150.80 kg ha^{-1}) was observed in $T_5$50% N as FYM+ biofertilizers. Increase in available potassium in T_1 and T_2 may be attributed to direct addition of potassium to the available pool of the soil. The beneficial effects of FYM, Vermicompost and Neemcake on available K may be ascribed to the reduction of fixation and release of K due to the interaction of organic matter with clay, besides the direct K addition to the available K pool of the soil. Increase in available potassium due to green manure and FYM was reported by many workers [28,29].

Table 1. Vine length, number of branches, yield and economics (Rs. Lakh ha^{-1}) of bottle gourd as influenced by the application of organic and inorganic fertilizer sources in onion-onion-bottle gourd crop sequence

Treatments	Wine length (cm)			No. of Branches			Yield (q ha^{-1})	Gross return (Rs.)	Net return (Rs.)	B : C Ratio
	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS				
T_1-Inorganic fertilizer	51.8	370.3	464.7	1.9	3.0	4.2	225.7	1.58	1.18	2.93
T_2-50%NPK as CF+50%N as FYM	44.7	353.0	447.1	1.6	2.8	3.6	211.8	1.48	1.03	2.27
T_3-50% N as FYM+50% N as VC	41.7	309.0	411.7	2.2	3.4	4.3	190.3	1.33	0.80	1.49
T_4-1/3 of N each through FYM+VC+NC	39.8	296.7	409.8	2.3	3.7	4.0	175.7	1.23	0.71	1.36
T_5-50% N through FYM+ biofertilizer	38.0	239.0	323.4	1.8	2.8	3.6	122.7	0.86	0.40	0.88
T_6-T3+biofertilizer	43.6	338.1	420.1	3.2	4.3	4.8	209.5	1.47	0.90	1.60
T_7-T4+biofertilizer	42.4	331.6	415.7	2.8	3.7	4.3	189.7	1.33	0.78	1.41
SEm±	6.1	32.4	28.3	0.9	0.6	0.4	13.7	-	-	-
C D at 5%	13.3	70.5	61.7	NS	1.3	1.0	30.0		-	-

Table 2. pH, EC, OC, available N, P and K as influenced by the application of different organic and inorganic fertilizer sources in bottle gourd after crop harvest in onion-onion-bottle gourd crop sequence

Treatments	pH (1:2)	EC (dS/m)	Org-C (%)	Available N (Kg/ha)	Available P (Kg/ha)	Available K (Kg/ha)
T_1- Chemical fertilizer	7.52	0.20	0.62	260.24	41.01	170.26
T_2-50%NPK as CF+50%N as FYM	7.40	0.18	0.64	269.13	35.83	162.48
T_3-50% N as FYM+50% N as VC	7.24	0.18	0.65	265.50	38.73	150.95
T_4-1/3 of N each as FYM+VC+NC	7.33	0.17	0.65	266.18	34.36	153.15
T_5-50% N as FYM+ biofertilizers	7.35	0.16	0.66	265.10	32.83	150.80
T_6-T3+biofertilizers	7.34	0.17	0.66	270.04	40.20	155.68
T_7-T4+biofertilizers	7.37	0.17	0.65	268.11	43.13	153.55
SEm±	0.06	0.02	0.04	7.85	5.18	6.03
C D at 5%	0.12	NS	NS	NS	NS	13.15

4. CONCLUSION

On the basis of result it has been concluded that T_2 having 50% NPK through inorganic fertilizer + 50% N through FYM may found suitable for sustainable bottle gourd production as it performed at par with T_1 in respect to crop growth and yield.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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