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Impact of Organic and Inorganic Sources of Nutrients on Growth, Yield Attributes and Yield of Bottle gourd (*Lagenaria siceraria* (Mol.) Standl.) in Bihar

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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 okra-cabbage-bottle gourd crop sequence. The experiment consists of seven treatments *viz.*,T_1-Chemical 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 + Azotobacter; T_6-T_3+PSB + Azotobacter and T_7-T_4+PSB + Azotobacter. These seven treatments were replicated thrice in Randomized Block Design. Results revealed that T_2-50%NPK through inorganic fertilizer+50%N through FYM recorded 238.9 q ha^{-1} fruit yield, which was statistically at par with rest of the fertilizer sources, except T_5 (173.4 q ha^{-1}). Although, T_1-RDF recorded maximum (247 q ha^{-1}).

KEYWORD

Bottle gourd, FYM, Vermicompost, Neemcake, Chemical fertilizer

INTRODUCTION

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} (Anonymous, 2017). Fruits at tender stage are used as a cooked vegetable and for preparation of sweets *e.g.* kheer, petha, burfi, and halwa, pickles and rayta. Hard shells of mature fruits are used as water jugs, domestic utensils, floats for fishing nets and making musical instruments, etc. As a vegetable it is easily digestible. It has cooling effect and has diuretic and having cardio-tonic properties. The fruits, leaves, oil, and seeds are edible and used by local people as folk medicines in the treatment of jaundice, diabetes, ulcer, piles, colitis, insanity, hypertension, congestive cardiac failure, and skin diseases. Fruit pulp is used as an antidote against certain poisons and is good for controlling constipation, night blindness and cough (Thamburaj and Singh, 2015), as an emetic, sedative, purgative, cooling, diuretic, antibilious, and pectoral (Duke and Ayensu, 1985; Rahman, 2003; Kirtikar and Basu, 2005). The fruit contain 0.2% protein, 2.9% carbohydrate, 0.5% fat and 11 mg vitamin C of per 100 g fresh weight (Thamburaj and Singh, 2015). The effect of organic and inorganic fertilizers is complementary to each other in terms of soil fertility improvement and sustainable agriculture. Therefore, it is necessary to make their judicious use in right proportion for harvesting better yield of different crops in cropping sequence and for sustaining soil fertility. 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. 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} (Meena and Bhati, 2017). Soil management practices have recently changed dramatically including an increased use of synthetic fertilizers and pesticides to increase crop yields. The cultivation of crop requires balance supply of plant nutrients, as vegetables are important components of the human diet since they provide essential nutrients that are required for most of the reactions occurring in the body. But farmers applying huge amount of chemical fertilizer for fetching maximum yield. Like fertilizers, pesticides are considered a vital component of modern farming, playing a major role in maintaining high agricultural productivity. Consequently, in high-input intensive agricultural production systems, the widespread use of pesticides to manage pests has emerged as a dominant feature (Tilman *et al.*, 2002). Problems associated with continuous use of chemical fertilizers and pesticides, causing nutrient imbalance, increased soil acidity, degradation in soil physical properties and loss of organic matter (Obi and Ofonduro, 1997) and Moyin-Jesu (2007). Hence, the tendency to supply all plant nutrients through chemical fertilizer should must be reconsidered because of the deleterious effect on soil productivity on a long-term basis. However, these

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requirements of plants nutrients can be met by applying organic manure or in combination with inorganic fertilizer. 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. 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. Organic manures contain all the essential plant nutrients, but after application they require time to convert it from unavailable to available form. That's why the response of crops to organic manures is initially low. But due to the residual and beneficial effects on soil properties, application of organic manures is needed to be encouraged. Recently, a great attention has been focused to decrease the applied amounts of chemical fertilizers to decrease the production costs and environmental pollution. The combined application of bio-fertilization and organic fertilizer alongside with mineral fertilizers is increasingly gaining recognition as one of the right practices of addressing low soil fertility, especially in arid regions (Suresh *et al.*, 2004; Naeem *et al.*, 2006; Vanlauwe *et al.*, 2010). Application of both organic and inorganic fertilizer altogether can increase the yield as well as keep the environment sound (Hsieh *et al.*, 1995). The combined application of organic and inorganic fertilizers improved the soil structure and produced the highest and sustainable crop yield of cucumber. The composted organic wastes can substitute for around 25% of chemical nitrogen fertilizers (Mahmoud *et al.*, 2009b). Singh et al. (2012) investigated the suitable combination of organic amendment with doses of chemical fertilizers to enhance the bottle gourd production on nutrient deficient. They found that the application of vermi-compost with 50% recommended dose of chemical fertilizer had a significant effect on growth and yield parameters of bottle gourd. Natsheh and Mousa (2014) found that compost application is the best management for increasing soil fertility, yield and decrease the cost of N mineral fertilizers in cucumber. Depletion of nutrients and poor organic matter contents of Egyptian soils can be replenished by applying rice straw compost to these soils (Mahmoud *et al.*, 2009a). Using effective microorganisms is one of the alternatives of nutrient supply. It can enhance the decomposition of organic materials and to improve physical, biological and chemical properties of soils (Higa, 2000; Jusoh *et al.*, 2013). 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.

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 okra-cabbage-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. There were seven treatments viz., T_1-Chemical fertilizers (120, 60, 40 kg N, P_2O_5 and K_2O), T_2-50%NPK through mineral fertilizer (MF)+50%N through FYM, T_3-50% N through FYM+50% N through VC, T_4-1/3 each through FYM+VC+Neemcake, T_5-50% N through FYM+biofertilizer, T_6-T_3+biofertilizer and T_7-T_4+biofertilizer, have been taken for study. These organic sources viz., FYM, vermicompost, neem cake and biofertilizers 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 within 15 days from sowing/planting. It was uniformly spread in the plots and incorporated into the soil manually during inter-cultural operations. Irrigation was given as per crop demand. Weeding was done manually at 25 days after transplanting. Harvesting of matured fruit started as they attain maturity in each experimental plot on treatment basis, and oobservations such as vine length, number of branches, 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 (Chopra and Kanwar, 1982), organic carbon determined by Walkley and Black's rapid titration method (Jackson, 1973). The determination of available nitrogen was done by alkaline permanganate method (Subbiah and Asija, 1956), available phosphorus by Olsen's (1954) method (Houba *et al.*, 1988), and potassium by flame photometer described by (Jackson, 1973). The data collected on different aspect of experimentation, were analyzed with the analysis of variance technique given by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

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. The longest vine (57.6 cm) was recorded in RDF followed by T_2-50% NPK as fertilizer + 50%N as FYM (54.9) which were statistically at par with rest of the organic treatments. Among organic T_6-T_3+biofertilizers recorded longest vine (54.0 cm) followed by T3-50% N through FYM+50% N through VC (53.0 cm) at 30 days after sowing. Similar trend in vine length were recorded at 60 days and 90 days after sowing also, but vine length differed significantly as the plant growth increased. T_4-1/3 each through FYM+VC+Neemcake with (297.7 cm) and T_5-50% N through FYM + biofertilizers (242.7 cm) vine length found statistically smallest vine as compared to RDF (385.6 cm). Among organic T_6-T_3+biofertilizers (339.7 cm) recorded statistically longest vine over T_5-50% N through FYM + biofertilizer (242.7 cm) at 60 days after sowing. Likewise, at 90 days after sowing the similar pattern of wine length were observed. 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 as compared to chemical fertilizer applied treatments. At 90 days after sowing highest number of branches was recorded in T_6-T_3+biofertilizers (4.7) which was significantly higher over T_1-Chemical fertilizers

(NKP) (3.7), T_2-50%NPK through mineral fertilizer (CF)+50%N through FYM (3.3), T_4-1/3 each through FYM+VC+Neemcake (3.3) and T_5-50% N through FYM + biofertilizers (3.0), and found at par with T_3-50% N through FYM+50% N through VC (4.0) and T_7-T4+biofertilizer (4.2).

Yield and economics

Number of fruit per plot and fruit yield per quintal differed significantly due to different inorganic and organic fertilization. Highest number of fruits per plot recorded in T_1-Chemical fertilizers (25) which was significantly higher over T_5-50% N through FYM+biofertilizer (19.3). Among organic, T_6-T_3+biofertilizers recorded highest (23) per plot followed by T_3-50% N through FYM+50% N through VC (23) and T_7-T_4+biofertilizer (22). The highest fruit yield recorded in T_1-Chemical fertilizers (247 q ha^{-1}), which was significantly higher over T_5-50% N through FYM + biofertilizers (173.4 q ha^{-1}), while at par with rest of the treatments. Although, T_2-50%NPK through mineral fertilizer (CF)+50%N through FYM with (238.9 q ha^{-1}) remained second highest. Among organic, T_6-T_3+biofertilizers recorded highest (232.1 q ha^{-1}) followed by T_3-50% N through FYM+50% N through VC (218.4 q ha^{-1}) and T_7-T_4+biofertilizer (214.0 q ha^{-1}). Highest gross return (lakh ha^{-1}), net return (lakh ha^{-1}) and B:C ratio was recorded in T_1-Chemical fertilizers (Rs. 1.23, Rs. 0.83 and 2.08 lakh ha^{-1}) respectively, followed by T_2-50%NPK through chemical fertilizer +50%N through FYM (Rs. 1.19, Rs. 0.74 and 1.63). T_1-Chemical fertilizers recorded significantly highest gross return over T_5-50% N through FYM + biofertilizers (Rs. 0.86). Among organic, T_6-T_3+biofertilizers recorded highest gross return (Rs 1.16 lakh ha^{-1}) followed by T_3-50 % N through FYM+50% N through VC (Rs. 1.09 lakh ha^{-1}) and T_7-T_4+biofertilizer (Rs.1.06 lakh ha^{-1}). Likewise, T_1-Chemical fertilizers recorded significantly highest net return (Rs. 0.83 lakh ha^{-1}) over T_3-50% N through FYM+50% N through VC (Rs. 0.55 lakh ha^{-1}), T_4-1/3 each through FYM+VC+Neemcake (Rs. 0.50 lakh ha^{-1}), T_5-50% N through FYM+biofertilizer (Rs. 0.41 lakh ha^{-1}), and T_7-T_4+biofertilizer (Rs. 0.51 lakh ha^{-1}), and at par with T_2-50%NPK through mineral fertilizer (CF)+50%N through FYM (Rs. 0.74 lakh ha^{-1}), and T_6-T_3+biofertilizer (Rs.0.59 lakh ha^{-1}).

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, (1972); Swarup and Singh (1989) 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*., 1992; Chaudhary *et al*., 2018). Kumar and Yadav (1995) 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 (0.643 %) was noticed in T_6 receiving 50% N through FYM+50% N through VC + PSB+ Azotobactor while, lowest (0.607 %) was measured with the treatment T_1-chemical 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, 2000), significantly lower in inorganic fertilizer treatments as compared to the treatments involving fertilizer with organic sources. These results corroborated with the finding of Numbiar and Abrol (1989); Bhandari *et al*., (1992) and More (1994).

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 (271.24 kg ha^{-1}) was measured in the treatment T_1 receiving chemical fertilizer (Table 2) followed by T_2 50%NPK through inorganic fertilizer+50%N through FYM (265.35 kg ha^{-1}). The availability of N in soil increased in the treatments (T_1) because of chemical fertilizer application that may be remained in the soil after crop harvest. Among organic treatments, maximum nitrogen is observed in T_3-50% N through FYM+50% N through (262.25 kg ha^{-1}) followed by T_6-T3+biofertilizer (260.59 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 (1995) and Sharma and Ghosh (2000). Lowest available phosphorus (Table 2) was noticed in T_4-1/3 each through FYM+VC+Neemcake (16.60 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 (17.95 kg ha^{-1}) was observed under the treatment T_6- receiving 50% N as FYM+50% N as VC + 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); More (1994) and Kumar *et al*., (2001). Chemical fertilizer treated plot recorded significantly higher amount of available K (165.25 kg ha^{-1}), while lowest (139.08 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 Neem cake 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 (Bharadwaj and Omanwar, 1994; Tolanur and Badanur, 2003).

On the basis result obtained T_6-T3+biofertilizer can be adapted as sustainable bottle gourd production, as it performed fruit yield at par with chemical fertilizer and also built-up appreciable amount of OC. This is one year of study and need few more years research on organic.

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 okra-cabbage-bottle gourd crop sequence.

Treatments	Wine length (cm)			No. of Branches			Fruits per plot	Yield (q ha^{-1})	Gross return (Rs.)	Cost (Rs.)	Net return (Rs.)	B : C Ratio
	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS						
T_1-Chemical fertilizer	57.6	385.6	583.3	2.3	3.3	3.7	25.0	247.0	1 235	0.40157	0.833	2.08
T_2-50%NPK as C F+50%N as FYM	54.9	353.0	561.1	2.2	2.8	3.3	22.7	238.9	1.194	0.45408	0.740	1.63
T_3-50% N as FYM+50% N as VC	53.0	322.4	531.1	2.3	3.7	4.0	23.0	218.4	1.092	0.53460	0.557	1.04
T_4-1/3 of N each through FYM+VC+NC	52.3	297.7	426.1	2.3	3.3	3.3	21.7	205.9	1 029	0.52210	0.507	0.97
T_5-50% N through FYM+ biofertilizer	47.8	242.7	386.1	1.9	2.4	3.0	19.3	173.4	0.867	0.45660	0.410	0.90
T_6-T3+biofertilizer	54.0	339.7	546.1	2.7	3.9	4.7	23.0	232.1	1 160	0.56460	0.595	1.06
T_7-T4+biofertilizer	51.8	312.3	525.6	2.4	3.4	4.2	22.0	214.0	1.069	0.55210	0.517	0.94
SEm±	6.1	30.2	62.3	0.8	0.4	0.3	1.5	24.7	0.123	-	0.123	0.26
C D at 5%	NS	65.8	135.8	NS	0.9	0.7	3.3	53.8	0.268	-	0.268	0.58

FYM;Farm yard manure, VC; Vermicompost, NC; Neemcake, CF; Chemical fertilizer

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 okra-cabbage-bottle gourd crop sequence.

Treatments	pH	EC	OC	Available N	Available P	Available K
T_1- Chemical fertilizer	7.42	0.19	0.607	271.24	17.38	165.25
T_2-50%NPK as CF+50%N as FYM	7.43	0.19	0.617	265.35	17.25	152.20
T_3-50% N as FYM+50% N as VC	7.39	0.18	0.630	262.25	16.90	148.85
T_4-1/3 of N each as FYM+VC+NC	7.41	0.17	0.637	257.15	16.60	143.00
T_5-50% N as FYM+ biofertilizer	7.37	0.16	0.620	251.14	17.14	139.08
T_6-T3+biofertilizer	7.40	0.16	0.643	260.59	17.95	154.50
T_7-T4+biofertilizer	7.38	0.16	0.637	254.45	17.22	147.00
SEm±	0.08	0.03	0.065	11.65	0.82	8.57
C D at 5%	0.17	0.06	0.141	25.41	1.79	18.68

FYM;Farm yard manure, VC; Vermicompost, NC; Neemcake, CF; Chemical fertilizer

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