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Effect of Different Organic and Inorganic Sources of Nutrients on Growth and Yield of *Rabi* Onion (*Allium cepa* L.)

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A B S T R A C T

An experiment was conducted in Bihar Agricultural University, at Nalanda College of Horticulture, Noorsarai, during *Rabi* season 2016, to evaluate the effect of complementary and sole applications of organic and inorganic fertilizers on the growth and yield of *rabi* onion. The soil of the experimental plot had 7.47 pH, 0.21 EC and 0.62 % organic carbon with 262, 14.60 and 142 kg ha^{-1} available N, P and K respectively. There were seven different organic and inorganic sources *viz.*, T_1-inorganic fertilizer (IF) 120:60:40; T_2-50 %NPK through IF+50 % N through FYM; T_3-50 % N through FYM+50 % N through VC; T_4- 1/3 of N each 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 have been taken for study. The experiment was conducted in randomized block design (RBD) with three replications. Results showed that plant height differed significantly due to different treatments at 30 and 60 DAT. At both the stages, 100% inorganic fertilizer (T_1) recorded significantly highest plant height followed by T_2 and T_6. Number of leaves didn't differ significantly during early stage of crop growth but during later stage (60 DAT) it differed significantly and recorded highest in T_1 followed by T_2 T_3 and T_6. Equatorial diameter of the bulb didn't differ significantly and found similar in T_1, T2 and T6. Bulb yield differed significantly and found highest in T_1 (245.3 q ha^{-1}) which was at par with T_2 (229.7 q ha^{-1}) and T_6 (200.3 q ha^{-1}). Gross and net return, didn't differ significantly but recorded maximum in T_1 followed by T_2 and T_6. Although, B: C ration differed significantly and found highest in T_1 (3.5). It may be due to low input cost and high yield. On the basis result obtained T_2 as 50 %NPK through fertilizer+50 %N through FYM can be adapted as sustainable crop production being at par with 100% inorganic fertilizer sources.

Introduction

Onion being important bulbous vegetable crop included in the top 15 commonly grown vegetables worldwide (Best, 2000); (Jahromi and Amirizadeh, 2015). It is globally the most marketable crop that too, round the year and can be grown under wide range of Agro-climate conditions. Irrespective of price, its demand remains almost constant in the

market as it is primarily used as seasoning for a wide variety of dishes. In India, onion is produced in three season *i.e. kharif, rabi* and late *kharif.* Of these, 64.7 percent production comes from *rabi* crop while *kharif* and late *kharif* crops contribute 15.1 and 20.08 percent, respectively (Anonymous 2016-17). Considering its domestic consumption and export, attention is needed for its quality and sustainable production. Since, intensive use of soils specifically those oriented to horticultural production, has caused the decrease of organic matter and nutrient, that has been identified as one of the most important threats to the quality of soils (Bevacqua and Mellano, 1994); (Maynard, 1995); (Kalaivanan and Hattab, 2016). Although, application of organic amendments, coming from the composting process of different kinds of wastes significantly improved the nutritional condition of the plant as well as in the performance and quality of harvested crops (Arancon *et al.,* 2004); (Lee *et al.,* 2004); (Giannakis *et al.,* 2014). Organic manure and inorganic fertilizers have paramount importance in ameliorating the yield and soil sustainability. Researches on various aspects of its production technology have been carried out, but limited number of works has been done on different organic sources of nutrients in onion.

The cultivation of crop requires balance supply of plant nutrients, but farmers applying only chemical fertilizer for fetching maximum yield. Furthermore, Obi and Ofonduro (1997) and Moyin-Jesu (2007) also reported that problems associated with continuous use of chemical fertilizers included nutrient imbalance, increased soil acidity, degradation in soil physical properties and loss of organic matter. And therefore, adequate and uniform supply of nitrogen is essential for plant growth, bulb yield and good quality (Tandon 1987). The tendency to supply all plant nutrients through chemical fertilizer should be reconsidered, because of the deleterious effect on soil productivity on a long-term basis. However, these requirements of nutrients can be met through applying organic manure or its combination with inorganic fertilizers that increase the soil organic matter which is (SOM) known to improve many soil properties such as soil structure, water holding capacity and nutrient supply (Johnston *et al.,* 2009). Since, fertility of a particular soil is determined by the presence of organic matter which rely on several factors like origin of soil, climatic conditions, type of vegetations and microbial activities. Therefore, organic matter is needed to restore in soil either by supplying nutrient through organic sources or through residue management.

Organic manures contain all the essential plant nutrients, but after application they require time to convert 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 need to be encouraged. Application of both organic and inorganic fertilizers altogether can increase the yield and keep the environment sound (Hsieh *et al.,* 1995), increase the productivity of soil as well as crop quality (Tindall, 2000). There is great scope in improving the yield, quality and shelf life of onion (Gupta *et al.,* 1999) with integrated nutrient management using organic fertilizers. Keeping above aspects in view the present investigation has been carried out to study the effect of organic and inorganic fertilizers on growth, yield attributes, yield and economics in *rabi* onion.

Materials and Methods

This experiment was conducted at Nalanda College of Horticulture, Noorsarai, Nalanda

during 2017, to assess the suitable source and optimum dose of organic fertilizer for *Rabi* onion in onion-onion- bottle gourd cropping system. The initial soil chemical properties of the experimental field were 7.47 pH, 0.21 EC and 0.62 % organic carbon and 262, 14.60 and 142 kg ha^{-1} available N, P and K, respectively.

The experiment was laid down in Randomized Block Design with three replications. There were seven nutrient treatments *viz.,* T_1-Inorganic fertilizers (120, 60, 40 kg N, P_2O_5 and K_2O), T_2-50 % NPK through inorganic fertilizer (IF)+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 + biofertilizers, T_6-T3+biofertilizer and T_7-T_4 + biofertilizer, have been taken for study. There were three organic fertilizer sources *viz.*, FYM, vermicompost, neem cake and biofertilizers namely azotobactor and PSB applied as per treatment. Recommended agronomic package of practices were followed excluding fertilizer treatments.

Organic fertilizers were applied a week before sowing. It was uniformly spread on the plots and incorporated into the soil manually. 35 days old seedling was planted at row and plant spacing of 15 and 10 cm respectively. Irrigation was given as per crop demand. Weeding was done manually at 25 days after transplanting. Observations such as number of leaves and plant height at different plant growth stages have taken followed by diameter of bulb and its weight per plot and yield per hectare were measured.

Harvesting of matured bulb started as they attain maturity in each experimental plot on treatment basis. After harvesting, soil samples were taken from each plot for routine laboratory analysis. Soil pH, Organic-C, N, P, and K were determined. The data collected on different aspect of experimentation, were analyzed with the help of computer applying analysis of variance technique given by Gomez and Gomez (1984).

Results and Discussion

Growth and yield

Plant height (Table 1) differed significantly at 30 and 60 DAT. It is found significantly highest in T_1 (27.26 cm) at 30 DAT which was at par with T_2 (26.17) and T_6 (24.59). But at 60 DAT, T_1 become significant over all the treatments. It may be due to instant supply of nutrient through inorganic fertilizers. Number of leaves didn't differ significantly during early stage (30 DAT) of crop growth but at later stage (60 DAT) it became significant and recorded more in T_1 (5.93) followed by T_2 (5.53) and T_6 (5.20).

Highest number of leaves (13.33) had also been recorded with RDF 75% + Azotobacter 25 % (Brinjh *et al.,* 2014). Equatorial diameter didn't differ significantly (Table 1) but found highest with similar value (4.1) in T_1, T_2 and T_6. Bulb yield (Table 1) differed significantly due to different treatments and found highest in T_1 (245.3 q ha^{-1}) which was at par with T_2 (229.7 q ha^{-1}), T_6 (200.3 q ha^{-1}). The lowest was recorded in T_5 (150 q ha^{-1}). Jayathilake *et al.,* (2003) reported that RDF (150:80:100) recorded 340 q ha^{-1} bulb yield which was significantly lower to the above organic amendments combined with chemical fertilizers.

Chaudhary *et al.,* (2018) reported similar finding in *kharif* onion. Increase in yield may be due to the application of biofertilizer and their direct role in nitrogen fixation and the production of phytohormone like substances and increase in nutrient uptake (Govindan and Purushottam, 1984).

Table.1 Plant height (cm) number of leaves, equatorial diameter (cm) yield and economics of *rabi* onion as influenced by the application of organic and inorganic fertilizer sources in onion-onion-bottle gourd crop sequence

Treatments	Plant height		No. of leaves		Equatorial diameter (cm)	Yield (q ha^{-1})	Gross return (Lac ha^{-1})	Net Retur (Lac ha^{-1})	B: C Ratio
	30 DAP	60 DAP	30 DAP	60 DAP					
T_1-100% from inorganic fertilizers	27.26	41.11	3.20	5.93	4.1	245.3	1.96	1.53	3.5
T_2-50%NPK as MF+50%N as FYM	26.17	35.45	3.20	5.53	4.1	229.7	1.84	1.35	2.76
T_3-50% N as FYM+50% N as VC	22.49	32.33	2.80	5.20	4.0	178.2	1.43	0.86	1.50
T_4-1/3 of N each as FYM+VC+NC	22.16	34.56	2.60	5.00	3.8	169.8	1.36	0.80	1.44
T_5-50% N through FYM+ biofertilizer	19.81	30.84	2.60	4.67	3.8	150.0	1.20	0.71	1.44
T_6-T3+biofertilizer	24.59	34.48	3.07	5.20	4.1	200.3	1.60	1.00	1.67
T_7-T4+biofertilizer	22.68	32.52	2.93	5.13	3.8	176.0	1.41	0.82	1.40
SE(d)	1.71	2.06	0.29	0.48	0.3	49.3	0.39	0.39	0.71
C D at 5%	3.74	4.50	NS	1.05	NS	77.11	0.86	0.86	1.55

FYM; Farm yard manure, VC; Vermicompost, NC; Neemcake, IF; inorganic fertilizers

Table.2 pH, EC, Org.-C, available N, P and K (kg ha^{-1}) as influenced by the application of different organic and inorganic fertilizer sources in *Rabi* onion after crop harvest in onion-onion-bottle gourd crop sequence

Treatments	pH 1:2.5	EC (dSm^{-1})	OC (%)	Available N (Kg h^{-1})	Available P (Kg h^{-1})	Available K (Kg h^{-1})
T_1-100% from inorganic fertilizers	7.44	0.19	0.62	278.1	39.67	160.5
T_2-50%NPK as IF+50%N as FYM	7.42	0.18	0.63	273.5	39.39	149.6
T_3-50% N as FYM+50% N as VC	7.41	0.17	0.64	271.3	38.60	146.8
T_4-1/3 of N each through FYM+VC+NC	7.42	0.17	0.64	267.1	37.88	142.5
T_5-50% N through FYM+ biofertilizer	7.39	0.15	0.63	257.4	39.17	137.1
T_6-T3+biofertilizer	7.38	0.16	0.65	269.2	40.62	149.3
T_7-T4+biofertilizer	7.38	0.16	0.64	263.9	39.11	144.6
SE(d)	0.06	0.02	0.02	9.1	1.95	8.8
C D at 5%	0.14	0.05	0.03	19.8	4.26	19.2
FYM; Farm yard manure, VC; Vermicompost, NC; Neemcake, IF; inorganic fertilizers						

Soil chemical properties

Reduction in pH was more over initial value (Table 2) in the plots receiving organic fertilizers *viz.*, T_3, T_4, T_5, T_6, and T_7. These reductions in pH in 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. Decrease in the soil pH by 0.3 to 0.9 unit after continuous application of chemical fertilizer along with green manure and FYM (Maurya and Ghosh, 1972; Swarup and Singh, 1989).

Maximum reduction (0.15) in the EC recorded in the treatment T_5 followed by T_6 and T_7. However, the reduction in EC was less over initial values in the plots receiving chemical fertilizers. 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.

The maximum organic carbon (0.65 %) 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.

The improvement in organic matter content of soil in the treatment receiving organic manure is attributed to direct incorporation of the organic matter in the soil. Soil organic carbon reported by (Swarup and Yaduvanshi 2000), significantly reduced 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), More (1994) and Chaudhary *et al.*, 2018).

Change in available nitrogen, phosphorus and potassium

Almost all the essential nutrients needed for crop production are found in organic manure. Of these, nitrogen is being a most common nutrient added to soil for increasing yield of the crops. Although, when it is supplied through organic sources, it undergoes through many transformations in soil as it is used, re-used, and made available by soil microbes. Result showed that maximum available N (278.1 kg ha^{-1}) was found in T_1 receiving inorganic fertilizers (Table 2) followed by T_2 and T_3 (273.5 and 271.3 kg ha^{-1}) respectively. Among organic treatments, maximum build-up of nitrogen is observed in T_6-50 % N through FYM+50 % N through (VC (269.2 kg ha^{-1}). It may be due to application of FYM and vermicomposts as these are rich in organic matter which increased N content in treatments. Similar finding were also observed by Bhandari *et al.*, (1992); Kumar and Yadav (1995) and Sharma and Ghosh (2000). Highest available P was observed in all those treatment where biofertilizers were applied along with organic manure such as FYM, Vermicompost and Neem cake. The available P didn't differ significantly but maximum buildup was observed in T_6-receiving 50 % N as FYM+50 % N as VC +biofertilizer (40.62 kg ha^{-1}). However, the lowest was observed in T_4 (37.88 kg ha^{-1}). Increased availability of phosphorus in soil under treatments may be by increased solubility due to production of organic acids. Similar P availability had been observed in *kharif* onion (Chaudhary *et al.*, 2018), cabbage (Chaudhary *et al.*, 2018) and in okra (Chaudhary *et al.*, 2017). Available K differed significantly and found highest in T_1-Inorganic fertilizer alone (160.5 kg ha^{-1}) followed by T_2-50% NPK as inorganic fertilizer + 50 % N as FYM (149.6 kg ha^{-1}) and T_6 (149.3 kg ha^{-1}), while lowest (137.1 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 in T_6 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 had been reported by many workers Bharadwaj and Omanwar (1994), Tolanur and Badanur (2003).

Economics

The economics as influenced by different treatments (Table 1) differed significantly and recorded maximum gross returns, (Rs. 1.96 lac), net return (1.53 lac) and B: C ration (3.5) in T_1 receiving 100% inorganic fertilizers followed by T2 and T_6. Highest net return in T_1 and T_2 is due to less cost of cultivation and more bulb production. However, among organics T_6 found best with 1.0 lac net return.

On the basis result obtained it is concluded that T_2 as 50 %NPK through inorganic fertilizers + 50 % N through FYM can be adapted as sustainable onion production, as it performed bulb yield statistically at par with 100% inorganic fertilizer This is one year trial and need few more years research on organics.

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