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

S. K. Chaudhary[1*], S. K. Yadav[2], D. K. Mahto[1], R. P. Sharma[3] and Giri Raj Kumar[4]

[1]*Department of Agronomy, NCOH, Noorsarai, Nalanda, India.*
[2]*Department of Soil Science, NCOH, Noorsarai, Nalanda, India.*
[3]*Bihar Agricultural College, Sabour, India.*
[4]*NCOH, Noorsarai, Nananda, India.*

Authors' contributions

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

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ABSTRACT

An experiment was conducted in Bihar Agricultural University, at Nalanda College of Horticulture, Noorsarai, during kharif season 2016, to assess the suitable source and optimum dose of organic fertilizer for *kharif* onion. The soil of the experimental plot was clay loam with 7.47 pH, 0.21 EC (dSm^{-1}) and 0.62 % organic carbon, 262 kg, 14.60 kg and 142 kg ha^{-1} available N, P and K, respectively. The experiment comprised of seven treatments *viz.,* T_1-Chemical fertilizer (CF)120:60:40; T_2-50 % NPK through CF+50 % N through FYM; T_3-50 % N through FYM + 50 % N through VC; T_4- 1/3rd of N each 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. The experiment was conducted in randomized block design (RBD) with three replications. Results showed that plant height didn't show significant difference at 30 DAT, but as plant growth progressed, height of the onion plants differed significantly. At 60 DAT, T_1 recorded highest plant (23.6 cm) which was significantly tall over T_4 and T_5. Although, at 90 DAT, T_7 recorded maximum plant height (60.1 cm) plant followed by T_6 (56.3 cm). No. of leaves differed significantly during early stage of crop growth but during later stage (90 DAT) it became non-significant. The number of leaves recorded more in T_1 followed by T_2, T_6, T_7 and T_3 at 30 DAT. The similar trend of leaves number were also observed at 60 DAT. Equatorial diameter of bulb found highest in T_1 (5.3 cm) followed by T_2 (5.2 cm) which

**Corresponding author: E-mail: chaudhary7002@gmail.com;*
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was significantly higher over T_5 (4.4 cm), T_7 (4.7 cm) and T_4 (4.8 cm). Bulb yield differed significantly and found highest in T_1 (364.79 q ha^{-1}) which was at par with T_2 (343.31 q ha^{-1}), T_6 (321.80 q ha^{-1}) and T_3 (307.25 q ha^{-1}). There were found significant difference in gross return, net return and B : C ratio. Among all, T_1 recorded highest gross return, net return and B : C ratio, followed by T_2, T_6, T_3 and T_7. Although, T_2, and T_6 recorded net return (Rs. 2.28, and 2.00 lacks ha^{-1}) which was at par with T_1 (Rs. 2.50 lack ha^{-1}). On the basis result obtained T_2 as 50 % NPK through chemical fertilizer + 50 % N through FYM can be adapted as sustainable onion production, as it performed bulb yield statistically at par with chemical fertilizer and also built-up appreciable amount of N (4.36 %), P (17.32 %) and K (3.86 %).

Keywords: Onion; FYM; vermicompost; Neemcake; chemical & organic fertiliser.

1. INTRODUCTION

Onion (*Allium cepa* L.) belongs to family Amaryllidaceae (Alliaceae), locally known as Pyaj. It is one of the most important bulbous vegetable crop grown all over the world and it is on the list of 15 most commonly grown vegetables in the world [1,2]. Onion is most marketable crop in the world throughout the year and can be grown under a wide range of Agro-climate condition. Irrespective of price, its demand remains almost constant in the market as it is primarily used as a seasoning for a wide variety of dishes. It is consumed as a vegetable and condiment. The green leaves, immature and mature bulbs are eaten raw or used in vegetable preparations. It is an indispensable item in every kitchen and used to enhance the flavour of different recipes. India is the second largest producer of dried onions after china contributing 21% of the total world production of 93.2 million tonnes [3]. Among the different states, Maharashtra is leading followed by Madhya Pradesh, Karnataka, Gujarat, Bihar, Rajasthan, Andhra Pradesh, Tamil Nadu and Haryana in terms of production that contributes 30.03, 16.59, 13.6, 5.75, 5.57, 5.12, 4.09, 3.35 and 3.05 % respectively, from total production (22.423 million tonnes) from 1.30 million hectare area [4]. In India, onion is produced in three season *i.e. kharif, rabi* and late *kharif.* The 64.7 percent production comes from *rabi* crop while *kharif* and late *kharif* crops contribute 15.1 and 20.08 percent, respectively [4]. The *rabi* season crop of onion is harvested in April-May, while *Kharif* onion and late *kharif* crop of onion is available in the market in October-December and January-February, respectively. The *kharif* onion is produced in part of Maharastra, Gujarat, Karnataka, Rajasthan. The major portion of *rabi* season crop is stored throughout the country. Stored onion is available for domestic markets as well as for export from May to October. There is a critical gap in the supply of onion from October to December in the country, and as a result, the prices shoot up. The *kharif* crop plays an important role in fulfilling consumers' demand and stabilising the prices of onion in the country. If *kharif* crop is delayed or spoiled due to vagaries of monsoon, the prices increase very rapidly in October and remain high till January-February. *Kharif* onion, is therefore, most crucial in controlling market prices *vis-a-vis* making available onions to consumers. Looking to its importance for domestic consumption as well as export, great attention is needed for its improvement. The production of *kharif* onion has several advantages *i.e.* increases total production per annum and fulfils the demand of fresh onion in the market. *Kharif* onion provides high price as compared to *rabi* season. The produce of *rabi* season is stored for consumption in summer and *kharif,* but due to lack of proper storage conditions and losses due to spoilage in the monsoon season and the prices goes up. Hence, production of onion during *kharif* is required to fill up the gap of demand and supply. 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 *Kharif* onion. Among the various factors involved in onion production, nutrient supply is an important for realizing higher bulb yield. The cultivation of crop requires balance supply of plant nutrients, but farmers applying only chemical fertilizer for fetching maximum yield. Furthermore, Obi and Ofonduro [5] and Moyin-Jesu [6] 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. Onion is a heavy feeder of mineral elements. It was reported that a crop of 35 tonnes of onion removes approximately 120 kg of N, 50 kg of

P_2O_5 and 160 kg of K_2O ha^{-1}. An adequate and uniform, supply of nitrogen is essential for plant growth, bulb yield and good quality [7]. Hence, the tendency to supply all plant nutrients through chemical fertiliser should be reconsidered, because of the deleterious effect on soil productivity on a long-term basis. However, these 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 which depends on several factors like origin of soil, climatic conditions, vegetation, microbial activities *etc*. 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 needed to be encouraged. Application of both organic and inorganic fertilizers altogether can increase the yield as well as keep the environment sound [8]. It is an established fact that use of inorganic fertilizer for the crops is not so good for health because of residual effect but in the case of organic fertilizer such problem does not arise and on the other hand, it increase the productivity of soil as well as crop quality and yield [9]. There is a great scope in improving the yield, quality and shelf life of onion [10] with integrated nutrient management using organic fertilizer. In view of above aspects the present investigation has been carried out, to study the effect of organic and inorganic fertilizers on growth, yield attributes and yield and economics of different treatments in *kharif* onion.

2. MATERIALS AND METHODS

This experiment was conducted at Nalanda College of Horticulture, Noorsarai, Nalanda during *Kharif,* 2016, to assess the suitable source and optimum dose of organic fertilizer for *kharif* onion. The soil of the experimental plot was clay loam with 7.47 pH, 0.21 EC and 0.62 % organic carbon, 262 kg, 14.60 kg 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 treatments viz., T_1-Chemical fertilizers (120, 60, 40 kg N, P_2O_5 and K_2O), T_2-50 % NPK through chemical fertilizer (CF)+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 fertiliser sources *viz.,* FYM, vermicompost, neem cake and biofertilizers namely azotobactor and PSB applied as per treatment. Recommended agronomical package of practices were followed excluding fertiliser treatments. Organic fertilisers 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 the 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 the diameter of bulb and its weight per plot and yield per hectare were measured. Harvesting of matured bulb and as green vegetables, started as they attain maturity in each experimental plot on a 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 a different aspect of experimentation were analysed with the help of computer applying the analysis of variance technique given by Gomez and Gomez [11].

3. RESULTS AND DISCUSSION

3.1 Growth and Yield

Results (Table 1) showed that plant height didn't differ significantly at 30 DAT, but as plant growth progressed, the height of the onion plants differed significantly. At 60 DAT, T_1 recorded highest plant (23.6 cm) which was significantly tall over T_4 and T_5. Although, at 90 DAT, T_7 recorded tallest (60.1 cm) plant followed by T_6 (56.3 cm). More plant height in T_7 and T_6 is organic fertilizer application that might be supplied continuous nutrition for plant growth. Brinjh et al. [12] also recorded maximum plant height (73.33 cm) under the 25 % Vermicompost + 75 % RDF. No. of leaves differed significantly during the early stage of crop growth but during later stage (90 DAT) it became non-significant. Number of leaves (Table 1) recorded more in T_1 followed by T_2, T_6, T_7 and T_3 at 30 DAT. The similar trend of leaves number was also observed at 60 DAT. Equatorial diameter (Table 1) of bulb found highest in T_1 (5.3 cm) followed by T_2 (5.2 cm) and T_6 (5.1 cm), and these three treatments were statistically at par to each other. Diameter of bulb from T_5 (4.4 cm), T_7 (4.7 cm) was significantly lower as compared to T_1 and T_2. Among Organic T_6 recorded significantly highest diameter (5.1 cm) over T_5. Number of leaves (13.33), neck thickness (1.69 cm) and number of scales were found in RDF 75% + Azotobacter 25 %. whereas, the diameter of bulb (7.67 cm), bulb length (6.80 cm) and yield (42.33 t/ha) were observed in RDF 75% + Phosphobacteria 25 % [12]. Bulb yield (Table 1) differed significantly due to different treatments and found highest in T_1 (364.79 q ha^{-1}) which was at par with T_2 (343.31 q ha^{-1}), T_6 (321.80 q ha^{-1}) and T_3 (307.25 q ha^{-1}). The lowest was recorded in T_5 (236.46 q ha^{-1}) Jayathilake et al. [13] reported that RDF (150:80:100) recorded a bulb yield of 340 q ha^{-1} which was significantly lower to the above organic amendments combined with chemical fertilizers. 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 [14].

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 onion shown in the Table 2. The reduction in pH was moreover initial value in the plots receiving organic fertilisers *viz.,* T_3, T_4, T_5, T_6, and T_7. The maximum reduction in pH of the soil in the plots receiving organic manures may be due to the production of organic acids, during decomposition of organic manures which neutralise the sodium salts present in the soil and increase the hydrogen ions concentration. Maurya and Ghosh, [15]; Swarup and Singh [16] also reported a decrease in the soil pH by 0.3 to 0.9 unit after continuous application of chemical fertiliser along with green manure and FYM. Maximum reduction (0.17) of the EC value recorded in the treatment T_4 and T_5 with application of 1/3 of N each through FYM + VC + Neemcake and 50% N as FYM + bio-fertiliser respectively. 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., [17,18]. Kumar and Yadav [19] also reported that organic plus chemical fertiliser treatments decrease EC at faster rate than inorganic fertilisers alone. The maximum organic carbon (0.64 %) 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 and T_2. 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, [20], significantly lower in inorganic fertiliser treatments as compared to the treatments involving fertiliser with organic sources. These results corroborated with the finding of Numbiar and Abrol [21], Bhandari et al. [22], More [23] and Chaudhary et al. [18].

3.3 Change in Available Nitrogen, Phosphorus and Potassium

Organic manure contains many nutrients required for crop production. Of these, nitrogen is one of the most important and is the most common added to soil for high yield of the crops. Although, it undergoes through many transformations in soil as it is used, re-used, and made available by soil microbes. Maximum available N (273.43 kg ha^{-1}) was found in T_1 receiving chemical fertilizers (Table 2) followed by T_6 and T_2 (269.39 and 269.08 kg ha^{-1}). The availability of N in soil increased in the treatments (T_1) because of 120, 60 and 40 kg ha^{-1} chemical fertilizer application, that may be remained in the soil after crop harvest. Among organic treatments, maximum buildup of nitrogen is observed in T_6-50 % N through FYM+50 % N through (VC (269.39 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, where FYM and vermicompost were added. Similar finding were also observed by Bhandari et al., [22]; Kumar and Yadav [19] and Sharma and Ghosh [24]. 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 maximum buildup of available phosphorus (18.49. kg ha^{-1}) was observed under the treatment T_7- receiving 50 % N as FYM+50 % N as VC +biofertilizer followed by T_6 receiving 50 % N as FYM+50 % N as VC +biofertilizer (18.33 kg ha^{-1}), The lowest available P was observed in T_5 receiving only 50 % N as FYM and biofertilizer. Increased availability of phosphorus in soil under treatments may be by increased solubility due to production of organic acids. Similar finding was

Table 1. Plant height, No. of leaves, equatorial diameter (cm), yield and economics (Rs lacks ha^{-1}) of Kharif onion as influenced by the application of organic and inorganic fertilizer sources

Treatments	Plant height (cm)			No. of leaves			Equatorial diameter (cm)	Yield (q ha^{-1})	Gross return	Net Return	B : C Ratio
	30 DAP	60 DAP	90 DAP	30 DAP	60 DAP	90 DAP					
T_1-Recommended dose of fertilizer	23.6	37.0	54.0	3.9	6.4	12.7	5.3	364.79	2.91	2.50	6.13
T_2-50%NPK as MF+50%N as FYM	23.5	34.6	53.0	3.7	6.2	12.2	5.2	343.31	2.74	2.28	4.95
T_3-50% N as FYM+50% N as VC	22.2	32.5	55.6	3.5	6.0	13.5	5.0	307.25	2.45	1.91	3.53
T_4-1/3 of N each as FYM+VC+NC	21.6	31.5	55.9	3.3	5.9	13.9	4.8	268.32	2.14	1.61	3.05
T_5-50% N through FYM+ biofertilizer	21.2	28.0	47.8	2.9	4.9	10.6	4.4	236.46	1.89	1.42	3.07
T_6-T3+biofertilizer	23.1	35.0	56.3	3.7	6.2	13.7	5.1	321.80	2.57	2.00	3.50
T_7-T4+biofertilizer	22.1	33.1	60.1	3.6	6.1	12.5	4.7	291.63	2.33	1.77	3.17
SE(d)	1.6	2.3	2.6	0.2	0.4	1.6	0.2	28.89	-	0.231	
C D at 5%	3.5	4.9	5.7	0.5	0.9	3.4	0.4	62.99	-	0.509	

FYM;Farm yard manure, VC; Vermicompost, NC; Neemcake

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

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-Recommended dose of fertilizer	7.44	0.19	0.62	273.43	16.1	154.97
T_2-50%NPK as MF+50%N as FYM	7.43	0.19	0.62	269.08	17.13	147.49
T_3-50% N as FYM+50% N as VC	7.41	0.18	0.63	266.81	17.73	143.50
T_4-1/3 of N each through FYM+VC+NC	7.42	0.19	0.63	263.61	16.76	142.43
T_5-50% N through FYM+ biofertilizer	7.40	0.17	0.63	252.46	15.95	135.57
T_6-T3+biofertilizer	7.39	0.17	0.64	269.39	18.33	146.33
T_7-T4+biofertilizer	7.41	0.19	0.63	266.48	18.49	142.47
SE(d)	0.07	0.02	0.02	7.06	1.37	6.72
C D at 5%	0.14	0.03	0.04	15.39	2.99	14.65

FYM;Farm yard manure, VC; Vermicompost, NC; Neemcake also observed by Bhandari et al. [22]; More [23] and Kumar et al. [25]. T_1-Chemical fertilizer alone and T_2-50% NPK as chemical fertilizer + 50 % N as FYM recorded higher amount of available K (154.97 and 147.49 kg ha^{-1}), while lowest (135.57 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 [26], Tolanur and Badanur [27].

3.4 Economics

The cost of cultivation, gross returns, net returns and benefit-cost ratio as influenced by different treatments are presented in Table 1. T_1 recorded maximum gross returns, (Rs. 2.91 lacks) followed by treatment T_2-50% CF +50 % N as FYM (Rs. 2.91 lacks) and T_6-T_3+biofertilizer (Rs. 2.57 lacks), whereas minimum gross return (Rs 1.89 ha^{-1}) was recorded in treatment T_5 . Data also revealed that the highest net return of Rs 2.50 ha^{-1} was obtained in T_1-Chemical fertilizer followed by T_2-50% CF +50 % N as FYM (Rs. 2.28 lacks) and T_6-T^3+biofertilizer (Rs. 2.00 lacks), along with cost benefit ratio 6.13, 4.95 and 3.5 respectively. While, lowest net return (Rs 1.42 lacks ha^{-1}) and lowest cost benefit ratio 3.07 was observed in treatment T_5. On the basis result obtained T_2 as 50 %NPK through chemical fertilizer + 50 % N through FYM can be adapted as sustainable onion production, as it performed bulb yield statistically at par with chemical fertilizer and also built-up appreciable amount of N (4.36%), P (17.32%) and K (3.86%). This is one year of study and need few years more research on organics.

4. CONCLUSION

The present study exhibited the response of different organic and inorganic sources of nutrients on growth and yield of *kharif* onion (*Allium cepa* L.). Result showed that T_2 as 50 % NPK through chemical fertilizer + 50 % N through FYM can be adapted as sustainable onion production, as it performed bulb yield statistically at par with chemical fertilizer and also built-up appreciable amount of N (4.36 %), P (17.32 %) and K (3.86 %).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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