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Effect of Integrated Nutrient Sources on Agronomic Performance of Onion (*Onion cepa* L.) and Soil Properties

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Abstract: A field experiment was conducted to study the effect of integrated nutrient management in onion for two years at Krishi Vigyan Kendra, Jalandhar. The different combinations of farmyard manure, vermicompost and poultry manure along with inorganic fertilizers were used to evaluate the performance of onion. The maximum plant height, number of leaves, neck thickness, bulb weight and fresh bulb yield was in treatment with Farmyard manure @ 20 tones + Vermicompost @ 5 tones + Poultry manure @ 2 tones +100 % of recommended NPK was applied followed by farmyard manure @50 tones +100% recommended NPK (37.5t ha^{-1}) and Poultry manure @ 7.5 tones + Biofertilizer + 75 % of recommended NPK (35.7 t ha^{-1}). This study concluded that the integrated application of manures and chemical fertilizers is a must for improving soil nutrient status and nutrient use efficiency and ultimately enhances nutritional security.

Keywords: Onion, Yield, Organic, inorganic, Soil properties

Onion (*Allium cepa* L.) belongs to family *Alliaceas*, is a bulbous biennial herb which is most important vegetable cum condiments, spice crops demanded worldwide. India is the second largest producer of onion in the world, next to China with an area of 1.31 million ha with a production of 22.1 million tones ha^{-1} (FAOSTAT 2018) but the productivity is low 16.87 tones ha^{-1} as compared to other countries. Intensive cropping, imbalanced fertilization, minimal usage of micro nutrients and limited application of organic manures have resulted in the depletion of soil fertility could have resulted in low productivity and quality of the crop.

Onion shows significant response to organic and inorganic fertilizers (Soleymani and Shahrajabian 2012). Therefore, the usage of organic manures as alternative source of nitrogen would give better result in its growth and yield .Organic material, such as farmyard manure improves soil physico-chemical properties that are important for plant growth (Kidanu 2017). Decomposition of materials would provide additional nutrients to the growing medium which may lead to higher uptake of nutrient by the crop and subsequently high yield. Besides, organic manures have positive effect on root growth by improving the root rhizosphere conditions (structure, humidity, etc.) and also plant growth is encouraged by increasing the population of microorganisms (Shaheen et al 2007). A part from this, Organic manures enhance the different properties of soil i.e. physical, chemical and biological and also increase the moisture holding capacity of soil which resulted more in maintaining the quality of crop production and crop production (Dauda et al 2008). Organic manure and biofertilizers mixture increased the yield and provide more nutrients to onion tuber (Shaheen et al 2007) Cultivation of this nutrient responsive crop using eco-friendly innovative techniques like integrated use of organic manures along with inorganic fertilizer for sustainable use of available resources could be best way to increase production level. Keeping above in view an On Farm Trial (OFT) was conducted at Krishi Vighan Kendra, Jalandhar to study the effect of organic and inorganic Fertilizer on economic characters of crops as well as on soil properties.

MATERIAL AND METHODS

The On Farm Trial (OFT) was conducted at Krishi Vighan Kendra, Jalandhar to study the effect organic and inorganic fertilizers on economic characters of onion and soil properties during the year 2018 and 2019 in *Rabi* season. Krishi Vigyan Kendra, Nurmahal, Jalandhar is geographically situated at 31°09'N latitude, 75°59' E longitude and at an altitude of about 237 m above mean sea level. The climate of the region is extremely hot during the summer and cold during winter. The soil samples were collected from 0-15 cm depth before start of the experiment to determine the basic physical and chemical soil properties. The soil of the experimental site was sandy loam in texture having pH 7.84, EC. 0.24 ds/m, low in organic carbon content (0.41%), low in available N (94.6 kg ha^{-1}), high in available P_2O_5 (23.7 kg ha^{-1}) and medium in available K_2O (242.5 kg ha^{-1}). The experiment was laid in complete randomized block design replicated

thrice. The experiment consists of six treatment combinations of organic and inorganic fertilizers viz. T_1-Farmyard manure @ 50 tones + Bio-fertilizer + 75 % of recommended NPK (75:37.5:37.5), T_2-Poultry manure @ 7.5 tones + Biofertilizer +75% of recommended NPK (75:37.5:37.5), T_3-Vermicompost @ 15tones + Bio-fertilizer + 75% of recommended NPK (75:37.5:37.5), T_4- Farmyard manure @ 20 tones + Vermi-compost @ 5 tones + Poultry manure@ 2 tones +100 % of recommended NPK (100:50:50), T_5-Farmyard manure @ 50+ tones +100% recommended NPK (100:50:50), T_6- 100% recommended NPK (100:50:50), T_7- Control.

Organic manures were mixed in the soil fifteen days prior to the transplanting of the onion. The chemical composition of organic manures is given in Table 1. The nursery of onion (cv. Punjab Naroya) was sown on raised beds using seed rate 10 kg ha^{-1} in last week of October. The transplanting was done in first fortnight of January in both the years following 15x7.5cm row to row and plant to plant spacing. Farmyard maures, vermi-compost and poultry manure were added 15 days prior to transplanting .The inorganic fertilizer sources used were urea for N (46% N), diammonium phosphate for P (18 % N and 46 % P2O5), muriate of potash for K (60% K2O). Full dose of phosphorus, potash, half nitrogen was applied before transplanting. The remaining dose of nitrogen was top dressed after one month of transplanting. The 10 kg of *consortium* bio-fertilizer per hectare was mixed with 25 kg of soil and was broadcasted before transplanting. All other practices of cultivation were followed as recommended by Punjab Agricultural University, Ludhiana (Anonymous 2018).

The uprooting of the bulbs was done manually in the first week of May during *Rabi* 2018 and last week April during *Rabi* 2019. After harvesting, the bulbs were cured and then leaves were cut 1-2 cm above the neck and bulb yield was recorded. Data on plant height (cm), leaves /plant (No.), neck thickness (mm),fresh bulb weight(g), fresh bulb yield (ton ha^{-1}). Data on growth and yield parameters were recorded from ten randomly selected plants from each plot. The data collected on various parameters under study were statistically analyzed with CPCS1 software

Analysis of soil samples: The soil samples from 0-15 cm depth were randomly collected at five places in each plot after the end of the experiment and determined for soil physical and chemical properties using standard procedures. Bulk density was determined by calculating the soil's dry weight (dried at 110°C) and volume of the soil sample. The pH of the soil samples were measured using 1:2 ratio of soil and water suspension (Jackson 1973) and electrical conductivity (EC) was determined using a soil–water supernatant in a 1:2 ratio (Richard 1954). The organic carbon was determined using the wet combustion method (Walkley and Black 1934). The available nitrogen was estimated using alkaline permanganate method (Subbiah and Asija 1956). Soil was analyzed for available potassium by extracting it with neutral ammonium acetate solution (Merwin and Peech 1950) and available phosphorous following the method of Olsen et al (1954).

RESULTS AND DISCUSSION

Effect on yield and yield attributes: The yield and yield attributes of onion also showed a significant variations among all the treatments (Table 2). A significant variation was observed in plant height (cm) of rabi onion due to application of organic and inorganic sources which varied from 35.6cm to 70.5cmwith average mean value of 60.0.The maximum number of leaves per plants was recorded higher in T_4 (7.8) followed by T_5 and T_3 which was at par with T_2. Minimum number of leaves was in T_7 (3.4) There was significant difference o in neck thickness with maximum neck in T_4(11.0) which was at par with T_5 followed by T_3 and T_3. Minimum neck thickness was ind T_7(5.0) followed by T_6(9.2).

Bulb yield (g) showed significant difference among all the treatment of inorganic and organic fertilizer which varied from 34.2 g-92.5 g with geometric mean of 76.4. Maximum Bulb yield was recorded in by T_4 where we applied Farmyard manure @ 50 tones + Vermicompost @ 5 tones + Poultry manure @ 2 tones + 100 % of recommended NPK , Minimum bulb weight (g) was recorded in T_7(34.2) Fresh bulb yield ton ha^{-1} was recorded significant difference among all treatment in this experiment . Maximum fresh bulb yield (ton

Table 1. Moisture and nutrient contents of organic manures

Organic manure	Moisture content (%)	Total nutrient content						
		%			mg kg^{-1}			
		N	P	K	Fe	Zn	Mn	Cu
Farmyard manure	61	1.92	0.72	2.15	550.3	120.3	193.8	69.8
Poultry manure	48	2.53	1.95	2.31	514.2	141.8	410.5	83.2
Vermicompost	53	2.05	0.95	2.12	590.8	107.9	313.6	53.8

/ha^{-1}) was recorded in T_4 followed by T_5, T_2, T_3 which was at par with T_1. Minimum bulb yield was recorded by T_7 (16.4). It was also revealed that bulb weight and bulb yield was directly correlated. Gebremichael et al 2017also concluded that the application of organic fertilizer along with inorganic fertilizer (nitrogen) increased onion yield, shelf life and soil fertility replenishment. Results were also in line with Saima Sultana (2014), Brar et al (2015) and Ali et al (2018)

Effect of integrated nutrient management on soil properties: The application of organic manures affected the soil properties significantly (Table 3). The bulk density of soil decreases significantly from initial value of 1.42 Mg m^{-3} to 1.22 Mg m^{-3} where FYM and 100% recommended fertilizers (T_5) were applied closely followed by combined application of organic manures in other treatments. It is mainly due to the application of organic manures which increases the pore capacity of the soils and reduces the bulk density (Gopinath and Mina 2011). Soil pH varied significantly with the treatments and it decreased with organic manures application and combined application but increased with only chemical fertilizer application (Table 3). The slight decrease in soil pH is due to the release of organic acids during the decomposition of organic manures The result are supported by the findings of Dhiman et al (2019) and Randhawa et al (2021). The EC of the soil samples increased non-significantly with the application of organic manures. The decomposition of organic manures released acids or acid-forming compounds that react with sparingly soluble salts already present in the soil and either converted them into soluble salts or at least increased their solubility (Sarwar et al

Table 2. Effect of integrated nutrient sources on growth parameter and yield (Pooled data of two years)

Treatment/	Plant height (cm)	Leaves/ plant (No.)	Neck thickness (mm)	Bulb weight (g)	Fresh bulb yield (ton ha^{-1})
T_1- Farmyard manure @ 50 tones + Bio-ferlilizer +75 % of recommended NPK (75:37.5:37.5)	63.7	6.9	10.2	83.0	34.3
T_2-Poultry manure @ 7.5 tones + Biofertilizer +75% of recommended NPK (75:37.5:37.5)	65.3	7.6	10.3	85.9	35.7
T_3-Vermicompost @ 15 tones + Bio-fertilizer + 75% of recommended NPK (75:37.5:37.5)	64.6	7.6	10.7	83.6	34.8
T_4- Farmyard manure @ 20 tones + Vermi-compost @ 5 tones + Poultry manure @ 2 tones +100 % of recommended NPK (100:50:50)	70.5	7.8	11.0	92.5	38.9
T_5-Farmyard manure @ 50+ tones +100% recommended NPK (100:50:50)	70.2	7.7	10.9	90.9	37.5
T_6- 100% recommended NPK (100:50:50)	50.6	6.5	9.2	65.3	31.4
T_7- Control	35.6	3.4	5.0	34.2	16.4
Mean	60.0	6.7	9.5	76.4	32.4
CD (P=0.05)	2.5	1.1	1.2	2.0	2.56

Table 3. Effect of different treatments on soil properties after two years

Organic manure	BD (Mg m^{-3})	pH	EC	Organic C (%)	Total nutrient content (%)		
					N	P	K
T_1- Farmyard manure @ 50 tones + Bio-ferlilizer +75 % of recommended NPK (75:37.5:37.5)	1.23	7.69	0.43	0.51	142.3	29.4	342.9
T_2-Poultry manure @ 7.5 tones + Biofertilizer +75% of recommended NPK (75:37.5:37.5)	1.32	7.73	0.39	0.47	132.7	35.4	356.4
T_3-Vermicompost @ 15 tones + Bio-fertilizer + 75% of recommended NPK (75:37.5:37.5)	1.29	7.72	0.36	0.48	138.5	27.4	337.6
T_4- Farmyard manure @ 20 tones + Vermi-compost @ 5 tones + Poultry manure @ 2 tones +100 % of recommended NPK (100:50:50)	1.25	7.82	0.42	0.49	141.8	32.1	339.7
T_5-Farmyard manure @ 50+ tones +100% recommended NPK (100:50:50)	1.22	7.68	0.41	0.50	129.3	28.3	329.2
T_6- 100% recommended NPK (100:50:50)	1.38	7.89	0.30	0.43	128.5	27.4	310.1
T_7- Control	1.40	7.83	0.24	0.41	92.8	21.3	258.4
CD (P=0.05)	0.14	0.15	NS	0.03	3.54	1.34	2.76

2008). There was a significant increase in organic carbon in all the treatment except the control and where only inorganic fertilizers were applied after the period of two years. Application of FYM resulted in highest increase in organic carbon (0.51%) along with the inorganic fertilizers as compared to control. The higher increase in OC content due to combined applications of manures and fertilizers may be because of better crop growth accompanied by higher root biomass generation and higher return of leftover plant residues (Mohana et al 2016). The available N, P and K were higher in integrated nutrient management as compared to control.The result might be due to improvement of other physical and chemical properties for organic manure application compared to the chemical fertilizer application.The highest N content (142.3 kg ha^{-1}) was observed where FYM was applied along with the inorganic fertilizers and biofertilizer. The highest P content (35.4 kg ha^{-1}) was in treatment where poultry manure was applied. This is due to the higher content of initial P in poultry manure as compared to other FYM and VC.The higher availability of phosphorus in manure-amended treatments might have been attributed to the solubilization of P by organic acids released during the decomposition of organic manures, organic materials can reduce the P-sorption capacity of the soil, enhance P availability, improve Recovery or result in better utilization by and due to a reduction in P fixation in soil with chelation of P fixing cations (Fe and Al) (Rathod et al 2013). The higher content of available K in treatments in which organic manures were added could be due to the addition of K through manures that could supply a certain amount of K in soil through the interaction of organic matter with clay. The results are in agreement with the findings of Mazumdar (2014) and Sathish et al(2011).The release of N, P and K was higher in T_1 where biofertilizer was applied along with the FYM as compared to T_5 where only FYM was applied..Some of the organic substances released during the mineralization may act as chelates that help in the absorption of iron and other micro-nutrients(Petrovic and Pokluda,2020). The results suggested that the integrated nutrient management not only results in higher yield but also significantly affects the soil health as compared to the application of inorganic fertilizers only. Due to improved soil properties it enables the roots to grow deeper ensuring strong stems and taller plants.

CONCLUSIONS

The results reported that the use of farmyard manure @20 tones +Vermi-compost@ 5 tones + Poultry manure@ 2 tones +100 % of recommended NPK(100:50:50)gave the maximum plant height, number of leaves ,neck thickness, bulb weight and yield as compared to other treatments. The organic manures also have positive effect on improving the soil organic carbon, pH, EC and nutrient content (N, P and K) of the soil. The application of organic manures improves the bulk density of soil significantly which helps in higher yield of the root crops. These results suggested that a certain combination of organic and inorganic fertilizers is equally important for obtaining higher yields. It can be concluded that the integrated nutrient management is important than the sole use of inorganic fertilizers which indicates the improved nutrient use efficiency with the aid of organic manures.

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