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Effect of Integrated Nutrient Management in Onion for Better Crop Productivity and Improved Soil Health

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ABSTRACT

Onion is major *rabi* vegetable crop grown for its edible bulbs. In Punjab, farmers grow onion on a large scale and often use chemical fertilizers injudiciously to harness its maximum yield potential to make it viable commercially. However non judicious use of these chemical fertilizers had adversely affected soil health, environment and other natural resources including human health. Therefore, it becomes necessary to reduce the use of harmful chemical fertilizers. Krishi Vigyan Kendra S.A.S. Nagar (Mohali) conducted on-farm trials during 2021-22 at five locations in the district to evaluate the effect of integrated nutrient management (INM) in onion for better crop productivity and improved soil health. The trial was conducted in randomized block design (RBD) with three treatments and three replications. The treatments comprised T_1: Non Judicious Use (Farmers' Practice), T_2: Application of NPK: 100:50:50 Kg/ha along with 50 t FYM (farm yard manure). T3: Combined application of 110:40:60:20 Kg/ha NPKS along with organic manures equivalent to 15 ton FYM and *Azospirillum* and PSB (phosphate solubilising bacteria) @ 5 Kg each. The results revealed that treatment T_3 provided highest yield (400.50 q/ha) with maximum BC ratio of 4.34 followed by T_2 (383.32 q/ha) with BC ratio of 3.93 and T_1 with yield of 359.17 q/ha and BC ratio of 3.55. Similar trends were observed for growth parameters. On the basis of above investigation it can be concluded that use of integrated nutrient management practice gave higher yields and better returns as compared to control. Combined application of 110:40:60:20 Kg/ha NPKS along with organic manures equivalent to 15 tonn FYM and *Azospirillum* and PSB @ 5 Kg each was found to be the best for sustainable production.

Key Words: Economics, Integrated Nutrient Management, Onion, Soil health, Sustainable.

INTRODUCTION

Onion is a major crop among vegetables grown during *rabi* season and fetch good price. Continuous use of inorganic fertilizers without supplementation with organic manure has often resulted in micronutrient deficiencies, imbalance soil physical and chemical properties and unsustainable crop production (Yohannes *et al,* 2017). Biofertilizers are carrier-based preparations which contain beneficial microorganisms in viable state used for seed or soil application. In recent years biofertilizers have emerged as a promising component of integrated nutrient supply system. These are likely to assume greater significance as a complements or supplements to the chemical fertilizers because of high nutrient turnover, exorbitant cost of fertilizers, soil and environmental protection. Biofertilizers are less expensive, ecofriendly, provides plant hormones and help in sustainable crop production through maintenance of soil productivity (Ramakrishnan and Thamizhiniyan, 2004). Integrated nutrient management (INM) provides excellent opportunities to overcome all the imbalances besides sustaining soil health and enhancing crop production. It optimizes the benefits from all possible sources of plant nutrients in an integrated manner. Hence, the present investigation was planned to identify the ideal integrated nutrient management practices for onion at district Mohali conditions.

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MATERIALS AND METHODS

Experimental site, treatments and design

Mohali district of Punjab falls under sub-mountainous zone (30.69°N latitude, 76.72°E longitude) having an average altitude of 316 m from the sea level. The present investigation was carried out at five farmer's fields during 2021-22 to evaluate the effect of integrated nutrient management (INM) in onion for better crop productivity and improved soil health. The area under each trial was kept 0.4 ha. The soil at the site of experiment was deep, loose and sandy loam. The trial was conducted in randomized block design. To achieve the mandate of sustainable vegetable production in addition with environmental conservation, KVK, S.A.S. Nagar (Mohali) conducted on-farm-trials during 2021-22 at five different locations in the district. The treatments comprised T_1: Non Judicious Use (Farmers Practice), T_2: Application of NPK: 100:50:50 Kg/ha along with 20 t FYM. T3: Combined application of 110:40:60:20 Kg/ha NPKS along with organic manures equivalent to 15 ton FYM and Azospirillum and PSB @ 5 Kg each. Observations were taken on various growth, yield and economic parameters. Selected farmers were trained on scientific cultivation of crop including method of raising crop, intercultural operations, nutrient management, water management, weed management and proper harvesting through on/off campus trainings. Crop was raised following recommended package of practices. The weather data of the experimental site was given in Table 1 for the growing period of the crop.

The soil of the experimental site was brought to a fine tilth by repeated ploughing and harrowing. The clods were broken and debris was removed. The soil was levelled and beds were prepared. Seeds were sown during the month of November. The seed rate employed was 12.5 kg/ha. The seedlings were transplanted during first fortnight of January in the main fields. The seedlings were transplanted at a spacing of 15 cm between ridges × 7.5 cm between plants. Before fertilizer application, random soil samples were taken from the experimental site and were analyzed. 50 tonnes of well rotten farmyard manure, 225 kg of urea, 312.5 kg of single superphosphate and 87.5 kg of muriate of potash was applied in one ha area. All the fertilizers were applied at the time of sowing except nitrogen which is applied in two equal split doses (half during field preparation and half after 4-6 weeks of planting). 3-4 hoeing were done for weed control. 10-15 irrigations were given to crop including one immediately after planting. The crop was harvested when tops dried up and fall.

Data collection

Five plants were selected at random from each plot for recording observations like days taken to harvest, plant height (cm), number of leaves/plant, leaf length (cm), bulb diameter (cm), average bulb weight (g) and yield (q/ha). Days taken for harvest were calculated as days from planting to first harvest. On the basis of net plot yield, bulb yield per hectare was calculated and expressed in quintal (q) per hectare. % increase was calculated as: % increase= (Increase/original number) × 100.

Table 1. Weather data of the district during growing season of crop

Month	Average Temp °C (Max)	Average Temp °C (Min)	Relative Humidity (%)
November 2021	27.67	10.32	72.0
December 2021	25.52	3.60	86.0
January 2022	21.50	5.10	82.2
February 2022	26.00	4.70	65.9
March 2022	37.00	10.50	57.2
April 2022	41.00	17.60	35.0

Economic analysis

The cost of cultivation and gross returns were worked out by using prevailing market prices of inputs during the period of investigation. Labour cost, power cost for different operations such as ploughing, weeding, irrigation, planting, bed preparation and harvesting etc. in addition to other inputs such as seed and fertilizers were calculated as per market price. Net returns were worked out using formula: Net Returns (Rs/ha) =Gross Returns (Rs/ha)-Cost of cultivation (Rs/ha). Benefit-cost ratio (BCR) was worked out by using the following formula. Benefit: Cost ratio (BCR) = Gross return (Rs/ha)/ Total cost of cultivation (Rs/ha). Statistical analysis was done using standard procedure given by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

Days taken to harvest

The results of the present investigation have been presented in Table 2. All treatments had significant effect on days taken to harvest. Treatment T_3 was earliest (122) followed by T_2 (128) and T_1 (136). It means treatment T_3 took minimum days to harvest as compared to other treatments which took longer days. This might be due to genetic phenomenon, inherited characters and their early acclimatization to area of cultivation which further improved growth and developments. The delayed maturity observed could be attributed to enhanced vegetative growth and photo assimilation that may have prolonged the start of physiological maturity. The results are in close line with those of Yohannes *et* al. (2017).

Plant height (cm)

Treatments had significant effect on plant height (cm). T_3 recorded maximum plant height (42.80 cm) followed by T_2 (38.40 cm) further followed by T_1 (35.50 cm). The augmentation in plant height is the result of intensive cell division and cell enlargement which in turn is influenced by protein synthesis. Therefore any variation in cell metabolism can consequently affect the plant height (Sharma *et* al, 2016). The increase in plant height in treatment T_3 may be ascribes due to sustained availability of balanced nutrient throughout the growing period, which resulted increased vegetative growth. Similar findings were reported by Yadav *et* al. (2015) and Prusty *et* al. (2019)

Number of leaves/plant

All treatments had significant effect on number of leaves/plant. T_3 recorded maximum number of leaves/plant (8.36) followed by T_2 (6.85) further followed by T_1 (5.32). The increase in leaf number in response to the increased application of fertilizers might be due to the role of the different nutrient elements such as nitrogen and phosphorus plays in root and shoot growth and development and formation of phosphoproteins and phospho-lipids that encourage meristematic activity of plants, resulting in increased number of leaves per plant (Bagali *et* al, 2012). These results are in close conformity with those of Gererufael (2020).

Table 2. Growth, yield and yield contributing characters as influenced by different treatments in onion.

Treatment	Days taken to harvest	Plant height (cm)	No of leaves/ plant	Leaf length (cm)	Bulb diameter (cm)	Average bulb weight (g)	Yield (q/ha)	% increase over check
T_1	136	35.50	5.32	53.49	3.80	62.20	359.17	--
T_2	128	38.40	6.85	56.22	4.98	68.60	383.32	6.72
T_3	122	42.80	8.36	59.17	5.88	72.40	400.50	11.51
SE(m)	2.00	1.25	0.16	0.34	0.19	0.58	2.03	--
CD	8.07	5.02	0.64	1.38	0.48	2.33	8.17	

Leaf length (cm)

All treatments had significant effect on leaf length. Treatment T_3 was having maximum leaf length (59.12 cm) followed by T_2 (56.22) and T_1 (53.49). Availability of higher quantity of nutrients, improvement in the physical properties of soil and increased activity of microbes with higher levels of organics in treatment T_3 might have helped in increasing vegetative growth (Bagali et al, 2012). These results are in close conformity with those of Gererufael (2020).

Bulb diameter (cm)

All treatments had significant effect on bulb diameter. Treatment T_3 was recorded for maximum bulb diameter (5.88 cm) followed by T_2 (4.98 cm) and T_1 (3.80 cm). Similar findings of Yohannes *et* al, (2017) also showed that the interaction of organic and inorganic fertilizers can enhance the diameter of the shallot bulbs.

Average bulb weight (g)

All treatments had significant effect on average bulb weight. Treatment T_3 was having maximum average bulb weight (72.40 g) followed by T_2 (68.60 g) and T_1 (62.20 g). However, the probable reason for the highest average bulb weight due to combined application of 110:40:60:20 Kg/ha NPKS along with organic manures equivalent to 15 ton FYM and *Azospirillum* and PSB @ 5 Kg each might be due to phosphorus, being an essential plant nutrient for better plant growth. Moreover, production of antibiotic like compound, synthesis of growth promoting substances due to phosphorus solublizing bacteria (PSB) helps in better plant growth. Similar findings were reported by Kumar *et* al (2019).

Bulb yield (q/ha)

All treatments had significant effect on yield/ha. Among all treatments T_3 was having highest yield (400.50 q/ha) followed by T_2 (383.32 q/ha) and T_1 (359.17 q/ha). The higher yield of T_3 was primarily attributed due to more plant height, number of leaves/plant, bulb diameter and average bulb weight. The beneficial effect of organic manures on yield might be due to the additional supply of plant nutrients as well as improvement in overall soil's physico-chemical and biological properties. It could also be attributed to the fact that after decomposition and mineralization, the applied manures supplied available nutrients directly to plant and also had solubilizing effect on fixed form of nutrients (Singh et al, 2001). It was noticed that, the treatment which performed better in a unit area is likely to perform better on large scale as the yield per hectare was calculated by multiplying yield per plot with hectare factor. Similar findings were reported by Thangasamy and Lawande (2015) and Rai *et al* (2016). Combining nutrient sources from organic manures, plant residues, biofertilizers, and chemical fertilizers would result in high nutrient use efficiency and improve the soil properties physically, biologically, and chemically by narrowing down the gap between nutrient removal and supply (Gnanasundari *et al*, 2022). The percentage increase over check of treatment T_3 was found to be 11.51 per cent and percentage increase over check of treatment T_2 was found to be 6.72 per cent.

Economics

The economic analysis describes the methods used in analyzing the economic behavior and the application of the results obtained to solve the

Table 3. Economic returns from different treatments in onion.

Treatment	Cost of cultivation (Rs/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	BC Ratio
T_1	1,11,250	3,95,082	2,83,833	3.55
T_2	1,15,000	4,52,332	3,37,332	3.93
T_3	1,16,250	5,04,000	3,87,750	4.34

economic problems. The input and output prices of commodities prevailed during the year of trial were taken for calculating cost of cultivation, net returns and benefit cost ratio. Net profit /ha also depends upon the availability of labour and a suitable market for selling of produce. Results of the present investigation (Table 3) revealed that among treatments T_3 gave net return of Rs. 3,87,750/ha with B: C ratio of 4.34 whereas T_2 gave net return of Rs. 3,37,332/ha with B: C ratio of 3.93 and T_1 gave net return of Rs. 2,83,833/- with B: C ratio of 3.55. The total cost of production was maximum for T_3 (Rs. 1,16,250 /-) followed by T_2 (Rs. 1,15,000/-) and T_1 (1,11,250/-). Gross return was found to be maximum for T_3 (Rs. 5,04,000/-) followed by T_2 (Rs. 4,52,332/-) and T_1 (3,95,082/-). The cost benefit ratio of any crop is an important factor that is responsible for the growing of crop by a particular farmer. For the adoption of any horticultural practice which is being adopted by a grower it must positively influence the cost benefit ratio. Similar findings were reported by Gupta *et* al, (2021) and Sharma and Khadda (2023).

CONCLUSION

The findings of the experiment revealed that combined application of 110:40:60:20 Kg/ha NPKS along with organic manures equivalent to 15 ton FYM, azospirillum and PSB @ 5 Kg each was found to be the best for higher yield and growth parameters. Moreover, economic analysis also indicated that combined application of gave the highest net returns however, considering sustainability of the resource, yield and economic feasibility T_3 can be used as an alternative option for onion production in the experimental area.

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