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Integrated Nutrient Management Approach for Increasing Growth, Yield and Economics of Onion (*Allium cepa* L.)

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Authors' contributions

This work was carried out in collaboration between all authors. Authors SKS and RBV designed the study, performed the statistical analysis, wrote the protocol and the first draft of the manuscript. Authors VKS, VBP and GSP managed the analyses of the study. Authors DKB, AK and RK managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

An investigation was carried out at Bihar Agricultural College, Sabour, (Bhagalpur) to find out the effect of integrated use of inorganic and organic fertilizers on growth and yield of onion. An application of 25% N of RDF as inorganic + 75% N from poultry manure as organic source showed significant influence on plant height (51.2 cm), number of leaves/ plant (8.56), length of leaves (42.92 cm), number of scales/ bulb (9.13), bulb length (5.75 cm), bulb diameter (5.85 cm), average bulb weight (49.64 gm), bulb volume (60.28 cc), total yield (288.41 q/ha) with highest trend in this treatment, which was found better over the 25% N of RDF as inorganic + 75% N from vermicompost, sole application of poultry manure (100% N of RDF was supplemented through poultry manure) and remaining all treatments.

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1. INTRODUCTION

Onion (*Allium cepa* L.) is one of the most important commercial crops, which earns about 70% of foreign exchange among the fresh vegetables in India. It belongs to Monocotyledonae family Amaryllidaceae. It is high in food energy, intermediate in protein and rich in calcium and Riboflavin. Onion is famous for its flavour and pungency which is due to the presence of a volatile oil Allyl Propyl Disulphide (compound rich in sulphur) And because of this onion is termed as 'Dynamite of Natural Food' and also known as 'Queen of Kitchen'. It is being consumed in several ways as fresh, frozen and dehydrated bulbs. Dehydrated onion is in great demand which reduces transport cost and storage losses. Notable onion growing countries are USA, U.S.S.R., Netherland, Japan, Spain and Turkey. In India it is cultivated in an area of 1.17 million hectare with production of about 18.93 million tonne and an average productivity of 16.13 tonne per hectare. However, the area, production and productivity of onion in Bihar is 0.05 million hectare, 1.25 million tonne and 22.97 tonne per hectare, respectively. (NHB 2014-15).

Onion is an important crop both as a condiment and income generation. However, Continuous use of inorganic fertilizers and inappropriate soil fertility management practices are among the major factors limiting onion productivity. The use of chemicals in agriculture started with the use of fertilizers followed by plant protection chemical and undoubtedly increased the crop yield manifold but on the other hand the present production system has endangered our health and environmental security due to abundant use of chemical fertilizers and pesticides [1]. Onion shows significant response to organic and inorganic fertilizers. The usage of organic manures as alternative source of nitrogen would give better result in its growth and yield. Organic materials, such as, vermicompost, poultry manure and farmyard manure improves soil physico-chemical properties that are important for plant growth [2]. 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 [3]. Integrated use of inorganic fertilizers with organic ones not only balances the nutrient supply but also improve the physical, biological and chemical properties of soil [4]. In a country like India where about 70 percent population lie on farming and a large population of farmers have small holdings, the use of organic sources of nutrients in combination with inorganic fertilizers may offer a great opportunity to increase the crop production at least cost [5]. Thus, the present investigation was conducted to explore the possibility of using appropriate dose of inorganic and organic sources of nutrients on growth and yield of onion.

2. MATERIALS AND METHODS

2.1 Experimental Materials and Site of Study

The present study was carried out during *Rabi* season at the experimental area of the Department of Horticulture (Veg. & Flori.), Bihar Agricultural College, Sabour, B.A.U., Sabour, Bhagalpur (Bihar).The organic carbon, available nitrogen, P_2O_5 and K_2O were 0.41 per cent, 228.15, 49.25 and 363.78 kg per ha, respectively in the soil. The fourteen treatments viz. T_1:100% inorganic RDF (N:P:K-120:60:80), T_2:75% RDF inorganic + 25% N through Farm yard manure (FYM), T_3: 75% RDF inorganic + 25% N through Poultry manure (PM), T_4:75% RDF inorganic + 25% N through Vermicompost (VC), T_5:50% RDF inorganic + 50% N through Farm yard manure (FYM), T_6: 50% RDF inorganic + 50% N through Poultry manure (PM), T_7: 50% RDF inorganic + 50% N through Vermicompost (VC), T_8: 25% RDF inorganic + 75% N through Farm yard manure (FYM), T_9: 25% RDF inorganic + 75% N through Poultry manure (PM), T_{10}: 25% RDF inorganic + 75% N through Vermicompost (VC), T_{11}: 100% N through Farm yard manure (FYM) (16.0 t), T_{12}: 100% N through Poultry manure (PM) (5.0 t), T_{13}: 100% N through Vermicompost (VC) (7.0t) and T_{14}: Control (without inorganic or organic sources of nutrition) were arranged in randomised block design (RBD) with three replications. The seedlings were transplanted at of 15 cm x 10 cm row to row and plant to plant spacing in the plots having size of 3.0 m x 1.5 m. The organic sources of nutrients as per treatment through farm yard manure, Poultry Manure and Vermicompost were supplemented before 20 days of planting of seedlings and inorganic

sources of nutrients were applied at the time of planting of seedlings as per treatment.

2.2 Growth and Yield Attributing Traits

Data on various growth (Plant height, length of leaves, number of leaves /plant,) and yield contributing traits (Number of scales /bulb, length of bulb, diameter of bulb, average bulb yield and volume of bulb) were recorded on five randomly selected plants per treatment per replications, while the bulb yield was recorded on per plot basis.

Plant height was measured at the time of maturity from the ground level to the height of the leaf tip, while leaf length was measured from the point of radiation to the growing tip with the help of a meter scale. Diameter of the bulb was measured with the help of a Vernier Callipers, while the volume was measured by water displacement method.

2.3 Bulb Yield (q/ha)

Bulbs were harvested at physiological maturity when more than 80% of the plants in a plot showed yellowing of leaves. Total bulb yield was computed based on the weight of matured bulb yield per plot and converted in to hectare base and expressed in quintal.

2.4 Data Analysis

Data on all parameters were subjected to analysis of variance (ANOVA) as suggested by Fisher and Yates [6]. When ANOVA showed significant differences, mean separation was carried out using Critical Difference (CD) test at 5% level of significance to draw the valid conclusion.

2.5 Economic Analysis

In order to identify economically feasible recommendations, Benefit: cost ratio was calculated by dividing the net return by treatment wise total cost of cultivation.

3. RESULTS AND DISCUSSION

3.1 Growth Parameters

The data concerning growth parameters as influenced by integrated use of inorganic and organic sources of nutrients have been presented in Fig. 1. It is obvious from the table that the various treatments brought variable influence on the plant height, length of leaves and number of leaves per plant. The significantly tallest plant (51.20 cm) was produced when the plot received 25% RDF + 75% N through poultry manure (T_9), which exhibited statistical equality with application of 100% N through poultry manure (T_{12}) alone, 25% RDF+75% vermicompost (T_{10}) and sole application of inorganic fertilizers @120:60:80 kg/ha RDF (T_1) giving the plant height of 47.72, 47.53 and 46.46 cm, respectively. There was a remarkable variation on length of leaves due to integrated use of inorganic and organic fertilisers. Highest length of leaves (42.92) were observed with application 25% RDF+75% N through poultry manure followed by 100% N through poultry manure, 25% RDF + 75% N through VC (T_{10}) and 120:60:80 kg NPK/ha (T_1) giving the leaf length of 41.28, 40.12 and 39.63 cm, respectively. Number of leaves showed significant increase with treatment nine (T*9*) followed by 100% poultry manure (T_{12}) and NPK @ 120:60:80 kg/ha (T_1) producing 7.86 and 7.82 leaves per plant respectively. Organic manures are known to contain micronutrients apart from major nutrients. Beside this, organic manures have been reported to contain several plant growth promoters, enzymes beneficial bacteria and mycorrhizae. Therefore, the availability of more quantity of nutrients, improvement in the physical properties of soil and increased activity of microbes with higher levels of organic sources might have helped in increasing plant height, number of leaves per plant and leaf length. The results of the present investigation get support from the earlier workers [7,8,1].

3.2 Yield and Yield Attributing Characters

Data pertaining to yield and its contributing traits have been mentioned in the Table 1. Among the different treatment combinations, application of 25% RDF+75% N through poultry manure (T_9) gave significantly highest number of scales per bulb (9.13) which proved its superiority over rest of the treatments and closely followed by 50% RDF + 50% N through poultry manure (T_6) having 8.40 scales per bulb. Similar trend was also observed in respect of bulb length. Maximum length of bulb (5.75 cm) was observed when the crop was supplied with 25% RDF + 75% N through poultry manure, followed by 50% RDF + 50% N through poultry manure (5.18 cm). However minimum bulb length (2.06 cm) was noticed in treatment without integration of organic and inorganic fertilizers (control). The diameter of bulb increased significantly with the application of 25% RDF + 75% N through poultry manure,

followed by 50% RDF + 50% N through poultry manure and sole application of 100% N through poultry manure, which recorded 5.85 cm, 5.78 cm and 5.45 cm, respectively. The significantly maximum bulb weight (49.64 g) was produced by the plants grown under the application of 25% RDF + 75% N through poultry manure (T_9) which was statistically on equal footing to 50% RDF + 50% N through poultry manure (T_6), 25% RDF + 75% N through vermicompost (T_{10}), 75% RDF + 25% N through poultry manure (T_3) producing the bulb weight of 48.94, 47.15 and 45.17 g, respectively. The combined application of 25% RDF + 75% N through poultry manure (T_9) produced significantly highest bulb volume (60.28cc) which was statistically comparable to 50% RDF + 50% N through poultry manure (T_6), 25% RDF + 75% N through vermicompost (T_{10}) and 75% RDF + 25% N through poultry manure (T_3) having bulb volume of 54.96, 54.50 and 54.06 cc, respectively. Similarly, the treatment (T_9) gives positive significant results for the traits bulb yield. The highest bulb yield (288.41 q/ha) was obtained from the plot treated with 25% RDF + 75% N through poultry manure, followed by the treatment (T_6), which yielded 264.20 q/ha onion bulb. The treatment T_{10} and treatment T_3 when applied to plot which responded to the bulb yield of 256.32 and 251.46 q/ha, respectively. The minimum bulb yield (139.97 q/ha) was recorded in the absence of inorganic and organic fertilizers i.e. in control (T_{14}).

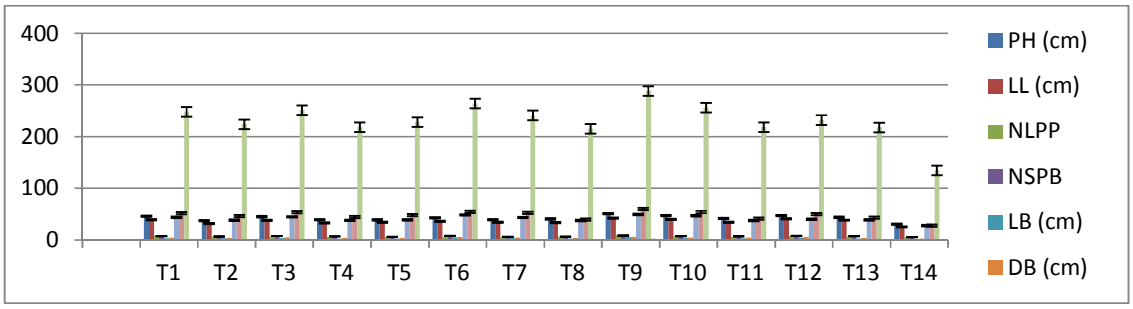

Fig. 1. Graphical representation of effect of integrated nutrient management on growth and economics of onion

Table 1. Effect of integrated use of inorganic and organic sources of nutrients on growth and yield attributing traits, yield and B:C ratio of onion

Treatment	PH (cm)	LL (cm)	NLPP	NSPB	LB (cm)	DB (cm)	ABY (g)	VB (cc)	BY (q/ha)	B: C ratio
T_1	46.46	39.63	07.82	7.66	3.62	4.64	44.34	52.51	248.26	2.20
T_2	37.83	32.42	06.53	7.20	3.14	4.11	38.54	46.76	224.12	1.70
T_3	45.50	38.48	07.13	8.06	4.22	5.32	45.17	54.06	251.46	2.20
T_4	39.63	33.34	05.96	7.40	3.08	3.95	38.39	44.68	218.49	1.52
T_5	39.40	34.74	05.56	6.73	2.90	3.82	39.42	48.66	228.32	1.57
T_6	43.36	36.53	05.66	8.40	5.18	5.78	48.94	54.96	264.20	2.30
T_7	39.58	34.54	05.76	6.60	4.12	4.70	43.96	53.07	241.26	1.52
T_8	41.20	34.22	05.32	6.80	2.86	3.79	38.08	39.79	215.64	1.28
T_9	51.20	42.92	08.56	9.13	5.75	5.85	49.64	60.28	288.41	2.65
T_{10}	47.53	40.12	07.66	7.80	3.75	4.75	47.15	54.50	256.32	1.07
T_{11}	41.94	34.84	05.73	7.46	3.12	4.29	38.04	41.58	218.71	1.33
T_{12}	47.72	41.28	07.86	8.20	4.46	5.45	40.37	50.40	232.42	2.12
T_{13}	44.30	38.79	06.83	7.66	2.96	3.93	39.46	43.65	218.00	0.92
T_{14}	30.80	25.70	04.96	5.73	2.06	2.98	28.12	28.18	134.97	0.93
C.D. at 5%	05.15	03.95	00.65	0.66	0.32	0.44	04.93	06.26	029.45	
C.V.%	07.45	06.52	05.95	5.30	5.27	5.90	07.10	07.76	007.58	

PH= Plant height, LL= Length of leaves, NLPP= No. of leaves /plant, NSPB= No. of scales /bulb, LB= Length of bulb, DB= Diameter of bulb, ABY= Average bulb yield, VB= Volume of bulb, BY= Bulb yield

From the above results it was observed that the there was a profound effect of integrated use of inorganic and organic fertilizers on number of scales, bulb length and bulb diameter. The maximum number of scales per bulb, length of bulb diameter of bulb, volume of bulb and bulb yield were produced when the plot was treated with 25% RDF+75% N of poultry manure and proved its superiority over remaining treatments with minimum in control treatment. It might be attributed to the fact that balanced application of fertilizers ensures synergistic reaction among nutrients and induced translocation of photosynthates from source to sink. The findings are also in close conformity with the findings of Singh et al. [1] and Magdi et al. [9]. The increased in starch and carbohydrates due to sufficient nutrients available in poultry manure might have resulted in the increase of bulb length, bulb diameter and number of scales/bulb and improved soil structure which reflected on decreasing nutrients losses by leaching and deep percolation compare to mineral fertilizers. The results of the present investigation in terms of number of scale per bulb, bulb length, bulb diameter and yield are in collaboration with the findings reported earlier by Bagali et al. [5], Seran et al. [10] and Rathi et al. [11]. Lalitha et al. [12] also noted that application of organic inputs like vermicompost attributed to better growth of plants and higher yield by slow release of nutrients. The lowest yield in the control treatment may be due to the fact that plots did not receive any organic and inorganic fertilizers and hence were deficient of essential plant nutrients.

The integrated use of inorganic and organic fertilizers influenced the benefit: cost ratio and maximum higher benefit: cost ratio was obtained when the crop was grown with integrated use of 25% RDF + 75% N of poultry manure followed 50% RDF + 50% N of poultry manure, sole application of recommended dose of NPK and 25% RDF + 75% N of poultry manure. This may be due to higher yield and lower cost of cultivation with the integrated use of inorganic fertilizers and poultry manure. The results are in agreement with the findings of Chattoo et al. [13] and Singh et al. [14].

4. CONCLUSION

The result of this experiment obviously indicates that the application of 25% RDF + 75% N through poultry manure not only gave higher yield (288.41q/ha) but also economically feasible as it gave higher Benefit: cost ratio (2.65). It can also be inferred that reducing the recommended dose of inorganic fertilizers by 75% or 50% did not significantly reduce yield, if supplemented with poultry manure. This does not only reduced the use of inorganic fertilizers but also improves the soil quality leading to sustainability. Therefore, for gaining higher yield with sustainable fertility one may go for the use of 25% RDF + 75% N of poultry manure.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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