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Effect of integrated nutrient management on some growth characteristics of onion (*Allium cepa* L.)

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Abstract
The present investigation entitled "Effect of integrated nutrient management on growth characterstics of onion (*Allium cepa* L.)" was carried out at the Vegetable Research Farm, Department of Vegetable Science, Dr. Y S Parmar University of Horticulture and Forestry, Nauni, Solan, (HP) during Rabi 2014-15 with the objective to study the effect of different integrated nutrient management treatments on growth of onion cv. 'Palam Lohit'. In this study, 10 treatments, *viz.* T_1: Control: RDF (FYM @ 250 q ha^{-1} and NPK- 125:76:60 kg ha^{-1}), T_2: RDF (NPK) + VC @ 8 t ha^{-1}, T_3: 75 % RDF + Azotobacter, T_4: 75 % RDF + Azotobacter + AM, T_5: 50 % RDF + Azotobacter, T_6: 50 % RDF + Azotobacter + AM, T_7: VC @ 8 t ha^{-1} + Azotobacter + AM, T_8: FYM @ 25 t ha^{-1} + Azotobacter + AM, T_9: VC @ 4 t ha^{-1} + Azotobacter + AM and T_{10}: FYM @ 12.5 t ha^{-1} + VC @ 4 t ha^{-1} + Azotobacter + AM, were compared in a Randomized Complete Block Design (RCBD) having three replications with a plot size of 3.0 x 1.5 m^2 and a plant spacing of 15 cm x 10 cm. The observations were recorded on leaf length (cm), no. of leaves per plant, no. of bulbs per plot. The results revealed that T_4 (75 % RDF + Azotobacter + AM) was rated as the best treatment for majority of characters like leaf length (cm), no. of leaves per plant, no. of bulbs per plot. Therefore, on the basis of present study, it is concluded that application of biofertilizers (Azotobacter and AM) in combination with 75 % RDF can be suggested cost effective combination for enhanced growth of onion in mid hills of Himachal Pradesh.

Keywords: *Allium cepa* L., Growth, Integrated nutrient management

Introduction
Onion (*Allium cepa* L.) is one of the most important commercial vegetable crops cultivated extensively in India and it belongs to family Alliaceae. It is most widely grown and popular vegetable crop among the alliums as well as cash crops. It is semi-perishable in nature and can be transported to a long distance without much injury. Onion is liked for its flavour and pungency which is due to the presence of a volatile oil 'allyl propyl disulphide'- organic compound rich in sulphur. Onion contains carbohydrates (11.0 g), proteins (1.2 g), fiber (0.6 g), moisture (86.8 g) and several vitamin like vitamin A (0.012 mg), vitamin C (11 mg), thiamin (0.08 mg), riboflavin (0.01 mg) and niacin (0.2 mg) and also some minerals like phosphorus (39 mg), calcium (27 mg), sodium (1.0 mg), iron (0.7 mg) and potassium (157 mg) per 100 g (Rahman *et al*. 2013) [1]. It is being used in several ways as fresh, frozen, dehydrated bulbs and green bunching types. Onion has got good medicinal value. It contains several anti-cancerous agents which have shown to prevent cancer in animals. The beneficial compound called 'quercetin' present in onion is a powerful antioxidant.

In recent years, it has been realized that judicious application of nutrients are essential for higher yield and better quality of onion. Under suitable agro-climatic conditions, nutrient management is the main factor which influences the growth and yield of onion to great extent. Onion necessitates the application of inorganic fertilizers for maximum growth and yield. However, inorganic fertilizers application may lead to soil acidity or alkalinity. Moreover, in the developing countries like India, the higher prices of fertilizers are hitting small and marginal farmers.

Chemical fertilizers are very expensive and sometimes unavailable to small-scale farmers. Production of any crop can be increased by supplying quality inputs.

To overcome the problems of ecological imbalance and increased cost of cultivation due to continuous use of chemical fertilizers, the latest trend of growing vegetable crops by using organic manure, biofertilizers together with inorganic fertilizers is called as integrated nutrient management (INM) which provides better and balanced environment, better food and living conditions to the human beings. Integrated nutrient management reduces the cost of production by utilization of organic wastes or its by-products against chemical fertilizers, which are said to be potential source for pollution unless they are used in productive and efficient way

Integrated nutrient supply approach for the crop by judicious mixture of organic manure and biofertilizers along with the inorganic fertilizers has a number of agronomical and environmental advantages. INM is not only a reliable way for obtaining fairly high productivity with substantial fertilizer economy but a concept of ecological soundness leading to sustainable agriculture by minimizing the cost of production, by improving the physical properties of soil.

Biofertilizers are widely accepted as low cost supplements to chemical fertilizers with no deleterious effect either on soil health or environment (Bhagyaraj and Suvarna, 1999) [2]. Amongst biofertilizers, Azotobacter strains play a key role in harnessing the atmospheric nitrogen through its fixation in the roots. Arbuscular mycorrhizal (AM) symbiosis facilitates plant growth through enhancing uptake of several macro and micro nutrients of low mobility in soil, like phosphorus, zinc, copper etc. Beside nutritional benefits to plant, AM also contributes to numerous ecological advantages like influencing microbial and chemical environment of the mycorrhizosphere, stabilizing soil aggregates (Dipankar, 2010) [3].

Keeping in view the significance of above aspects research have been planned to study the effect of integrated nutrient management on growth characteristics of onion

2. Materials and methods

The present study was conducted at the experimental farm of Department of Vegetable Science, Dr. Y S Parmar University of Horticulture and Forestry, Nauni, Solan, (HP) in the Rabi season of 2014-2015 in onion variety Palam Lohit to measure the Leaf length, No of leaves per plant, No of bulbs per plot, No of days for bulb maturity by applying the below mentioned IPM treatments in the field of size 3.0 x 1.5 m^2 with spacing 15 cm x 10 cm. The experiment consisted of ten 10 combinations of inorganic (N, P and K), organic (FYM and Vermicompost) and biofertilizers (Azotobacter and Arbuscular mycorrhizae) treatments which were laid out in randomized complete block design with three replications.

Table 3

T_1	Control: RDF (FYM @ 250 q ha^{-1} and NPK @ 125:76:60 kg ha^{-1})
T_2	RDF (NPK) + VC @ 8 t ha^{-1}
T_3	75 % RDF + Azotobacter
T_4	75 % RDF + Azotobacter + AM
T_5	50 % RDF + Azotobacter
T_6	50 % RDF + Azotobacter + AM
T_7	VC @ 8 t ha^{-1} + Azotobacter + AM
T_8	FYM @ 25 t ha^{-1} + Azotobacter + AM
T_9	VC @ 4 t ha^{-1} + Azotobacter + AM
T_{10}	FYM @12.5 t ha^{-1} + VC @ 4 t ha^{-1} + Azotobacter + AM

The methodology used in present work is represented as under

2.1 Application of inorganic fertilizers

The inorganic fertilizers in the form of Urea, SSP and MOP were applied in the respective treatment. NPK was applied as per the treatment, in which 1/3 rd dose of nitrogen along with full doses of phosphorus and potassium were incorporated in soil before the transplanting of seedlings. The remaining dose of nitrogen for each treatment was given in two splits; after 30 and 60 DAT.

2.2 Application of biofertilizers

Application was done through root dip method and soil application method as per the treatment combination as follow:

2.3 Root dip

This method was followed for Azotobacter application. A solution of biofertilizer was prepared by dissolving 0.5 kg of Azotobacter in 10 liters of water for one hectare. The seedling roots were dipped in this solution for 30 minutes and immediately transplanted in the field.

2.4 Soil application

Azotobacter and Arbuscular mycorrhizae (AM) were applied @ 5kg and 10 kg ha^{-1}, respectively, by thoroughly mixing it with 10 times FYM or Vermicompost in respective plots. In the experimental plots, the biofertilizers were applied as per the treatments at the time of transplanting

2.5 Aftercare of crop

Three hand weedings were done to keep the crop free from weeds. Irrigations were given as per crop requirement.

2.6 Transplanting

Nursery of eight weeks old, uniform and healthy seedlings were transplanted in the plots at a spacing of 15 x 10 cm between and within rows respectively thus accommodating 300 plants /plot (4.5 m^2). The plots were irrigated to facilitate transplanting.

2.7 Leaf length (cm)

The length of leaf of ten plants was recorded in centimeter (cm) from bulb neck to tip of leaf when held vertically and the average length of leaf was worked out.

2.8 Number of leaves
The numbers of fully opened, grown and green leaves were recorded and average numbers of leaves per plant were worked out from ten randomly selected plants.

2.9 Number of bulbs per plot
The total number of bulbs per plot were recorded at the time of harvest of the crop.

2.10 Number of days taken to bulb maturity
The number of days taken from the day of sowing to the day when more than half of the population in each plot reaches the optimum bulb stage. It is visually judged when the plant reaches neck fall or leaf yellowing stage.

2.11 statistical analysis
All the data pertaining to growth, yield and quality characters of onion were subjected to statistical analysis to find out the significance of the results obtained. The statistical analysis was carried out for each observed character under study, using MS-Excel and OPSTAT packages. The data recorded under field conditions were analyzed using randomized complete block design (RCBD) (Gomez and Gomez, 1984) [4].

3. Results and discussion
The results of the experiment found clear support for the effects of integrated nutrient management on important growth characteristics. The important findings were:

3.1 Number of leaves per plant at 60 and 90 DAT
The highest number of leaves per plant (5.17) were produced by the treatment T_4 (75 % RDF + Azotobacter + AM) and it was statistically at par with treatment T_3, T_2, T_1, T_5, T_6, T_{10} and T_7 (Table 3.1). The lowest number of leaves per plant (4.17) were found in treatment T_8 (FYM @ 25 t ha^{-1}+ Azotobacter + AM) at 60 DAT and other observations has been recorded at 90 DAT (Table 3.1) which indicated that number of leaves per plant were influenced significantly with the treatments under investigation. The highest number of leaves per plant (6.23) were recorded in treatment T_4 (75 % RDF + Azotobacter + AM) which was statistically at par with T_3 and minimum (4.90) were recorded in T_8 (FYM @ 25 t ha^{-1} + Azotobacter + AM)

3.3 Leaf length of onion at 60 DAT (cm) and 90 DAT(cm)
The data on effect of integrated nutrient management and their combinations on length of leaf at different growth stages of onion is presented in the Table 3.1. Leaf length differed significantly due to the effect of different nutrient sources on onion at 60 and 90 DAT.

Table 2

Treatment		Effect of INM on number of leaves per plant at different stages of crop growth in onion		Effect of INM on leaf length (cm) of onion at different stages of crop growth in onion	
		60 Day after transplanting	90 Day after transplanting	60 Day after transplanting	90 Day after transplanting
		2014-15	2014-15	2014-15	2014-15
T_1	Control: RDF (FYM @ 250 q ha^{-1} and NPK-125:76:60 kg ha^{-1})	4.83	5.40	34.83	47.71
T_2	RDF (NPK) + VC @ 8 t ha^{-1}	4.93	5.60	37.93	53.01
T_3	75 % RDF + Azotobacter	5.07	5.80	37.22	47.95
T_4	75 % RDF + Azotobacter + AM	5.17	6.23	38.92	55.97
T_5	50 % RDF + Azotobacter	4.83	5.30	31.93	42.23
T_6	50 % RDF + Azotobacter + AM	4.70	5.37	32.66	43.40
T_7	VC @ 8 t ha^{-1} + Azotobacter + AM	4.60	5.10	28.20	38.32
T_8	FYM @ 25 t ha^{-1} + Azotobacter + AM	4.17	4.90	26.16	33.92
T_9	VC @ 4 t ha^{-1} + Azotobacter + AM	4.33	4.97	27.11	35.07
T_{10}	FYM @ 12.5 t ha^{-1} + VC @ 4 t ha^{-1} + Azotobacter + AM	4.63	5.07	30.61	39.81
Mean		4.73	5.37	35.56	43.74
$CD_{0.05}$		0.59	0.52	4.91	4.03

The variation in leaf length at 60 DAT due to effect of INM was significant. The average leaf length (38.92 cm) was maximum in treatment T_4 (75 % RDF + Azotobacter + AM) which was statistically at par with T_2 [RDF (NPK) + VC @ 8 t ha^{-1}], T_3 (75 % RDF + Azotobacter) and T_1 (control). However, minimum leaf length (26.16 cm) was recorded in treatment T_8 (FYM @ 25 t ha^{-1} + Azotobacter + AM). At 90 DAT data depicted in Table 3.1 revealed that maximum leaf length (55.97 cm) was found in treatment T_4 (75 % RDF + Azotobacter + AM) which was statistically at par with T_2 [RDF (NPK) + VC @ 8 t ha^{-1}]. Whereas, minimum leaf length (33.92 cm) was seen in treatment T_8 (FYM @ 25 t ha^{-1} + Azotobacter + AM).

3.5 Number of bulbs per plot at harvest
Statistical analysis revealed that there were non-significant differences between the treatments for the number of bulbs per plot (Table 3.2). However, maximum number of bulbs per plot (269.00) were recorded in treatment T_4 (75 % RDF + Azotobacter + AM) and minimum number of bulbs per plot (233.66) were obtained in T_9 VC @ 4 t ha^{-1} + Azotobacter + AM.

Table 3: Effect of INM on number of bulbs per plot and number of days taken to bulb maturity in onion

Treatment		Number of bulbs per plot	Number of days taken to bulb maturity
		2014-15	
T_1	Control: RDF (FYM @ 250 q ha^{-1} and NPK- 125:76:60 kg ha^{-1})	143.67	264.33
T_2	RDF (NPK) + VC @ 8 t ha^{-1}	140.00	263.33
T_3	75 % RDF + Azotobacter	136.33	261.33
T_4	75 % RDF + Azotobacter + AM	139.67	269.00
T_5	50 % RDF + Azotobacter	143.00	258.33
T_6	50 % RDF + Azotobacter + AM	142.33	259.33
T_7	VC @ 8 t ha^{-1} + Azotobacter + AM	147.33	247.00
T_8	FYM @ 25 t ha^{-1} + Azotobacter + AM	151.00	238.66
T_9	VC @ 4 t ha^{-1} + Azotobacter + AM	149.00	233.66
T_{10}	FYM @ 12.5 t ha^{-1} + VC @ 4 t ha^{-1} + Azotobacter + AM	146.67	267.67
Mean		256.27	143.90
$CD_{0.05}$		NS	3.45

3.6 Number of days taken to bulb maturity

Number of days taken to bulb maturity as influenced by different INM sources is presented in Table 3.2. It clearly indicated that the effect of INM showed significant variations with respect to days to bulb maturity. Significantly less number of days to bulb maturity (136.33 days) were observed in treatment T_3 (75 % RDF + Azotobacter) which was statistically at par with T_4 (75 % RDF + Azotobacter + AM). However, the maximum numbers of days to bulb maturity (151.00 days) were observed in treatment T_8 (FYM @ 25 t ha^{-1} + Azotobacter + AM).

4. Conclusion

From above findings it has been concluded that Treatment T_4 (75 % RDF + Azotobacter + AM) was rated as the best treatment for majority of characters like leaf length, number of leaves per plant, number of bulbs per plot. The maximum number of days to bulb maturity was observed in T_8 and minimum days to bulb maturity in $T_{3.}$ All the inorganic INM combination treatments were statistically superior over the organic INM combination treatments. On the basis of experiment conducted, it is concluded that treatment T_4 i.e., application of 75 % RDF + Azotobacter + AM was found superior among all other treatments for growth parameters like Leaf length, No of leaves per plant, No of bulbs per plot, No of days for bulb maturity. So, 75 % RDF + Azotobacter + AM may be recommended for profitable crop production of onion. The present research work was carried out at a single location during one season only (Rabi, 2014-15). Further, trials of this research work in different locations of the Himachal Pradesh are needed to recommend the results for use at farmer's level.

5. References

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