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Effect of Inorganic Fertilizers and Bio Fertilizers on Yield and Economics of Onion (*Allium cepa* L.) Production

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A B S T R A C T

The experiment was carried out in the Department of Horticulture (Vegetable and Floriculture), Bihar Agricultural College, Sabour to study the role of bio fertilizers and chemical fertilizers on onion production. The experiment was laid out in a factorial randomized block design, replicated thrice with onion variety Agrifound Light Red. The experiment was framed with bio fertilizers *viz.*, M_0- 0, M_1- *Azotobacter*, M_2-*Azospirillum*, M_3-PSB, M_4-VAM and four levels of chemical fertilizers, (F_1-N_{80} P_{40} K_{60}, F_2-$N_{100}P_{60}K_{80}$, F_3-$N_{120}P_{80}K_{100}$, F_4-$N_{140}P_{100}K_{120}$ having 20 treatment combinations. The results of the experiment showed that the fertility level F_3-$N_{120}P_{80}K_{100}$ with inoculation of M_2- *Azospirillum i.e.*, F_3M_2 the maximum average bulb weight (77.53 g), diameter of bulb (6.17 cm), bulb length (5.97 cm), bulb yield (438.56 q/ha) was recorded F_3M_2 treatment combination, and treatment combination F_1M_O shows lowest value. However, inoculation of *Azospirillum* with soil application at the fertility level of F_3-$N_{120}P_{80}K_{100}$ was the most effective combination for higher net return and B: C ratio (4.70).

Introduction

Onion (*Allium cepa* L.) is one of the important commercial vegetable crops grown in India. It belongs to family Amaryllidaceae, grown across over the country. India is 2nd largest producer next to china. It is rich source of minerals like phosphorus, calcium and carbohydrate. It also contains protein, vitamin C. and it has good medicinal values, it act against carcinogenic factor. Low productivity of onion may be attributed due to poor management efficiency rather than that in the uncontrollable climatic factors. Thus, it

makes it imperative to make a concerted effort to bridge the gap between potential yield and actual yield harvested by the farmers to make onion cultivation more remunerative through better management strategic of inputs like nutrient management practices and microbial inoculants for better exploitation of yield potentialities. Escalating cost of chemical fertilizers are hampering our way to produce more per unit area. Moreover, their excessive use has also resulted in serious damage to our soil and soil resources and to human health too. Biofertilizer are carrier based preparations containing beneficial microorganism in viable state for soil or seed application. In recent years they have emerged as a promising component of integrated nutrient supply system. They 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. Biofertilizer are less expensive, ecofriendly viable and quality of produce, providing plant hormones and help in sustainable crop production through maintenance of soil productivity (Vijayakumar *et al.*, 2000; Ramakrishnan and Thamizhiniyan, 2004). The use of chemical fertilizers in combination with bio fertilizers offers a great opportunity to increase the crop production at less cost (Gunjan *et al.*, 2005). Therefore, the experiment was conducted for sustainable production of onion with combine use of bio fertilizers and chemical fertilizers.

Materials and Methods

The investigation was carried out at Vegetable research farm, BAU, Sabour in the *Rabi* season 2018. The design of experiment was factorial randomized block design, replicated thrice and variety was "Agrifound Light red". 45 days old seedlings of uniform growth were transplanted in evening hour at a spacing of 15×10 cm in flat beds. The plot size was 2.5 m×1.5 m. The treatment comprised four bio fertilizers (Mo-No biofertilizer, M_1-Azotobacter, M_2-*Azospirillum*, M_3-PSB, M_4-VAM) and four levels of chemical fertilizers (F_1-N_{80} P_{40} K_{60}, F_2-$N_{100}P_{60}K_{80}$, F_3-$N_{120}P_{80}K_{100}$, F_4-$N_{140}P_{100}K_{120}$). Bio fertilizers were used as soil application. Treatment wise different microbial inoculants were applied at the rate of 5kg/ha and dried F.Y.M in the ratio of 1:20 were mixed thoroughly and mixture was broadcasted and incorporated in the sub-plots. After application of the microbial inoculants the seedlings allocated with respective microbial inoculants were transplanted at the spacing of 15 x 10 cm. Full dose of phosphorus (P_2O_5) as diammonium phosphate and potash (K_2O) as murate of potash with 1/3rd dose of nitrogen as urea were applied before transplanting of seedlings as basal dressing commensurating with treatments specifications. As per treatment the remaining dose of N was top dressed in two equal split *i.e.*, one third at 25 days of transplanting and the rest at 50 days after transplanting. Necessary irrigations were given. Gap filling, intercultural operation and plant protection measures were given for the better establishment of crop.

The observations of growth parameter plant height, number of leaves per plant, diameter of leaves, and yield attributing characters like bulb length, bulb diameter, bulb weight and bulb yield. The statistical analysis of the data noted in all observations was carried out by the method of "Analysis of variance as suggested by Fisher and Yates (1963). Comparison of the treatments was made with the help of critical differences (C.D.). The economics studies of the crop was done by computing the cost of cultivation and net profit in rupees per hectare on the basis of the prevailing rate of inputs and output obtained from the local market. Gross return was calculated by multiplying yield (q/ha) with

average selling rate of onion bulbs. The net return (Rs/ha) was computed by subtracting the cost of cultivation from the gross return obtained from the sale of the harvested bulb. The benefit cost ratio *i.e*. the net return per rupee investment was obtained by dividing net profit with total cost of cultivation.

Results and Discussion

The results revealed that the application of microbial inoculant M_2 (*Azospirillum*) produced maximum plant height (48.57cm), number of leaves per plant (11.54), leaf length (43.66 cm), diameter of leaves (1.87 cm) This treatment was most outstanding being significantly superior to rest of the biofertilizers used.

This may be due to change in the metabolic activities of the plant and the uptake of water and nutrients. In addition to these, microbial inoculants have ability to produce some growth promoting substances which might have led to enhanced cell division and cell elongation, resulting maximum plant length and highest number of leaves per plant, leaf length, collar thickness and fresh weight of leaves/ plant. The results in respect of these characters are in complete agreement with the findings of Mahmoud and El-Hefny (1999), Rather *et al.,* (2003) and Jha *et al.,* (2006). It is evident from the data this treatment was also found effective for producing maximum bulb length (5.59 cm), bulb diameter (6.11cm), bulb weight (77.14 g), bulb yield (435.72 q/ha) followed by the application of M_1 *i.e., Azotobacter*. The yield improvement might be due to vigorous habit in terms of plant height, leaf length, number of leaves and plants developed under *Azospirillum* or *Azotobacter*.

Azospirillum might have fixed higher amount of nitrogen in soil and made available to the plants resulting in better uptake of N by plants. VAM or PSB would have caused more mobilization and solubilization of insoluble P in the soil and improve the availability of phosphorus to plants. Better crop due to all these factors which might have helped in increasing photosynthetic rate and more physiological and biochemical activities which in turn, perhaps increased the movement of photosynthates from source to sink. Thus, finally resulted in increasing the yield and yield components. These results are in accordance with the findings of Muthuramalingam *et al.,* (2002), Sule *et al.,* (2002), Rather *et al.,* (2003), Yadav *et al.,* (2005) and Jha *et al.,* (2006).

Growth and yield attributing characters were influenced significantly due to different fertility level. The maximum plant height (44.90 cm), number of leaves per plant (10.39), leaf length (39.86 cm), bulb length (5.31 cm), bulb diameter (5.46cm), bulb weight (70.37g), bulb yield (392.94 q/ha), and were obtained at the fertility level F3-$N_{120}P_{80}K_{100,}$ This level was most outstanding being significantly superior to rest of the fertility Significant increase in bulb yield due to different fertility levels has been reported by Girigowda *et al.,* (2005), Kumar *et al.,* (2006) and Dilruba *et al.,* (2006).

The interaction effect between different levels of inorganic fertilizers and bio fertilizers were found to be quite superior to their sole application. Among the treatment combinations F_3M_2 i.e., application of higher dosages of inorganic fertilizers i.e., F_3 ($N_{120}P_{80}K_{100}$) along with inoculation of biofertilizer M_2 (Azospirillum) exhibited significantly highest values of plant height (48.57 cm),number of leaves per plant(11.54), leaf length (43.66cm), bulb length(5.97cm),bulb diameter(6.17 cm),bulb weight (77.53 g), bulb yield (438.56q/ha).

Table.1 Effect of levels of biofertilizer and chemical fertilizer on growth and yield attributes for sustainable onion production

Treatments	Plant height (cm.)	No.of leaves /Plant	Leaf length (cm.)	Bulb length (cm)	Bulb diameter (cm)	Bulb weight (g)	Bulb yield q/ha
Level of Bio fertilizers							
M_0-No biofertilizer	31.74	7.46	27.89	3.77	4.20	49.31	278.43
M_1 Azotobacter	46.94	10.85	41.35	5.32	5.83	75.46	420.00
M_2 Azospirillum	47.13	11.04	41.64	5.59	6.11	77.14	435.72
M_3 PSB	44.96	10.45	40.64	5.41	5.47	72.24	393.83
M_4 VAM	39.94	9.38	35.48	4.80	4.82	62.80	343.70
CD at 5%	1.99	0.50	1.95	0.24	0.24	3.71	20.06
Level of chemical fertilizer							
F_1-N_{80} P_{40} K_{60}	40.48	9.04	34.46	4.36	4.96	63.02	350.69
F_2-$N_{100}P_{60}K_{80}$	44.48	10.23	39.24	5.19	5.38	69.63	384.77
F_3-$N_{120}P_{80}K_{100}$	44.90	10.39	39.86	5.31	5.46	70.37	392.94
F_4-$N_{140}P_{100}K_{120}$	42.70	9.69	36.05	5.07	5.33	66.54	368.94
CD at 5%	1.78	0.44	1.74	0.22	0.22	3.32	17.94

Table.2 Combined effect of bio fertilizers and chemical fertilizer on growth and yield attributes for onion production

Interaction	Plant height (cm.)	No. of leaves /Plant	Leaf length (cm.)	Bulb length (cm)	Bulb diameter (cm)	Bulb weight (g)	Bulb yield (q/ha)
F_1M_0	24.50	5.86	21.20	2.88	3.25	37.64	211.45
F_1M_1	46.99	11.11	42.53	5.51	5.66	74.21	409.13
F_1M_2	49.51	11.35	43.25	5.67	6.03	76.66	433.22
F_1M_3	45.22	10.31	39.78	5.31	5.11	70.46	388.21
F_1M_4	36.20	8.66	31.89	4.41	4.70	56.13	311.46
F_2M_0	34.56	7.99	30.57	4.11	4.51	54.32	306.21
F_2M_1	49.07	11.21	42.78	5.57	5.82	75.91	423.66
F_2M_2	49.53	11.52	43.43	5.92	6.11	77.51	435.99
F_2M_3	46.40	10.52	41.20	5.43	5.61	73.21	396.75
F_2M_4	42.85	9.99	38.23	4.92	4.87	67.21	361.24
F_3M_0	35.30	8.33	31.12	4.20	4.66	55.01	311.26
F_3M_1	49.49	11.35	43.15	5.63	5.98	76.25	430.22
F_3M_2	49.57	11.56	43.66	5.97	6.17	77.53	438.56
F_3M_3	46.55	10.56	42.14	5.48	5.63	73.43	401.12
F_3M_4	43.60	10.24	39.25	5.25	4.87	69.65	383.54
F_4M_0	32.60	7.70	28.66	3.88	4.37	50.26	284.78
F_4M_1	48.65	11.20	42.74	5.57	5.82	75.47	416.99
F_4M_2	49.53	11.45	43.42	5.83	6.11	76.87	435.11
F_4M_3	45.60	10.51	40.62	5.42	5.52	71.87	389.25
F_4M_4	37.12	8.71	32.53	4.63	4.82	58.21	318.56

Table.3 Effect of levels of biofertilizer and chemical fertilizer on economics for sustainable onion production

Treatment	Bulb yield (q/ha)	Rate in (q/ha)	Gross income (Rs)	Total cost of cultivation (Rs)	Net income (Rs)	B : C Ratio
F_1M_0	271.45	1000	271450	71931	199519	**2.77**
F_1M_1	409.13	1000	409130	75931	333199	4.39
F_1M_2	403.22	1000	403220	75931	327289	4.31
F_1M_3	388.21	1000	388210	75931	312279	4.11
F_1M_4	361.46	1000	361460	75931	285529	3.76
F_2M_0	326.21	1000	326210	77251	248959	3.22
F_2M_1	413.66	1000	413660	81251	332409	4.09
F_2M_2	420.99	1000	420990	81251	339739	4.18
F_2M_3	396.75	1000	396750	81251	315499	3.88
F_2M_4	361.24	1000	361240	81251	279989	3.45
F_3M_0	311.26	1000	311260	72952	238308	3.27
F_3M_1	425.22	1000	425220	76952	348268	4.53
F_3M_2	438.56	1000	438560	76952	361608	**4.70**
F_3M_3	401.12	1000	401120	76952	324168	4.21
F_3M_4	395.54	1000	395540	76952	318588	4.14
F_4M_0	334.78	1000	334780	73491	261289	3.56
F_4M_1	416.99	1000	416990	77491	339499	4.38
F_4M_2	415.11	1000	415110	77491	337619	4.36
F_4M_3	389.25	1000	389250	77491	311759	4.02
F_4M_4	308.56	1000	308560	77491	231069	2.98

This may be due to the profuse vegetative growth induced by higher dose of chemical fertilizers and application of microbial inoculant M_2 (*Azospirillum*). This ultimately may increase the photosynthetic assimilation. All these physiological activities brought about increase in bulb size and bulb weight as the weight of individual bulb increased it reflected positively on the total bulb yield. The results are closely in consonance with the finding of Singh and Singh (2002), El-Shaikh (2005), Jayathilake *et al*., (2002), Singh and Pandey (2006) and Yogita and Ram (2012)

Economics

The interaction between bio fertilizers and inorganic fertilizers was found to be highly significant, meaning thereby that different fertility levels influenced the bio fertilizers behavior and vice-versa. The highest net profit of Rs.361608.00/ha with the maximum benefit-cost ratio of 4.70 were obtained with the application of microbial inoculant M_2 (*Azospirillum)* at the fertility level of F_3 ($N_{120}P_{80}K_{100}$) *i.e.*, F_3M_2. The lowest fertility level of F_1 in the absence of bio fertilizers *i.e.*, F_1M_O produced the minimum net profit (Rs. 199519. 00/ha) with B: C ratio (2:77).

Application of higher dosages of inorganic fertilizers *i.e.* F_3 ($N_{120}P_{80}K_{100}$) along with inoculation of bio fertilizer M_2 (*Azospirillum)* influenced the growth as well as yield

contributing characters and bulb yield significantly in comparison to the remaining treatment combinations. Hence, the use and management of natural resources in sustainable agriculture, the microbial fertilizers hold vast potential for the future.

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