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Influence of Bio-Fertilzer with Recommended Doses of Fertlizer on Plant Growth, Yield, Quality And Economics of Onion (*Allium cepa* L.) cv. NHRDF Red 2

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ABSTRACT

The invstigation was carried out in the rabi season in 2016-17 at garden of department of horticulture, C.S. Azad University of Agriculture and Technology, Kanpur to study the effect of N, P and K levels with biofertilizers on growth, yield and economics of onion crop. The experiment was laid in Randomized block design with the three replications for onion (Allium cepa L.) cv. NHRDF Red 2 and the treatments were consisted of three different levels of chemical fertilizers. Among the various treatments the treatmnt T_{13} viz. 100 per cent RDF + Azospyrillum + PSB, has recorded significantly higher plant height, length of leaves, number of leaves, diameter of bulb, shoot thickness, fresh weight per plant and fresh weight per bulb and shoot weight at 50, 75 and 100 DAT. The bulb yield and yield components such as bulb length, bulb diameter and bulb weight were recorded significantly higher in T_{13} than the other treatments. The nitrogen, phosphorus and potassium ccontent (%) was observed significantly highest with the application of 100% RDF + Azospyrillum + PSB. Treatment T_{13} has recorded significantly higher gross returns as well as net return but highest B:C ratio was observed in 75 per cent RDF + Azospyrillum + PSB treatmnt T_9 from onion over all the treatment.

Key words: *Allium cepa L. Bio-fertilizer, Onion, Azospyrillum, PSB, NPK level, NHRDF Red 2*

INTRODUCTION

Onion (*Allium cepa* L.) is bulb, valued for its bulbs having characteristic odour, flavour and pungency, which is due to the presence of a volatile oil – allyl-propyl-disulphide. Pungency is formed by enzymatic reaction when tissues are broken. Bulbs are suited for storage for a long period and for long distance transport. It is used as salad and cooked in many ways in curries, fried, boiled, baked and used in making soups, pickles etc. Value addition in onion is done by marketing dehydrated onions and onion flakes. Onion bulb is rich in minerals like phosphorus (50 mg / 100 g) and calcium (180 mg / 100 g). Many medicinal uses are reported for bulbs and is commonly used as diuretic and applied on wounds and boils. Onion greens are also used by harvesting crop at pencil thickness and when small bulb is formed[7].

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India ranks second in area and production of onion in the world after china. In India major onion growing states are Maharashtra, Karnataka, Madhya Pradesh, Gujarat, Bihar, Orissa, Andhra Pradesh and Uttar Pradesh. It is cultivated in an area of 1203.6 thousand hectare with a production of 19401.7 thousand MT and productivity 22.2 MT/ha in India. In Uttar Pradesh, it is grown in about 24.31 thousand hectare with a production of 415.23 thousand metric tonnes per hectare and the average productivity is 17.8 tonnes/ha.

As regard with the productivity the combined application of organic manures and inorganic fertilizers to increase yield but has paramount importance in ameliorating the yield. Use of Inorganic fertilizers now a day is costly affair and increases cost of cultivation. Secondly the sole application of inorganic fertilizers deteriorates soil fertility level day by day, that affect the production, economics of production and human health, where organic manure and bio-fertilizers are cheap, easily available and eco friendly, giving quality produce, improving keeping quality, T.S.S. and pungency. It improves the physiochemical properties of the soil which is very useful for the sustainable crop production as well as soil fertility and productivity[11].

Conventional methods of fertilization (inorganic fertiliser) have undoubtedly helped in improving bulb yield. But it degrades the quality and shelf life and in India appears to be incapable of maintaining yields over the long-term. Shifting from using purely inorganic sources to introducing some proportion of organic fertilization is gaining acceptance today. The area under onion cultivation is continuously increasing to match the internal as well as external demand. So, it is obvious that increasing demand requires more production and in turn it requires more inorganic fertilizer application. Excess use of chemical fertilizers resulted in harmful and long term impact on the soil health and sustainability in yield of crop. As nutrients are the major contributing factors their appropriate management practices is essential to achieve the optimum yield of onion. The under and above fertilization of integrated nutrient management may lead to poor growth and yield in terms of quality and quantity of onion. Otherwise, organic farming systems, the use of organic production systems; positive management of biological and ecological systems replaces inputs of synthetic fertilizers and soluble NPK mineral fertilizers. While crop selection must, inevitably, be market driven to provide efficient economic production, a well balanced sequence of crops should be chosen that requires minimum external inputs, nutrients, machinery and energy to maintain soil fertility, and quality and yield of production[10].

Presently agricultural research is focused on continuous use of inorganic fertilizers without using of organic manures and biofertilizers causes unsustainable soil productivity by reducing microbial activity and affecting soil physical and chemical conditions. The application of organic manures, biofertilizers along with inorganic fertilizers improves productivity of the soil and provides good soil health by reducing the consumption of chemical fertilizers.

With this background of investigations, an attempt has been made to investigate the effect of bio-fertilizer with chemical fertilizer on plant growth, Yield and economics of Rabi season onion (*Allium cepa* L). cv. NHRDF RED 2.

MATERIAL AND METHODS

The prsent experiment was carried out in the garden of the Department of Horticulture, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, U.P; during the winter 2016-17. The soil of experimental field was sandy loam having poor content of organic carbon and available nitrogen. The experiment was laid down in Randomized Block Design with laboratory testing with fourteen treatment combinations *viz,* Control, RDF 50%, RDF 50% + Azospirilum, RDF 50% + PSB, RDF 50% + Azospirilum + PSB, RDF 75%, RDF 75% + Azospirilum, RDF 75% + PSB, RDF 75% + Azospirilum + PSB, RDF 100%, RDF 100%

+ Azospirilum, RDF 100% + PSB, RDF 100% + Azospirilum + PSB and Azospirilum + PSB with three replications. The onion variety used in the experiment was "NHRDF RED 2". Seedlings of 45 days had uniform growth were transplanted in evening hour at a spacing of 15x10 cm.. The fertilizer applications were done as NPK @150:80:100kg/ha and Bio-fertilizer @ 200g/2 liter of water seedlings treatment. Observations of vegetative parameters like Survival of plants (%), Plant height (cm), Length of leaves (cm), Number of leaves per plant, Diameter of bulb (cm), Shoot thickness (cm), Fresh weight per plant (g), Fresh weight per bulb (g), Shoot weight per plant (g) was recorded at 50, 75 and 100 days after transplanting. Observations were recorded for yield parameters like Yield of fresh bulb (q/ha), Dry weight per bulb (g), Diameter of dry bulb (mm), Yield of bulb after curing (q/ha). For fresh weight per plant, Fresh weight per bulb, Diameter of bulb, and Shoot weight per plant three plants per plot were selected at random for the purpose in each observation at different stages of plant growth as mentioned earlier. These three plants including underground portion were lifted from soil with the help of khurpi. After removing soil particles from underground part, these three plants and bulbs were weighed on physical balance and diameter of bulb was measured with the help of vernier-calliper. Aftr that the average value was calculated. At harvest two plants from each net plot were lifted from the soil. These plants mixed for all the three replications treatment wise. Thus a composite sample of eight plants was prepared for each treatment combination. These samples of eight plants each, were weighed separately and chopped into fine pieces and left for sun drying. After sun drying for a week, these samples were dried in electrical oven at 100^0C temperature till constant weight. The weight of dried samples was recorded and half quantity of each sample was utilized for nitrogen phosphorus and potassium estimation. The estimation was done by Modified Kjeldahl's method[6].

For economic study, prevailing market prices were used for different outputs and inputs The economic feasibility of treatments was calculated as under:

Gross Return = Yield (q ha^{-1}) x Selling rate (Rs. q^{-1})

Net return = Gross return – cost of cultivation

$$\text{Cost: Benefit ratio} = \frac{\text{Gross return (Rs. ha}^{-1})}{\text{Cost of cultivation (Rs. ha}^{-1})}$$

RESULTS AND DISCUSSION

Effect on crop growth:

The data presented in Tables 1 and 2 revealed that all the vegetative parameters of onion significant variations among the treatments.. Among the following treatments, the treatment T_{13} (RDF 100% + Azospyrillum + PSB) exhibited the better results in terms of survival of the plant (96.58%) , plant height (cm) at 50 DAT (33.61), at 75 DAT (80.36) and at 100 DAP (84.02), Length of leaves(cm) at 50 DAT (30.09), at 75 DAT (34.10) and at 100 DAP (37.20), Diameter of bulb(cm) at 50 DAT (15.13), at 75 DAT (25.20) and at 100 DAP (45.50), No of leaves at 50 DAT (7.42), at 75 DAT (8.76) and at 100 DAP (10.20), Shoot thickness (cm) at 50 DAT (6.53), at 75 DAT (12.99) and at 100 DAP (13.42), Freshweight/ plant(g) at 50 DAT (14.29), at 75 DAT (30.19) and at 100 DAP (57.48), Fresh weight per bulb(g)) at 50 DAT (5.55), at 75 DAT (8.29) and at 100 DAP (41.87) and Shoot weight/bulb(g) at 50 DAT (11.15), at 75 DAT (22.29) and at 100 DAP (18.95) followd by the treatment T_{11} (RDF 100% + *Azospyrillum*) for survival of the plant (94.77%), plant height (cm) at 50 DAT (31.32) at 75 DAT (77.35) and at 100 DAP (83.32), Length of leaves(cm) at 50 DAT (29.83), at 75 DAT (33.79) and at 100 DAP (36.02), Diameter of bulb(cm) at 50 DAT (14.25), at 75 DAT (24.20) and at 100 DAP (43.20), No of leaves at 50 DAT (7.11), at 75 DAT (8.49) and at 100 DAP (9.61), Shoot thickness (cm) at 50 DAT (6.42), at 75 DAT (12.30) and at 100 DAP (12.57),

Freshweight/ plant(g) at 50 DAT (13.92), at 75 DAT (29.09) and at 100 DAP (55.48), Fresh weight per bulb(g)) at 50 DAT (5.22), at 75 DAT (7.49) and at 100 DAP (39.99) and Shoot weight/bulb(g) at 50 DAT (10.64), at 75 DAT (21.28) and at 100 DAP (20.82).

Significant increase in plant height, lenth of leaves due to nitrogen application in soil enhances the biological potential of soils and consequently affects plant production. The *Azospyrillum* and PSB seed treatment increased phosphate availability in soils which in turn helped better proliferation of root growth and uptake of other nutrients to the greater extent. So that the enlargement in cell size and cell division, which might have helped in plant height and number of branches. These findings are also corroborated by Anburani and Manivannan[1], Jayathilake *et al.*[2], Patil *et al.*[5], The increased in starch and carbohydrates due to sufficient nutrients available in bio-fertilizer might have resulted in the increase of bulb diameter and shoot thickness. The results of the present investigation in terms of bulb diameter and shoot thickness are in collaboration with the findings reported Shinde *et al.*[12], Probable region for increased weight of bulb due to humus substances could have mobilized the reserve food materials to the sink through increased activity of hydrolyzing and oxidizing enzymes. Similar results have been reported by Jayathilake *et al*[2].

Effect on yield attributes:

The data presented in Tables 3 revealed that all the yield parameters of onion significant variations among the treatments.. Among the following treatments, the treatment T_{13} (RDF 100% + Azospyrillum + PSB) exhibited the better results in terms of Yield of fresh bulb (368.82), Dry weight per bulb(91.60), Diameter of dry bulb(71.92) and Yield of bulb after curing (336.82) followed by the treatment T_9 (RDF 75% + *Azospyrillum* + PSB) for Yield of fresh bulb (355.04), Dry weight per bulb (83.59), Diameter of dry bulb (67.66) and Yield of bulb after curing (329.16).

Superiority of bio-fertilizer in combination with inorganic fertilizers with respect to improvement in growth and yield over the rest of the levels of inorganic could be attributed to balanced fertilization rates, higher organic matter build up, efficient microbial activity which produced growth promoting substances, less leaching, more nutrients availability and translocation to aerial parts, leading to enhancement in growth and yield of onion bulb. These results are in close conformity with the findings of Sule *et al*[13].

Effect on quality:

The data presented in Tables 4 showed that the. NPK content (%) in onion was influenced significantly by bio-fertilizers with different NPK levels. The maximum N% (1.63) was recorded in treatment T_{13} (100 % RDF + *Azospyrillum* + PSB followed by (1.62) in T_{11} (100 % RDF + *Azospyrillum*). The maximum P% (0.63) was recorded in both treatment T_{13} (100 % RDF + *Azospyrillum* + PSB and T_9 (75 % RDF + *Azospyrillum* + PSB) followed by (0.62) in T_{11} (100 % RDF + *Azospyrillum*). The maximum K% (1.47) was recorded in treatment T_{13} (100 % RDF + *Azospyrillum* + PSB followed by (1.46) in T_{11} (100 % RDF + *Azospyrillum*). The results are in agreement with the findings reported by Kale *et al*[4].

Effect on economics:

The data presented in Tables 5 revealed that the. significantly maximum bulb yield 336.82 and the highest net return of Rs 168030 was recorded under treatment T_{13} (100 % RDF + *Azospyrillum* + PSB), followed by T_9 (75 % RDF + *Azospyrillum* + PSB), (329.16ha^{-1} yield and net return Rs 1167127 respectively), but maximum benefit: cost ratio 3.64 was observed under the treatment T_9 (75 % RDF + *Azospyrillum* + PSB) due to low cost of cultivation (Rs 63285 Rs / ha respectively. Similar results have been reported by Yadav *et al.*[14], Meena *et al*[8].

Table 1: Effect of bio-fertilizer with chemical fertilizer on vegetative growth of the plant of onion (*Allium cepa* L.)

Treatments	Survival (%) of the plant	Plant height (cm)			Length of leaves(cm)			Diameter of bulb(mm)			No of leaves		
		50 DAT	75 DAT	100 DAT	50 DAT	75 DAT	100 DAT	50 DAT	75 DAT	100 DAT	50 DAT	75 DAT	100 DAT
Control	80.90	26.74	69.83	74.15	22.14	25.47	28.20	9.50	17.20	24.10	3.46	6.26	6.96
RDF 50%	82.53	26.02	72.13	77.54	25.85	28.21	31.91	9.93	19.20	30.53	4.69	6.48	7.60
RDF 50% + *Azospyrillum*	84.71	28.78	74.15	78.75	26.89	29.71	33.25	11.46	21.20	33.63	5.25	6.77	8.34
RFD 50% + PSB	83.03	28.01	73.65	77.74	26.26	29.35	32.50	10.70	20.20	32.43	4.77	6.61	8.02
RDF 50% + *Azospyrillum* + PSB	86.95	29.93	77.00	80.09	28.26	31.09	34.02	11.20	22.53	34.10	5.43	7.26	8.45
RDF 75%	88.22	27.63	74.10	79.16	27.48	31.85	33.22	11.50	20.53	33.22	5.60	7.40	7.91
RDF 75% + *Azospyrillum*	91.02	29.04	75.96	82.68	28.58	32.62	34.46	12.80	22.96	35.53	6.15	7.73	8.91
RFD 75% + PSB	90.43	26.31	75.24	79.67	28.10	32.02	34.03	13.20	21.16	38.44	5.97	7.64	8.25
RDF 75% + *Azospyrillum* + PSB	93.23	30.58	77.20	84.09	29.40	32.96	35.14	14.23	24.20	41.86	6.46	7.85	9.18
RDF 100%	92.37	29.65	76.37	80.96	28.34	32.19	34.31	13.20	21.87	36.10	6.83	8.10	8.59
RDF 100% + *Azospyrillum*	94.77	31.32	77.35	83.32	29.83	33.79	36.02	14.25	24.20	43.20	7.11	8.49	9.61
RDF 100% + PSB	94.40	30.38	76.93	82.51	29.20	32.93	34.99	13.59	23.20	42.10	7.00	8.30	8.90
RDF 100% + *Azospyrillum* + PSB	96.58	33.61	80.36	84.02	30.09	34.10	37.20	15.13	25.20	45.50	7.42	8.76	10.20
***Azospyrillum* + PSB alone**	82.18	27.03	71.40	75.33	23.49	26.49	29.31	10.20	18.53	25.30	4.14	6.38	7.20
SE m ±	3.83	1.39	1.64	1.61	1.59	1.80	1.65	0.91	1.27	1.95	0.58	0.54	0.19
CD at 5%	NS	4.06	4.79	4.71	4.66	5.26	4.83	2.66	3.73	5.71	1.70	1.57	0.56

Table 2: Effect of bio-fertilizer with chemical fertilizer on Vegetative growth of the plant of onion (*Allium cepa* L.)

Treatments	Shoot thickness (cm)			Freshweight/ plant(g)			Fresh weight per bulb(g)			Shoot weight/bulb(g)		
	50 DAT	75 DAT	100 DAT	50 DAT	75 DAT	100 DAT	50 DAT	75 DAT	100 DAT	50 DAT	75 DAT	100 DAT
Control	4.44	6.60	6.96	8.45	20.54	42.85	0.95	4.15	19.51	5.26	11.57	9.20
RDF 50%	5.01	6.83	8.96	9.97	24.10	46.43	1.40	5.23	28.10	8.38	17.10	18.71
RDF 50% + *Azospyrillum*	5.44	8.30	10.32	11.25	26.46	51.76	1.60	6.81	36.75	9.45	18.07	18.66
RFD 50% + PSB	5.15	7.16	9.47	10.99	24.65	48.90	1.52	6.25	34.90	9.16	17.56	18.68
RDF 50% + *Azospyrillum* + PSB	5.72	10.42	11.50	12.55	27.74	53.18	1.65	7.13	39.20	10.17	18.15	20.17
RDF 75%	5.40	9.51	9.62	10.41	25.77	48.88	3.95	6.20	32.51	8.54	18.24	21.14
RDF 75% + *Azospyrillum*	6.14	11.14	11.52	12.65	27.16	53.58	4.35	7.00	37.86	9.42	20.43	21.40
RFD 75% + PSB	5.65	10.77	10.85	11.67	26.50	50.17	4.04	6.54	39.16	9.09	19.26	21.38
RDF 75% + *Azospyrillum* + PSB	6.35	11.92	12.43	13.05	28.17	54.84	4.70	7.65	40.90	10.42	21.25	23.20
RDF 100%	5.86	10.54	10.80	10.52	26.08	51.60	4.38	7.13	35.45	9.93	19.47	20.81
RDF 100% + *Azospyrillum*	6.42	12.30	12.57	13.92	29.09	55.48	5.22	7.49	39.99	10.64	21.28	20.82
RDF 100% + PSB	6.12	11.95	11.41	12.90	27.86	53.41	4.90	7.45	38.85	10.15	20.14	20.83
RDF 100% + *Azospyrillum* + PSB	6.53	12.99	13.42	14.29	30.19	57.48	5.55	8.29	41.87	11.15	22.29	18.95
***Azospyrillum* + PSB alone**	4.51	6.75	7.10	9.10	23.27	44.50	1.08	4.85	26.50	5.65	13.25	10.26
SE m ±	0.38	1.09	1.12	1.15	1.42	2.13	0.50	0.78	2.36	1.16	1.99	0.88
CD at 5%	1.10	3.18	3.28	3.36	4.15	6.22	1.46	2.28	6.91	3.38	5.82	2.58

Table 3: Effect of bio-fertilizer with chemical fertilizer on various yield parameters of the plant of onion (*Allium cepa* L.)

Treatments	Yield of fresh bulb (q/ha)	Dry weight per bulb(g)	Diameter of dry bulb(mm)	Yield of bulb after curing (q/ha)
Control	156.44	63.57	36.02	136.44
RDF 50%	247.17	69.59	46.23	227.17
RDF 50% + *Azospyrillum*	265.63	72.70	55.66	245.63
RFD 50% + PSB	255.63	72.55	49.88	235.63
RDF 50% + *Azospyrillum* + PSB	275.29	79.68	58.18	255.29
RDF 75%	257.57	72.75	55.94	241.90
RDF 75% + *Azospyrillum*	282.93	77.92	65.10	265.63
RFD 75% + PSB	263.41	74.95	57.83	250.41
RDF 75% + *Azospyrillum* + PSB	355.04	83.59	67.66	329.16
RDF 100%	269.13	77.46	57.77	246.80
RDF 100% + *Azospyrillum*	289.97	82.29	65.68	273.30
RDF 100% + PSB	277.14	79.89	65.33	260.48
RDF 100% + *Azospyrillum* + PSB	368.82	91.60	71.92	336.82
***Azospyrillum* + PSB alone**	171.09	65.40	38.14	151.09
SE m ±	3.27	1.84	1.50	2.68
CD at 5%	9.56	5.37	4.38	7.83

Table 4: Effect of bio-fertilizer with NPK levels on nitrogen, phosphorus and potassium (%) in onion (*Allium cepa* L.)

Treatments	N content (%) in onion	P content (%) in onion	K content (%) in onion
Control	1.54	0.53	1.34
RDF 50%	1.56	0.54	1.37
RDF 50% + *Azospyrillum*	1.57	0.57	1.41
RFD 50% + PSB	1.57	0.55	1.37
RDF 50% + *Azospyrillum* + PSB	1.59	0.58	1.42
RDF 75%	1.57	0.59	1.38
RDF 75% + *Azospyrillum*	1.58	0.60	1.43
RFD 75% + PSB	1.58	0.60	1.43
RDF 75% + *Azospyrillum* + PSB	1.61	0.63	1.45
RDF 100%	1.58	0.59	1.43
RDF 100% + *Azospyrillum*	1.62	0.62	1.46
RDF 100% + PSB	1.61	0.60	1.43
RDF 100% + *Azospyrillum* + PSB	1.63	0.63	1.47
***Azospyrillum* + PSB alone**	1.55	0.54	1.36
SE m ±	0.01	0.01	0.01
CD at 5%	0.02	0.03	0.02

Table 5: Effect of bio-fertilizer with chemical fertilizer on economics of onion (*Allium cepa* L.)

Treatments	Common cost (Rs/ha)	Variable cost (Rs/ha)	Total cost (Rs/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	B: C ratio
Control	58698	-	58698	95508	36810	1.63
RDF 50%	58698	2971	61669	159019	97350	2.58
RDF 50% + *Azospyrillum*	58698	3051	61749	171943	110194	2.78
RFD 50% + PSB	58698	3011	61709	164943	103234	2.67
RDF 50% + *Azospyrillum* + PSB	58698	3101	61799	178701	116902	2.89
RDF 75%	58698	4457	63155	169330	106175	2.68
RDF 75% + *Azospyrillum*	58698	4537	63235	185939	122704	2.94
RFD 75% + PSB	58698	4497	63195	175285	112090	2.77
RDF 75% + *Azospyrillum* + PSB	58698	4587	63285	230412	167127	3.64
RDF 100%	58698	8914	67612	172758	105146	2.56
RDF 100% + *Azospyrillum*	58698	8994	67692	191312	123620	2.83
RDF 100% + PSB	58698	8954	67652	182334	114682	2.70
RDF 100% + *Azospyrillum* + PSB	58698	9044	67742	235772	168030	3.48
***Azospyrillum* + PSB alone**	58698	130	58828	105761	46933	1.80

CONCLUSION

The present study conclude that fertilizer techniques viz.; 100% RDF + *Azospyrillum* + PSB (T_{13}) as well as 75 % RDF + *Azospyrillum* + PSB (T_{13}) (T_6) in onion crop production but the economical benefit was found more in 75% RDF + *Azospyrillum* + PSB (T_{13}) than corresponding fertilizer management for farmers.

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