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Study on 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

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Abstract
The present experiment was conducted in the sandy loam soils during *rabi* season in 2015-16 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 *viz.*, 100 per cent RDF (*i.e.* N, P and K @ 150:80:100 kg ha^{-1}), 75 per cent and 50 per cent along with biofertilizers like Azospyrillum and PSB. 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. 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

Keywords: Bio-fertilizer, chemical fertilizer, onion, Azospyrillum, PSB and NHRDF Red 2

Introduction
Onion (*Allium cepa* L.) is bulb vegetable crop grown in Rabi season and used in daily diet of people in the whole world. It becomes a major cash crop with higher market demand and price due to its culinary, dietary and medicinal values. (Anonymous, 2012) [1]. India is the second largest producer of onion in the world, next to China, accounting for 22.18 % of the world area and 18.78 % of the world production. In India, onion is being grown in an area of 0.83 mha with production of 13.57 millon tone and the productivity is 16.30 t/ha. Maharashtra is the leading onion growing state and other important states are Karnataka, Gujarat, Bihar, Madhya Pradesh, Andhra Pradesh, Rajasthan, Haryana, Uttar Pradesh and Tamil Nadu (Shah and Rana, 2016) [9].

As the area of onion cultivation is continuously increasing to meet the demand of domestic as well as in international market, it is obvious that increasing cultivation requires more fertilizers. Intensive cultivation and excess use of chemical fertilizers resulted in harmful and long term impact on the health of soil and unstable yield of crops. Therefore, integrated nutrients management has become necessary for increasing productivity of onion by sustaining the soil productivity. So, for the last few years organic cultivation is gaining importance as a substitute of chemical fertilisation to reduce the high cost of cultivation and to sustain the fertility and productivity of soil also. In view of the following facts, an experiment was conducted to assess the effect of inorganic, organic and biofertilizers as compared to solely application of inorganic fertilizer, on onion production and quality (Singh and Ram, 2014) [10].

Fertilizer application proved to be a great success and production of vegetables crops increasing in our country. Intensive cultivation and excess use of chemical fertilizers resulted in ill health of soil and unstable yield of crops. The modern civilization is posing a threat to environment. So in last few years, a greater concern regarding use of biofertilizers and organic sources as an alternative/supplement to chemical fertilization, has been derived to reduce the high costs that inorganic fertilizer represent in agricultural production. (Bharadwaj *et al.*, 1994) [4].

Now a days there is a need to devise alternate ways to collect, process, compost, utilize organic manure as well as biofertlizers like Azotobacter, Azospirillum, Acetobacter, Rhizobium, Azolla, Blue green algae and Phosphate solubilizing bacteria enrich fertility status of the soil The chemical fertilizers like N, P and K have played significant role on increasing

the yield and quality in plants during early seventies. But in recent years the usage of chemical fertilizers indiscriminately in an unbalanced manner has been shown to result in several problems like loss of fertility, soil health and multiple nutrient deficiencies and loss of microbial activities etc, which ultimately resulting in reduced crop productivity and quality (Singh *et al.*, 2017) [12].

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.

Materials and Methods

The experiment was carried out in at the garden of the Department of Horticulture, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, U.P; during the winter season. The experimental site is located in the an elevation of 125.9 meter above mean sea level, $26^0$20'35" North latitude and $80^0$18'35" East longitude. 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". 45 days old seedlings of uniform growth were transplanted in evening hour at a spacing of 15x10 cm in flat beds. The gross plot size was 1.8 m x 3.6 m. The fertilizer applications were done as NPK @150:80:100kg/ha and Bio-fertilizer @ 200g/2 liter of water seedlings treatment. The recommended plant protection measures were taken as and when required. 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. 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

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

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 (95.91%), plant height (cm) at 50 DAT (32.95), at 75 DAT (79.70) and at 100 DAP (83.35), Length of leaves(cm) at 50 DAT (29.76), at 75 DAT (33.76) and at 100 DAP (36.87), Diameter of bulb(cm) at 50 DAT (14.88), at 75 DAT (24.90) and at 100 DAP (45.13), No of leaves at 50 DAT (7.36), at 75 DAT (8.69) and at 100 DAP (10.13), Shoot thickness (cm) at 50 DAT (6.47), at 75 DAT (12.70) and at 100 DAP (13.21), Freshweight/ plant(g) at 50 DAT (14.09), at 75 DAT (30.03) and at 100 DAP (57.28), Fresh weight per bulb(g)) at 50 DAT (5.45), at 75 DAT (8.22) and at 100 DAP (41.60) and Shoot weight/bulb(g) at 50 DAT (11.02), at 75 DAT (22.12) and at 100 DAP (24.78) followd by the treatment T_{11} (RDF 100% + *Azospyrillum*) for survival of the plant (94.11, plant height (cm) at 50 DAT (30.32) at 75 DAT (76.68) and at 100 DAP (82.65), Length of leaves(cm) at 50 DAT (29.50), at 75 DAT (33.46) and at 100 DAP (35.69), Diameter of bulb(cm) at 50 DAT (14.25), at 75 DAT (23.97and at 100 DAP (42.96), No of leaves at 50 DAT (7.04), at 75 DAT (8.52) and at 100 DAP (9.54), Shoot thickness (cm) at 50 DAT (6.35), at 75 DAT (12.17) and at 100 DAP (12.33), Freshweight/ plant(g) at 50 DAT (13.72), at 75 DAT (28.89) and at 100 DAP (55.28), Fresh weight per bulb(g)) at 50 DAT (5.09), at 75 DAT (7.42) and at 100 DAP (39.80) and Shoot weight/bulb(g) at 50 DAT (10.44), at 75 DAT (21.11) and at 100 DAP (23.65).

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 (2002) [2], Jayathilake *et al.* (2002) [5], Patil *et al.* (2010) [8], 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.* (2013) [11], 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.* (2003) [6], Krishnamurthy (2005) [7].

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 (362.82), Dry weight per bulb(90.94), Diameter of dry bulb (71.25) and Yield of bulb after curing (332.15) followed by the treatment T_9 (RDF 75% + *Azospyrillum* + PSB) for Yield of fresh bulb (348.38), Dry weight per bulb(82.93), Diameter of dry bulb(67.00and Yield of bulb after curing (322.49).

This increase is due to more number of bulbs per plot, bulb size and average weight of bulbs. Use of *Azospyrillum* and PSB not only makes the atmospheric nitrogen and soil phosphorus available, respectively, to plants but also

enhances the plant growth and bulb yield due to release of hormones, vitamins and nutrients. Similar findings were also reported by Yadav *et al.* (2005) [13].

Effect on economics

The data presented in Tables 4 revealed that the. significantly maximum bulb yield 332.15 and the highest net return of Rs 135585 was recorded under treatment T_{13} (100 % RDF + *Azospyrillum* + PSB), followed by T_9 (75 % RDF + *Azospyrillum* + PSB), (322.49 ha^{-1} yield and net return Rs 134246 respectively), but maximum benefit: cost ratio 3.27 was observed under the treatment T_9 (75 % RDF + *Azospyrillum* + PSB) due to low cost of cultivation (Rs 59248 Rs / ha, respectively. Similar results have been reported by Yadav *et al.* (2012) [14], Azam *et al.* (2013) [3].

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.

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	80.23	24.74	69.16	73.49	21.80	25.14	27.87	9.34	16.96	23.93	3.36	6.19	6.90
RDF 50%	81.86	25.35	72.13	76.87	25.19	27.88	31.58	9.83	18.93	30.33	4.62	6.42	7.53
RDF 50% + *Azospyrillum*	84.04	28.11	73.48	78.08	26.55	29.38	32.92	11.36	21.11	33.40	5.18	6.71	8.27
RFD 50% + PSB	82.36	27.34	72.98	77.07	25.92	29.02	32.17	10.53	19.96	32.23	4.71	6.54	7.95
RDF 50% + *Azospyrillum* + PSB	86.28	29.26	76.33	79.43	27.93	30.76	33.69	11.06	22.37	33.93	5.37	7.19	8.38
RDF 75%	87.55	26.96	73.43	78.49	27.15	31.51	32.89	11.36	20.27	33.02	5.54	7.34	7.84
RDF 75% + *Azospyrillum*	90.35	28.37	75.29	81.68	28.24	32.28	34.13	12.63	22.60	35.30	6.09	7.67	8.84
RFD 75% + PSB	89.76	25.64	74.57	79.00	27.76	31.69	33.70	13.14	20.96	38.14	5.91	7.58	8.19
RDF 75% + *Azospyrillum* + PSB	92.57	29.91	76.54	83.42	29.07	32.63	34.81	14.00	23.93	41.50	6.40	7.79	9.11
RDF 100%	91.37	28.98	75.70	80.29	28.01	31.85	33.98	12.94	21.60	35.83	6.76	7.92	8.52
RDF 100% + *Azospyrillum*	94.11	30.32	76.68	82.65	29.50	33.46	35.69	14.25	23.97	42.96	7.04	8.52	9.54
RDF 100% + PSB	93.73	29.71	76.26	81.84	28.87	32.59	34.66	13.32	23.01	41.95	6.94	8.21	8.83
RDF 100% + *Azospyrillum* + PSB	95.91	32.95	79.70	83.35	29.76	33.76	36.87	14.88	24.90	45.13	7.36	8.69	10.13
Azospyrillum + PSB alone	81.51	26.03	70.73	74.67	23.15	26.15	28.98	10.05	18.17	25.13	4.07	6.28	7.13
SE m ±	3.69	1.50	1.76	1.83	1.41	1.76	1.37	0.42	1.20	1.81	0.56	0.50	0.20
CD at 5%	NS	4.38	5.13	5.34	4.12	5.13	4.01	2.39	3.51	5.29	1.65	1.47	0.58

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	4.37	6.54	6.96	8.21	20.27	42.65	0.78	4.10	19.37	5.03	11.40	9.10
RDF 50%	4.94	6.77	8.84	9.80	23.96	46.27	1.30	5.19	27.93	8.18	16.93	18.54
RDF 50% + *Azospyrillum*	5.37	8.23	10.12	11.05	26.26	51.56	1.47	6.74	36.49	9.25	17.91	18.50
RFD 50% + PSB	5.08	7.06	9.30	10.79	24.42	48.70	1.42	6.18	34.70	9.03	17.39	18.52
RDF 50% + *Azospyrillum* + PSB	5.65	10.32	11.34	12.35	27.58	52.94	1.51	7.06	39.20	10.03	17.98	20.07
RDF 75%	5.33	9.41	9.42	10.31	25.51	48.78	3.82	6.13	32.21	8.41	18.07	20.97
RDF 75% + *Azospyrillum*	6.07	11.00	11.39	12.45	27.00	53.47	4.22	6.93	37.62	9.15	20.26	21.23
RFD 75% + PSB	5.59	10.64	10.73	11.47	26.50	49.94	4.00	6.47	38.93	8.89	19.09	21.23
RDF 75% + *Azospyrillum* + PSB	6.29	11.79	12.23	12.85	28.00	54.64	4.63	7.58	40.73	10.19	21.03	23.06
RDF 100%	5.79	10.47	10.80	10.39	25.84	51.40	4.25	7.06	35.25	9.70	19.31	20.65
RDF 100% + *Azospyrillum*	6.35	12.17	12.33	13.72	28.89	55.28	5.09	7.42	39.80	10.44	21.11	23.65
RDF 100% + PSB	6.05	11.82	11.25	12.77	27.66	53.18	4.83	7.38	38.69	10.01	19.98	20.66
RDF 100% + *Azospyrillum* + PSB	6.47	12.70	13.21	14.09	30.03	57.28	5.45	8.22	41.60	11.02	22.12	24.78
Azospyrillum + PSB alone	4.44	6.62	7.04	8.96	23.14	44.27	0.99	4.78	26.13	5.49	13.05	10.08
SE m ±	0.35	1.01	1.07	1.06	1.35	2.03	0.49	0.75	2.29	1.10	1.97	0.89
CD at 5%	1.02	2.96	3.12	3.09	3.94	5.94	1.44	2.20	6.68	3.22	5.75	2.60

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	155.77	62.90	35.35	135.77
RDF 50%	246.50	68.92	45.56	226.50
RDF 50% + *Azospyrillum*	264.97	72.03	54.99	244.97
RFD 50% + PSB	254.97	71.89	49.21	234.97
RDF 50% + *Azospyrillum* + PSB	274.62	79.01	57.52	254.62
RDF 75%	256.90	72.08	55.28	236.90
RDF 75% + *Azospyrillum*	282.26	77.25	64.43	254.96
RFD 75% + PSB	262.74	74.28	57.16	242.74
RDF 75% + *Azospyrillum* + PSB	348.38	82.93	67.00	322.49
RDF 100%	268.46	76.80	57.11	246.13
RDF 100% + *Azospyrillum*	289.30	81.63	65.02	269.30
RDF 100% + PSB	276.48	79.22	64.66	256.48
RDF 100% + *Azospyrillum* + PSB	362.82	90.94	71.25	332.15
Azospyrillum + PSB alone	170.42	64.73	37.47	150.42
SE m ±	2.92	2.00	1.99	2.67
CD at 5%	8.54	5.84	5.80	7.81

Table 4: 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	54661	-	54661	81464	26803	1.49
RDF 50%	54661	2971	57632	135902	78270	2.36
RDF 50% + *Azospyrillum*	54661	3051	57712	146980	89268	2.55
RFD 50% + PSB	54661	3011	57672	140980	83308	2.44
RDF 50% + *Azospyrillum* + PSB	54661	3101	57762	152772	95010	2.64
RDF 75%	54661	4457	59118	142140	83022	2.40
RDF 75% + *Azospyrillum*	54661	4537	59198	152976	93778	2.58
RFD 75% + PSB	54661	4497	59158	145644	86486	2.46
RDF 75% + *Azospyrillum* + PSB	54661	4587	59248	193494	134246	3.27
RDF 100%	54661	8914	63575	147678	84103	2.32
RDF 100% + *Azospyrillum*	54661	8994	63655	161582	97927	2.54
RDF 100% + PSB	54661	8954	63615	153886	90271	2.42
RDF 100% + *Azospyrillum* + PSB	54661	9044	63705	199290	135585	3.13
Azospyrillum + PSB alone	54661	130	54791	90252	35461	1.65

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