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Effect of biofertilizers with levels of fertilizer on growth of onion bulbs

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Abstract
The experiment was conducted at Horticultural Research Farm, College of Agriculture, RVSKVV, Gwalior (M.P.) during *Rabi* season 2018-19 and 2019-20. The treatments included combination of different bio-fertilizers and RDF. The experiment was laid out in randomized block design (RBD) with 15 treatments replicated thrice. Application of bio-fertilizer with different dose of fertilizers had significantly enhanced the growth of plants. Maximum plant height (33.73 cm, 47.83 cm, 67.23 cm and 74.10 cm), length of leaves (31.07 cm, 44.10 cm, 62.60 cm and 67.93 cm), width of leaves (0.77 cm, 0.91 cm, 1.38 cm and 1.58 cm), no. of leaves (5.90, 8.18, 11.73 and 12.97), neck thickness (6.42 mm, 8.82 mm, 11.31 mm and 13.21 mm), leaf area (81.73 cm^2, 320.23 cm^2, 838.23 cm^2 and 829.23 cm^2) and leaf area index (0.54, 2.13, 5.59 and 5.52) were recorded under treatment T_{15} – 100% RDF + *Azospirillum* + *Azotobacter* + PSB at 30, 60, 90 and 120 days after transplanting, respectively. While, minimum values of all growth observations were recorded under T_1 (Absolute control).

Keywords: Biofertilizers, fertilizers, growth, onion, Agrifound light red (AFLR)

Introduction
Onion (*Allium cepa L.*) is a bulbous, biennial herb belonging to the family Alliaceae and genus Allium. This is consumed all over the world throughout the year. It is one of the important vegetables and spice crop grown in India and being exported to other countries.
India is second largest producer of onion after China in the world. In India, onion is grown in 1315 thousand hectare area and its production is 21838 thousand MT of onion bulb whereas in Madhya Pradesh, it is grown in 152.8 thousand hectares area and production is 3859.83 thousand MT (NHB, 2017-18). The pungency in the onion bulb is due to a volatile oil known as allyl-propyl-disulphide ($C_6H_{12}S_2$) and the red colour is because of the pigment "anthocyanin" and yellow colour because of "quercetin". The nutritive value of onion varies from variety to variety. Nutritionally, fresh onion contains about 86.6 per cent moisture, 11.6 per cent carbohydrates, 0.2 to 0.5 per cent calcium, 0.05 per cent phosphorus and traces of iron and ascorbic acid (Raj *et al*, 2004) [5]. Bio-fertilizers have recently gained with momentum for affecting the sustainable increase in crop yield under various agro-climatic conditions. Role of biofertilizer on the crop growth and yield was documented by Vijayakumar *et al.* (2000) [14] and Ramakrishnan and Thamizhiniyan (2009) [6].

Methods and Materials
The experiment was carried out in at Horticultural Research Farm, College of Agriculture, RVSKVV, Gwalior (M.P.) in during *Rabi* season 2018-19 and 2019-20. The experimental site is located in the north part of Madhya Pradesh at 26^0 13' North latitude and 74^0 4' East longitudes and altitude of 280 meter above mean sea level. The treatments included combination of different bio-fertilizers and RDF. The experiment was laid out in randomized block design (RBD) with 15 treatments *viz.* T_1 – Control (without fertilizer and biofertilizer), T_2 – 50% RDF, T_3 – 100% RDF, T_4 – *Azospirillum*, T_5 – *Azotobacter*, T_6 – PSB, T_7 – 50% RDF + *Azospirillum*, T_8 – 50% RDF + *Azotobacter*, T_9 – 50% RDF + PSB, T_{10} – 100% RDF + *Azospirillum*, T_{11} – 100% RDF + *Azotobacter*, T_{12} – 100% RDF + PSB, T_{13} – *Azospirillum* + *Azotobacter* + PSB, T_{14} – 50% RDF + *Azospirillum* + *Azotobacter* + PSB and T_{15} – 100% RDF + *Azospirillum* + *Azotobacter* + PSB and three replications. The onion variety was used in the experiment "Agri found Light red". About seven week old seedlings having of 12 to 15 cm height were transplanted in evening hours at spacing of 15 x 10 cm in flat beds. The gross plot size was 3 m x 2 m.

Leaf area of plant was determined by multiplying factor K, length and width of leaf for each treatment. After this, leaf area/plant was determined by using the following formula.

Leaf area = L×W×N×K

Where,
L – Length of leaf (cm)
W – Width of leaf (cm)
N – Number of leaves/plant
K – is a constant (0.627)

Result and discussion

Effect on crop growth

Growth of plant is a vital process which brings about permanent changes in plant and its part in respect to its size, form, weight and volume. The supply of food is directly proportional to the rate of growth. Apical meristems are responsible for the increase in length, differentiation of various appendages and formation of plant tissues. The vigorous growth of onion in terms of plant height, number of leaves per plant, width of leaves per plant, neck thickness, length of leaves per and leaf area might be due to higher uptake of N, P, K and S. The significant differences among the treatments were observed.

On the basis of two years pooled data, the data present in table 1a and 1b revealed that significantly maximum plant height (33.73, 47.83 cm, 67.23 cm and 74.10 cm, respectively) were recorded in the treatment T_{15} - 100% RDF + *Azospirillum* + *Azotobacter* + PSB at 30, 60, 90 and 120 DAT, which was significant over the all treatments. Similar findings are also reported by Yadav *et al.* (2020) [16], Solanki *et al.* (2019) [9], Vachan and Tripathi (2018) [13], Vachan and Tripathi (2017) [12] and Jayathilake (2002) [2].

Table 1a: Effect of different bio-fertilizers and fertilizers doses on growth parameters of onion bulb in pooled (2018-19 &19-20).

Treatment	Plant height (cm)				Length of leaves plant^{-1} (cm)				Width of leaves plant^{-1} (cm)			
	30 DAT	60 DAT	90 DAT	120 DAT	30 DAT	60 DAT	90 DAT	120 DAT	30 DAT	60 DAT	90 DAT	120 DAT
T_1	23.68	37.07	53.68	58.02	21.72	33.95	49.65	53.13	0.35	0.52	0.66	0.72
T_2	28.17	40.80	58.63	62.57	25.63	37.13	53.90	57.60	0.55	0.67	0.81	0.86
T_3	30.93	44.57	62.53	68.23	28.23	41.00	57.83	62.67	0.67	0.78	1.00	1.06
T_4	25.87	39.00	55.85	59.68	23.80	35.80	51.93	55.33	0.45	0.59	0.73	0.80
T_5	26.25	39.47	56.87	60.87	23.42	35.75	52.02	55.72	0.47	0.62	0.76	0.82
T_6	25.10	38.37	55.17	59.43	22.45	34.83	50.50	54.37	0.42	0.56	0.70	0.77
T_7	29.53	42.50	59.58	64.90	26.80	38.70	55.20	59.87	0.59	0.70	0.88	0.93
T_8	30.25	43.63	60.63	65.93	27.63	39.50	55.73	60.73	0.62	0.69	0.91	0.97
T_9	28.67	41.77	58.70	64.07	26.15	38.07	54.00	59.77	0.57	0.68	0.83	0.90
T_{10}	32.33	45.77	64.53	70.23	30.00	42.87	60.00	65.70	0.73	0.85	1.15	1.27
T_{11}	32.58	46.42	65.47	72.08	30.18	42.87	59.88	65.70	0.71	0.85	1.23	1.36
T_{12}	31.83	45.17	63.43	68.80	29.15	41.93	58.67	63.73	0.72	0.82	1.05	1.14
T_{13}	27.30	40.10	57.67	61.32	24.70	36.77	52.58	56.50	0.52	0.64	0.78	0.85
T_{14}	33.30	43.97	61.22	67.08	30.02	40.67	57.05	62.07	0.67	0.76	0.95	1.02
T_{15}	33.73	47.83	67.23	74.10	31.07	44.10	62.60	67.93	0.77	0.91	1.38	1.58
SE(m)	0.614	0.871	1.250	1.372	0.564	0.808	1.259	1.277	0.014	0.019	0.029	0.030
CD(5%)	1.728	2.451	3.517	3.859	1.586	2.273	3.541	3.593	0.038	0.055	0.082	0.083

Table 1b: Effect of different bio-fertilizers and fertilizers doses on growth parameters of onion bulb in pooled (2018-19 &19-20).

Treatment	Number of leaves plant^{-1}				Neck thickness (mm)				Bolting (%)
	30 DAT	60 DAT	90 DAT	120 DAT	30 DAT	60 DAT	90 DAT	120 DAT	
T_1	3.57	4.95	8.10	8.70	3.34	5.22	6.48	7.01	5.95
T_2	4.92	6.48	9.50	10.18	4.69	6.91	8.15	8.99	3.27
T_3	5.68	7.33	10.82	11.37	5.69	7.88	9.64	11.41	1.82
T_4	4.52	6.12	9.07	9.85	4.33	6.23	7.14	8.04	4.26
T_5	4.58	6.17	9.10	9.87	4.40	6.35	7.48	8.41	3.98
T_6	4.02	5.73	8.67	9.67	4.18	5.97	6.99	7.82	4.63
T_7	5.22	6.78	9.77	10.52	4.85	7.22	8.80	9.62	2.41
T_8	5.35	6.87	10.23	10.73	5.20	7.44	9.16	10.22	2.15
T_9	5.10	6.80	9.53	10.37	4.89	6.99	8.49	9.36	2.73
T_{10}	5.93	7.77	11.13	12.30	5.96	8.26	10.32	12.28	1.47
T_{11}	6.18	7.93	11.42	12.55	6.13	8.47	10.79	12.95	1.26
T_{12}	5.78	7.57	10.97	11.73	5.88	8.15	9.86	11.73	1.64
T_{13}	4.42	5.85	9.05	9.83	4.46	6.53	7.70	8.85	3.00
T_{14}	5.62	7.22	10.63	11.20	5.35	7.57	9.44	10.81	1.93
T_{15}	5.90	8.18	11.73	12.97	6.42	8.82	11.31	13.21	1.00
SE(m)	0.262	0.303	0.283	0.340	0.255	0.286	0.285	0.272	0.252
CD (5%)	0.737	0.851	0.796	0.957	0.716	0.805	0.801	0.765	0.708

The average maximum length of leaves plant^{-1} (31.07 cm, 44.10 cm, 62.60 cm and 67.93 cm, respectively) were recorded under the treatment T_{15} -100% RDF + *Azospirillum* + *Azotobacter* + PSB, over the treatment T_{11} - 100% RDF + *Azotobacter* (30.66 cm, 43.13 cm, 60.31 cm and 66.60 cm). Whereas, the minimum length of leaves per plant (21.71 cm, 33.95 cm, 49.65 cm and 53.13 cm) was recorded under treatment T_1 – (Absolute control), which was significant over the all treatments. Although, *Azotobacter* showed a better performance compared with *Azospirillum* and PSB in aspects

for growth parameters. Similar findings are also reported by Yadav *et al.* (2020) [16], Kumar, *et al.* (2019) [4] and Singh, *et al.* (2017) [8].

The maximum width of leaves plant^{-1} (0.76 cm, 0.91 cm, 1.37 cm and 1.56 cm, respectively) were observed significantly increased by the treatment T_{15} - 100% RDF + *Azospirillum* + *Azotobacter* + PSB, which is at par T_{11} - 100% RDF + *Azotobacter* (0.73 cm, 0.86 cm, 1.22 cm and 1.36 cm), Whereas, the significantly minimum width of leaves plant^{-1} (0.35 cm, 0.52 cm, 0.66 cm and 0.72 cm) were recorded in the treatment T_1- Control (without biofertilizer and RDF) at all stage of plant growth (30, 60, 90 and 120 DAT). The same results were found by Somashekar and Choudhuri (2015) [10].

The maximum number of leaves plant^{-1} (6.18) were recorded under the treatment T_{11} - 100% RDF + *Azotobacter*, followed by T_{10} - 100% RDF + *Azotobacter* (5.93) at 30 DAT.

At 60, 90 and 120 DAT intervals, the highest no. of leaves per plant (8.18, 11.73 and 12.97, respectively) were recorded under the treatment T_{15} - 100% RDF + *Azospirillum* + *Azotobacter* + PSB, closely followed by T_{11} - 100% RDF + *Azotobacter* (8.43, 11.87 and 12.80). Significantly minimum number of leaves plant^{-1} (3.60, 5.53, 8.93 and 9.03, respectively) was noticed under the treatment T_1- Control, respectively. The result also agreement with wankhade and Kale (2019) [15], Solanki, *et al.* (2019) [9], Kuar and Singh (2019) [3], Vachan and Tripathi (2018) [13] and Singh and Ram (2014) [7].

Significantly and maximum neck thickness of plant^{-1} (mm) were recorded under the treatment T_{15} - 100% RDF + *Azospirillum* + *Azotobacter* + PSB (6.42 mm, 8.82 mm, 11.31 mm and 13.21 mm), which is at par by T_{11} – 100% RDF + *Azotobacter* (6.13 mm, 8.47 mm, 10.79 mm and 12.94 mm, respectively), whereas significantly lowest values of neck thickness of plant^{-1} (mm) were observed under the treatment T_1 - Control (3.33 mm, 5.22 mm, 6.48 mm and 7.01 mm, respectively) at 30, 60, 90 and 120 day after transplanting. The results are close agreement with those of Wankhade and Kale (2019) [15], Solanki, *et al.* (2019) [9], Kumar, *et al.* (2019) [4] and Vachan and Tripathi (2018) [13].

The bolting percent is depending on transplanting date of nursery, highly temperature made of bulb and varieties of onion. At flowering stage, significantly lowest bolting (1.0%) was recorded in treatment T_{15} - 100% RDF + *Azospirillum* + *Azotobacter* + PSB, followed by T_{11} - 100% RDF + *Azotobacter* (1.26%), T_{10} - 100% RDF + *Azospirillum* (1.47%), T_{12} - 100% RDF + PSB (1.64%) and other treatments. However, the significantly maximum value of bolting (5.95%) was observed in the treatment T_1 - Control. The results of bio-fertilizers and control values are similar findings by Solanki, *et al.* (2019) [9].

Growth analysis parameters

The data pertaining to continuously progressive average leaf area (cm^2) and leaf area index influenced by different doses of fertilizers and bio-fertilizers at different growth intervals were statistically analyzed and is being presented in table – 2.

Table 2: Effect of different bio-fertilizers and fertilizers doses on growth analysis parameters of onion bulb in pooled (2018-19 &19-20).

Treatment	Leaf area (cm^2)				Leaf area index				Bulb: Green top rario
	30 DAT	60 DAT	90 DAT	120 DAT	30 DAT	60 DAT	90 DAT	120 DAT	
T_1	44.63	189.80	487.07	479.70	0.30	1.27	3.25	3.20	1.32
T_2	58.13	231.25	558.90	555.23	0.39	1.54	3.73	3.70	1.47
T_3	70.37	287.87	703.57	686.40	0.47	1.92	4.69	4.58	1.56
T_4	54.97	214.37	515.00	508.17	0.37	1.43	3.43	3.39	1.41
T_5	52.50	216.62	523.37	516.60	0.35	1.44	3.49	3.44	1.39
T_6	48.90	208.77	502.77	499.27	0.33	1.39	3.35	3.33	1.42
T_7	61.83	252.67	601.70	588.20	0.41	1.68	4.01	3.92	1.51
T_8	63.67	265.83	619.50	609.33	0.42	1.77	4.13	4.06	1.55
T_9	59.50	238.17	575.13	562.47	0.40	1.59	3.83	3.75	1.49
T_{10}	76.03	298.70	763.30	753.13	0.51	1.99	5.09	5.02	1.63
T_{11}	79.27	311.93	808.27	794.27	0.53	2.08	5.39	5.30	1.63
T_{12}	73.07	292.33	731.60	719.27	0.49	1.95	4.88	4.80	1.59
T_{13}	55.63	221.87	541.63	531.30	0.37	1.48	3.61	3.54	1.46
T_{14}	66.52	276.93	648.77	643.77	0.44	1.85	4.33	4.29	1.53
T_{15}	81.73	320.23	838.73	829.23	0.54	2.13	5.59	5.53	1.63
SE(m)	2.124	4.757	13.697	13.120	0.022	0.057	0.114	0.099	0.113
CD (5%)	5.975	13.381	38.527	36.906	0.061	0.162	0.320	0.279	NS

Leaf area (81.73 cm^2, 320.23 cm^2, 838.73 cm^2 and 829.23 cm^2, respectively) were recorded under the treatment T_{15}, closely followed by T_{11} (79.27 cm^2, 311.93 cm^2 808.27 cm^2 and 794.27 cm^2, respectively). Significantly minimum leaf area (44.63 cm^2, 189.80 cm^2, 487.07 cm^2 and 479.70 cm^2, respectively) were observed in the treatment T_1 - Control at 30, 60, 90 and 120 DAT stage.

Significantly and positive maximum leaf area index (LAI) were observed under the treatment T_{15} (0.54, 2.13, 5.59 and 5.52, respectively), closely followed by T_{11} (0.53, 2.08, 5.39 and 5.30, respectively). Whereas, minimum value of leaf area index (0.30, 1.27, 3.25 and 3.20, respectively) was noticed in the treatment T_1 - Control at 30, 60, 90 and 120 DAT stage.

Bio-fertilizers *viz*., *Azotobacter*, *Azospirillum*, PSB and *Trichoderma spp*. have ability to produce growth promoting substances and change in the metabolic activities which might have led to enhanced cell division and cell elongation leading to increased uptake of water and nutrients further resulting in maximum plant height, number of leaves per plant, leaf length and leaf area and leaf area index. The results are similar are with Talwar, *et al.* (2016) [11] and Chandalinga, *et al.* (2019) [1].

Conclusion

Application of T_{15} - 100% RDF + *Azospirillum* + *Azotobacter* + PSB of recommended dose of bio-fertilizer with level of fertilizers has been found suitable. However, the treatment T_{11} and T_{10} for promote the growth and growth analysis parameters.

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