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Studies on influence of bio-fertilizers and level chemical fertilizers on growth of onion (*Allium cepa* L.) *cv.* Bhima Red

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Abstract
An experiment entitled "Studies on influence of bio-fertilizers and level chemical fertilizers on growth of Onion (*Allium cepa* L.) *cv.* Bhima Red" was carried out at Agricultural Farm, Krishi Vigyan Kendra, Dhar, M.P. during 2020-21 and 2021-22 with the objectives to study effect of bio-fertilizers application on growth characters. The experiment was conducted in Randomised Block Design with 3 replications. It comprised of 14 treatments of bio-fertilizers and levels of chemical fertilizers.
Growth parameters like Leaf area(cm^2) at 30, 60, 90 and 120 DAT, Leaf area index at 30, 60, 90 and 120 DAT, Bulb/green top ration, Leaf dry matter, Chlorophyll content in leaves and Bulb dry matter were recorded and statistically analysed. From the experiment, it may be concluded that the bio-fertilizers and various levels of chemical fertilizers had a significant effect on the growth of the crop. The treatment with 100% RDF + *Azospirillum* + *Azotobacter* + *VAM* was found the best treatment among all treatments whereas the minimum effect was observed under treatment with no bio-fertilizer and chemical fertilizer.

Keywords: Onion, *Allium cepa*, bio fertilizers, VAM, *Azospirillum*, *Azotobacter*

Introduction
Onion (*Allium cepa* L.) is a biennial herb that belongs to the family *Alliaceae*. It is known in Hindi as *Pyaj*. It is an old-world crop which was domesticated in Iran and Pakistan *i.e.,* Central Asia. Maharashtra is the leading onion growing state in India. Other major onion growing states in India are Karnataka, Gujarat, Bihar, Madhya Pradesh, Andhra Pradesh, Rajasthan, Haryana, Uttar Pradesh and Tamil Nadu. It is one of the most important bulbous vegetables and grown all over the world. It is also used for culinary purpose in everyday cooking. The crop semi-perishable in nature and it can be transported to a long distance without much transit injury losses. It becomes a major cash crop with higher market demand and price due to its culinary, dietary and medicinal values.
Worldwide India ranks second in area and production of onion after China. In India, the area and production of onion are 1624 thousand hectare and 26641 thousand MT (Anonymous, 2020-21). In Madhya Pradesh, The area and production of onion are 186.92 thousand hectare and 4548.56 thousand MT (Anonymous, 2020-21). Onion is a good source of ascorbic acid, dietary fiber and it also possesses a high content of flavanoids (mainly quercetin and its conjugates) and sulphur compounds (i.e. thio sulphinate), both contain a high level of antioxidants.
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) [2] and Ramakrishnan and Thamizhiniyan (2009) [1].
Onion a seasonal crop has comparatively low storage ability. Sometimes bulbs are to be stored for longer period due to seasonal glut in the market. Significant losses in quality and quantity of onion occur during storage. The annual storage losses of onion have been estimated to be more than 40 percent on different accounts during storage and handling (Maini *et al.* 1984) [8].
Organic farming improves the quality of the produce combine with higher nutritive value and better storage life than those grown conventionally with mineral fertilizers. In onion, the information on studies of organic farming using different kinds of organic manure and bio-fertilizers is very meagre. The post-harvest losses, *viz.*, sprouting, rotting and physiological loss in weight pose a great problem.

The reported that annual storage losses were over 40% and between 40 to 60% in India (Bhagachandani *et al.* 1980) [3].

Material and Method

Experimental site and location

The present experiment was conducted at Agriculture farm, Krishi Vigyan Kendra, Dhar (M.P.). The topography of the field was uniform with proper drainage system.

Climate and weather condition

Dhar belongs to "Malwa Plateau" under 10th Agro-Climatic Zone of Madhya Pradesh as per classification made by National Agricultural Research Project. It is situated in the south-western part of Madhya Pradesh. It lies between the parallels of North latitude 22° 01'14 to 23° 08'49'' North latitude and 74° 28'15 to 75° 42''43 East longitudes and altitude of 588 meter above mean sea level. Dhar enjoys a typical sub-tropical climate consisting of hot dry summers and cool dry winters. The minimum and maximum temperature during crop growth period 2020-21 and 2021-22 varies between 7.36 °C to 26.71 °C and from 7.00 °C to 43.00 °C, with season's average values of 19.00 °C and 34.57 °C, respectively. The morning and evening relative humidity ranged between 12.26 to 87.29% and 11.26 to 76.66% with season's average of 38.14% and 19.01%, respectively. The rainfall of crop growth period 2020-21 was about 266.2 mm and 2021-22 was 221.1 mm which was mostly received between June – July.

Bhima Red was developed by ICAR-Directorate of Onion and Garlic Research (ICAR-DOGR), Pune, Maharashtra and entirely resembles with (B780531, IC No. 561258) has been developed through bulb to row selection method. Bulbs are attractive red in colour with round shape. It can be grown during rabi season also for immediate marketing as it can be stored up to 3 months during rabi. It matures after 115-120days of transplanting. TSS ranges from 10-11%. Bhima Red is a high yielding onion variety. This variety produced bulbs up to 480-520 qt/ha. It was released by ICAR-Directorate on Onion and Garlic Research, Pune 12th November, 2014, Pune, Maharashtra.

Treatment details

T_0: Control
T_1: 100% RDF
T_2: 100% RDF+Azospirillum
T_3: 100% RDF+Azotobacter
T_4: 100% RDF+VAM
T_5: 75% RDF+Azospirillum
T_6: 75% RDF+Azotobactor
T_7: 75% RDF+ VAM
T_8: 50% RDF+.Azospirillum
T_9: 50% RDF+ Azotobactor
T_{10}: 50% RDF+ VAM
T_{11}: 100% RDFAzospirillum+Azotobactor+VAM
T_{12}: 75% RDF+Azospirillum+Azotobactor+VAM
T_{13}: 50% RDF+Azospirillum+Azotobactor+VAM

Parameters under study

1. Leaf area (cm^2) at 30, 60, 90 and 120 DAT
2. Leaf area index at 30, 60, 90 and 120 DAT
3. Bulb/green top ration
4. Leaf dry matter
5. Chlorophyll content in leaves
6. Bulb dry matter

Result

Leaf area (cm^2)

Result clearly shows that the treatment T_{11} (100% RDF + *Azospirillum* + *Azotobacter* + *VAM*) was significantly influenced the leaf area (cm^2) of onion and it gave the maximum leaf area (450.00, 441.00 and 445.50 cm^2) in first, second year and in pooled. It was at par to all treatments except T_0, T_8, T_9 and T_{10} in first year, at par to all treatments except T_0, T_9 and T_{10} in second year and at par to all treatments except T_0, T_8, T_9, T_{10} and T_{13} in pooled. However, the minimum leaf area (383.33, 374.67 and 379.00 cm^2) in first, second year and in pooled was observed in treatment T_0 (Control).

Table 1: Effect of bio-fertilizers and chemical fertilizers on leaf area

Treatments detail	Leaf area (cm^2)		
	I Year	II Year	Pooled
T_0 – Control	383.33	374.67	379.00
T_1– 100% RDF	431.67	423.33	427.50
T_2 – 100% RDF + *Azospirillum*	444.67	437.67	441.17
T_3– 100% RDF + *Azotobacter*	445.33	438.67	442.00
T_4–100% RDF + *VAM*	440.00	436.33	438.17
T_5– 75% RDF + *Azospirillum*	438.67	433.67	436.17
T_6– 75% RDF + *Azotobacter*	435.67	428.33	432.00
T_7 – 75% RDF + *VAM*	435.33	427.00	431.17
T_8– 50% RDF +.*Azospirillum*	410.67	420.33	415.50
T_9 – 50% RDF + *Azotobacter*	405.67	397.33	401.50
T_{10} – 50% RDF+ *VAM*	405.33	393.33	399.33
T_{11}–100% RDF + *Azospirillum* + *Azotobacter* + *VAM*	450.00	441.00	445.50
T_{12}–75% RDF + *Azospirillum* + *Azotobacter* + *VAM*	446.33	440.67	443.50
T_{13} -50% RDF + *Azospirillum* + *Azotobacter* + *VAM*	426.33	420.33	423.33
SEm ±	10.887	7.485	6.606
CD 5%	31.648	21.758	18.746

Leaf area index

Perusal of data indicates that the maximum leaf area index (1.52, 1.50 and 1.51) in first year, second year and in pooled was observed in treatment T_{11} (100% RDF + *Azospirillum* + *Azotobacter* + *VAM*) and it was found the best treatment for influencing the leaf area index in onion. It was at par to treatments T_2, T_3, T_4, T_5, T_6 and T_{12} in first year, treatments T_2, T_3, T_4, T_5, T_6, T_7 and T_{12} in second year and T_2, T_3, T_4, T_5 and T_{12} in pooled. However, the minimum leaf area index (0.92, 1.04 and 0.98) in first year, second year and in pooled was found in treatment T_0 (Control).

Table 2: Effect of bio-fertilizers and chemical fertilizers on leaf area index

Treatments detail	Leaf area index		
	I Year	II Year	Pooled
T_0 – Control	0.92	1.04	0.98
T_1– 100% RDF	1.13	1.07	1.10
T_2 – 100% RDF + *Azospirillum*	1.41	1.41	1.41
T_3– 100% RDF + *Azotobacter*	1.46	1.42	1.44
T_4–100% RDF + *VAM*	1.36	1.39	1.38
T_5– 75% RDF + *Azospirillum*	1.32	1.25	1.28
T_6– 75% RDF + *Azotobacter*	1.30	1.24	1.27
T_7 – 75% RDF + *VAM*	1.13	1.18	1.16
T_8– 50% RDF +.*Azospirillum*	1.08	1.06	1.07
T_9 – 50% RDF + *Azotobacter*	1.02	1.05	1.04
T_{10} – 50% RDF+ *VAM*	0.96	1.05	1.01
T_{11}–100% RDF + *Azospirillum* + *Azotobacter* + *VAM*	1.52	1.50	1.51
T_{12}–75% RDF + *Azospirillum* + *Azotobacter* + *VAM*	1.50	1.45	1.48
T_{13} -50% RDF + *Azospirillum* + *Azotobacter* + *VAM*	1.09	1.07	1.08
SEm ±	0.113	0.116	0.081
CD 5%	0.329	0.337	0.230

Bulb/green top ratio

Result revealed that the maximum bulb/green top ratio (1.58, 1.59 and 1.59) in first year, second year and in pooled was observed in treatment T_{11} (100% RDF + *Azospirillum* + *Azotobacter* + *VAM*) and it was found the best treatment for influencing the bulb/green top ratio in onion. It was at par to treatments T_3 and T_{12} in first year and in pooled, at par to treatments T_2, T_3 and T_{12} in second year. However, the minimum bulb/green top ratio (1.02, 1.08 and 1.05) in first year, second year and in pooled was found in treatment T_0 (Control).

Table 3: Effect of bio-fertilizers and chemical fertilizers on bulb/green top ratio

Treatments detail	Bulb/green top ratio		
	I Year	II Year	Pooled
T_0 – Control	1.02	1.08	1.05
T_1– 100% RDF	1.35	1.27	1.31
T_2 – 100% RDF + *Azospirillum*	1.47	1.50	1.49
T_3– 100% RDF + *Azotobacter*	1.50	1.51	1.51
T_4–100% RDF + *VAM*	1.46	1.40	1.43
T_5– 75% RDF + *Azospirillum*	1.43	1.39	1.41
T_6– 75% RDF + *Azotobacter*	1.43	1.36	1.39
T_7 – 75% RDF + *VAM*	1.36	1.34	1.35
T_8– 50% RDF +.*Azospirillum*	1.29	1.18	1.24
T_9 – 50% RDF + *Azotobacter*	1.28	1.11	1.20
T_{10} – 50% RDF+ *VAM*	1.07	1.09	1.08
T_{11}–100% RDF + *Azospirillum* + *Azotobacter* + *VAM*	1.58	1.59	1.59
T_{12}–75% RDF + *Azospirillum* + *Azotobacter* + *VAM*	1.52	1.55	1.53
T_{13} -50% RDF + *Azospirillum* + *Azotobacter* + *VAM*	1.30	1.22	1.26
SEm ±	0.034	0.055	0.033
CD 5%	0.099	0.161	0.092

Leaf dry matter (g/100g)

The investigation revealed that the different treatments of biofertilizers were significantly influenced the leaf dry matter (g/100g). The treatment T_{11} (100% RDF + *Azospirillum* + *Azotobacter* + *VAM*) was found the best treatment among all treatments and it gave the maximum leaf dry matter (24.13, 24.13 and 24.13 g) in first year, second year and in pooled was observed in treatment T_{11} (100% RDF + *Azospirillum* + *Azotobacter* + *VAM*) and it was at par to treatments T_2, T_3, T_4, T_5, T_6, T_7 and T_{12} in first year, second year and in pooled. However, the minimum leaf dry matter (22.64, 22.03 and 22.34 g) in first year, second year and in pooled was found in treatment T_0 (Control).

Table 4: Effect of bio-fertilizers and chemical fertilizers on leaf dry matter

Treatments detail	Leaf dry matter (g/100g)		
	I Year	II Year	Pooled
T_0 – Control	22.64	22.03	22.34
T_1– 100% RDF	23.64	23.57	23.61
T_2 – 100% RDF + *Azospirillum*	24.08	23.97	24.03
T_3– 100% RDF + *Azotobacter*	24.09	24.05	24.07
T_4–100% RDF + *VAM*	24.06	23.93	24.00
T_5– 75% RDF + *Azospirillum*	24.03	23.81	23.92
T_6– 75% RDF + *Azotobacter*	24.01	23.69	23.85
T_7 – 75% RDF + *VAM*	23.94	23.65	23.80
T_8– 50% RDF +.*Azospirillum*	23.28	23.44	23.36
T_9 – 50% RDF + *Azotobacter*	23.11	22.86	22.99
T_{10} – 50% RDF+ *VAM*	22.75	22.27	22.51
T_{11}–100% RDF + *Azospirillum* + *Azotobacter* + *VAM*	24.13	24.13	24.13
T_{12}–75% RDF + *Azospirillum* + *Azotobacter* + *VAM*	24.09	24.05	24.07
T_{13} -50% RDF + *Azospirillum* + *Azotobacter* + *VAM*	23.34	23.56	23.45
SEm ±	0.158	0.184	0.121
CD 5%	0.459	0.536	0.344

Chlorophyll content in leaves (mg/100g)

A perusal of data indicates that the maximum chlorophyll content in leaves (1.12, 1.12 and 1.12 mg) in first year, second year and in pooled was observed in treatment T_{11} (100% RDF + *Azospirillum* + *Azotobacter* + *VAM*) and it was found the best treatment for influencing the chlorophyll content in onion leaves. It was at par to treatments T_2, T_3, T_4 and T_{12} in first year and second year, while at par to treatment T_{12} in pooled. However, the minimum chlorophyll content in leaves (0.92, 0.92 and 0.92 mg) in first year, second year and in pooled was found in treatment T_0 (Control).

Table 5: Effect of bio-fertilizers and chemical fertilizers on chlorophyll content in leaves

Treatments detail	Chlorophyll content in leaves (mg/100g)		
	I Year	II Year	Pooled
T_0 – Control	0.92	0.92	0.92
T_1– 100% RDF	1.01	1.00	1.00
T_2 – 100% RDF + *Azospirillum*	1.07	1.06	1.06
T_3– 100% RDF + *Azotobacter*	1.07	1.07	1.07
T_4–100% RDF + *VAM*	1.06	1.05	1.05
T_5– 75% RDF + *Azospirillum*	1.04	1.04	1.04
T_6– 75% RDF + *Azotobacter*	1.02	1.03	1.03
T_7 – 75% RDF + *VAM*	1.02	1.02	1.02
T_8– 50% RDF +.*Azospirillum*	0.98	0.98	0.98
T_9 – 50% RDF + *Azotobacter*	0.98	0.98	0.98
T_{10} – 50% RDF+ *VAM*	0.93	0.97	0.95
T_{11}–100% RDF + *Azospirillum* + *Azotobacter* + *VAM*	1.12	1.12	1.12
T_{12}–75% RDF + *Azospirillum* + *Azotobacter* + *VAM*	1.11	1.08	1.10
T_{13} -50% RDF + *Azospirillum* + *Azotobacter* + *VAM*	0.99	0.99	0.99
SEm ±	0.021	0.023	0.016
CD 5%	0.060	0.068	0.044

Bulb dry matter (g/100g)

It is evident from the data that the treatment T_{11} (100% RDF + *Azospirillum* + *Azotobacter* + *VAM*) was significantly influenced the bulb dry matter (g/100g) of onion and it gave the maximum bulb dry matter (13.10, 12.71 and 12.91 g) in first, second year and in pooled. It was at par to treatments T_2, T_3, T_4, T_5, T_6 and T_{12} in first, second year and in pooled. However, the minimum bulb dry matter (9.15, 9.30 and 9.22 g) in first, second year and in pooled was observed in treatment T_0 (Control).

Table 6: Effect of bio-fertilizers and chemical fertilizers on bulb dry matter

Treatments detail	Bulb dry matter (g/100g)		
	I Year	II Year	Pooled
T_0 – Control	9.15	9.30	9.22
T_1– 100% RDF	10.86	10.67	10.76
T_2 – 100% RDF + *Azospirillum*	12.07	12.19	12.13
T_3– 100% RDF + *Azotobacter*	12.23	12.33	12.28
T_4–100% RDF + *VAM*	11.82	11.86	11.84
T_5– 75% RDF + *Azospirillum*	11.71	11.66	11.69
T_6– 75% RDF + *Azotobacter*	11.67	11.60	11.63
T_7 – 75% RDF + *VAM*	10.89	11.04	10.96
T_8– 50% RDF +.*Azospirillum*	10.52	9.89	10.20

T_9 – 50% RDF + *Azotobacter*	10.46	9.57	10.02
T_{10} – 50% RDF+ *VAM*	9.50	9.38	9.44
T_{11}–100% RDF + *Azospirillum* + *Azotobacter* + *VAM*	13.10	12.71	12.91
T_{12}–75% RDF + *Azospirillum* + *Azotobacter* + *VAM*	12.59	12.43	12.51
T_{13} -50% RDF + *Azospirillum* + *Azotobacter* + *VAM*	10.82	10.11	10.46
SEm ±	0.746	0.552	0.464
CD 5%	2.170	1.606	1.318

Discussion

Result reported that the treatment T_{11} (100% RDF + *Azospirillum* + *Azotobacter* + *VAM*) significantly influenced the growth parameters (*viz*., leaf area, leaf area index, bulb/green top ratio, leaf dry matter, chlorophyll content in leaves and bulb dry matter) of onion and it gave the maximum growth parameters in first, second year and in pooled, whereas the minimum growth parameters in first, second year and in pooled was observed in treatment T_0 (Control). The application of biofertilizers improves the availability of nutrients to plants which help to increase in leaf area, chlorophyll content and bulb dry matter in plants. Findings are in agreement with those of Mukhim *et al.* (2019) [4], Ranjan *et al.* (2019) [5], Singh *et al.* (2020) [6] and Vishvkarma *et al.* (2020b) [7].

Conclusion

It may be concluded from the study that T_{11} (100% RDF + *Azospirillum* + *Azotobacter* + *VAM*) was significantly superior to all the parameters under study. It improved the growth of the onion plants to a great extent. T_0 (Control) recorded the minimum values as regard to all the growth parameters.

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