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Root parameters and soil microflora as influenced by vesicular arbuscular mycorrhiza (VAM) in onion (*Allium cepa*) under irrigated ecosystem of northern dry zone of Karnataka

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ABSTRACT

An experiment was carried out at Kittur Rani Channamma College of Horticulture, Arabhavi, (UHS, Bagalkot) under irrigated ecosystem of Northern dry zone of Karnataka during *Kharif* 2012 and *Kharif* 2013 to find out the effect of vesicular arbuscular mycorrhiza and biofertilizers on root parameters and soil microflora of onion. The extent of root growth and soil microflora varied with the VAM and biofertilizers used. The treatment T_{10} (T_1 + *Azospirillum brasilense* + *Azotobacter chroococcum* + VAM+ PSB + *T. harzianum)* recorded significantly higher root parameters (root length, number of roots, root volume and fresh root weight) and microbial load in the soil whereas, lower in the treatment supplemented with T_1 (RDF).

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INTRODUCTION

Onion (*Allium cepa* L.) is one of the important commercial bulbous crop cultivated extensively in India and it belongs to the family Alliaceae. In the world, onion is cultivated in 175 countries in 6.7 million acres with an annual production of 47.5 billion tonnes. Leading onion producing countries are China, India, US, Turkey and Pakistan (Anonymous, 2012).

Vesicular Arbuscular mycorrhiza (VAM) fungi are highly evolved and symbiotically associated with plant roots. It is estimated that 95 per cent of plant species characteristically form mycorrhizae. VAM offers a novel opportunity to transplanted horticultural crops as a biofertilizer, biocontrol agent, growth promoter and ultimately increase in yield by two to many folds (Helgason and Fitter, 2009). Onion roots from organic fields had higher fractional colonization levels than those from conventional fields. Onion yields in conventional farming were positively correlated with microbial colonization level (Galvan *et al.*, 2009). Onion being shallow rooted bulb crop is highly responsive to irrigation, soil physical conditions and nutrient applications. The present investigation was thus, an attempt made to study the effect of combined use of VA mycorrhizal fungi with biofertilizers on root parameters of onion.

MATERIAL AND METHODS

The field experiment was carried out at the KRCCH, Arabhavi, UHS, Bagalkot, Karnataka during *Kharif* 2012 and *Kharif* 2013. The details of the materials used and the techniques adopted during the investigation are presented here under. The trial was laid out in a Randomized Block Design with thirteen treatments replicated thrice. Soil of the experimental field was black soil with pH (8.3), electrical conductivity (0.41 dSm^{-1}).

Culture of VAM fungi (*Gigaspora gigantia*) was obtained from Department of Agricultural Microbiology, K.R.C.C.H Arabhavi. The inoculum used consisted of sand and soil in 1:1 proportion and root segments of maize comprising of hyphae, vesicles, arbusclues and chlamydospores of VAM fungus *Gigaspora gigantia*. The inoculation of VAM fungus to onion was done during sowing at the rate of one kg per square metre of nursery bed. For biofertilizer treatments, roots of 30 days old seedlings were dipped in a slurry of *Azospirillum brasilense*, *Azotobacter chroococcum* and phosphorus solubilizing bacteria for half an hour before transplanting. The treatments are (1.RDF, 2.T_1+VAM, 3.FYM (30 tha^{-1})+VAM, 4.T_1+ *Azospirillum brasilense*, 5.T_1 + *Azotobacter chroococcum*, 6.T_1+ *Azospirillum brasilense* + *Azotobacter chroococcum*, 7. T_1 + *Trichoderma harzianum*, 8. T_1+PSB (*Pseudomonas striata*), 9. T_1+ PSB + VAM, 10.T_1+ *Azospirillum brasilense* + *Azotobacter chroococcum* + VAM+ PSB + *T. harzianum*, 11. FYM (30 t ha^{-1}) + *Azospirillum brasilense* + *Azotobacter chroococcum* + VAM + PSB + *T. harzianum*).

RESULTS AND DISCUSSION

Root length, number of roots, root volume and fresh root weight recorded due to the effect of bio-inoculants (VAM) and biofertilizers showed significant differences during both the years of experimentation as well as in pooled data. The treatment T_{10} (T_1+ *Azospirillum brasilense* + *Azotobacter chroococcum* + VAM+ PSB + *T. harzianum*) recorded significantly higher root length

Table 1 : Root length (cm), number of roots, root volume and fresh root weight (g) in onion seedlings as influenced by VAM (*Gigaspora gigantia*) at the time of transplanting

Treatments	Per cent root colonization	Root length			No. of roots			Root volume			Fresh root weight		
		2012	2013	Pooled mean	2012	2013	Pooled mean	2012	2013	Pooled mean	2012	2013	Pooled mean
T_1	7.97	8.14	8.68	8.41	28.75	29.28	29.02	0.43	0.52	0.48	0.38	0.43	0.41
T_2	88.90	12.21	13.09	12.65	35.61	37.72	36.67	1.71	1.9	1.81	0.69	0.77	0.73
T_3	84.98	11.47	12.24	11.86	34.08	36.74	35.41	1.34	1.46	1.40	0.65	0.71	0.68
T_4	85.69	9.61	10.23	9.92	30.51	31.36	30.94	0.72	0.83	0.78	0.42	0.48	0.45
T_5	79.89	9.94	10.68	10.31	31.19	33.01	32.10	0.81	0.86	0.84	0.47	0.52	0.50
T_6	83.67	10.74	11.94	11.34	32.77	34.47	33.62	1.16	1.29	1.23	0.54	0.6	0.57
T_7	81.56	10.23	11.02	10.63	31.84	33.58	32.71	0.92	1.06	0.99	0.51	0.56	0.54
T_8	87.15	11.02	11.67	11.35	34.89	36.24	35.57	2.07	2.63	2.35	0.58	0.63	0.61
T_9	87.69	13.04	14.25	13.65	36.41	38.14	37.28	2.54	2.73	2.64	0.72	0.79	0.76
T_{10}	93.69	18.54	19.24	18.89	41.23	46.37	43.80	4.47	4.99	4.73	0.96	1.04	1.00
T_{11}	91.12	15.31	16.62	15.97	38.11	40.33	39.22	2.78	3.04	2.91	0.78	0.82	0.80
S.E.±	0.36	0.402	0.516	0.437	0.213	0.411	0.325	0.028	0.039	0.022	0.017	0.053	0.036
C.D. (P=0.01)	1.06	1.185	1.522	1.289	0.628	1.212	0.958	0.082	0.115	0.064	0.050	0.156	0.106
C.V.(%)	2.81	3.67	3.22	4.47	2.96	4.12	4.34	3.11	3.04	3.58	3.88	2.66	2.07

Treatment details :

T_1- RDF (125: 50: 125 kg NPK ha^{-1}+ FYM 30 t ha^{-1})
T_2- T_1 + VAM
T_3- FYM (30 t ha^{-1}) + VAM
T_4- T_1 + *Azospirillum brasilense*
T_5- T_1 + *Azotobacter chroococcum*
T_6- T_1 + *Azospirillum brasilense* + *Azotobacter chroococcum*
T_7- T_1 + *Trichoderma harzianum*
T_8- T_1 + PSB (*Pseudomonas striata*)
T_9- T_1+ PSB + VAM
T_{10}- T_1 + *Azospirillum brasilense* + *Azotobacter chroococcum* + VAM+ PSB + *T. harzianum*
T_{11}- FYM (30 t ha^{-1}) + *Azospirillum brasilense* + *Azotobacter chroococcum* + VAM + PSB + *T. harzianum*

Table 2: Per cent root colonization enumeration of total bacteria, fungi, *Actinomycete*, *Azotobacter*, *Azospirillum* and PSB in soil as influenced by the application of microbial bio-inoculants (VAM) and biofertilizers

Treatments	*A.chroococcum* (No. X 10^4 CFU/ g of soil)			*A.brasilense* (No. X 10^4 CFU/ g of soil)			*P. striata* (No.X 10^4 CFU/g of soil)			Bacteria (No. X 10^6 CFU/ g of soil)			Fungi (No. X 10^3 CFU/ g of soil)			Actinomycete (No. X 10^4 CFU/ g of soil)		
	2012	2013	Pooled mean	2012	2013	Pooled mean	2012	2013	Pooled mean	2012	2013	Pooled mean	2012	2013	Pooled mean	2012	2013	Pooled mean
T_1	11.64	13.04	12.34	10.54	12.41	11.48	8.18	10.12	9.15	41.29	45.57	43.43	37.14	40.28	38.71	22.67	25.91	24.29
T_2	21.26	30.50	25.88	29.61	41.29	35.45	20.08	29.02	24.55	50.26	59.38	54.82	53.24	64.29	58.76	44.23	51.09	47.66
T_3	29.92	39.16	34.54	45.31	56.99	51.15	45.27	54.21	49.74	55.58	64.7	60.14	60.16	71.21	65.68	40.24	47.10	43.67
T_4	42.71	51.95	47.33	83.31	94.24	88.78	61.05	69.99	65.52	76.81	85.93	81.37	69.13	80.18	74.65	43.12	49.98	46.55
T_5	47.59	56.83	52.21	72.24	83.92	78.08	59.41	68.35	63.88	78.54	87.66	83.10	67.83	78.88	73.35	41.29	48.15	44.72
T_6	42.26	51.50	46.88	68.34	80.02	74.18	64.12	73.06	68.59	81.21	90.33	85.77	89.21	100.26	94.35	62.14	69.00	65.57
T_7	19.47	28.71	24.09	16.84	28.52	22.68	15.34	24.28	19.81	71.23	80.35	75.79	61.24	72.29	66.75	45.19	52.05	48.62
T_8	28.31	37.55	32.93	52.64	64.32	58.48	63.64	72.58	68.11	69.38	78.5	73.94	75.61	86.66	81.13	47.46	54.32	50.89
T_9	36.11	45.35	40.73	49.41	62.03	55.72	71.2	80.14	75.67	110.21	119.33	114.77	113.17	124.22	118.69	71.24	78.10	74.67
T_{10}	62.51	71.75	67.13	126.41	138.09	132.25	87.08	96.02	91.55	146.47	155.59	151.03	107.42	118.47	112.94	78.91	85.77	82.34
T_{11}	56.2	65.44	60.82	106.5	118.18	112.34	78.8	87.74	83.27	131.12	140.24	135.68	101.13	112.18	106.65	73.65	80.51	77.08
S.E.±	1.08	1.57	1.14	3.26	4.13	3.69	1.63	2.61	2.02	1.03	1.79	1.44	1.06	1.93	1.57	0.85	1.28	0.92
C.D. (P=0.01)	3.18	4.63	3.36	9.61	12.18	10.88	4.80	7.69	5.95	3.03	5.28	4.21	3.12	5.69	4.63	2.50	3.77	2.71
C.V.(%)	2.30	3.98	4.03	2.78	3.12	4.52	3.27	2.64	4.05	4.13	3.07	2.30	3.98	4.43	2.28	3.18	3.82	3.91

Treatment details:
T_1- RDF (125: 50: 125 kg NPK ha^{-1}+ FYM 30 t ha^{-1}) T_2- T_1 + VAM T_3- FYM (30 t ha^{-1}) + VAM T_4- T_1 + *Azospirillum brasilense*
T_5- T_1 + *Azotobacter chroococcum* T_6- T_1 + *Azospirillum brasilense* + *Azotobacter chroococcum* T_7- T_1 + *Trichoderma harzianum*
T_8- T_1 + PSB (*Pseudomonas striata*) T_9- T_1+ PSB + VAM
T_{10}- T_1 + *Azospirillum brasilense* + *Azotobacter chroococcum* + VAM+ PSB + *T. harzianum*
T_{11}- FYM (30 t ha^{-1}) + *Azospirillum brasilense* + *Azotobacter chroococcum* + VAM + PSB + *T. harzianum*

(18.89 cm), number of roots (43.80), root volume (4.73) and fresh root weight (1.00g) in pooled data (Table 1). The increased root parameters obtained in the present treatment is attributed to the mycorrhizae which are vital for uptake and accumulation of ions from soil and translocation to hosts because of their high metabolic rate and strategically diffuse distribution in the upper soil layers.

In fact, the fungus serves as a highly efficient extension of the host root system. Minerals like N, P, K, Ca, S, Zn, Cu and S absorbed from soils by mycorrhizal fungi are translocated to the host plant. Ions such as P, Zn, Cu do not diffuse readily through soil. Because of this poor diffusion, roots deplete the immobile soil nutrients from a zone immediately surrounding the root. Mycorrhizal fungal hyphae extend into the soil, penetrating the zone of nutrient depletion and can increase the effectiveness of absorption of immobile elements by as much as 60 times (Jothi *et al.*, 2005). In the pooled values per cent root colonization ranged between (93.69) T_{10} and (7.97) T_1. The total number of *Azotobacter*, *Azospirillum*, PSB, Bacteria, Fungi and Actinomycete due to bioinoculants and biofertilizers treatments showed significant differences in 2012, 2013 and pooled data. Significantly the treatment T_{10} recorded higher number of *Azotobacter* (67.13*10^4CFU/g of soil), *Azospirillum* (132.25*10^4CFU/g of soil), PSB (91.55*10^4CFU/g of soil), Bacteria (151.03*10^4CFU/g of soil), Fungi (112.94*10^3 CFU/g of soil) and Actinomycete (82.34 *10^4CFU/g of soil) in the pooled values, respectively. Our findings are in line with Yaseen *et al.* (2012); Kungu (2004) and Ezawa *et al.* (2000).

Conclusion :

VAM fungi have been shown to

improve productivity in soils of low fertility and were particularly important for increasing the uptake of less mobile and immobile nutrients, such as P, Zn and Cu. VAM fungi inoculated host plants exhibited high photosynthetic rates. Since large area under onion in other parts of India, extensive research works are required to create a database of mycorrhizal species colonizing these vegetable crops and to determine their efficiency in promoting growth and increasing the yield and other nutritional values.

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