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Research Article

EFFECT OF DIFFERENT LEVELS OF VAM AND TRICHODERMA ON PAPAYA (CARICA PAPAYA L.) CV. MADHUBINDU

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A B S T R A C T

An experiment on effect of different levels of VAM and *Trichoderma* on papaya (*Carica papaya L.*) cv. Madhubindu was carried out at Khengarvav farm, Fruit research station, Junagadh Agricultural University, Junagadh during the period from May, 2014 to May, 2015. Various growth parameters like minimum days to first flowering (53.50), plant height (209 cm), number of leaves per plant (29.65), leaf area (3778.50 cm^2), shoot fresh weight (177.06 g), root fresh weight (43.98 g), root dry weight (9.78 g) and shoot dry weight (14.01 g) were found maximum in treatment 10 g VAM + 75 g *Trichoderma* (V_2T_2).Various yield parameters like number of fruits per plant (36.18), average weight of fruit (1.56 kg), length of fruit (19.38 cm), diameter of fruit (12.45 cm) and yield (56.48 kg/plant) were also found significantly higher in V_2T_2 (10 g VAM + 75 g *Trichoderma*).Other parameters like N content (3.50%), P content (0.85%) and K content (3.83%) of leaf were also found significantly higher in V_2T_2 (10 g VAM + 75 g *Trichoderma*). YVM incidence and mortality percentage are found minimum among the all treatments except V_0T_0 (control).

INTRODUCTION

Papaya regards as the wonder fruit of tropics and sub tropics. It has got great importance due to its high nutritive value and production potentiality. Owing to the increasing demand for fruits and papain and high returns, the area and production of papaya have increased during the last few decades.

The symbiotic association between VAM fungi and roots provides a significant contribution to plant nutrition and growth. In papaya, due to the hallow plant stem and poor root colonization it do not resist in adverse condition especially in waterlogged condition. Plants also affected by the root diseases. VAM can provide a crucial link between plants and the surrounding soil environment, which leads to many direct and indirect benefits to plant communities. VAM hyphae associates with the roots and create root complex that can helps plant for better nutrition, enhance drought and chilling resistance (Mao *et al.,*2009). *Trichoderma* induce metabolic changes in plants that increase resistance to a wide range of plant pathogenic micro-organisms and viruses. VAM and *Trichoderma* can interact synergically to stimulate plant growth through a range of mechanism that includes improved nutrition acquisition and inhibition of fungal plant pathogens.

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MATERIALS AND METHODS

The present investigation entitled effect of different levels of VAM and *Trichoderma* on papaya (*Carica papaya* L.) cv. Madhubindu was carried out at Khengarvav Farm, Fruit Research Station, Junagadh Agricultural University, Junagadh during the year 2014-15. The investigation was carried out with three levels of V_0- No VAM, VAM-V_1- 5 g, V_2- 10 g and three levels of *Trichoderma*- T_0- No *Trichoderma*, T_1- 50 g and T_2- 75 g having nine treatment combinations. The experiment was laid out in Randomized Block Design with factorial concept and replicated four times. One and half month old seedlings comparable in size were planted at a spacing of 2.0 x 1.5 m. VAM and *Trichoderma* culture were applied in powder form directly in pits at the time of transplanting. A recommended dose of nitrogen, phosphorus and potash were applied in all cases. Proper plant protection measures were adopted by spraying insecticides and fungicides as and when required. Observations were recorded on days to first flowering, plant height, stem girth, number of leaves per plant, leaf area, root and shoot fresh weight, root and shoot dry weight, N, P, K content, number of fruits per plant, average weight of fruit, fruit length, fruit diameter and yield. Statistical analysis was performed following the method outlined by Panse and Sukhatme (1989).

RESULTS AND DISCUSSION

VAM and *Trichoderma* were found significant with respect to days to first flowering. Significantly the minimum days to first flowering (53.50) were registered in treatment combination of V_2T_2 (10 g VAM + 75 g *Trichoderma*) which was at par with the treatments V_2T_0 (10 g VAM + No *Trichoderma*), V_2T_1 (10 g VAM + 50 g *Trichoderma*) and V_1T_2 (5 g VAM + 75 g *Trichoderma*) with 55, 55.25, 55.25 days to first flowering, respectively. The treatment combination of V_0T_0 (control) had recorded maximum days to first flowering (66.75).Early flowering with higher number of flowers in mycorrhizal plants may be due to the increased P nutrition and greater development of water conducting tissues (Chang, 1992).

VAM and *Trichoderma* were found significant with respect to plant height. Significantly the maximum plant height (209 cm) was registered in treatment combination of V_2T_2 (10 g VAM + 75 g *Trichoderma*) which was followed by treatment V_2T_0 (10 g VAM + No *Trichoderma*) with 204 cm plant height. The treatment combination of V_0T_0 (control) had recorded the lowest plant height (120 cm).These results are in close conformity with those reported by Ghori *et al*. (2014) in papaya and Tanwar *et al*. (2013) in tomato and Chauhan *et al*. (2010) in strawberry.

Interaction effect of VAM and *Trichoderma* were found not significant with respect to stem girth.

Table 1 Effect of different levels of VAM and *Trichoderma* on growth parameters of papaya (*Carica papaya L.*) cv. Madhubindu

Treatments	Days to first flowering	Plant height (cm)	No. of leaves/ plant	Leaf area (cm^2)	Root fresh weight (g)	Shoot fresh weight (g)	Root dry weight (g)	Shoot dry weight (g)
V_0T_0	66.75	120	11.90	2747.75	27.18	146.06	6.80	9.51
V_0T_1	60.25	168	21.28	3139.50	31.44	151.54	7.86	10.11
V_0T_2	58.25	174	22.65	3167.75	31.70	151.94	7.93	10.21
V_1T_0	58.00	189	22.85	3213.75	32.70	152.98	7.98	10.39
V_1T_1	57.00	181	23.35	3343.25	33.71	155.81	8.22	10.94
V_1T_2	55.25	200	23.45	3448.00	36.27	160.81	8.64	11.74
V_2T_0	55.00	204	25.40	3662.25	40.55	170.72	9.43	13.35
V_2T_1	55.25	189	23.93	3535.25	38.67	164.31	8.88	12.14
V_2T_2	53.50	209	29.65	3778.50	43.98	177.06	9.78	14.01
S.Em±	1.13	0.90	0.92	69.20	0.87	2.26	0.19	0.25
C.D. at 5%	3.29	0.27	2.68	201.98	2.54	2.85	0.55	0.72

V_0T_0 – Control; V_0T_1 - No VAM + 50 g *Trichoderma viride;* V_0T_2 - No VAM + 75 g *Trichoderma viride* ; V_1T_0 - 5 g VAM + No *Trichoderma viride*; V_1T_1 - 5 g VAM + 50 g *Trichoderma viride;* V_1T_2 - 5 g VAM + 75 g *Trichoderma viride;* V_2T_0 - 10 g VAM + No *Trichoderma viride;* V_2T_1 - 10 g VAM + 50 g *Trichoderma viride;* V_2T_2 - 10 g VAM + 75 g *Trichoderma viride;*

Table 2 Effect of different levels of VAM and *Trichoderma* on N, P and K content of papaya (*Carica papaya L.*) cv. Madhubindu

Treatments	N content (%)	P content (%)	K content (%)
V_0T_0	1.05	0.30	2.06
V_0T_1	1.40	0.50	2.24
V_0T_2	1.43	0.59	2.25
V_1T_0	1.34	0.52	2.33
V_1T_1	1.59	0.57	2.63
V_1T_2	1.48	0.70	2.64
V_2T_0	2.62	0.75	3.38
V_2T_1	2.06	0.65	2.96
V_2T_2	3.50	0.85	3.83
S.Em±	0.11	0.04	0.13
C.D. at 5%	0.32	0.37	0.37

Table 3 Effect of different levels of VAM and *Trichoderma* on yield parameters of papaya (*Carica papaya L.*) cv. Madhubindu

Treatments	No. of fruits/ plant	Av. weight of fruit (kg)	Fruit length (cm)	Fruit diameter (cm)	Yield (kg/ plant)
V_0T_0	23.33	1.00	13.85	9.50	23.13
V_0T_1	29.50	1.39	16.03	10.63	40.84
V_0T_2	29.28	1.42	16.41	11.56	40.97
V_1T_0	28.48	1.36	16.36	11.61	38.74
V_1T_1	30.50	1.49	16.97	11.73	45.24
V_1T_2	31.70	1.33	18.35	11.68	41.68
V_2T_0	34.95	1.45	18.81	12.35	50.62
V_2T_1	31.58	1.32	17.60	11.71	41.42
V_2T_2	36.18	1.56	19.38	12.45	56.48
S.Em±	1.13	0.07	0.42	0.32	2.14
C.D. at 5%	3.30	0.21	1.22	0.94	6.26

The effect of VAM and *Trichoderma* were found significant with respect to number of leaves per plant. Significantly the maximum number of leaves per plant (29.65) was registered in treatmentcombination of V_2T_2 (10 g VAM + 75 g *Trichoderma*) which was followed by the treatments V_2T_0 (10 g VAM + No *Trichoderma*), V_2T_1 (10 g VAM + 50 g *Trichoderma*) and V_1T_2 (5 g VAM + 75 g *Trichoderma*) with 25.40, 23.93 and 23.45 leaves per plant respectively. The treatment combination of V_0T_0 (control) had recorded the lowest number of leaves per plant (19.90). Similar results were also reported by Tanwar *et al*. (2013) in tomato.

Treatment of VAM and *Trichoderma* were found significant with respect to leaf area. Significantly the maximum leaf area (3778.50 cm^2) was registered in treatment combination of V_2T_2 (10 g VAM + 75 g *Trichoderma*) which was at par with V_2T_0 (10g VAM + No *Trichoderma*) with 3662.25 cm^2 leaf area. The treatment combination of V_0T_0 (control) had recorded the lowest leaf area (2747.75 cm^2). Increased in leaf area may be attributed to the fact that, AM fungi increased the water uptake through improved hydraulic conductivity helping in increasing leaf area (Mahadevan, 1988).

Significantly the maximum fresh weight of roots (43.98 g) was registered in treatment combination of V_2T_2 (10 g VAM + 75 g *Trichoderma*) which was followed by the treatments V_2T_0 (10 g VAM + No *Trichoderma*) with 40.55 g fresh weight of roots. The treatment combination of V_0T_0 (control) had recorded the lowest fresh weight of roots (27.18 g). VAM and *Trichoderma* were also found significant with respect to fresh weight of shoots. Significantly the maximum fresh weight of shoots (177.06) was registered in treatment combination of V_2T_2 (10 g VAM + 75 g *Trichoderma*) which was followed the treatments V_2T_0 (10 g VAM + No *Trichoderma*) with 170.72

g. The treatment combination of V_0T_0 (control) had recorded the lowest fresh weight of shoots (146.06 g). These results are in close conformity with those reported by Ghori *et al*. (2014) in papaya, Tanvar *et al*. (2013) in tomato and Chauhan *et al*. (2010) in strawberry.

The application of VAM and *Trichoderma* were found significant with respect to dry weight of roots. Significantly the maximum dry weight of roots (9.78 g) was registered in treatment combination of V_2T_2 (10 g VAM + 75 g *Trichoderma*) which was at par with the treatments V_2T_0 (10 g VAM + No *Trichoderma*) with 9.43 g dry weight of roots followed by V_2T_1 (10 g VAM + 50 g *Trichoderma*) and V_1T_2 (5 g VAM + 75 g *Trichoderma*). The treatment combination of V_0T_0 (control) had recorded the lowest dry weight of roots (6.80 g). VAM and *Trichoderma* were also found significant with respect to dry weight of shoots. Significantly the maximum dry weight of shoots (14.01 g) was registered in treatment combination of V_2T_2 (10 g VAM + 75 g *Trichoderma*) which was followed by V_2T_0 (10 g VAM + No *Trichoderma*) with 13.35 g dry weight of shoots. Treatment combination of V_0T_0 (control) had recorded the lowest dry weight of shoots (9.42 g). These results are in close conformity with those reported by Ghori *et al*. (2014) in papaya and Tanvar *et al*. (2013) in tomato and Chauhan *et al*. (2010) in strawberry

N, P and K content of plant were also affected by application of VAM and *Trichoderma*. Significantly the maximum N, P and K content of plant (3.50%, 0.85%, 3.83% respectively) was registered in treatment combination of V_2T_2 (10 g VAM + 75 g *Trichoderma*). The treatment combination of V_0T_0 (control) had recorded the lowest N, P, K content of plant (1.43%, 0.70%, 2.25% respectively).The positive response of both the inoculants might be due to VAM fungal hyphae squeeze into soil pores and provide huge surface area and efficiency of nutrient uptake being increased.

VAM and *Trichoderma* were also affected with respect to number of fruits per plant. Significantly the maximum number of fruits per plant (36.18) was registered in treatment combination of V_2T_2 (10 g VAM + 75 g *Trichoderma*) which was followed by the treatment V_2T_0 (10 g VAM + No *Trichoderma*) with 34.95 fruit per plant. These results are in close conformity with those reported by Tanwar *et al*. (2013) in tomato and Hazarika *et al*. (2011) in banana.

VAM and *Trichoderma* were found significant with respect to average weight of fruit (g). Significantly the maximum average weight of fruit (1.56 kg) was registered in treatment combination of V_2T_2 (10 g VAM + 75 g *Trichoderma*) which was followed by the treatment V_1T_1 (5 g VAM + 50 g *Trichoderma*) with 1.49 kg average weight of fruit**.** These results are in close conformity with those reported by Tanwar *et al*. (2013) in tomato and Hazarika *et al*. (2011) in banana.

Both, VAM and *Trichoderma* were found effective with respect to fruit length. Significantly the maximum fruit length (19.38 cm) was registered in treatment combination of V_2T_2 (10 g VAM + 75 g *Trichoderma*) which was at par with V_2T_0 (10 g VAM + No *Trichoderma*) with 18.81 cm fruit length. The treatment combination of V_0T_0 (control) had recorded the lowest fruit length (13.85 cm). This result confirmed with early finding by Manivannan *et al*. (2013) and *Hazarika et al*. (2011) in banana.

Significantly the maximum fruit diameter (12.45 cm) was registered in treatment combination of V_2T_2 (10 g VAM + 75 g *Trichoderma*) which was at par with remaining all combination except control. The treatment combination of V_0T_0 (control) had recorded the lowest fruit diameter (9.50 cm). This result confirmed with early finding by Manivannan *et al*. (2013), Hazarika *et al*. (2011) in banana and Pawar *et al*. (2007) in onion.

VAM and *Trichoderma* were found significant with respect to yield (kg/ plant). Significantly the maximum yield (56.48 kg/ plant) was registered in treatment combination of V_2T_2 (10 g VAM + 75 g *Trichoderma*) which was followed by the treatment V_2T_0 (10 g VAM + No *Trichoderma*) with 50.62 kg/ plant**.** The treatment combination of V_0T_0 (control) had recorded the lowest yield (23.13 kg/ plant). These results are in close conformity with those reported by Tanwar *et al*. (2013) in tomato and Hazarika *et al*. (2011) in banana.

The highest mortality percentage was observed in treatment V_0T_0 (control) with 16.66 % mortality followed by treatment V_1T_1 (5 g VAM + 50 g *Trichoderma*) with 8.33 % mortality. VAM and *Trichoderma* induced better root growth as well as better vegetative growth. They also prevent disease caused by fungi, thus rate of survival increased in treated plants than control. Vasane and Kothari (2008) also reported least mortality in banana inoculated with VAM.

No Yellow Vein Mosaic (YVM) incidence was observed in field during the period of experiment and it might be due to unfavourable environment parameters or insufficient vector population.

CONCLUSION

Based on the result of this experimentation, it can be concluded that the application of VAM and *Trichoderma* enhance the nutritional status of papaya plants and thereby aid in increased growth and yield. The present investigation clearly demonstrated that application of VAM fungi and *Trichoderma* in combination (10 g VAM + 75 g *Trichoderma*) proved to be a promising factor for improved growth performance like plant height, number of leaves/ plant, leaf area, fresh weight of roots and shoots, dry weight of roots and shoot, plant nutrition, fruit length, fruit diameter, yield and survival of papaya plant to an acceptable level.

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