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RESPONSE OF MULBERRY VARIETIES TO VAM AND AZOTOBACTER BIOFERTILIZERS INOCULATION

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SUMMARY

An experiment was conducted to study the influence of VAM and *Azotobacter* biofertilizers inoculation (alone and in combination) on the growth characters and certain metabolites in V1 and S13 mulberry saplings. The survival percentage, growth characters, leaf moisture and total biomass increased with biofertilizers inoculation. Similarly, nitrogen, phosphorus, potash, chlorophyll and carbohydrate status also increased considerably in the inoculated saplings. The increase was more pronounced with integrated application, in both the mulberry varieties which may be due to the increase in microbial population and root colonization in the rhizosphere.

Key words: ***Azotobacter*, integrated application, mulberry, VAM.**

INTRODUCTION

The use of bacterial biofertilizers (*Azotobacter and Azospirillum*) to supplement the nitrogen requirements has been studied by several investigators (Chauhan *et al.* 1995, Panwar *et al.* 2000). Further, Vesicular Arbuscular Mycorrhiza (VAM) are broad spectrum bioinoculants suitable for transplanted nursery and plantation crops (Marwaha 1995). The VAM associations also help in improving plant growth through better uptake of water and nutrients and tolerance to drought (Selvaraj *et al.* 1996), ability to withstand transplant shock and boosts synergistic interaction with beneficial soil microorganisms such as N-fixers and P-solubilisers (Marwaha 1995). However, not many studies on synergistic interaction of VAM with N-fixers (*Azotobacter*) have been done and hence in the present investigation the response of mulberry, to VAM and *Azotobacter* biofertilizers inoculation was studied.

MATERIALS AND METHODS

Mulberry variety S13 and V1 and VAM (*Glomus mosseae*) and bacterial biofertilizer (*Azotobacter chroococcum*) were taken for the present experiment. For each treatment 10 nursery beds of size 5m x 1.5m were prepared and beds were burnt with dry weeds to eliminate native biofertilizers. For VAM treatment, six inches deep furrows were made at a distance of 15cm each, and soil based VAM inoculums @ 3.5 kg (20 spores g^{-1}dry soil) and *Azotobacter* @ 1.6 kg/ac mixed in FYM was applied to the plots. A proper control was maintained. The treatments were T_1 (control: minus *Azotobacter* and VAM), T_2 (*Azotobacter* alone), T_3 (VAM alone), T_4(*Azotobacter* + VAM). Nitrogen was applied as urea (@ 1.3 kg/bed) after two months of planting (Dandin 1990). The nursery beds were irrigated once in four days and the saplings raised from mulberry

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cuttings were allowed to grow for four months in a nursery. Data were recorded at 60 and 120 days after plantation on survival percentage and growth parameters. Nitrogen, phosphorus and Potash (Jackson 1973), Chlorophyll (Arnon 1949), total carbohydrates (Highkin and Frankel 1962) and root colonization was done after 120 days in control and inoculated saplings.

RESULTS AND DISCUSSION

Sprouting of the cuttings and survival of the saplings is an important character in mulberry as it is propagated mainly through cuttings. The present investigation revealed no significant differences in sprouting percentage among the varieties and treatments. However, survival percentage (Table 1) was significantly greater in V1 as compared to S13 and integrated use of VAM + *Azotobacter* further promoted the survivability over other treatments. Enhanced survivability under the influence of VAM alone in mulberry has been reported by Reddy *et al.* (1998). The beneficial effects of VAM and bacterial biofertilizers independently have also been reported in several other plant species (Barathkumar *et al.* 2001) including legumes (Singh 1994, Rajashekar and Reddy 1996) and mulberry (Katiyar *et al.* 1995).

The height of saplings and number of leaves/sapling were significantly higher in V1 over S13 in all the treatments (Table 1). However, the per cent increment over control (T1) was greater in S13 than V1 indicating the higher response of S13 over V1 to biofertilizers application. Among the treatments, integrated application of *Azotobacter* + VAM showed a significantly greater response over independent treatments in both the varieties. Further, the response was greater in VAM as compared to *Azotobacter* alone. Similar observations with VAM alone has been reported in mulberry (Katiyar *et al.* 1990, Das *et al.* 1995 and Reddy *et al.* 1998) and in Aswagandha (Barathkumar *et al.* 2001) with *Azospirillum* and Phosphobacterial treatments. The enhanced growth characters in the present study may be attributed to increased supply of plant hormones (auxins, cytokinins,

Table 1. Survival %, height of saplings, leaves/sapling, total biomass and leaf moisture content in response to biofertilizers in S13 and V1 mulberry varieties.

	T_1		T_2		T_3		T_4	
Character	**60 DAP**	**120 DAP**	**60 DAP**	**120 DAP**	**60 DAP**	**120 DAP**	**60 DAP**	**120 DAP**
S13								
Survival %	63.25	57.28	83.25 (31.26)	80.26 (40.11)	79.36 (25.47)	73.24 (27.86)	87.23 (37.21)	83.26 (45.36)
Height of saplings (cm)	13.26	41.54	23.54 (77.52)	72.63 (74.84)	17.23 (29.93)	61.24 (47.24)	26.38 (98.94)	85.63 (106.17)
No. of leaves/ saplings	6.23	15.43	12.24 (96.46)	25.65 (66.23)	10.26 (64.68)	22.26 (44.54)	14.24 (128.57)	31.35 (103.17)
Total biomass (g)	4.35	12.26	8.21 (88.73)	30.38 (147.70)	5.21 (19.77)	26.35 (114.92)	10.34 (137.70)	38.34 (212.72)
Leaf moisture (%)	67.28	60.24	74.24 (10.34)	71.24 (18.26)	70.35 (4.56)	64.36 (6.83)	78.23 (16.27)	72.86 (20.94)
V1								
Survival %	72.15	66.32	87.28 (20.97)	81.35 (22.66)	81.26 (12.62)	74.36 (12.12)	92.23 (27.83)	88.54 (33.50)
Height of sapling (cm)	15.24	53.54	25.63 (68.17)	88.23 (64.79)	19.26 (26.37)	79.26 (48.03)	29.32 (92.38)	96.28 (79.82)
No. of leaves/ saplings	7.25	20.23	14.26 (96.68)	33.26 (64.40)	11.23 (54.89)	26.25 (29.75)	18.26 (151.86)	40.21 (98.76)
Total biomass (g)	7.63	16.28	12.62 (65.39)	46.25 (184.09)	10.21 (33.81)	42.35 (160.13)	14.68 (92.39)	52.15 (220.33)
Leaf moisture (%)	73.28	65.26	80.35 (9.64)	78.54 (20.34)	76.23 (4.02)	71.35 (18.19)	84.28 (15.01)	80.26 (22.98)

Values in parentheses indicate per cent increase over control, DAP: days after plantation

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gibberellins) by the microorganisms or by roots as a results of reaction to microbial colonization as also reported by Avivi and Feldman (1982). Sushila (1998) also reported increase in microbial population in the rhizosphere of wheat with both *Azotobacter* and *Azospirillum* inoculation.

In mulberry leaf moisture plays a vital role in improving the nutrition levels of leaves, which inturn improves the palatability of leaves for silkworm. Hence, moisture content in the leaves serve as one of the criteria in estimating their quality. In the present study, the values for moisture percentage was higher in V1 and S13 which is attributed to greater root proliferation and root VAM colonization (Table 2). The moisture percentage values were greater in integrated treatments than independent treatments. The inoculation of VAM helps in more uptake of soil moisture which may help in other physiological activities in the plant. Similar increase in moisture percentage was reported by Reddy (1998). However, moisture content in leaves decreased in all treatments with increased age of the saplings.

The biomass yield was more in V1 than S13 in all the treatments. Inoculation with biofertilizers further increased the biomass yield in both the varieties and also in all the treatments over control (T1). The yield increment was greater in combinations treatment in both the varieties than independent treatments. Further, the values were higher in VAM than in bacterial of biofertilizer treatments. It is revealed that micorrhizal fungi have considerable ability to translocate nutrients such as P, Zn, S, Ca and nitrogen and thereby increase the yield and yield contributing factors (Smith and Pearson 1988). The enhanced biomass is also attributed to production of phytohormones and increased supply of photosynthates (Sundara Rao and Sinha 1963) due to VAM treatments. The greater biomass yield in V1 over S13 is also attributed to greater nutrient status in V1 compared to S13 as revealed from present investigation (Table 2). The values for nitrogen, phosphorus, potash (Reddy,1998, Barathkumar *et al.* 2001), carbohydrate status were always higher in all the treatments over control in both the varieties. The increased levels of major nutrients is attributed to enhanced absorption. The increased carbohydrate content may be due to increased Chlorophyll (Table 2) in the leaves (Barathkumar *et al.* 2001). The chlorophyll content was higher in V1 than S13 which is also reflected through increased carbohydrate status. The increased chlorophyll levels in leaves of treated plants help in increased light reaction and supply of NADPH. This can lead to increased nitrate reeducates activity helping in greater utilization efficiency of nitrogen source available, and increasing nitrogen status and the total biomass in inoculated mulberry. The findings indicate that VAM in combination with *Azotobacter* can be used to raise the

Table 2. N, P, K content (%), chlorophyll (mg/g^{-1} fresh weight) carbohydrate content (%) and root colonisation (%) in response to biofertilizers in S13 and V1 mulberry varieties 120 days after plantation.

Treatment	N	P	K	Chl a	Chl b	Total Chl.	Total carbohydrates (%)	Root colonization (%)
S13								
T1	2.86	0.26	2.22	2.98	0.62	3.60	26.24	18.62
T2	3.46 (20.97)	0.43 (65.38)	3.48 (56.75)	3.14 (58.58)	0.73 (17.74)	3.82 (48.84)	32.16 (22.56)	52.71 (183.08)
T3	3.42 (19.58)	0.31 (19.23)	2.63 (18.46)	3.05 (54.04)	0.68 (9.67)	3.73 (43.46)	30.34 (15.62)	21.38 (14.82)
T4	3.83 (33.91)	0.48 (84.61)	3.76 (69.36)	3.24 (63.63)	0.79 (27.41)	4.03 (55.00)	34.13 (30.06)	63.62 (241.63)
V1								
T1	2.94	0.31	2.35	2.26	0.73	2.39	31.16	21.86
T2	3.62 (23.12)	0.49 (58.06)	3.26 (38.72)	3.74 (65.48)	0.82 (12.32)	4.56 (90.79)	40.15 (28.85)	69.54 (218.15)
T3	3.60 (22.44)	0.39 (25.80)	2.78 (18.29)	3.34 (47.78)	0.78 (4.10)	4.10 (71.54)	36.54 (17.26)	22.15 (1.32)
T4	3.93 (33.67)	0.52 (67.74)	3.34 (42.12)	3.85 (70.35)	0.89 (21.91)	4.79 (98.32)	42.32 (35.81)	71.63 (227.67)

Values in parentheses indicate per cent increase over control.

mulberry saplings that may help in early transplantation to the main field due to faster growth. VAM inoculation can help in reducing the usage of phosphatic fertilizer in transplanted plantation as opined by Das et al. (1995). However, application of *Azotobacter* biofertilizer can not be avoided in transplanted plantation due to less association like VAM to the root system.

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