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Outcome of AM Fungi on Mulberry Saplings at Nursery Stage under Temperate Conditions of Kashmir

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Abstract: Kashmir represents the traditional sericulture state having temperate climatic conditions and is well suited for the bivoltine sericulture. Being cost effective and eco-friendly, use of biofertilizers in various agricultural and horticultural crops is gaining momentum with mulberry being no exception. Among the biofertilizers, AM fungi association is ubiquitous and occurs over a wide range of ecological conditions. It can be used for maximization of plant growth and establishment of plants after transplantation of saplings from nursery to field so as to help the plants to withstand stress. As such a study was undertaken at two different locations viz: CSR&TI, Pampore and DOS, Mirgund to test the effect of AM fungi in mulberry cultivation. Two AM fungi *Glomus mossae* and *Glomus fasciculatum* were tested at nursery stage with different levels of phosphatic chemical fertilizers. The study revealed highly significant differences among the treatments in terms of various growth parameters. However, the treatments using 50% and 75% of phosphatic chemical fertilizers together with AM fungi were at par with the treatments in which 100% chemical phosphorus was applied. The result indicates that the application of AM at nursery stage helps to reduce the use of chemical Phosphorus up to the extent of 50%. Further, the root proliferation studies revealed significant differences in terms of length of longest root, number of roots per sapling and root volume.

Key words: AM · Nursery · Temperate · Mulberry

INTRODUCTION

Mycorrhiza refers to an association or symbiosis between plants and fungi that colonize the cortical tissue of roots during periods of active plant growth. The association is characterized by the movement of plant-produced carbon to the fungus and fungal acquired nutrients to the plant. The term mycorrhiza, which literally means fungus-root, was first applied to fungus tree associations described in 1885 by the German forest pathologist A.B. Frank. Since then we have learned that the vast majority of land plants form symbiotic associations with fungi: an estimated 95% of all plant species belong to genera that characteristically form mycorrhizae. The mycorrhizal condition is the rule among plants, not the exception.

The benefits afforded plants from mycorrhizal symbioses can be characterized either agronomically by increased growth and yield or ecologically by improved fitness (i.e. reproductive ability). In either case, the benefit accrues primarily because mycorrhizal fungi form a critical linkage between plant roots and the soil. Mycorrhizal fungi usually proliferate both in the root and in the soil. The soil borne or extramatrical hyphae take up nutrients from the soil solution and transport them to the root. By this mechanism, mycorrhizae increase the effective absorptive surface area of the plant. In nutrient-poor or moisture-deficient soils, nutrients taken up by the extramatrical hyphae can lead to improved plant growth and reproduction. As a result, mycorrhizal plants are often more competitive and better able to tolerate environmental stresses than are nonmycorrhizal plants. Mycorrhizal associations vary widely in structure and function. Despite the many exceptions, it is possible to state broad generalizations about latitude (or altitude), soil properties and structure and function of the different mycorrhizal types that colonize the dominant vegetation in a gradient of climatic zones [1].

Mulberry (*Morus spp.*) is the only known food plant for silkworm, *Bombyx mori* [2]. The plant is perennial and remains productive for many years. The plants at farmers level in Northern India, in general do not receive any inputs, being under extensive cultivation on road side, bund-side and hence the productivity declines in cocoon

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production. The plantation at farmer level is carried out using the saplings raised in the departmental nurseries. The use of AM as biofertilizers at nursery stage itself could help in raising inoculated saplings which could withstand the no input dose, presently in vogue in North Indian states, to some extent because the mycorrhizae are symbiotic associations between the hyphae of certain fungi and the absorbing organs typically the roots of the plants. Vesicular arbuscular mycorrhiza literally means "fungus roots" resulting in mutually beneficial symbiosis between fungi and plant roots.

Further, the importance of AM inoculation in many agricultural and horticultural crops has been well documented [3, 4]. Elsewhere many workers have studied the association of AM in mulberry [5-7]. Findings at CSR & TI, Mysore has shown that AM inoculation can be used in nursery beds for raising of mulberry saplings under semi-arid for their establishment and is also helpful in reducing the 'P' fertilizer application [8]. But no such work was initiated so far under temperate conditions of Kashmir in sericulture. The present study was, therefore, taken up at CSR & TI, Pampore and DOS, Mirgund, Baramullah to finds out the response of AM on growth parameters of the mulberry saplings at nursery stage.

MATERIALS AND METHODS

The Study Was Undertaken at Two Sites Viz: CSR & TI, Pampore, Pulwama Kashmir and Department of Sericulture, Mirgund, Barramullah Kashmir during 2004 and 2005. The land for nursery was prepared and surface soil of the nursery beds were sterilized by burning dry leaves, weeds and twigs twice at weekly intervals. Decomposed F.Y.M. & 20 MT/ha/yr was thoroughly mixed in the soil before planting. Chinese white cuttings were used along with different treatments of AM spp. i.e. (i) *G. mosseae* (ii) *G. fasciculatum*

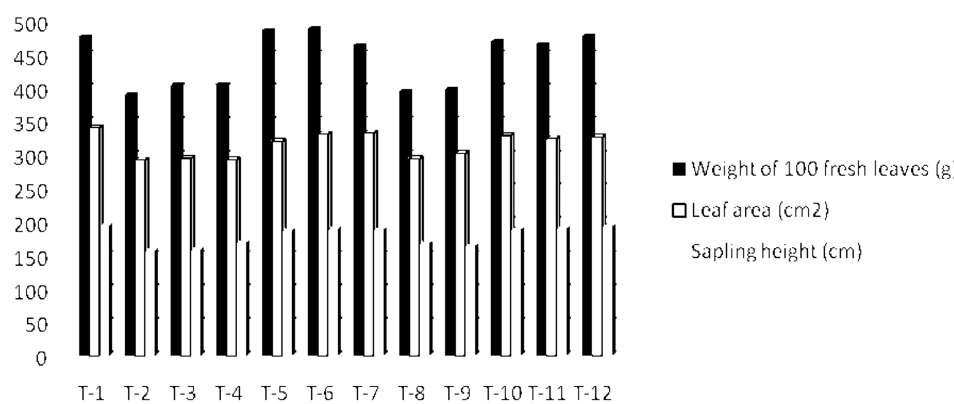
After 75 days of planting the cuttings 10-15 cm deep furrows along the rows were prepared and AM & 200kg per hectare per year was applied in furrows followed by covering of soil. Light irrigation was provided to the cuttings after its application. Chemical fertilizer was applied after 15 days of the application of AM. The nursery was maintained by timely weeding and irrigation. After 180 days of planting of the cuttings, the data in terms weight of 100 fresh leaves, leaf area, leaves per sapling height, sapling thickness and leaf moisture content was recorded. The two years data for each site was pooled and analysis of variance (one way) was done to find out whether the variance due to the treatments was significant. During the final year of experimentation i.e. 2005 root proliferation studies was conducted in terms of length of longest root, number of roots per sapling and root volume.

RESULTS AND DISCUSSIONS

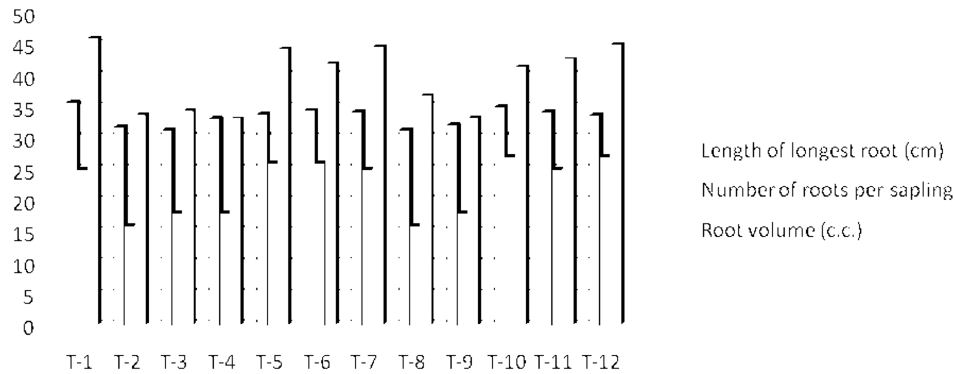
The pooled data of two years for site CSR&TI, Pampore and DOS, Mirgund in terms of weight of 100 fresh leaves, leaf area, leaves per sapling height, sapling thickness and leaf moisture content is presented in Graph-1 and Graph-2 and is described in this paper.

Significant differences among the treatments were recorded at both the locations. The pooled data reflects maximum weight of 100 fresh leaves in T-5 (490.17g) at CSR&TI, Pampore and T-1 (479.33g) at DOS, Mirgund. At both the locations, the treatments T-1, T-5, T-6, T-7, T-10, T-11 & T-12 were statistically at par with one another.

Though the treatments exhibited significant differences among them with regard to this parameter, yet the treatments T-1, T-5, T-6, T-7, T-10, T-11 & T-12 were statistically at par at both the locations. The data revealed significant differences at both the locations and number of leaves per sapling ranged from 30 to 37. C.S.R. & T.I,



Graph 1: Effect of AM on various growth parameters of mulberry saplings.



Graph 2: Effect of AM on the root development in mulberry saplings.

Pampore: The treatments exhibited highly significant differences among them with T-12 registering maximum height (200.37cm.). The treatments T-1, T-5, T-6, T-7, T-10, T-11 & T-12 were statistically at par with one another. DOS, Mirgund: Here also the treatments T-1, T-5, T-7, T-10, T-11 & T-12 were statistically at par with T-6 registering maximum height (199.92cm.). The sapling thickness varied from 1.06cm (T-2) to 1.45cm (T-6 & T-12) at C.S.R. & T.I, Pampore and 1.09cm (T-2) to 1.43cm (T-5) at DOS, Mirgund and the differences being significant. Moisture content: The moisture content was recorded more than 73% in each of the treatments and the treatments did not exhibit any significant differences among them. Root proliferation studies: The data recorded during 2005 in terms of length of longest root, number of roots per sapling and root volume is furnished in Graph-3 and is discussed. The length of longest root was recorded by T-1 (35.67cm.) at CSR&TI, Pampore and T-6 (35.25cm.) at DOS, Mirgund. The treatments T-1, T-5, T-6, T-7, T-10, T-11 & T-12 were statistically at par with one another. Number of roots per sapling: The number of roots per sapling ranged from 15.78 (T-2) to 27.44 (T-12) at CSR&TI, Pampore and 15.15 (T-8) to 26.11 (T-6) at DOS, Mirgund. The root volume exhibited significant differences among the treatments with T-1 recording maximum root volume (46.00c.c at CSR & TI, Pampore and 48.02c.c at DOS, Mirgund).

The review of the literature reveals the importance of AM inoculation in many agricultural and horticultural crops [2, 4]. It is also reported that Arbuscular mycorrhizal fungi has a vital role in reducing plant diseases, alleviating chemical and physical stresses of soil due to drought and in improving soil structure stabilization and overall soil fertility. Mycorrhizal fungi increases plant growth mainly by increasing soil volume from which plant root absorb relatively less mobile nutrients such as P, Zn and Cu [9]. Responses of AM vary depending upon crop species. When a nutrient is deficient in soil solution, the critical root parameter controlling its uptake is surface area. Hyphae of mycorrhizal fungi have the potential to greatly increase the absorbing surface area of the root. For example, extramatrical mycelia (aggregates of hyphae) accounted for less than 20% of the total nutrient absorbing surface mass [10], they contributed nearly 80% of the absorbing surface area of pine seedlings. It is also important to consider the distribution and function of the extramatrical hyphae. If the mycorrhiza is to be effective in nutrient uptake, the hyphae must be distributed beyond the nutrient depletion zone that develops around the root. A nutrient depletion zone develops when nutrients are removed from the soil solution more rapidly than they can be replaced by diffusion. For a poorly-mobile ion such as phosphate, a sharp and narrow depletion zone develops close to the root. Hyphae can readily bridge this depletion zone and grow into soil with an adequate supply of phosphorus. Uptake of micronutrients such as zinc and copper is also improved by mycorrhizae because these elements are also diffusion-limited in many soils. For more mobile nutrients such as nitrate, the depletion zone is wide and it is less likely that hyphae grow extensively into the zone that is not influenced by the root alone.

Castor (*R. cummunis*) has been registered highly mycorrhizophic in nature. The use of AM in mulberry cultivation and its beneficial effects on mulberry growth and silkworm performance had been worked out [6]. Significant beneficial effects were recorded on growth and yield of V-1 mulberry variety due to co-inoculation with microbial consortium nitrogen fixing bacteria (*Azotobacter*) and AM even after curtailing nitrogen and phosphorus to the extent of 25-50% of the recommended dose [11]. The present study is in conformity that use of AM can help in the curtailment of chemical Phosphorus up the extent of 50% in nursery under temperate conditions. Mycorrhizal fungi colonize feeder roots and thereby interact with root pathogens that parasitize this same tissue. In a natural ecosystem where the uptake of phosphorus is low, a major role of mycorrhizal fungi may be protection of the root system from endemic pathogens such as *Fusarium* spp. Mycorrhizae may stimulate root colonization by selected biocontrol agents, but our understanding of these interactions is meager. Much more research has been conducted on the potential effects of mycorrhizal colonization on root pathogens. Mycorrhizal fungi may reduce the incidence and severity of root diseases. The mechanisms proposed to explain this protective effect include: (i) development of a mechanical barrier-especially the mantle of the EM-to infection by pathogens, (ii) production of antibiotic compounds that suppress the pathogen, (iii) competition for nutrients with the pathogen, including production of siderophores and (iv) induction of generalized host defense mechanisms.

AM inoculation has been found useful in nursery beds for raising mulberry under semi-arid conditions under tropical climatic conditions for their better establishment under reduced Phosphorus application [8]. The saplings raised in the present study, when transplanted in the field revealed 80% survival ability without the application of chemical fertilizer thereby confirmed that mycorrhizal associated saplings can be transplanted in the field to get them established under stress conditions. As the knowledge about the use of biofertilizers was lacking in mulberry cultivation under Kashmir conditions, the present study has helped to remove this deficiency and shall pave a way for further study on many aspects of established mulberry plantation under temperate conditions as the biofertilizers are eco-friendly besides being cheaper in comparison to chemical fertilizers.

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