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# RESPONSE OF MAIZE (*ZEA MAYS* L.) GENOTYPES TO INOCULATION OF TWO ARBUSCULAR MYCORRHIZAL SPECIES

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## ABSTRACT

Growth and mycorrhizal colonization of maize (*Zea mays* L.) genotypes in response to two arbuscular mycorrhizal (AM) species viz. *Glomus mosseae* Nic. & Gerd.and *G. monosporum* Gerd. & Trap. was tested in pot trials under normal environmental and soil conditions. Four maize varieties viz. 3025-W, 3012-DS, 2002-SP and 2002-Sadaf were used in the experiment. A variable plant growth and mycorrhizal colonization response was exhibited by different varieties to the two introduced AM species. In general, *G. mosseae* inoculation induced higher mycorrhizal colonization as compared to *G. monosporum.* Consequently parallel plant growth response to *G. mosseae* inculcation was recorded. Various plant growth and mycorrhizal parameters exhibited positive correlation in *G. mosseae* inoculated plants. Among the four test varieties, 3025-W was found to be superior with respect to its response to mycorrhizal inoculation with *G. mosseae.*

**Key words**: *Zea mays* genotypes, *Glomus mosseae*, *G. monosporum*, arbuscular mycorrhizal fungi.

**Short running title:** Response of maize genotype to arbuscular mycorrhizae

## INTRODUCTION

Arbuscular mycorrhizae (AM) are among the most abundant fungi in grassland and agricultural soils. Mycorrhizal symbioses facilitate plant uptake of soil resources including P, N, and water, affect plant-pathogen interactions, and mediate the outcome of plant competition (George *et al*. 1995, Newsham *et al*. 1995, Zobel and Moora 1997). There appears to be no specificity at the host genus level. AM fungi isolated from one host generally form mycorrhizae with a wide range of other hosts (Molina *et al.*1978). However, earlier workers (Mosse, 1975; Johnson *et al*.1991) have suggested the existence of host preference. Host response to AM differs with fungal species (Graw *et al*., 1979; Carling & Brown, 1980; Wilson, 1988) and with geographic isolates within a species (Bethlenfalvay *et al.*, 1989). Furthermore, a significant interaction between cultivars within a species and mycorrhizal colonization has been demonstrated (Hall, 1978; Mercy *et al*, 1990). It has been suggested that mycorrhizal colonization is a host dependant and heritable trait (Lackie *et al.*, 1988). Moreover, genes involved in mycorrhizal penetration have also been studied in pea mutants (Guillemin *et al*., 1990). Differential response to mycorrhizal inoculation has been demonstrated among cultivars of wheat (Kapulnik and Kushnir, 1991), pearl millet (Krishna *et al*., 1985), pea (Estaun *et al*., 1987) and rice (Rabbani *et al.*, 2001). The objective of this study was to assess the relative root colonization and plant growth response of four maize genotypes to inoculation with two AM species viz. *Glomus mosseae* and *G. monosporum.*

## MATERIALS AND METHODS

Preparation of mycorrhizal monocultures: AM spores were extracted from rhizospheric soil of maize by wet sieving and decanting technique (Gerdemann and Nicolson, 1963). Mycorrhizal spores were identified following the synaptic key of Trappe (1982). Monocultures of two most frequently occurring species viz. *Glomus mosseae* and *Glomus monosporum* were prepared in sterilized soil sand mixture (1:1 ratio) using maize as a host plant. The soil sand mixture containing spores and mycorrhizal root fragments were used as inoculum.

Pot experiment: Earthen pots of 20 cm diameter were filled with sandy loam field soil. Each pot contained 2 kg soil. Home garden fertilizer @ 5 g/pot was thoroughly mixed in the pot soil. Seeds of four maize varieties viz.3025-W, 3012-DS, 2002-SP and 2002-SADAF were surface sterilized with 3 % sodium hypochlorite solution. Seeds were sown in pots in planting holes containing 5 g inoculum of *Glomus mosseae* and *Glomus monosporum* separately. Seeds for controls were sown without AM inoculum. There were four seeds in a pot, which were thinned to two uniform seedlings after one week of germination. Each treatment was replicated thrice. Pots were arranged in a completely randomized design in wire netting house under natural environment conditions.

Plants were harvested 60 days after sowing. Data regarding the shoot and root growth were recorded. A part of fresh roots of each sample was cut into 1 cm pieces and stained with 0.05% trypan blue solution for AM

colonization study (Phillips and Hayman, 1970). All the data were analyzed by applying Duncan's multiple range (DMR) test (Steel and Torrie, 1980).

## RESULTS AND DISCUSSION

### Shoot growth response to AM inoculation

Maximum shoot length was recorded in var.3025-W followed by 2002- SADAF, 3012-DS and 2002-SP. The shoot dry biomass exhibited a similar trend in different test varieties (Fig 1). The shoot length was significantly enhanced by *G. mosseae* inoculation in all the four test varieties (Fig 1 A). Shoot dry biomass was also enhanced by *G. mosseae* inoculation in all the four test varieties. However, the effect was only significant in 3025-W (Fig. 1 B). Earlier similar differential response to *G. intraradices* inoculation has been observed in wheat (Kapulnik and Kushnir, 1991). Variable dependence on mycorrhizal colonization has also been reported in tomato (Bryla and Koide, 1990), citrus (Menge *et al*. 1978) and pea (Balazai *et al*. 1994). Shoot dry biomass response to *G. monosporum* was insignificant in all the four varieties (Fig. 1 B). Similarly, shoot length response of var. 3012-DS and 2002-SADAF to *G. monosporum* inoculation was also nonsignificant. However, shoot length in var. 2002-SP was significantly increased by *G. monosporum* inoculation. Conversely, *G. monosporum* inoculation significantly and adversely affected shoot length in variety 3012-DS (Fig.1 A). The differential growth response of maize genotypes to two AM species may be due to changing efficiencies of different mycorrhizal endophytes during the growing season (Daft *et al*.1981) and to varying uptake or exclusion capabilities of different fungi for different elements (Meng *et al*.1982).

### Root growth response to AM inoculation

Root length and dry biomass were highest in variety 2002-SADAF followed by variety 3025-W. Root length was significantly enhanced by both AM species in variety 3025-W and 3012-DS. Similarly a significant increase was also recorded in variety 2002-SP due to *G. monosporum* inoculation. By contrast, root length in variety 2002-SADAF was significantly reduced due to *G. mosseae* inoculation. (Fig.2 A). Root dry biomass is also significantly reduced by both AM species in this variety. By contrast, variety 3025-W showed a positive and a significant response to inoculation of both AM species. Root biomass responses to AM inoculation was significant in variety 3012-DS and 2002-SP. (Fig.2 B).

**Table 1.** Correlation between mycorrhizal colonization and plant growth parameters in control and mycorrhizal inoculated plants of four maize varieties.

| | Vesicular infection | Arbascular infection | Mycelial infection |
|---|---|---|---|
| ***Control*** | | | |
| Shoot length | -0.13 | 0.70 | -0.02 |
| Shoot dry wt. | 0.25 | 0.90* | 0.35 |
| Root length | 0.03 | 0.62 | -0.55 |
| Root dry wt. | -0.15 | 0.31 | -0.81 |
| *Glomus mosseae* | | | |
| Shoot length | 0.88* | 0.59 | 0.92* |
| Shoot dry wt. | 0.99*** | 0.72 | 0.98** |
| Root length | 0.90* | 0.51 | 0.75 |
| Root dry wt. | 0.98** | 0.79 | 0.97** |
| *Glomus monosporum* | | | |
| Shoot length | -0.90* | -0.45 | 0.91* |
| Shoot dry wt. | -0.60 | 0.43 | 0.58 |
| Root length | -0.27 | 0.72 | 0.42 |
| Root dry wt. | -0.14 | 0.79 | 0.39 |

*, **, ***, significant at 5, 1 and 0.1 % level of significance, respectively.

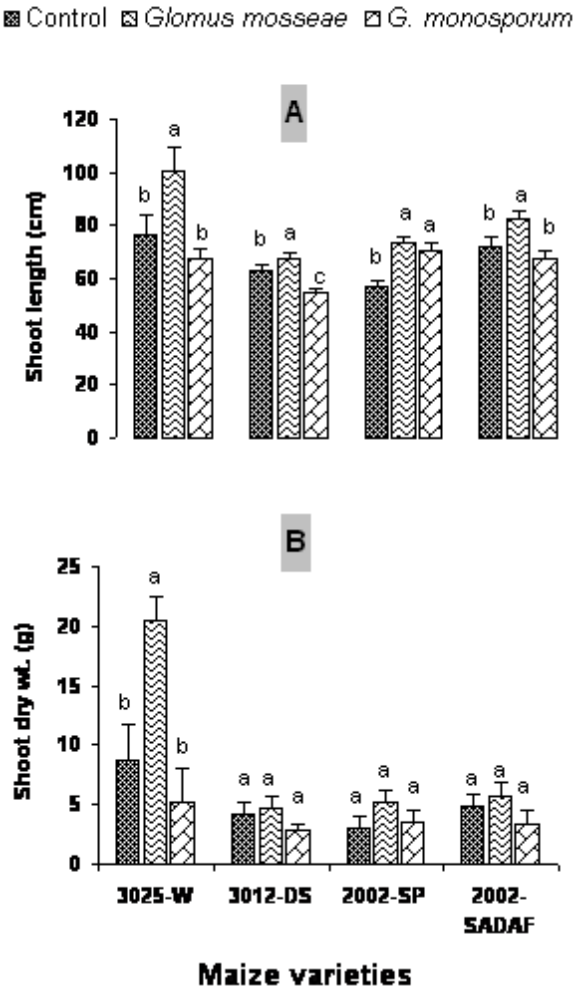


Fig. 1: Shoot growth resposne of four maize varieties to inoculation of two AM species.
For each variety values with different letters show signiifcant difference (P = 0.05) as determined by DMR Test.

**Mycorrhizal colonization response to AM inoculation**

Vesicular infection in all the four test varieties showed a positive and a significant response to *G. mosseae* inoculation. Conversely, vesicular infection was significantly suppressed by *G. monosporum* in all varieties except variety 3012-DS where a significant increase in vesicle number was recorded in response to inoculations (Fig.3A). Arbuscular infection was significantly increased by *G. mosseae* inoculation in all varieties except 2002-SADAF. Arbuscular infection in asvariety 3012-DS was also significantly enhanced due to *G. monosporum* inoculation. By contrast, Arbuscular infection in variety 2002-SADAF showed a significantly negative response to inoculation of *G.monosporum.* The response of other two varieties to this AM specie was insignificant. (Fig. 3 B).

Extent of hyphal infection was significantly enhanced by *G. mosseae* inoculation in all varieties except 3012-DS. *G. monosporum* inoculation results in a significant reduction in mycelial infection in varieties 3025-W and 3012-DS, while the other two varieties failed to exhibit any significant response to this AM specie inoculation (Fig. 3 C). Earlier Azcon and Ocampo (1981) reported that wheat cultivars inoculated by *G. mosseae* showed different degree on mycorrhizal infection. Similar genotypic variation in mycorrhizal colonization has also been recorded in pea (Bryla and Koide, 1990). Variation in contents of root exudates possibly be the difference in mycorrhizal infection in different genotypes (Azcon and Ocampo, 1981).

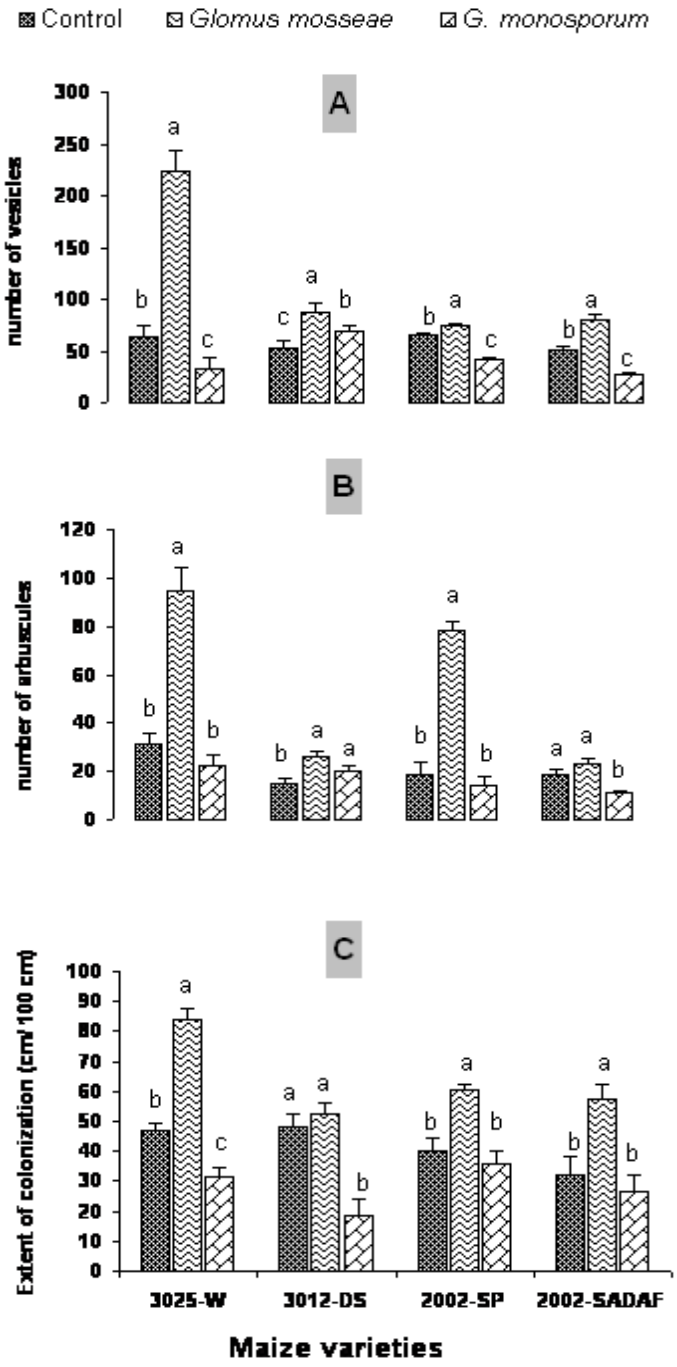


Fig. 3. AM colonization in four varieties of maize. Verticle bars show standard error. Values with different letters in each maize variety show significant difference (P = 0.05) as determined by DMR Test

In general, the four test varieties were not markedly different from one another in vesicular and mycelial infection when exposed to indigenous mycorrhizal flora. However, arbuscular infection was markedly higher in variety 3025 W as compared to other test varieties. By contrast, Rabbani *et al*. (2001) have reported a highly variable colonization response of rice genotypes to indigenous mycorrhizal flora. Presently among the two

introduced test AM species, *G. mosseae* mostly enhanced mycorrhizal colonization, while effect of *G. monosporum* was generally suppressive. Among the four test varieties 3025-W was found the superior to other varieties with regard to its AM colonization to *G. mosseae* inoculation.

**Correlation studies**

Data regarding the correlation between plant growth and mycorrhizal infection in control and mycorrhizal inoculated treatments is shown in Table 1. The results indicate that in control there was a negative correlation of vesicular infection with shoot and root dry weight. Similarly, mycelial infection was also negatively correlated with all parameters except shoot dry weight. Arbuscular infection was positively correlated with all the studied parameters. Correlation was significant between arbuscular infection and shoot dry weight. In *G. mosseae* inoculated plants there was positive correlation between different plant growth and mycorrhizal parameters.

In *G. monosporum* inoculated plants all the plant growth parameters were negatively correlated with the vesicular infection while correlation between hyphal infection and different plant growth parameters were positive (Table 1). In the present study var. 3025-W showed a significantly positive mycorrhizal colonization response to *G. mosseae* and exhibited a parallel increase in root and shoot growth. This study shows that mycorrhiza have great potential to improve crop productivity when appropriate AM species are employed.

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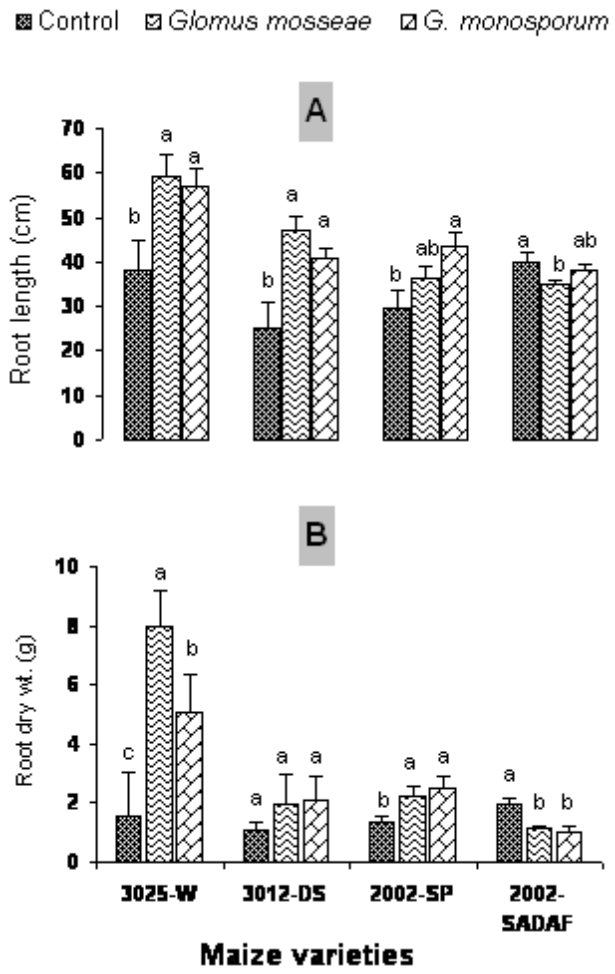


Fig. 2 (A & B): Root growth resonse of four maize varieties to inoculation of two AM species.
For each variety values with different letters show signiifcant difference (P = 0.05) as determined by DMR Test