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EM and VAM Technology in Pakistan VIII: Nodulation, Yield and VAM Colonization in *Vigna mungo* (L.) in Soils with different Histories of EM application

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ABSTRACT

A pot experiment was conducted during July-August 1998 to study the effect of EM application on crop growth, nodulation and vesicular arbuscular mycorrhizal (VAM) colonization in *Vigna mungo* (L.) Hepper, in soils with different histories of effective microorganisms (EM) application and amended with farmyard manure (FYM) and *Trifolium alexandrianum* green manure (GM). In soil 1, EM application was started six months prior to soil 2. Root and shoot growth in soil 1, irrespective of the organic amendment, showed a positive response to EM application at 45 days growth stage with an initial decline at 30 days growth stage. In soil 2, response of root and shoot growth to EM was variable with respect to organic amendments. Nodulation was better in FYM than GM amended soils. EM enhanced the nodule number in both the soils with either amendment. Nodules biomass was, however, reduced by EM application in FYM amended soil 1. A positive response of VAM to EM was observed at later growth stage.

Key Words: Effective microorganisms; VA mycorrhiza; *Vigna mungo* (L.)

INTRODUCTION

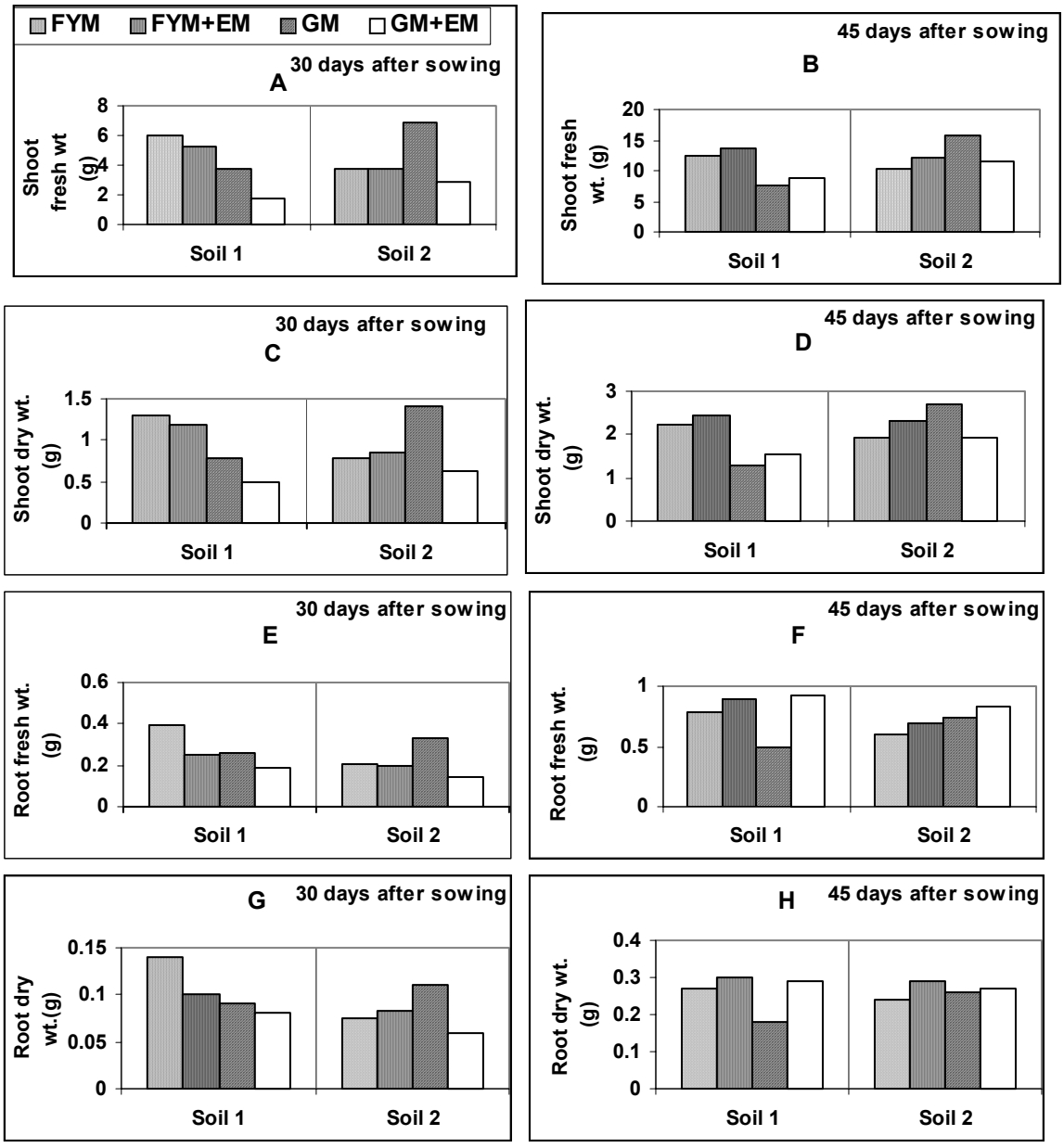
Upon discovery of chemical fertilizers and pesticides, mankind thought of having won the battle against food shortage. Although chemical based farming practices have substantially increased crop yields, they have created numerous problems for mankind. They have contributed significantly to the pollution of both surface and ground water. Moreover, residual pesticides prolong both in food and the environment, posing menace to human and animal health. In addition, the increasing cost of agricultural chemicals has continued to lower farmer's net cash return. A growing worldwide concern for these problems has motivated researches to seek alternatives to chemical based, conventional agriculture. Of the various emerging farming systems, farming with effective microorganisms (EM) appears to be a promising method for overcoming problems of conventional chemical farming. The term EM was introduced by Higa (1988). EM is a mixed culture of photosynthetic bacteria, *Azotobacte*r, *Streptomyces* and *Lactobacillus* spp., which improve crop yield by increasing photosynthesis, nitrogen fixation, controlling soil diseases and accelerating decomposition of lignin material in the soil (Hussain *et al.,* 1994). EM application has proved beneficial in increasing crop growth and yield in rice (Hussain *et al*., 1993), wheat (Ibrahim *et al*., 1993), pea (Chaudhary & Iqbal, 1993; Javaid *et al*., 1997), potato (Ayub *et al*., 1993), mungbean (Sangakkara & Higa, 1994) and vegetables (Sangakkara & Higa, 1994a). However, in contrast to this, experience of other workers revealed that the effect of EM on crop yield was not evident or even adverse particularly in the first test crop (Higa, 1989, 1991; Lin, 1991; Panchaban, 1991). Generally crop yields tend to increase gradually as subsequent crops are grown (Higa, 1989). Some workers have also studied the interactions between EM and VAM fungi (Bajwa & Jilani, 1994; Bajwa *et al*., 1997, 1998, 1999; Javaid *et al*., 1995, 1999) and observed variable effects of EM application on VAM development and subsequent growth and yield of the host plant. The present research work was, therefore, undertaken to investigate the effect of EM on VAM and crop growth in *Vigna mungo*, in two types of soil with different histories of EM application.

MATERIALS AND METHODS

Experiment was conducted in earthen pots (diameter 22-cm) during July-August 1998. With respect to history of EM application two types of soils namely soil 1 and soil 2 were used in the experiment. EM application was started in November 1997 and May 1997 in soil 1 and soil 2, respectively. Two types of organic amendments *viz*. farmyard manure (FYM) and *Trifolium alexandrianum* green manure (GM) were employed.

FYM and GM were moistened with dilute EM solution in water (1:1000), packed in air-tight polythene bags and left for seven days to prepare Bokashi (Anonymous, 1995). Bokashi was mixed in the pot soils @ 10% volume of the soil 10 days before sowing. Pots to be used as control received the same amount of amendments without EM treatment. Seeds of *Vigna*

Fig. 1 (A-H). Effect of EM application on root and shoot growth of *Vigna mungo*



Soil 1: EM application started in November 1997; Soil 2: EM application started in May 1998; FYM: Farmyard manure; GM: Green manure.

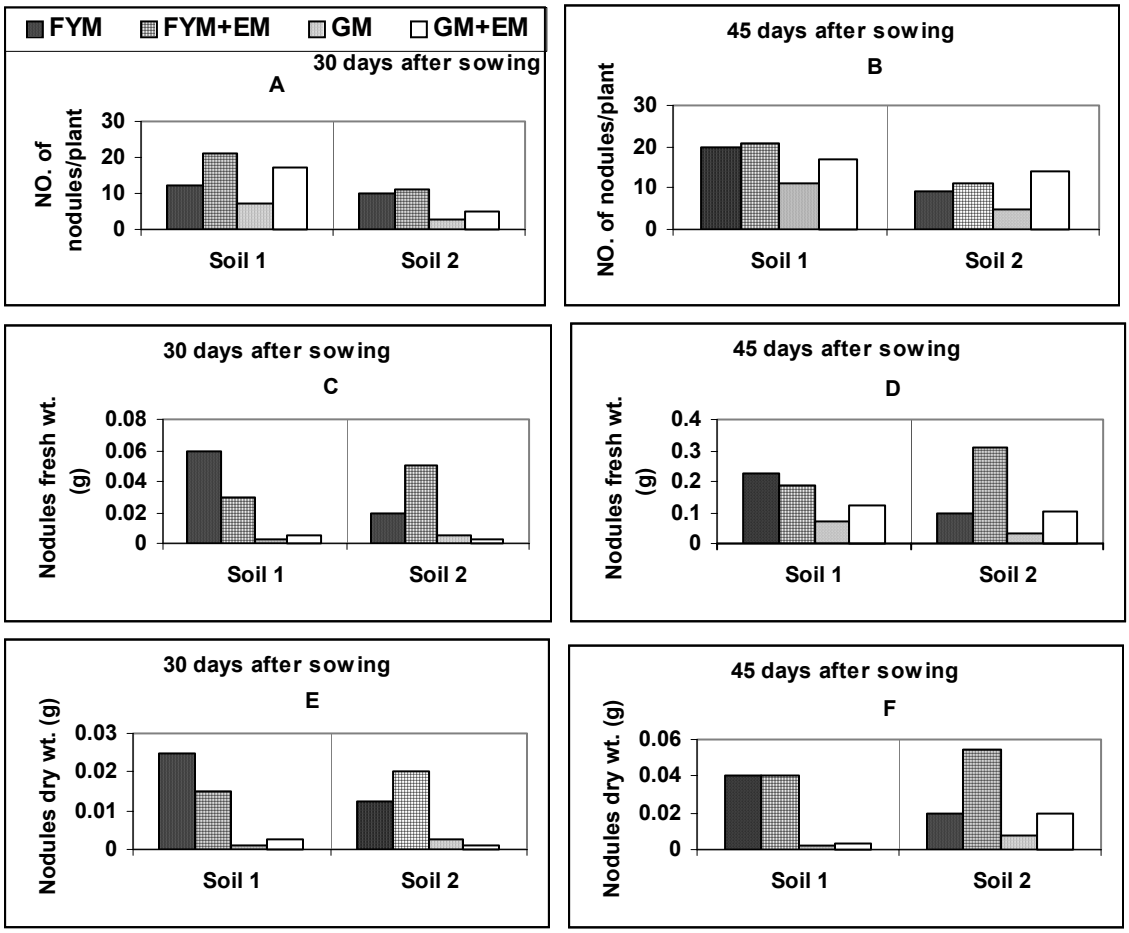
mungo (L.), surface sterilized with 1% sodium hypochlorite solution, were sown in all pots. There were three replicate pots of each treatment with two plants/pot. Pots which received EM treated FYM and GM also received dilute EM solution in water (1:1000) @ 300 mL/pot at fortnight intervals.

Plants were harvested 30 and 45 days after sowing. At each harvest, nodules were separated from roots and counted. Fresh and dry weights of root, shoot and nodules were recorded. A part of roots was cleared and stained following the procedure of Phillips and Hayman (1970) for VAM infection study. Stained roots were cut into 1 cm pieces and examined under compound microscope. Percentage infection of mycorrhizal structures i.e. mycelium, arbuscules and vesicles was recorded. Extent of VAM infection was measured by slide length method (Giovenitti & Mosse, 1981).

RESULTS AND DISCUSSION

In soil 1, after an initial decline at 30 days growth stage (DGS), root and shoot biomass was enhanced by

Fig. 2 (A-F): Effect of EM application on nodulation of *Vigna mungo*

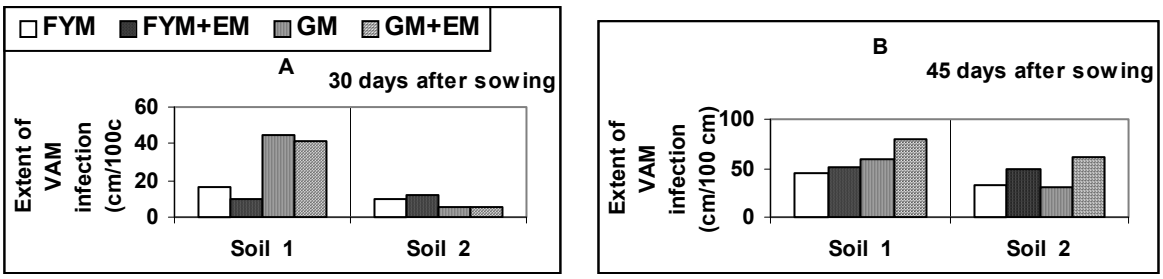


Soil 1: EM application started in November 1997; Soil 2: EM application started in May 1998; FYM: Farmyard manure; GM: Green manure

EM application at 45 DGS with either organic amendment. In soil 2, a variable response of root and shoot biomass production to EM application was observed with respect to organic amendments. With FYM amendment, root and shoot biomass was increased gradually by EM. With GM amendment, shoot biomass showed a persistent negative response to EM while root biomass was increased at 45 DGS after an initial decline at 30 DGS (Fig. 1 A-H). These results confirm the findings of some earlier workers (Higa, 1989; Lin, 1991; Panchaban, 1991; Bajwa *et al*., 1999) who observed that effect of EM on crop growth was usually not evident or even negative in the first test crop. Generally, crop growth tends to increase as the subsequent crops are grown (Higa, 1989). The present study also reveals that type of organic is as important as history of EM application in EM technology. Probably microorganisms in EM solution take different times to establish themselves when different organic manures are incorporated in the soil.

Nodulation in terms of number, and fresh and dry weight was better in FYM amended soils as compared to those amended with GM. Such similar differential response of nodulation to FYM and GM has also been reported in *Trifolium alexandrianum* by Bajwa *et al*. (1999). Since nodulation is negatively correlated with the availability of nitrogen in the soil (Munns, 1977), the suppression of nodulation in GM amended soil could be attributed to the presence of more nitrogen in GM than in FYM. EM application enhanced nodule number irrespective of the soil type, organic amendment and growth stage. Effect was more pronounced in GM amended soil (Fig. 2 A, B). The enhanced nodule number may be the result of increased rhizobial population due to EM application (Sangakkara & Higa, 1994). Similar response of nodulation to EM has also been reported in pea, *Phaseolus vulgaris* and *Vigna radiata* (Javaid *et al*., 1997, 1999; Sangakkara & Higa, 1994). The response of nodule biomass to EM was variable with respect to soil type and organic

Fig. 3 (A & B). Effect of EM application on VAM colonization in *Vigna mungo* in soils amended with farmyard manure (FYM) and green manure (GM)



Soil 1: EM application started in November 1997; Soil 2: EM application started in May 1998

amendment. In FYM amended soil 1, EM application significantly reduced the nodules fresh and dry weight at 30 DGS while effect was insignificant at later growth stage. In FYM amended soil 2, a persistent and significant increase in both fresh and dry biomass of nodules was recorded. With GM amendment, the effect of EM was insignificant in soil 1, while a significant increase was observed in soil 2 at 45 DGS (Fig. 2 C – F). Relationship between nodulation and crop growth was not evident. Probably it could be due to difference in N_2-fixing capabilities of nodules in different treatments.

EM application in soil 1 increased the extent of VAM colonization in roots with either organic amendment at 45 DGS after an initial decline at 30 DGS. In soil 2, a gradual increase in VAM infection was observed due to EM (Fig. 3). The increase in VAM infection in soil 2 was parallel to enhanced nodulation due to EM. However, any parallel relationship between VAM colonization and crop growth due to EM application was entirely lacking. In our earlier studies (Javaid *et al.,* 1999; Bajwa *et al*., 1999) similar observations have been reported in *Trifolium alexandrianum* and *Vigna radiata*. However, in contrast, enhanced VAM colonization due to EM with a parallel increase in crop growth has been reported in maize (Bajwa & Jilani, 1994), chickpea (Bajwa *et al*., 1998) and sunflower (Javaid *et al*., 1999). Further studies regarding the effect of EM on VAM colonization, nodulation and crop growth with respect to history of EM application, organic amendments and test species is needed before any conclusion can be drawn.

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