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Influence of (vesicular-) arbuscular mycorrhiza on survival and development of micropropagated oil palms during acclimatization

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Abstract

In vitro propagated oil palm (*Elaeis guineensis* Jacq.) plantlets have to be acclimatized in the greenhouse to natural conditions. The percentage of mortality is about 30-40 % during this phase. Further investigations on micropropageted grapevine, apple and pear have shown that the use of (vesicular-) arbuscular mycorrhizal fungi ((V)AMF) can overcome this mortality problem.
Several experiments were conducted at the Indonesian Oil Palm Research Institute, in Medan, to investigate the effect of ((V)AMF) inoculation on the survival and development of oil palm plantlets during acclimatization. In an initial screening of 12 different mycorrhizal fungal species inoculation significantly increased survival rates of plantlets from 60 % to 100 % and improved plant development. A second experiment was carried out to investigate the role of Phosphate supplementation in this sensitive stage.

Keywords: Mycorrhiza, micropropagation, oil palm plantlets, acclimatization, survival rate

Introduction

The oil palm (*Elaeis guineensis* Jacq.) is one of the most important crop in Indonesia, and the acreage has increased by about a factor of three to 2 million ha in the last 10 years. There is a huge demand for improved planting material to develop the oil palm plantations. Micropropagation facilitates multiplication of high quality and homogeneous plant material in mass production. The weaning of the plants propagated *in vitro* to greenhouse conditions is on of the most critical steps in the morphological and physiological adaptation during the preparation of plantlets. In this stage, known as acclimatization phase, plantlets are subject to severe environmental stress, due to poor root and shoot growth and reduced cuticular wax formation, the percentage of mortality is about 30-40%.
(Vesicular-) arbuscular mycorrhizal fungi ((V)AMF) are known to improve the vitality of plants by increasing the uptake of water and mineral nutrients, especially of phosphorus, and to protect host plants from root pathogens. The aim of our work was to evaluate the effects of (V)AMF inoculation on the development of oil palm plantlets in the weaning process.

Materials and Methods

Several greenhouse experiments were conducted at the 'Indonesian Oil Palm Research Institute, (IOPRI)' in Medan from November 1996 to February 1998. This presentation is focused on two experiments.

Experiment 1

The first experiment was laid out as an initial 'screening' of different (V)AMF isolates to test their effectiveness in improving the survival and development of plantlets. The plantlets were inoculated with 12 different mycorrhizal species (M1-M12). No fertilizer was applied. The number of replications for each treatment was 13, the number of control plantlets without inoculation (NM) was 40.

Experiment 2

The second experiment was carried out to investigate the role of phosphate supplementation in the weaning stage. The plantlets were inoculated with four (V)AM fungi (M1-M4), which were selected out of experiment 1. Three levels of phosphate fertilization were applied:

PO: control, no phosphate fertilization
HA: medium, with Hydroxylapatite ($Ca_5(PO_4)_3OH$)
BAY: high, with a liquid complete foliar fertilizer 'Bayfolan'
(N 11%, P_2O_5 8%, K 6%) which is used at 'IOPRI'.

The number of replications for each treatment, also for the non-inoculated controls (NM), was 30 plantlets.

In both experiments the acclimatization lasted three months.

Results

Experiment 1

The 12 different mycorrhizal fungal species significantly increased the survival rates of plantlets from 62% (NM) up to 100% (M1, M2; Fig. 1). In general, dry matter of shoots was significantly higher after inoculation than that of control plantlets. The growth stimulation was associated with increased phosphorus concentration in shoots. (V)AMF colonization varied among the fungal species.

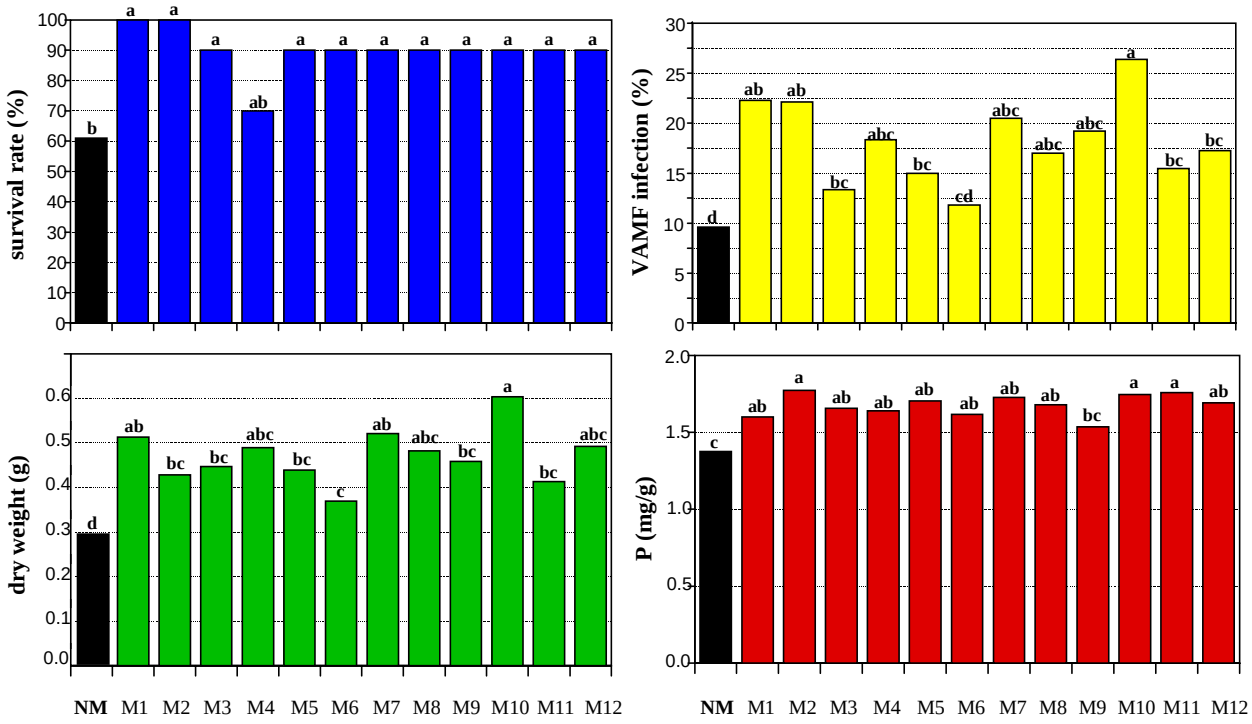

Figure 1: Effect of inoculation with different (V)AMF (M1-M12) on survival, shoot growth, phosphate concentration and (V)AM infection of micropropagated oil palm plantlets during acclimatization. Bars with the same letter are not significantly different at *P=0.05.*

Experiment 2

Without phosphate fertilization the survival rates increased after inoculation from 45% to 95% (PO; Fig.2). Plantlets which were fertilized with sparingly soluble Hydroxylapatite (HA) showed improved survival only when inoculated. The foliar fertilization (BAY) increased the survival rate without inoculation (NM).
The effect of inoculation with (V)AMF on plant growth was stronger than of fertilization. In some cases inoculated plantlets doubled their dry weights and showed a significantly higher P concentration compared to the non-inoculated controls (NM). The rate of (V)AMF colonization of the plantlets was dependent on fungal species and type of fertilization.

In both experiments non-inoculated plantlets (NM) showed mycorrhizal colonization, due to soil born (V)AMF.

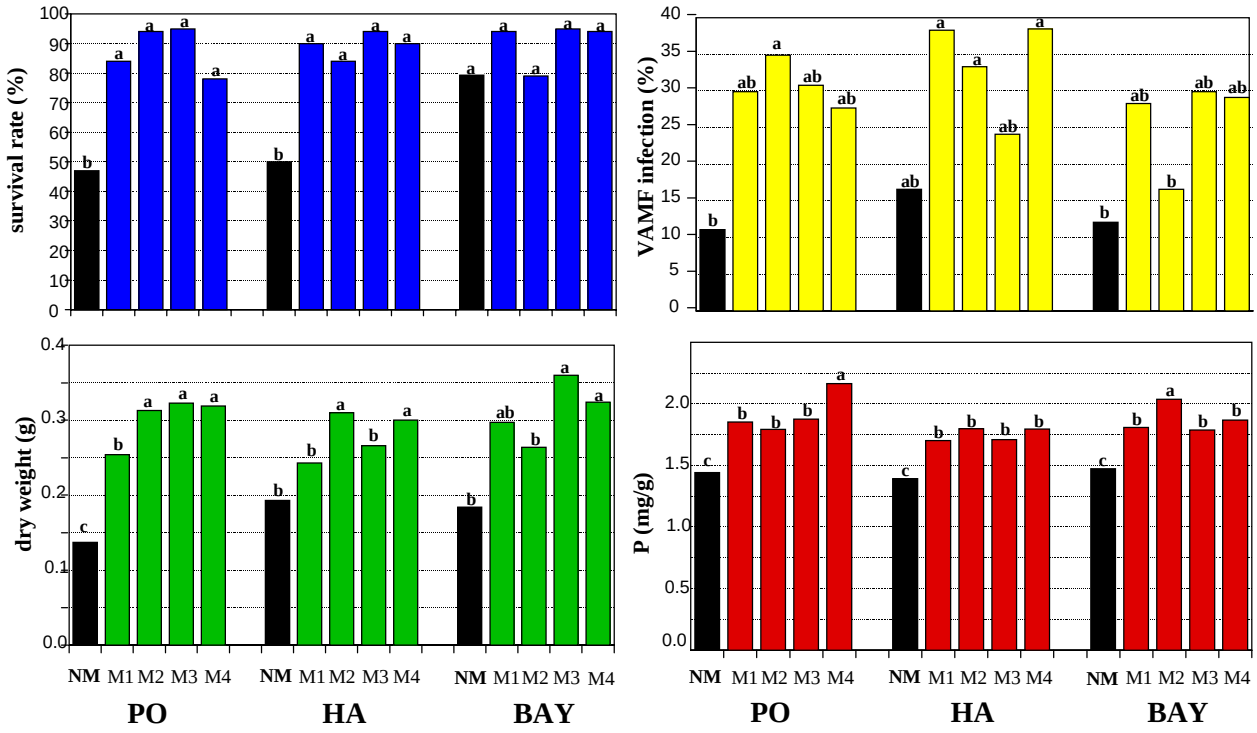

Figure 2: Effect of inoculation with different (V)AMF (M1-M4) and phosphate fertilization (PO, HA, BAY) on survival, growth, phosphate concentration and (V)AMF infection of microprogated oil palm plantlets during acclimatization. Bars with the same letter are not significantly different at *P=0.05*.

Discussion and Conclusions

(V)AM fungi are known to have beneficial effects on the growth and development of most micropropagated species due to improved mineral nutrition and root formation (Berta et al., 1995; Azcon-Aguilar et al., 1997).

The survival rates could be increased to 90-100%. Phosphate seems to play an important role in improving the development of plantlets during the sensitive stage. Phosphate fertilization and/or (V)AMF inoculation improved growth and increased the phosphate concentration of shoot tissue. In general, elements with low mobility in the soil, such as P, are absorbed in higher amounts by mycorrhizal than non-mycorrhizal plants (Colozzi-Filho and Bolota, 1994).

(V)AMF colonization varied among the inoculated treatments in this study. According to Douds et al. (1998) the physiological response of a plant is the resultant of interactions between environment, plant and fungus genotype. Increases in growth rate are not always related to colonization (Guillemin et al., 1994). The weak mycorrhizal infection in the control plantlets (NM), indicates the range of infection rates which occur in plant roots under 'normal' acclimatization practice. Inoculation greatly increased this and resulted in improved growth and development.

The results of the experiments reported here confirm that the biotechnology of using (V)AMF at the stage of acclimatization appears to be a promising way to optimize the production of micropropagated oil palm plantlets.

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