

Magnetic Stimulation of Seed of Leucaena Leucocephala and its Effect on the Morphological Changes

Estimulación Magnética de Semillas de Leucaena Leucocephala y su Efecto en Cambios Morfológicos

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Recibido Mayo 26 2011 – Aceptado Noviembre 30 de 2011

ABSTRACT

The controlled magnetic stimulation of seeds of Leucaena leucocephala, which improves the plant development in several ways, is an important methodology to study the contribution of magnetism in the development of this legume in silvopastoral systems. Based on criteria for the treatment of plant material as defined in the literature, exposure was performed with homogeneous static magnetic field. The magnetic flux density (30, 62.5, 125, 200 and 250) mT and the exposure time of seeds (0,5, 1, 3, 5, 10, 15,

20, 25, 30, 60) minutes were considered as exposure parameters. Root length, stem length and leaf mass were measured in order to determine the effect of magnetic field on plants 15 days after germination. An analysis of variance was applied to determine significant differences between treatments; in general, variables of plant growth from seeds stimulated magnetically were increased, and significant differences were found to stem length for treatments 250 mT/15 min (70,9%) and for leaf mass the treatment 30 mT/10 min (63,2%) compared to the control group.

Key words: magnetic treatment, seeds, magnetobiology.

RESUMEN

Con la estimulación magnética controlada de semillas de Leucaena leucocephala, se busca afectar las plantas de manera que incremente las cualidades de las plantas en condiciones ambientales exteriores, como un apoyo importante del magnetismo en el desarrollo de las investigaciones sobre esta leguminosa forrajera en los sistemas silvopastoriles. Basados en criterios para el tratamiento de material vegetal definidos en la literatura, la exposición fue realizada con campo magnético estático homogéneo. Fueron consideradas como parámetros de exposición, la densidad de flujo magnético (30, 62.5, 125, 200 and 250) mT y el tiempo de exposición (0.5, 1, 3, 5, 10, 15, 20, 25, 30, 60) minutos. La longitud de la raíz, tallo y masas foliar fueron medidas para evaluar el efecto del campo magnético sobre plantas 15 días después de la germinación. Se realizó análisis de varianza para determinar diferencias significativas entre cada tratamiento; encontrando en general, un aumento en las variables para plantas provenientes de semillas estimuladas magnéticamente, diferencias significativas se hallaron en la longitud del tallo para el tratamiento 250 mT/15 min (70,9%) y para la masa foliar el tratamiento 30 mT/10 min (63,2 %) comparado con el grupo de control.

Palabras clave: tratamiento magnético, semillas, magnetobiología.

1. INTRODUCTION

Use of techniques involving physical factors could be an alternative to agriculture development. Techniques including plant's exposition to laser radiation [1], ultrasound, microwaves, gamma rays [2, 3], electric field [4], magnetic field [5], ultraviolet-B radiation and, combination of latter with magnetic field [6] have been used.

The investigation of magnetic field effects applied to agriculture has been used since 30's, and its development has shown usefulness in the pretreatment of seeds, looking for improvement qualities in the germination and plant development [7]. This new technique has been used mainly in legumes, vegetables and cereals. However, there are gaps in the methods used and the consequence of these may have differences on the results, additional to this there is not unification of criteria and is difficult to generate extrapolation between researches.

Studies about effect of the magnetic field at different stages of plant growth are varied taking into account several factors involved in the experiments. Using specific magnetic stimulation on vegetable material could produce a response that achieves a better performance in environmental conditions and then a greater production with good quality, hence the different physicals, environmental, and biological characteristics involved must be clarified.

Although this is a subject that rises in some European countries, in the called agrophysics, there are few reports in Colombia [8, 9, 10]. Indeed, the study was conducted on the effect of pretreatment of seeds of *Leucaena leucocephala* with magnetic field, analyzing its behavior in the early days of growth.

2. MATERIALS AND METHODS

Seeds and Magnetic field

The *Leucaena leucocephala* seeds were obtained from Semicol Company (Colombia, Bogota), whose guaranteed germination percentage of 91%.

Magnetic field was generated by an electromagnet Phylatex ($0 - 1.000 \text{ mT} \pm 0,08 \%$), with pole pieces of circular area with diameter of 9 cm, a power supply Kepco ATE 75-15M automatically controlled was used.

The magnetic flux density was measured with a hall magnetometer, implemented from a FW Bell BH701 sensor.

Magnetic exposition

Based on criteria for the treatment of plant material as defined in the literature [11, 12], exposure was performed with homogeneous static magnetic field.

For treatment of *Leucaena leucocephala* seeds were chosen, two independent variables, i.e., magnetic flux density (30, 62,5, 125, 200, 250) mT and time exposition (0,5, 1, 3, 5, 10, 15, 20, 25, 30, 60) minutes; combinations of factor generate 51 groups, taking into account a control group, without magnetic exposition; to each group were used 80 seeds.

Germination and growth

Immediately after exposition seeds were placed in rectangular trays which had a layer of absorbent paper, in this condition of germination seeds were 10 days and then, groups that presented 12 seed germinated were transplanted to plastic containers. The germination process and plant growth was carried out in nursery of Universidad Tecnológica de Pereira with no controlled environmental conditions. Measurements of stem length, root length, and plant mass were made on 6 plants 15 days after transplant.

Statistical analysis

Statistical analysis was performed using SPSS for Windows. To determine significant difference among the factors used and the dependent variables measured, analysis of variance between groups (ANOVA) was applied. Mean values were compared using the Bonferroni method with a significance level of 0,05, to detect differences between treated plants and control.

3. RESULTS AND DISCUSSION

Data were collected at 15 days after transplanting seedlings. Figures 1, 2 y 3 shows the dependent variables stem length, root length and leaf mass respectively, related with applied exposure time and magnetic field.

In the figures, for some groups in the graph there is not continuity, because in the tenth day, at the time of transplanting the seedlings, the groups did not present the minimum specified for that purpose (12 seedlings).

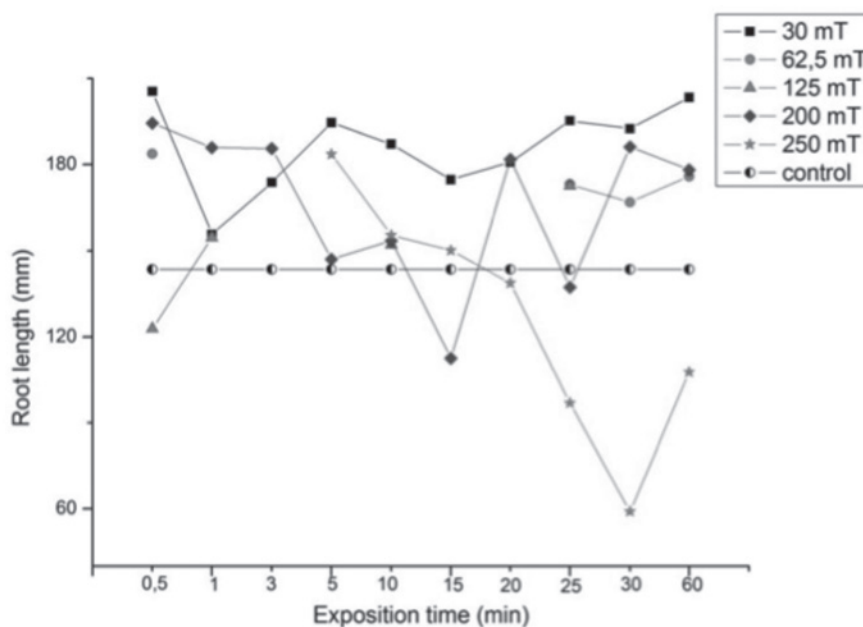


FIGURE 1. Root length of *Leucaena leucocephala* measured 15 days after transplanting seedling, including control group (Length \pm 0,01mm)

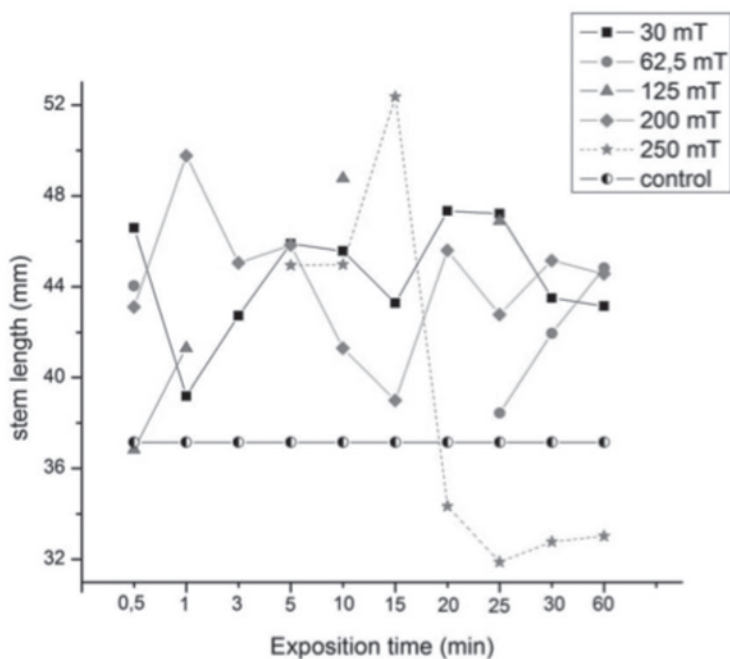


FIGURE 2. Stem length of *Leucaena leucocephala* measured 15 days after transplanting seedling, including control group (Length \pm 0,01mm)

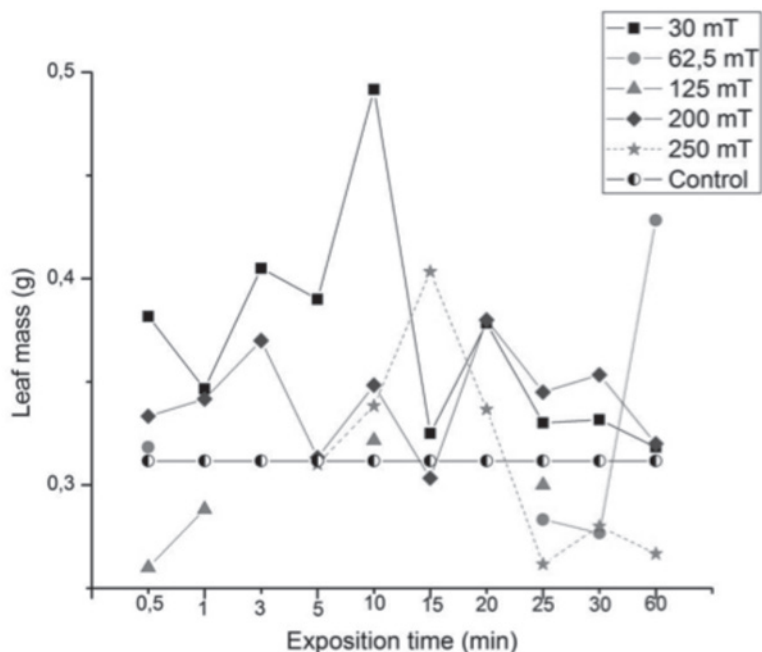


FIGURE 3. Leaf mass of *Leucaena leucocephala* measured 15 days after transplanting seedling, including control group (Mass \pm 0,01mm)

Root length

Despite the apparent increase in root length that can be seen in figure 1, it was only found that the factor, magnetic field has a significant effect on root length ($p < 0,05$), which is not the case to exposure time. Also it was observed an interaction between factors used. The group of 30 mT shows significant differences compared to control group. Multiple comparisons were performed to find out specific groups that showed significant differences. Finding that only occurs for the group of 250 mT /30 min with length of 53,98 mm compared with control group (143,53 mm).

Stem length

In the same way that for root length, only the groups defined by the magnetic field have a stem length means statistically different, also presenting an interaction effect between the factors. On average the groups that showed significant differences with respect to the control were (30, 62, 5, 125, and 200) mT. From the multiple comparisons, were showed that the groups differ with respect to control (37, 15 mm) are:

- To 30 mT groups with exposure times (0, 5, 5 and 20) minutes with lengths (46,59, 45,89 and 47,33) mm respectively.
- In the case of 125 mT, exposure times (10 and 25) minutes, with lengths (48, 77 and 46, 89) mm respectively.
- For 250 mT only differences were found in the 15 minutes of exposure, with a stem length of 52, 36 mm.

Leaf mass

For the leaf mass, the same way as for the other two dependent variables studied, the magnetic field had an effect on the average mass between groups, but in this case there is not interaction effect among variables. Again the flux density of 30 mT shows significant differences compared to control group. Specifically the treatment of 30 mT / 10 min with a mass average of 0, 49 g, compared with the control group (0, 31 g).

The root length is an important parameter in plant growth, because this structure function is holding the plant and sucking down water and minerals necessary for the maintenance of the plant [13]. Thus, increasing the root length might accelerate the growth of this legume and allow a greater number of nodes to increase the soil nitrogen-fixing.

The treatment 30 mT is a good starting point to improvement in the development of this plant; below this magnetic density an assumption concerning to dependents variables could not be correct, due to erratic behaviour between the used factors, as can be seen in figures 1, 2 and 3. On the other hand, the treatment of 250 mT is not an option in the search for improved applications of *Leucaena leucocephala*.

The increase in stem length and leaf mass that could be observed, partly corroborate the results shown for controlled magnetic stimulation in maize [14, 15] and barley [16], because all groups didn't show an increase in measured variables in a uniform way or with a tendency as marked as seen in the above mentioned reports.

Unlike the tendency of previous studies, in which the magnetic field range and exposure time used are limited [5, 16], and others in which only one scan is performed with exposure times [15, 16, 17], this study aims at extending the range studied factors, in order to investigate the possible trend that may have the response curves for the different variables measured and, finding a precise dose for optimal response of plants exposed.

4. CONCLUSIONS

Exposure of *Leucaena leucocephala* seeds to a static magnetic field before planting has a positive effect regarding to increase of the morphological variables studied, mainly for a flux density of 30 mT. But, there was a decrease of such variables to 250 mT exposures longer than 25 minutes. Statistical analysis of the exposition factors effect, showed that is more important the level of magnetic flux density that the exposure time. But there is not a specific and decisive treatment to improve all variables measured. However, these results suggest a direction that must be considered in the future investigation, specifically in dose definition.

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