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VISUAL SYMPTOMS AND CHLOROPHYLL PRODUCTION OF *AILANTHUS TRIPHYSA* SEEDLINGS IN RESPONSE TO NUTRIENT DEFICIENCY

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ANOOP, E.V., GOPIKUMAR, K. & BABU, L.C. 1998. Visual symptoms and chlorophyll production of *Ailanthus triphysa* seedlings in response to nutrient deficiency. A study was conducted at the College of Forestry, Kerala Agricultural University, Vellanikkara, to find out the effect of deficiency of various nutrient elements on the visual symptoms and chlorophyll production of *Ailanthus triphysa* seedlings. To induce deficiency of nutrient elements, namely N, P, K, Mg and S, sand culture experiments were carried out under controlled conditions inside a glasshouse. The chlorophyll concentration of the leaves was found to be significantly influenced by the deficiency of various nutrient elements, especially during the fourth and sixth months. The amounts of chlorophyll a, chlorophyll b and total chlorophyll decreased gradually during the study period for all the treatments . This also concurred with the advancement of visual symptoms of nutrient deficiency. The reduction in all fractions of chlorophyll concentration in the leaves with the advancement of chlorotic symptoms, particularly due to nitrogen and magnesium deficiencies, was very pronounced in the present study.

Key words: *Ailanthus triphysa* - sand culture - chlorophyll - chlorosis - deficiency symptoms - major nutrients - glasshouse

ANOOP, E.V., GOPIKUMAR, K. & BABU, L.C. 1998. Tindak balas simptom visual dan pengeluaran klorofil anak benih *Ailanthus triphysa* terhadap pengurangan nutrien. Kajian dijalankan di Kolej Perhutanan, Universiti Pertanian Kerala, Vellanikkara, untuk mengetahui kesan pengurangan pelbagai unsur nutrien terhadap simptom visual dan pengeluaran klorofil anak benih *Ailanthus triphysa.* Untuk mendorong kekurangan unsur nutrien iaitu N, P, K, Mg dan S, ujian kultur pasir dijalankan dengan kawalan di dalam rumah kaca. Kepekatan klorofil daunnya dipengaruhi dengan bererti oleh pengurangan pelbagai unsur nutrien, terutamanya pada bulan keempat dan keenam. Amaun klorofil a, klorofil b dan jumlah klorofil berkurangan secara beransur-ansur bagi semua rawatan di sepanjang tempoh kajian. Ini juga sejajar dengan kemajuan dalam simptom visual bagi kekurangan nutrien. Pengurangan semua bahagian dalam kepekatan klorofil daun dengan kemajuan dalam simptom klorotik, terutamanya disebabkan oleh kekurangan nitrogen dan magnesium sangat ketara dalam kajian yang dijalankan sekarang.

Introduction

Ailanthus triphysa (Dennst.) Alston (syn: *Ailanthus malabarica* DC.) is a fast growing tree species of considerable economic importance in tropical countries . Locally known as matti, perumaram, pongilyam, etc. in the peninsular Indian state of Kerala , the wood of this tree is widely used in match, packing case and paper pulp industries. It is raised in plantations by the state forest department over large areas. Of late , it is also grown in many homesteads , particularly in places where match industries are prevalent. It also serves as a good support for pepper in South India.

Despite its immense popularity and commerical importance, nutritional aspects of this species have seldom been studied, especially in the nursery stage. Severe nutritional disorders have also been observed in *Ailanthus* seedlings grown in nurseries of the Forest Department, as well as in other commerical nurseries. A sand culture study was taken up with the view to understand the mineral nutrition of *Ailanthus* seedlings . In this paper, the effect of mineral nutrient deficiency on the chlorophyll production and visual symptoms of *Ailanthus* seedlings is discussed.

Methodology

Sand culture experiments to study the effect of deficiency of major nutrients, viz. N, P, K, Mg and S, on the chlorophyll concentrations of the leaves of *Ailanthus triphysa* were carried out at the College of Forestry, Kerala Agricultural, University, Vellanikkara, India, during the period 1991-93.

Pure quartz silica sand of 250 mesh was used for the sand culture studies. The sand was first washed with tap water and then soaked in dilute hydrochloric acid for about eight hours. The sand was then washed thoroughly with tap water and subsequently with deionised water until it became chloride free. Seeds of *Ailanthus triphysa* were collected from a single, healthy mother tree of about eight years old from the University main campus, Vellanikkara, during the last week of April 1991. The seeds were sown in sand beds which were prepared under partial shade. The seedlings of about one month old were transplanted to polybags.

Sand culture studies were conducted inside a glasshouse under controlled conditions. Two-month-old seedlings of uniform growth in respect of height, collar diameter and leaf number were selected and planted in plastic pots of size 30 cm (diameter) × 10 cm (height), filled with pure quartz sand.

All the experimental seedlings were supplied with complete Hoagland No.2 (1948) nutrient solution for a period of 10 days till they established well in the sand. The various treatments tried for the present study were:

- Complete Hoagland nutrient solution
- Nutrient solution lacking nitrogen
- Nutrient solution lacking phosphorus

- Nutrient solution lacking potassium
- Nutrient solution lacking magnesium
- Nutrient solution lacking sulphur

The experiment was laid out in completely randomised design. Initially there were 36 seedlings per treatment.

The chemical composition of complete Hoagland No.2 (1948) nutrient solution is furnished in Table 1. From the stock solution, the required quantities of each nutrient as mentioned were pipetted and made to one litre. The nutrient solutions required for each treatment were carefully prepared in bulk by eliminating the desired nutrient from the stock. Every alternate day, 50 ml of nutrient solution and 2-3 drops of 0.1 % $FeSO_4$ solution were added to each plant. On other days, deionised water was supplied at the rate of 50 ml per plant.

Three seedlings each from a treatment were uprooted at bimonthly intervals for analysis of the chlorophyll concentration of the leaves. Leaves of each seedling were pooled together and the amounts of total chlorophyll, chlorophylls a and b were measured by the method of Arnon (1949).

All the observations recorded were statistically analysed following the analysis of variance.

Table 1. The composition of Hoagland No. 2 (1948) nutrient solution

Complete solution (stock solution)	Quantity pipetted (ml l^{-1}) (working solution)
$NH_4H_2PO_4$ (1 M)	1
KNO_3\ KCL (1M)	6
$Ca(NO_3)_2$\ $Ca(H_2PO_4)_2$ (1 M)	4
$MgSO_4 . 7H_2O$ (1 M)	2
Boric acid (2.86 g l^{-1})	1
$MnCl_2 . 4H_2O$ (1.81 g l^{-1})	1
$ZnSO_4 . 5H_2O$ (0.28 g l^{-1})	1
$CuSO_4 . 5H_2O$ (0.08 g l^{-1})	1
Molybdic acid (0.02 g l^{-1})	1

Results and discussion

The chlorophyll concentration of the leaves was found to be significantly influenced by the deficiency of various nutrient elements, especially during the last two periods of observations. It was also found that the chlorophyll concentration decreased gradually during the course of study for all the treatments.

The chlorophyll a concentration differed significantly between the various treatments during the fourth and sixth months (Figure 1). The Mg deficient plants had the lowest (0.51 mg g^{-1} of leaf tissue) and P deficient plants had the highest (0.85 mg g^{-1}) chlorophyll a concentration in the fourth month. Magnesium deficient plants were also found to record relatively low chlorophyll a concentration (0.30 mg g^{-1} of leaf tissue) during the last month of observation. However, N deficient plants recorded the lowest (0.21 mg g^{-1}) and K deficient plants the highest (0.58 mg g^{-1}) values in the sixth month. The treatments were in the order - N< - Mg < -S <- P < control < - K during the sixth month.

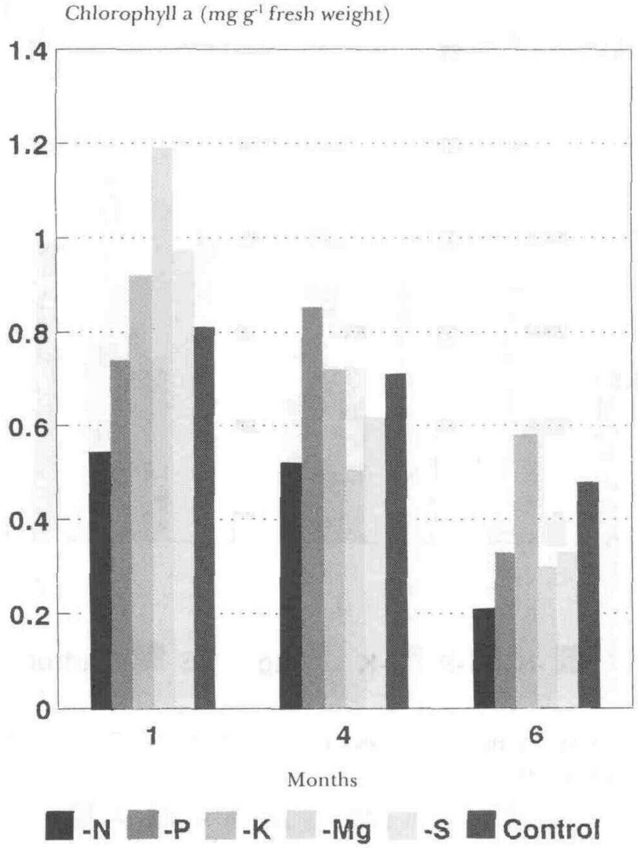

Figure 1. Effect of nutrient deficiencies on the chlorophyll a concentration (mg g^{-1} fresh weight)

Chlorophyll b concentrations were influenced similarly by the treatments (Figure 2). While the N deleted treatment recorded the lowest value during the fourth month, the Mg deleted treatment recorded the lowest during the sixth month, even though both were not significantly different from the other treatments. Potassium deficient plants recorded the highest chlorophyll b concentrations of 1.41 mg g^{-1} and 1.20 mg g^{-1} respectively during the fourth and sixth months. These were found to be higher when compared to the concentration obtained for plants receiving complete nutrient solution.

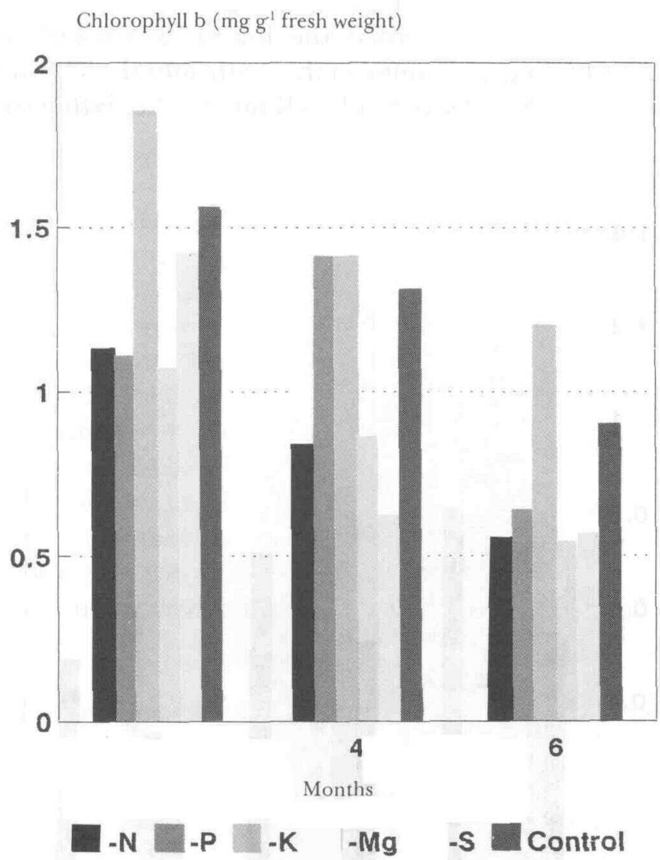

Figure 2. Effect of nutrient deficiencies on the chlorophyll b concentration (mg g^{-1} fresh weight)

Seedlings subjected to nitrogen stress recorded the lowest total chlorophyll concentration throughout the period of study (Figure 3). The total chlorophyll concentration decreased from 1.66 mg g^{-1} during the first month to 0.76 mg g^{-1} during the last month. Moreover, nitrogen and magnesium deficient plants were statistically comparable during the fourth and sixth months. Seedlings that received all the nutrients (control) had relatively higher total chlorophyll concentration (1.38 mg g^{-1}) and this could be ranked next to potassium deficient seedlings. With regard to total chlorophyll concentration, the treatments were in the order - N < -Mg < -S < -P < control < -K in this month.

The symptoms observed in the nitrogen deficiency treatment were found to coincide with the reduction in the two chlorophyll fractions of N deficient plants. The initial symptoms of nitrogen deficiency was yellow chlorotic patches in the older leaves of the seedlings which appeared by the end of the first month. By the end of the fourth month, the entire lamina of the lower leaves became pale yellow. In the acute stage of deficiency which was evident at the end of five months of study, the entire seedling appeared severly chlorotic. Incidentally N deficient seedlings had the lowest total chlorophyll concentration at this stage (0.76 mg g^{-1}).

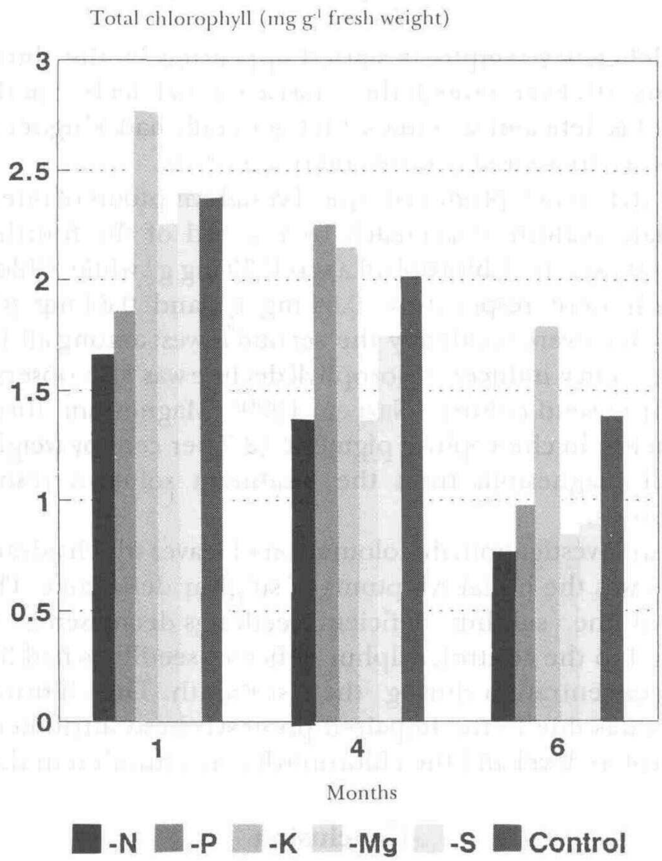

Figure 3. Effect of nutrient deficiencies on the total chlorophyll concentration (mg g^{-1} fresh weight)

The reduction in the chlorophyll concentration of chlorotic leaves due to N deficiency was also reported by Nazeem (1989) in nutmeg. Chlorosis of older leaves and the low chlorophyll concentration in N deficient seedlings was a result of inadequate supplies of nitrogen for chloroplast protein synthesis (Greulach 1973).

Phosphorus deficiency symptoms appeared on the older leaves as purple bronze patches (second month after imposing treatment) which in the advanced stage of deficiency extended to the entire leaflet. Like nitrogen, phosphorous deficient seedlings also showed gradual reduction in chlorophyll concentration and they had comparatively lower chlorophyll concentration in their leaf tissues compared to the healthy seedlings grown in complete Hoagland solution, by the end of the study. Phosphorus deficiency is reported to result in the formation and accumulation of anthocyanin pigments which lead to the development of purple colouration (Muller 1966). It is also noteworthy that phosphorus is an important structural component of the chloroplasts and its deficiency might have resulted in the lower concentration of chlorophyll in the leaf tissues, finally resulting in typical discolouration.

Potassium deficiency symptoms started appearing by the third month after imposing treatments. Even though there was a gradual decline in the chlorophyll concentration of K deficient seedlings, they generally had a higher concentration compared to other treatments by the end of the study.

Magnesium deficiency produced typical visual symptoms of interveinal chlorosis with reticulate pattern, particularly by the end of the fourth month when deficiency became severe. Chlorophyll a was 0.30 mg g^{-1} while Chlorophyll b and total chlorophyll were respectively 0.54 mg g^{-1} and 0.84 mg g^{-1} in the sixth month. These values were incidently the second lowest among all the treatments. Magnesium deficiency induced chlorophyll decline was also observed in nutmeg seedlings grown in sand culture (Nazeem 1989). Magnesium forms one of the major constituents in chlorophyll pigment (2.7 per cent by weight) and hence, the removal of magnesium from the treatment solution results in varying degrees of chlorosis.

In the present investigation, discolouration of leaves which advanced from the margin inwards was the initial symptoms of sulphur deficiency. The chlorophyll concentration of the sulphur deficient seedlings decreased by the end of the study. Compared to the control, sulphur deficient seedlings had 36 per cent less chlorophyll a concentration during the last month. The chlorotic nature of S deficient plants was due to the impaired photosynthesis attributed to the direct effect on the protein level and the chlorophyll concentration in the chloroplasts.

Conclusion

A significant reduction in all the fractions of chlorophyll in the leaves of *Ailanthus triphysa*, with the advancement of chlorotic symptoms, particularly due to nitrogen and magnesium deficiencies, was very pronounced in sand culture studies carried out under controlled conditions. Thus, along with the visual symptom method, chlorophyll analysis of the leaves of tree seedlings could be employed as an additional tool for accurate diagnosis of nutritional problems at the nursery stage.

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