*J. Phytol. Res.* **19**(1) : 43-45, 2006

# SOME EFFECTS OF ALUMINIUM TOXICITY ON *HYPTIS SUAVEOLENS* (L.) POIT.

**S. VASANTHA PILLAY**
Department of Botany, P.G. College of Science, O.U. Saifabad, Hyderabad – 500 004, India.

A soil culture experiment was carried out to evaluate the effect of high concentrations of aluminium on the growth, and pigment composition of *Hyptis suaveolens* (L.) Poit. Shoot dry weight reduced by 53% and root dry weight reduced by 24% at a level of 1000 ppm aluminium. Leaves had a withered appearance with margins rolled inwards. Both chl a and chl b decreased due to aluminium treatment. A reduction in carotene and xanthophyll content was noted. Aluminium treatment caused an increase in the content of aluminium in different plant organs. Roots contained the maximum aluminium concentrations.

**Keywords :** Aluminium toxicity; Growth; *Hyptis suaveolens;* Pigment composition.

Aluminium toxicity is considered an important growth limiting factor for plants in many acidic soils. The problem is further aggravated by the use of acid forming nitrogenous fertilizers. Higher concentrations of aluminium have been shown to be inhibitory for plant growth and metabolism[1-3]. There are several reports of the effects of soluble aluminium on dry matter production [4-6] and root growth[7,8]. *Hyptis suaveolens* is a predominant weed growing in these areas. The aim of the experiment was to study the effect of aluminium in excess concentrations on the growth of *Hyptis,* in order to evaluate aluminium toxicity effects on this plant.

*Hyptis suaveolens* (L.) Poit. plants were raised from seed in earthen pots (26cm x 28 cm) containing known amounts of air dried red loamy soil. Seedlings were thinned to four healthy plants of almost the same height and vigour in each pot. A week after thinning, each pot was fertilized with 100, 109 and 137 ppm N, P and K, respectively, as $NH_4NO_3$ and $KH_2PO_4$ in aqueous solution [9] and 2 ppm (dry weight basis) of Fe-EDTA. Metal ion treatment was given to one-month old plants. Selected aluminium concentrations (500, 1000, 1500 ppm of dry weight of soil) were added to the soil in appropriate quantities as 6% aluminium sulphate solution. The treatments were replicated three times. Throughout the experiment, care was taken to water the plants to field capacity to avoid leaching. The control plants were similarly maintained, except for the metal ion treatment.

About 25-30 days after treatment, the plants were harvested for the determination of dry matter yield and tissue aluminium content. Thoroughly cleaned leaves, stems and roots were dried to a constant weight in an oven maintained at 80°C and dry weights for these were determined. The dried samples were dry ashed and their aluminium content was analyzed by atomic absorption spectrophotometer. The chloroplast pigments were estimated in the fresh leaves following the method of Weybrew[10].

On addition of 500 ppm aluminium to the soil, Hyptis plants did not exhibit any apparent visual symptom of toxicity. Plants appeared healthy, with normal green leaves, which remained green till the harvest. At soil aluminium concentration of 1000 ppm, the plants appeared normal initially, but later, the leaves had a withered appearance, with margins slightly rolled in. Leaves started senescing slowly towards harvest time i.e., approximately three weeks after the treatment. Soil aluminium addition of 1500 ppm produced visual symptoms of toxicity from 4$^{th}$ to 5$^{th}$ day of treatment. Burning of leaves from tip downwards and from margins inwards were the first symptoms. Later they become dry and ultimately perished. The symptoms of aluminium injury are sometimes described as resembling those of phosphorus deficiency[11] or of calcium deficiency[12].

The effect of different concentrations of aluminium on the dry weight yield of *Hyptis* is shown in Table 1. Aluminium treatment caused a decrease in the dry weight of shoots and roots. Yield of *Hyptis* plants was 77.7% at 500 ppm aluminium, decreasing drastically to 48.4% at 1000 ppm aluminium. Shoot dry weight decreased by more than 50% of the control. Chlorophyll a as well as chlorophyll b decreased with increase in concentration of aluminium(Table 2). Chlorophyll a was comparatively more affected than chlorophyll b. Increase in the concentration of aluminium treatment caused a reduction in the content of carotene and xanthophyll.

Decrease in chlorophyll a/b and chlorophyll/ carotene ratio suggests oxidative damage of chlorophyll a. By lowering chlorophyll content, aluminium has been

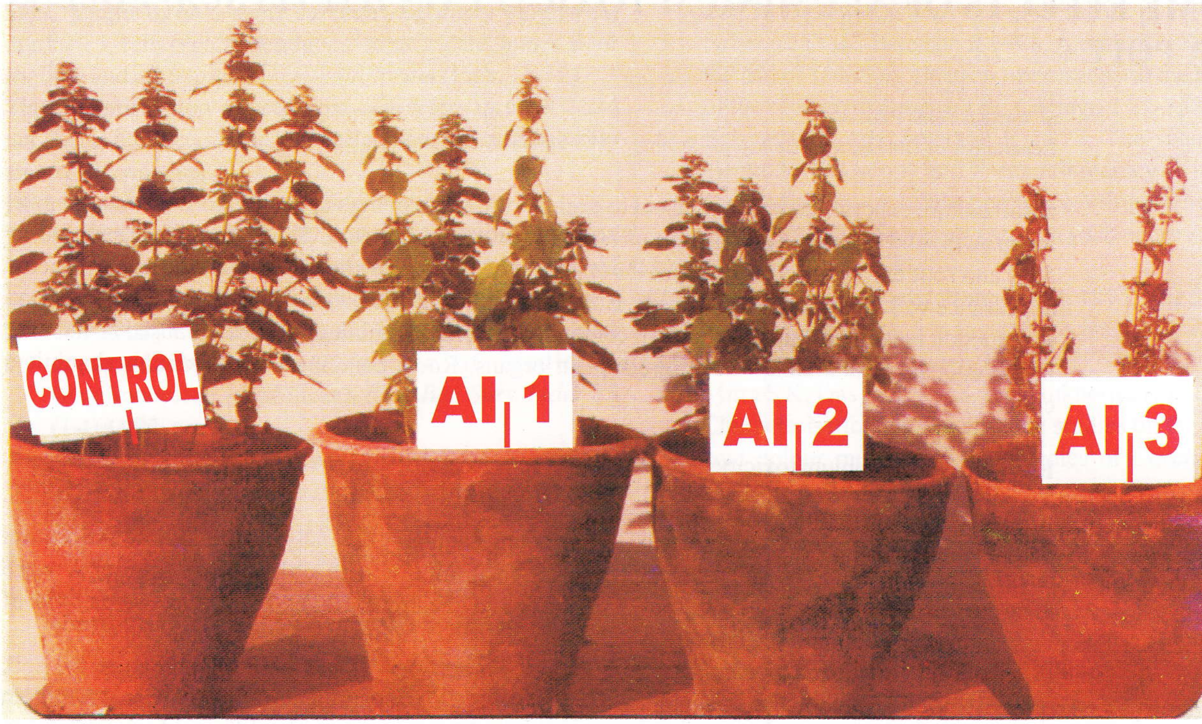


**Fig. 1.** Photograph showing the effect of different levels of Al application on the growth of *Hyptis suaveolens*. Al, 1, 2, 3 represent 500, 1000 and 1500 ppm Al respectively.

**Table 1.** Effect of excess aluminium on the dry weight yield of *Hyptis suaveolens* (L). Poit.

| Treatment | Dry weight per plant in gm | | | |
|---|---|---|---|---|
| | Shoot | Root | Whole Plant | Yield % of Control |
| Control | 1.33 ± 0.24 | 0.050 ± 0.001 | 1.380 | 100 |
| Al 500ppm | 1.03 ± 0.05 | 0.043 ± 0.008 | 1.073 | 77.7 |
| Al 1000ppm | 0.63 ± 0.09 | 0.038 ± 0.002 | 0.668 | 48.4 |
| *Al 1500ppm | - | - | - | - |

* Insufficient material due to severe toxicity

**Table 2.** Effect of excess of aluminum on the chloroplast pigments of leaves of *Hyptis*. (Results expressed as mg/gr fresh weight) (Mean of 3 replicates)

| Treatments | Chl a | Chl b | Total Chlorophylls | Chl a/b ratio | Caortene | Xantho-phyll | Total Carotenoids | Chl/car ratio |
|---|---|---|---|---|---|---|---|---|
| Control | 1381 | 578 | 1959 | 2.39 | 186 | 321 | 507 | 3.86 |
| Al 500 ppm | 1148 | 528 | 1676 | 2.17 | 185 | 289 | 474 | 3.54 |
| Al 1000 ppm | 973 | 476 | 1449 | 2.04 | 155 | 253 | 408 | 3.55 |
| *Al 1500 ppm | - | - | - | - | - | - | - | - |

* Insufficient material due to severe toxicity

shown to affect photosynthesis[13]. The reduction in growth observed in the present study for the aluminium treated plants is correlated with decrease in the pigment content, leading to a disturbance in metabolism as reflected by the phytotoxic symptoms exhibited.

**Table 3.** Aluminium content in different plant parts of control and Al-treated *Hyptis* plants (µg/gr dry wt) (Results are mean of 3 replicates)

| | Control | 500ppm | 1000ppm | 1500ppm |
|---|---|---|---|---|
| Calyx | 20 | 880 | 1740 | - |
| Leaves | 82 | 1200 | 3240 | - |
| Stem | 60 | 440 | 1500 | - |
| Root | 320 | 2460 | 6000 | - |

A direct linear relationship was observed between soil applied aluminium treatments and tissue aluminium concentration in *Hyptis* plants (Table3). Within the different plant organs, the stems contained the minimum aluminium concentration and the roots the maximum. Although much of the absorbed aluminium was retained in the roots, a considerable amount was also translocated to the above ground parts. This was more prominent at 1000ppm level of aluminum treatment where more aluminium seemed to have been translocated upwards, as indicated by the high leaf aluminum concentration. Hence, at the highest level of 1500 ppm aluminium, *Hyptis* did not survive due to severe toxicity.

A decrease in dry weight seems to be a common effect of metal toxicity[14-16]. The high leaf aluminium content of *Hyptis* plants at 1000 ppm, brought down the dry weight yield drastically, due to aluminium toxicity. Aluminum concentrations in plant tops correlate with aluminium injury. Several investigators found that aluminium tolerant varieties contained less amount of aluminium in shoots as compared to aluminium sensitive ones, as observed in wheat[17], alfalfa[18] and cranberry[19]. *Hyptis* was found sensitive to aluminium at higher levels, because it accumulates considerable aluminium in the leaves.


1. Foy C D, Chaney R C and White M C 1978, The Physiology of metal toxicity in plants. *Ann Rev. Plant Physiology* **29** 511-566
2. Kochian L V 1995, Cellular mechanisms of Al toxicity and resistance in plants. *Annv. Rev. Plant Physiology Plant Mol. Biol.* **46** 237-260
3. Clark R B 1997, Effect of Al on growth and mineral elements of Al tolerant and Al intolerant corn. *Plant Soil* **47** 653-662
4. Lance J C and Pearson R W 1969, Effect of low concentrations of aluminium on growth and water nutrient uptake by cotton roots. *Soil Sci. Soc. Am. Proc.* **33** 95-98
5. Foy C D, Fleming A L and Armiger W H 1969, Alumnium tolerance of soyabean vatieties in relation to calcium nutrition. *Agron. J.* **61** 505 – 511
6. Lee C R 1971, Influence of aluminium on plant growth and mineral nutrition of potatoes. *Agron. J.* **63** 604-608
7. Fleming A L and Foy C D 1968, Root structure reflects differential aluminium tolerance in what in wheat varieties. *Agron. J.* **60** 172-176
8. Adams F and Lund Z.F 1966, Effect of chemical activity of soil solution aluminium. *Soil Sci.* **101** 193-198
9. Foy C D 1976, In : *Plant adaptaion to mineral stress in problem soils* (Ed, M.J. Wright) Cornell University, Ithaca, pp 255-267.
10. Weybrew J A 1957, Estimation of the Plastid pigments in Tobacco. *Tobacco Science* **1** 1-5
11. Munns D N 1965, Soil acidity and the growth of a legume. II. Reactions of aluminium and phosphate in solution and effects of Al, phosphate Ca and pH on *Medicago sativa,* L. and *Trifolium subterraneum.* L. in solution culture. *Aust. J. Agric. Res.* **16** 743-755.
12. Edwards J H and Horton B D 1977, Aluminium - induced calcium deficiency in peach seedlings. *J. Am. Soc. Hortic. Sci.* **102** 459-461.
13. Roy A K, Sharma A and Talukder G 1988, Some aspects of aluminium toxicity in plants. *The Bot. Rev.* **54** 145-178.
14. Wallace A, Muller R T and Alexander G V 1976, High levels of four heavy metals on the iron status of plants. *Soil Science and Plant Analysis* **7** 43-46
15. Veeranjaneyulu K and Das V S R 1982, Heavy metal torerance in normal populations of some weed species. *Indian J.Plant Physiology* **XXV**, 400-406.
16. Pillay S V, Rao V S and Rao KVN 1994, Comparative effects of copper and zinc toxicity and tolerance of *Hyptis suaveolens* (L.) Poit. and *Helianthus annuus* L. *Intern. J. Environ. Studies* **46** 173-182
17. Ostuka K 1968, Aluminium and manganese toxicity in plants. II. Effects of aluminium on growth of barley, wheat, oats and rye-seedling. *J. Sci. Soil Manure* (Tokyo) **39** 469-474
18. Ouellette G J and Dessureaux, L. 1958, Chemical composition of alfa alfa as related to degree of tolerance to manganese and aluminium. *Can. J. Plant Sci.* **38** 206-214
19. Medappa K C and Dana M N 1970, Tolerance of cranberry plants to manganese, iron and aluminium. *J. Amer. Soc. Hort. Sci.* **95** 107-110