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Effect of Trace Elements on Groundnut (*Arachis hypogaea*)

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Trace elements (B, Cu, Mn and Zn) and their combinations substantially increased both root and shoot length of groundnut plants. Maximum root length was recorded in nutrient solution containing Cu, Zn, Cu + Zn and shoot length in Cu + Mn and Cu + Zn. Chlorophyll 'a', 'b' and carotenoid increased in the leaves of treated plants except in B, Cu + Mn and Cu + Mn + B.
Addition of Zn, Cu + Mn, Cu + Zn, Cu + Mn + Zn and B + Cu + Mn + Zn increased the pod yield of groundnut by 200%. Biomass of groundnut plants was also increased by trace elements and their combinations.

Key Words - Carotenoid Chlorophyll Growth Plants Root Shoot Trace Elements.

Groundnut is one of the important oil seed crops in India. Frequent germination failure of groundnut and common occurrence of root rot in young seedlings are attributed to the pre-emergence infection and seedling dry rot caused by *Rhizoctonia bataticola* (Taub.) Butl., (Shanmugam, 1971). In addition, this fungus causes wilt and leaf spot of seedlings and mature plants.

Trace elements are indispensable for the growth of higher plants and influence the development of diseases (Sadasivan, 1965). The morphological, anatomical and physiological characteristics of the plant are modified by nutrients in such a way that the disease may be hastened or retarded.

We investigated the importance of trace elements in the control of root rot of groundnut. As part of the investigation, we studied the effect of trace elements on groundnut plants and the results are reported.

MATERIALS & METHODS Groundnut (*Arachis hypogaea* L.) seeds cv. TMV-2 were obtained from the Oil Seeds Research Station, Putlur, Tamil Nadu. Uniform sized seeds were surface sterilized with 0.1% $HgCl_2$ for 1 to 2 min, washed in several changes of sterile distilled water and kept in sterile earthenware pots (24 x 12 cms) filled with vermiculite. For each treatment, 10 pots, with 5 seedlings were used.

B as Na_2B4O_7, Cu as $CuSO_4.5H_2O$, Mn as $MnSO_4.H_2O$ and Zn as $ZnSO_4.7H_2O$ were used. Concn of stock solution was 1 mM and dilutions of 0.25, 0.5 and 1 mM were prepared.

Eight day old plants were treated with trace element solution. Combinations and concns used were B - 0.25 mM; Cu - 0.5 mM; Mn - 1 mM; Zn - 1 mM; Cu + Mn - 0.5 + 1 mM; Cu + Zn - 0.5 + 1.0 mM; Cu + Mn + B - 0.5 + 1 + 0.25 mM; Cu + Zn + B - 0.5 + 1 + 0.25 mM; Cu + Mn + Zn - 0.5 + 1 + 1 mM; B + Cu + Mn + Zn - 0.25 + 0.5 + 1 + 1 mM. Hoagland's solution modified by Johnson *et al.* (1957) without the trace elements was employed to water the plants grown in pots kept in a wiremesh house. The nutrient solution was added every alternate day, keeping the water holding capacity of the vermiculite at 50 to 55%.

After 6 weeks of growth, the plants were removed; roots and shoots were separated; washed with glass distilled water free of vermiculite and length of root and shoot was measured. Third leaf from the base of groundnut plants grown in vermiculite was used for the estimation of chlorophyll and carotenoid (Mahadevan & Sridhar, 1982).

In another set of experiment, the plants were grown to maturity and the yield of pods and biomass (sun dried plant residue) was measured.

RESULTS Root length - Root length of groundnut seedlings was promoted by B and Mn by 18 and 26% respectively, while Cu and Zn increased it by more than 50% (Table 1).

Cu along with Mn inhibited root length with reference to Cu and Mn controls. With Zn, its promoting activity declined.

Addition of B or Zn to Cu + Mn, slightly enhanced root length while B along with Cu + Zn reduced it.

Combination of all the metals increased the root length by 27% over the control.

Shoot length - B and Mn did not alter the shoot length of plants but Cu and Zn stimulated it by 38 and 29% respectively (Table 1).

Table 1 Effect of Trace Elements on the Root and Shoot Length of 42 day old Groundnut Plants

Treatment	Root length (mm)	Shoot length (mm)
Control	130	164
B - 0.25 mM	154	179
Cu - 0.5 mM	197	227
Mn - 1.0 mM	164	171
Zn - 1.0 mM	195	212
Cu + Mn 0.5 + 1.0 mM	154	224
Cu + Zn 0.5 + 1.0 mM	182	229
Cu + Mn + B 0.5 + 1.0 + 0.25 mM	161	190
Cu + Zn + B 0.5 + 1.0 + 0.25 mM	173	215
Cu + Mn + Zn 0.5 + 1.0 + 1.0 mM	163	194
B + Cu + Mn + Zn 0.25 + 0.5 + 1.0 + 1.0 mM	165	185

Table 2 Effect of Trace Elements on the Pod Yield and Dry Weight of Groundnut Plants (105 day)

Treatment	No. of Pods	Dry weight of Pods (mg)	Dry weight of plants (g)
Control	13	390	4.1
B - 0.25 mM	20	680	6.8
Cu - 0.5 mM	20	490	8.8
Mn - 1.0 mM	23	605	9.1
Zn - 1.0 mM	26	658	8.3
Cu + Mn 0.5 + 1.0 mM	27	782	10.8
Cu + Zn 0.5 + 1.0 mM	29	805	11.0
Cu + Mn + B 0.5 + 1.0 + 0.25 mM	24	650	9.9
Cu + Zn + B 0.5 + 1.0 + 0.25 mM	22	520	10.5
Cu + Mn + Zn 0.5 + 1.0 + 1.0 mM	30	820	9.0
B + Cu + Mn + Zn 0.25 + 0.5 + 1.0 + 1.0 mM	33	1,060	11.0

Table 3 Total Chlorophyll and Carotenoid in 20 day old Healthy Groundnut Leaves

Treatment	Chlorophyll a		Chlorophyll b		Carotenoid	
	Amount	% control	Amount	% control	Amount	% control
Control	6.8	100	4.4	100	12	100
B - 0.25 mM	7.2	106	4.0	91	9	75
Cu - 0.5 mM	15.4	226	4.7	107	22	183
Mn - 1.0 mM	15.8	232	12.5	284	16	133
Zn - 1.0 mM	13.1	193	11.2	255	20	167
Cu + Mn 0.5 + 1.0 mM	5.9	87	5.9	134	40	333
Cu + Zn 0.5 + 1.0 mM	6.5	96	6.0	136	26	217
Cu + Mn + B 0.5 + 1.0 + 0.25 mM	6.0	88	6.5	148	14	117
Cu + Zn + B 0.5 + 1.0 + 0.25 mM	6.5	96	7.3	166	12	100
Cu + Mn + Zn 0.5 + 1.0 + 1.0 mM	16.4	241	11.9	270	13	108
B + Cu + Mn + Zn 0.25 + 0.5 + 1.0 + 1.0 mM	10.5	154	8.6	195	12	100

Cu in presence of either Mn or Zn did not change the length of shoot with reference to metal control. Addition of B to Cu + Mn or Cu + Zn reduced the favourable effect. Although Cu + Mn + Zn increased the shoot length, it was much low.

Application of B + Cu + Mn + Zn increased the shoot length by 13% over the control but in fact, it was less when the data were compared with the corresponding metal control.

Yield of Pods - Trace elements promoted the number and yield of pods, Zn increased it by 2-fold followed by Mn (77% over control). B and Cu effectively increased the yield by 54% (Table 2). Cu + Mn and Cu + Zn exerted synergistic effect on the yield . When B was added to Cu + Mn or Cu + Zn, the yield decreased with reference to metal control. Combined application of Cu + Mn + Zn effectively increased the number of pods. The yield substantially increased (254%) when plants were grown in a solution containing B + Cu + Mn + Zn (Table 2).

Dry weight of plants- B, 0.25 mM increased the dry weight of plants by 66% while Cu, Mn and Zn increased it by more than 2-fold.

Cu either with Mn or Zn markedly increased the dry weight by 163 and 168% over the control (Table 2).

Addition of either B or Zn to Cu + Mn reduced the favourable effect. Similarly when B was combined with Cu + Zn, the yield declined.

Dry weight production was maximum when plants were grown in a solution containing all the metals. However, it was equal to the one induced Cu + Zn (Table 2).

Chlorophyll content The leaves of groundnut plants grown in nutrient solution containing Cu, Mn and Zn contained high levels of chlorophyll 'a' and 'b' and maximum increase was in Mn treated plants (Table 3). In the plants grown in Cu + Mn or Cu + Zn, Chorophyll 'b' registered a 50% increase over the control while chlorophyll 'a' was not altered. Chlorophyll 'a' decreased by 14% in plant grown in Cu + Mn. similar was the trend when B was combined either with Cu + Mn or Cu +Zn. In the leaves of plants grown in Cu + Mn + Zn, Chlorophyll 'a' and 'b' increased more than 100% over the control (Table 3). In the Solution B + Cu + Mn + Zn both chlorophyll 'a' and 'b' increased, however, it was less with reference to metal control (Table 3).

Carotenoid- Application of trace elements altered the carotenoid level of leaves. B markedly reduced it while Cu, Mn and Zn increased it (Table 3). Cu in combination with Mn increased the carotenoid by more than 3 fold and Zn by 2 fold. Addition of B to Cu + Mn decreased the pigment when compared to metal control. But B when added to Cu + Zn caused little change in carotenoid. When plants were treated with Cu + Mn + Zn solution, carotenoid level decreased. However, in the leaves of plants grown in B + Cu + Mn + Zn, carotenoid was not altered.

Discussion- Trace elements (B, Cu Mn and Zn) individually and in combination increased both root and shoot length of plants and changed the pigments. According to Dyar & Webb (1968) B is essential for the biosynthesis of auxin in *Phaseolus sp.* The enzyme which converts indole acetaldehyde to IAA requires B for its activity. In fact, in B deficient *Vicia faba* and *Zea mays* plants, IAA level declined (Shkolnik, 1975). Mn stimulated auxin activity of bean , oat , pea and wheat (Krishna & Bharti, 1983). Zn is required for the synthesis of tryptophan and auxin in tomato plants (Tsui, 1948). Indeed, it activated the enzyme which condenses indole and serine to form tryptophan (Shkolnik, 1975). Typtophan content of *Zea mays* (Orabi & Abdel-Aziz, 1982) *Catharanthus roseus* (Vasuki *et al.*, 1980) increased in response to Zn treatment. According to Shkolnik (1975), Cu plays an imporant role in auxin and nucleic acid metabolism by influencing enzymes. Cu affects DNA synthesis (Ozolinya & Lapinya, 1965).

Zn acts on naturally occurring gibberellin like substance and caused an increase in elongation of stem and internode of bean (Dancer, 1959). We found that Zn promoted root and shoot length of groundnut plants.

Increase in chlorphyll content was associated with increased yield and dry weight of groundnut plants. B promoted translocation of photosynthates in bean (Mc Nairn & Currier, 1965). Bond & Hewitt (1967) reported that there was a positive correlation between increased chlorophyll due to Cu and dry weight of plants (*Alnus glutinosa*). Cu, 0.5 mM increased Chlorophyll and Photosynthesis and ultimately yield of groundnut plants.

Yield and dry weight of pods of groundnut were increased by B, Cu, Mn and Zn. Similar increase in pod yield of groundnut by B was reported (Asokan 1970; Asokan & Raj, 1976; Golakiya & Patel, 1986; Gopal & Rao, 1969; Sankaran, 1972). This may be due to the effect of B on

flower viability and fertility (Garg *et al.*, 1980; John, 1958) which in turn reduced the number of aborted fruits and increased the number of mature kernels (Cox & Reid, 1964).

Substantial increase in dry matter and pod yield of groundnut was obtained by the application of Mn (Benac, 1977; Saini *et al.*, 1976; Sanjeevalah, 1969, Solankey *et al.*, 1973) and Zn (De & Chatterjee, 1976; Lakshminarasimham *et al.*, 1977; Shukla & Prasad, 1979) to soil

Clearly, trace elements and their combinations influence the growth and yield of groundnut plants, however, the physiological mechanism is far from clear.

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