STUDIES ON THE ESSENTIAL TRACE ELEMENTS ON THE GROWTH AND YIELD OF TWO SOLANACEOUS PLANTS

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SUMMARY: The effect of essential trace elements on the growth of leaves, flowers and fruits yield components of Solanum melongena L. (egg plant) and Capsicum annum L. (Chili Pepper) by foliar application were studied.

Foliar micronutrients were prepared in the laboratories and compared with a standard sample. The trials were conducted in the experimental farm of PCSIR Laboratories Complex, Karachi in April, 1993. The crop was harvested four months later in August. One set of experiment was kept as controls and were sprayed with equivalent quantity of water.

In the treated plants the flowering and fruiting took place twenty days earlier as compared to the controls. The treated plants bore more fruits and their sizes were also bigger than those of the control series.

The analysis of variance means reveals that in treated sets the growth factors had significant difference at both levels ($p<0.05$ and $p<0.01$) as compared with the control. The role of trace elements on the growth of plants by foliar application has been discussed.

Key Words: Trace elements, crop yield, economics, solanum melongena L., capsicum annum L.

INTRODUCTION

Most of the soils of Pakistan are deficient in certain micronutrients especially in iron and Zinc (1). The agro-climatic conditions in Sindh are conducive for high yields of chili pepper and egg plant, but the present yield levels are dismally low. Among other factors, the deficiency or non-availability of some essential trace elements in these crops result in considerable yield reductions. Generally nitrogen and phosphate fertilizers are added into the soil and considered sufficient while replenishment with micronutrients is seldom done. The per acre yield of these crops is considerably low as compared to that of other countries because of the deficiencies. Spectacular increase in yield have been recorded in experiments with micronutrients in many countries like Australia and New Zealand (2,3). It has been observed that there was considerable increase in the yield of straw and grain of wheat crop on the application of two doses each of Fe (60 and 120 ppm) and Zn (8 and 12 ppm) alone or in combination (4). Zinc is involved in formation of growth hormones, promotion of protein synthesis, grain maturation etc. Iron is involved in chlorophyll synthesis, oxidation-

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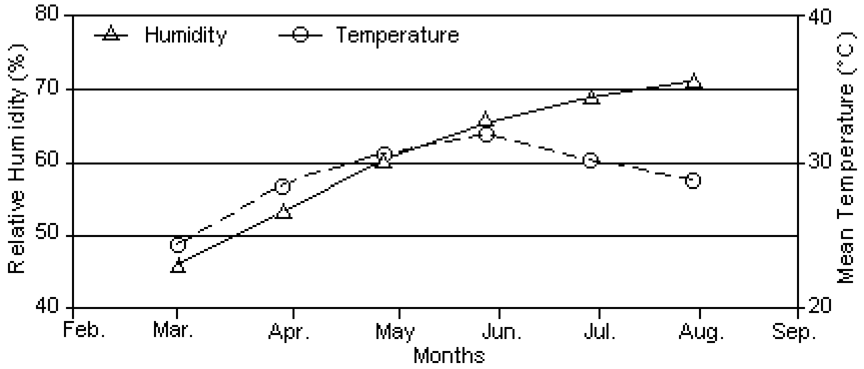
Figure 1: Showing temperature and humidity % in the months (March-August) 1993.



reduction and respiration. Copper acts as catalysts for respiration and is a constituent of enzymes. Trace elements like manganese is essential for nitrogen metabolism, nitrogen fixation, carbon dioxide assimilation and carbohydrate breakdown (5). Foliar feeding constitutes one of the important milestones in the progress of agriculture crop production. It has been an established practice with many crops (6-8).

The present study was therefore conducted to observe effect of supplementation of micronutrients on the yield of two vegetables by foliar application as no such work was previously conducted in Sindh region. Some medicinal uses of egg plant include treatment of diabetes, asthma, Cholera, bronchitis, and dysuria; it's fruits and leaves are reported to promote lowered blood cholesterol levels (9). Chili peppers have high nutritional value; they are good sources of Vitamins, particularly Vitamins A and C (10).

MATERIALS AND METHODS

Culture experiments:

Experimental conditions: All culture experiments were conducted at experimental fields of PCSIR Laboratories Complex, Karachi. The seeds of two vegetables namely *Capsicum annum L.* Var acuminatum Fingh. and *Solanum melongena L.* Var melongena were sown in the pots. Experiment was laid in randomized factorial arrangement with four replicates of each set i.e. GreenZit (a standard), Sarzabz, micronutrient concentrate and control for each crop. The experiments were carried out in the earthen pot 35 cm diameter and 35 cm depth during the month of March 1993 to August 1993. The minimum and maximum temperature (°C) with relative humidity (%) of desired months have been incorporated in Figure 1.

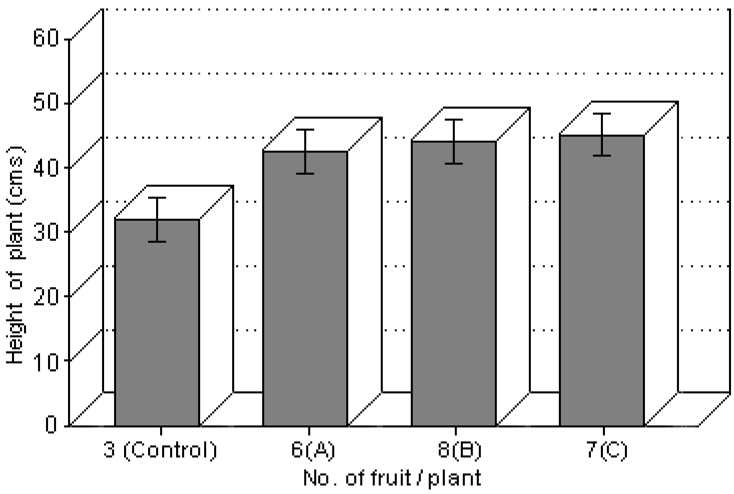
Inner wall of each pot was lined with polyethylene sheet to avoid any contamination and subsequently filled with 10 kg. soil. A composite sample of the soil was taken to determine its physicochemical properties; Clay, Silt and Sand contents were determined by Bouyoucos hydrometer (11). The pH and electrical conductivity were determined in a suspension of soil to water ratio 1:2 on pH meter using a glass electrode and on the conductivity meter respectively. Carbonates were determined by potentiometric method (A.O.A.C.) (12). Concentration of micronutrients was determined on Atomic Absorption (Hitachi Z-8000 coupled with Zeeman's correction) employing DTPA extraction method (13). Organic matter was determined by dichromate method (14).

The study of physicochemical properties of the soil shows that it contained sand (77.4%), Clay (11.3%), Silt (11.3) and it's texture was loamy sand. It's pH (Soil 1: water 2) was 7.8, and it's electrical conductivity 1.5 mmhos. It contained organic matter 2.92%, $CaCO_3$ 15%. The moisture contents was 6.03% (15). DTPA extract of soil contained Zn (8.2 ppm), Fe (60.8 ppm), Cu (0.16 ppm), Mn (13.4 ppm) and Mg (660 ppm).

Three micronutrients preparations: A, B and C were used in the experiments. Preparation C is a popular propriety commercial product (Standard) while A and B were developed in our labs. Micronutrients composition of A and B per liter was Fe (5000), Cu (50), Mn (500), Zn (250), B (500) and Mo (40) and Fe (1000). Cu (10), Mn (100), Zn (50), B (100) respectively. For treating the plants 5 ml. of preparation B, C and 2.5 ml of A were dissolved in 1L water and total quantity was sprayed on the leaves of the plant in each pot. Only three plants were left to grow in each pot and they received a total of 16 sprays in four months time (4 Sprays per month).

The soil was prepared by mixing sweet sand and well composted cowdung-manure in a ratio of 1:2. Seeds were

Figure 2: Effect of different foliar fertilizers on the growth and yield of *S. melongena L.*



planted in the first week of March and the crop was harvested in August.

The data collected after selecting normal looking 5 plants in each treatment and were analyzed statistically using analysis of variance method. The significant difference among the treatment means were computed by Dunnett's procedure (16) and respective means of each treatment were compared with control means.

RESULTS AND DISCUSSION

The effectiveness and role of foliar sprays in preventing and correcting nutritional disorders and supplementing root absorption in supplying the nutritional needs of a Crop, is conditioned both by the rate of uptake and by the subsequent mobility of nutrients involved. The concept that foliar sprays should be applied only after the deficiency disorder appears is unsound, since depressions in the yield and quality precede the appearance of visual symptoms (17). Thus the role of trace elements by foliar sprays on the yield of fruits on two solanaceous plants has been studied. The growth responses in respect of average height of plant, length of leaves, length of root, shoot and their ratio have been determined in both crops. The leaves and fruits of both vegetables have been analyzed for Fe, Mn, Zn and Cu.

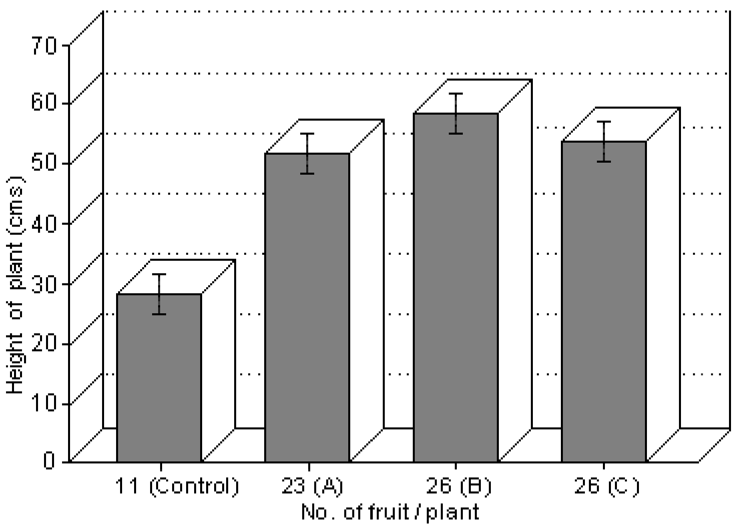
Table 1: Effect of different foliar fertilizers on the growth and yield of *C. annum L.*

S. No. Treatments	Mean height of plant (cm)	Mean length of leaf (cm)	Mean length of internode (cm)	Mean Root/Shoot ratio (cm)	Mean number of fruit/plant
1. Control	28.6	5.24	2.64	1.49	11.0
2. M.N. Concentrate (A)	51.0*	8.90	3.68**	1.02	23.0
3. Sarsabz (B)	56.6**	9.42	3.86**	1.22	26.0*
4. Standard (C)	52.2**	9.00	3.96**	1.28	26.0*
Computation of Dunnett's significant diference (one sided)					
(a) P 0.05	16.44	4.87	0.54	0.70	14.0
(b) P 0.01	22.60	-	0.75	-	-

* Significant at P 0.05

** Significant at P0.01 and 0.05

Figure 3: Effect of different foliar fertilizers on the growth and yield of C. annum L.



1. Plant height: The data was subjected to analysis of variance and significant difference was calculated by Dunnett's procedure and respective means of each treatments were compared with control mean. Computed data has been incorporated in Table 1 and Table 2. The Sarsabz (B) gave highest mean value for the plant height (*Capsicum annum L.*) and Value is significant at both p<0.05 and p<0.01, levels. Standard (C) gave the second best mean value for plant height which is significant at both p<0.05 and p<0.01, levels, while foliar Spray, M. N. Concentrate (A), gave the lowest mean for plant height which is significant at p<0.05 only.

In the case of *Solanum melongena L*, the standard (C) foliar spray, however, gave the highest mean value for plant height which is significant at p<0.05 only, Sarsabz (B) and M. N. Concentrate (A) gave the non-significant difference in plant height.

2. Length of leaves per plant: It is depicted from the analysis of variance means that foliar sprays Sarsabz

Table 2: Effect of different foliar fertilizers on the growth and yield of *S. melongena L.*

S. No. Treatments	Mean height of plant (cm)	Mean length of leaf (cm)	Mean length of internode (cm)	Mean Root/Shoot ratio (cm)	Mean number of fruit/plant
1. Control	31.4	7.7	3.6	1.25	3.0
2. M.N. Concentrate (A)	42.6	12.4**	4.64**	1.24	6.0
3. Sarsabz (B)	43.4	12.7**	4.86**	1.22	8.0*
4. Standard (C)	44.2*	12.5**	4.78**	1.20	7.0*
Computation of Dunnett's significant diference (one sided)					
(a) P 0.05	12.47	1.24	0.55	Non significant	5.0
(b) P 0.01	17.14	1.70	0.76	Non significant	-

* Significant at P 0.05

** Significant at P0.01 and 0.05

Table 3: The Trace Element Composition (ppm) of *Capsicum annum* (leaves).

No.	Treatments	Fe	Mn	Mg	Zn	Cu
1.	Control	273.47	50.57	10577	25.8	6.19
2.	Mic-Concn. (A)	282.63	53.33	10370	25.14	6.42
3.	Sarsabz. (B)	290.73	54.95	10448	25.5	6.39
4.	Standard. (C)	280.30	52.05	10632	26.00	6.24

Table 4: The Trace Element Composition (ppm) of *Capsicum annum* (fruits).

No.	Treatment	Fe	Mn	Mg	Zn	Cu
1.	Control	273.72	21.72	3344.80	23.53	11.69
2.	Mic-Concn. (A)	269.90	25.2	2074.46	24.7	10.45
3.	Sarsabz. (B)	280.15	22.4	3492.8	22.35	14.37
4.	Standard. (C)	264.12	25.78	3222.48	21.30	15.04

(B), standard (C) and M. N. Concentrate (A) had highly significant effect on the length of leaves of *S. melongena* at both $p<0.05$ and $p<0.01$ levels. Highest mean value was recorded for Sarsabz (B). An increase of 1.2 cm in average length of the leaf per plant was observed and thus healthier leaves gave better results by producing larger number of flower and fruits per plant (Table 2). No significant effect of foliar sprays, on the length of leaves of *C. annum L.* was observed (Table 1).

3. Length of internodes: It is depicted from the analysis of variance means that all foliar sprays had highly significant effect on the length of internodes of *C. annum L* at both ($p<0.01$ and $p<0.05$) levels (Table 1). In the case of *S. melongena* the same results obtained at both levels by spraying with Sarsabz (B) and Standard (C), and M. N. Concentrate, (Table 2).

4. Root/Shoot ratio: All the foliar fertilizers had no significant effect on the root shoot/shoot ratio in both crops.

5. Number of fruits per plant: It is explicit from the data given in (Tables 1 and 2) that number of fruits per plant were significantly affected ($p<0.05$) by foliar sprays in both crops.

In case of *S. melongena L*; the control set bore average 3 fruits per plant while in the treated sets the following number of fruits per plant were harvested i.e.

Table 5: The Trace Element Composition (ppm) of *Solanum melongena* (brinjal leaves).

No.	Treatment	Fe	Mn	Mg	Zn	Cu
1.	Control	273.9	42.91	10413	15.5	9.94
2.	Mic-Concn. (A)	264.33	43.92	10964.3	14.13	8.83
3.	Sarsabz. (B)	252.77	46.25	10142	13.88	8.95
4.	Standard. (C)	263.3	49.58	10632	12.12	7.71

Table 6: The Trace Element Composition (ppm) of *Solanum melongena* (brinjal fruit).

No.	Treatment	Fe	Mn	Mg	Zn	Cu
1.	Control	42.02	16.44	2744.99	21.92	10.35
2.	Mic-Concn. (A)	45.62	14.91	2546.89	19.78	9.82
3.	Sarsabz. (B)	42.61	14.02	2803.32	19.64	9.29
4.	Standard. (C)	49.37	15.56	2576.11	20.15	8.54

A(6), B(8), C(7) (Table 2 and Figure 2). A substantial increase around 2.5 times was observed. Flowering started 22 days earlier in the treated sets. In *C. annum L*; the maximum number (26) fruits per plant was observed. Again a substantial increase around 2.5 times was observed in treated plants (Table 1 and Figure 3).

The analysis of the trace elements were carried out two times. The first analysis was done after 8 weekly sprays and second analysis after 16 weekly sprays. The Table 3 shows the analysis for Fe, Mn, Mg, Zn, Cu in leaves of control and treated *C. annum* after sprays, while Table 4 shows the trace elements contents in fruits. Table 5 shows the trace elements composition of leaves, and Table 6 of fruits of *S. melongena*. It may be seen that virtually there has not been any change in trace element contents of leaves and fruits of the treated plants in both vegetables even after 16 sprays. It has been observed that their excess use on the contrary, exerts strong toxic effects on crop growth (18-20).

Precisely, the plants require micronutrient in small quantities, their deficiencies depress yields drastically (21,22). The recommendation of early research workers strongly advocate the use of micronutrients preferentially by foliar application and these findings are in agreement with those obtained by them (23,24).

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