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# Effect of micro-nutrients on flower, pollen production, yield and quality in male parental line of tomato hybrid CoTH 1

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## ABSTRACT

**Field experiments were conducted to study the effect of micro-nutrients on flower production, pollen viability, seed yield and quality. Pollen viability and number of flowers plant$^{-1}$ were maximum with soil (10 kg ha$^{-1}$) and foliar (0.1% twice) application of borax. Combined application of borax through soil and foliage recorded the highest percentage of seed recovery (1.02%) and 100-seed weight (240 mg). Micronutrient application showed their superiority over control in the resultant seeds in terms of germination and vigour.**

**Key words**: Micro-nutrients, seed yield, seed quality, pollen viability.

## INTRODUCTION

In tomato for successful hybrid seed production, increased pollen production accompanied with high level of viability is the basic requirement. Pollen grains of zinc deficient plant show high sterility. Micro-nutrient deficiencies, such as boron, zinc and copper normally result in premature floral abscission that leads to failure of seed set. Floral and fruiting organs are especially sensitive to boron deficiency (Brown *et al.,* 5). In many crops, there is a much higher demand for boron during flowering and seed set. Foliar application of boron will increase the fruit set and yield (Perica *et al.*, 9; Asad *et al.*, 3; Dordas, 6). Boron deficiency leads to small size and low viable pollen grains. Hence, intensive studies on the involvement of micro-nutrients in reproduction physiology would generate more information on the reproductive metabolism. The main means to compensate shortage of flowers and / or pollen production particularly in hybrid seed production is to increase the area under male parent in a crossing block. Though the proposition, it is uneconomical to the producers, as the male seeds are not needed for further multiplication. In addition, the cost involved on foundation seed production and crop maintenance adds up cost of inputs. Hence, an appropriate management strategy to augment flower and pollen production associated with good viability is highly required in tomato hybrid seed production.

## MATERIALS AND METHODS

Field experiments were laid out in randomized block design with three replications during December in year 1 ($Y_1$) and January year 2 ($Y_2$) to find out the influence of micro-nutrient levels on plant growth, flower and pollen production, seed yield and seed quality of male parent. The seedlings were raised in the nursery and 25-day-old seedlings were transplanted in the main field (60 cm × 45 cm) with recommended dose of NPK (150: 100: 50 kg ha$^{-1}$). The following treatments were designed; $T_0$-control, $T_1$-zinc sulphate soil application (50 kg ha$^{-1}$), $T_2$-borax soil application (10 kg ha$^{-1}$), $T_3$-zinc sulphate (0.5%) foliar application at flower initiation and 50% flowering, $T_4$ -borax foliar (0.1%) application at flower initiation and 50% flowering, $T_5 = (T_1 + T_2)$, $T_6 = (T_1 + T_3)$, $T_7 = (T_1 + T_4)$, $T_8 = (T_2 + T_3)$ and $T_9 = (T_2 + T_4)$. All the recommended agronomic practices and plant protection measures were carried out to raise the crop. To find out the pollen viability, the pollen grains randomly collected at anthesis in each plot were taken in cavity slides and stained with one per cent acetocarmine solution. The viable pollen stained immediately as dark red and the non-viable ones remained as light. The number of viable and non-viable pollen grains were counted using stereomicroscope. The viability percentage was calculated from the mean of three microscopic field counts. The observations on number of flowers plant$^{-1}$, fruits plant$^{-1}$, fruit set, seeds fruit$^{-1}$, seed weight fruit$^{-1}$, seed recovery and seed yield ha$^{-1}$were taken. Well ripened fruits were collected at four day interval to find out the seed quality parameters *viz.*, 100-seed weight, germination percentage and vigour index (germination (%) × seedling length).

## RESULTS AND DISCUSSION

The nutrientional problems due to micro nutrient deficiency are coming up with the introduction of high yielding varieties of crops under intensive cropping systems (Randhawa and Arora, 13). The application of micro nutrients besides macro-nutrients gained importance due to intense cultivation and increased use of high analysis fertilizers (Ramadass and Krishnasamy, 12). When borax was applied through soil or foliar application or in combination an increase in the pollen viability to the extent of 94 per cent

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in both years was recorded. These results gained support from findings of Agarwala *et al*. (2) on maize, where they observed boron to induce repression of male sexuality in plants. The pollen production and viability, which formed the foremost objective of this study also, showed significant differences. The flowers from the plant supplied with boron or zinc in any form of application showed increased pollen viability compared to control. The role of micro-nutrients, on pollen production in many crops has been reported. In maize, pollen development was retarded when zinc was withdrawn 28 days after the onset of male reproductive phase (Sharma *et al*., 14). Sharma *et al*. (15) found slow activities of catalase and peroxidase and unaffected that of acid phosphatase in zinc deficient wheat anthers. Zinc deficiency during crucial phase of early division caused irreparable damage to the developing pollen grains. The plants applied with borax through soil and foliage produced maximum number of flowers, which was 55.4 per cent more than control, irrespective of years. Soil and foliar application of borax also resulted in the increase of yield attributing characters like fruit number and fruit weight. This may be because boron takes part in photosynthesis, which ultimately helps towards increase in number and weight of fruits. Earlier, Sharma (16) recorded similar results in tomato. Irrespective of years, all the micro nutrient combinations increased the fruit set. Among combinations, borax application through both soil and foliar means increased the fruit set per cent (31.8). Application of boron through soil and foliage exhibited pronounced effect in improving yield contributing parameters like seed number and seed weight fruit$^{-1}$, irrespective of years. This may be due to enhanced pollen viability, germination and pollen tube growth which inturn helped in increasing seed number. These results were in conformity with the findings of Sharma (16) and Rahman *et al*. (11) in tomato, Bhattacharya

**Table 1.** Effect of micro nutrients on pollen viability, number of flowers and fruits and fruit set (%) in the male parent of tomato hybrid CoTH 1.

| Treatment | Pollen viability (%) | | | No. of flowers plant$^{-1}$ | | | No. of fruits plant$^{-1}$ | | | Fruit set (%) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $Y_1$ | $Y_2$ | Mean | $Y_1$ | $Y_2$ | Mean | $Y_1$ | $Y_2$ | Mean | $Y_1$ | $Y_2$ | Mean |
| T0 | 81 (64.2) | 83 (65.3) | 82 (64.8) | 32.5 | 31.9 | 32.2 | 10.4 | 8.5 | 9.4 | 37.5 | 30.6 | 34.0 |
| T1 | 89 (70.8) | 89 (70.3) | 89 (70.5) | 35.0 | 34.9 | 34.9 | 13.4 | 13.0 | 13.2 | 38.1 | 39.0 | 38.6 |
| T2 | 93 (69.6) | 90 (71.4) | 89 (70.5) | 41.0 | 43.6 | 42.3 | 15.1 | 16.0 | 15.5 | 38.2 | 38.6 | 38.4 |
| T3 | 92 (74.7) | 92 (73.9) | 93 (74.3) | 44.5 | 45.3 | 44.9 | 13.0 | 13.5 | 13.2 | 29.1 | 33.5 | 31.3 |
| T4 | 92 (74.0) | 94 (76.4) | 93 (75.2) | 50.1 | 47.5 | 44.8 | 13.1 | 13.0 | 13.0 | 26.9 | 25.5 | 33.9 |
| T5 | 91 (74.0) | 93 (75.4) | 93 (74.5) | 35.9 | 34.8 | 35.3 | 13.6 | 14.0 | 13.8 | 38.9 | 35.3 | 37.5 |
| T6 | 94 (73.3) | 92 (73.1) | 92 (73.3) | 38.3 | 35.2 | 36.8 | 14.5 | 13.6 | 14.0 | 41.3 | 39.5 | 39.5 |
| T7 | 91 (76.8) | 91 (72.6) | 92 (74.7) | 35.6 | 33.3 | 34.5 | 13.8 | 14.3 | 14.1 | 40.9 | 41.0 | 39.8 |
| T8 | 95 (72.8) | 92 (73.1) | 91 (73.0) | 35.0 | 35.2 | 35.1 | 12.7 | 13.3 | 13.0 | 37.3 | 35.7 | 37.1 |
| T9 | 95 (76.8) | 94 (76.6) | 94 (76.7) | 49.5 | 50.6 | 50.1 | 16.0 | 17.0 | 16.5 | 44.5 | 45.2 | 42.1 |
| Mean | 91 (72.7) | 91 (72.7) | | 39.8 | 39.2 | 39.5 | 13.5 | 13.6 | 13.6 | 37.3 | 37.4 | 37.6 |
| | T | Y | T × Y | T | Y | T × Y | T | Y | T × Y | T | Y | T × Y |
| $CD_{0.05}$ | 3.21 | NS | NS | 0.28 | 0.13 | 0.40 | 0.083 | 0.037 | 0.118 | 0.202 | 0.090 | 0.286 |

Figures in parentheses indicate arc sine values.

$Y_1$ = 1st year; $Y_2$ = 2nd year.

*et al.* (4) in groundnut, Singh *et al.* (17) in mungbean, and Acar *et al.* (1) in pistachio. Significantly higher seed recovery per cent was recorded with soil and foliar application of borax, which was about 29.1 per cent higher than that of control. Increased seed recovery per cent brought about a parallel increase in seed yield indicating strong correlation between boron and seed recovery per cent. Increased seed yield plant$^{-1}$ and ha$^{-1}$ was recorded in plants applied with soil and foliar spray of borax. The increase in seed yield due to application of borax might be due to the involvement of micro nutrients as activators of several enzymes which, in turn, could directly or indirectly influence synthesis of carbohydrates and proteins as in the case of pigeon pea (Puste and Jana, 10). Our results were in agreement with the results obtained

**Table 2.** Effect of micro-nutrients on number of seeds fruit$^{-1}$, seed weight fruit$^{-1}$, seed recovery and seed yield in the male parent of tomato hybrid CoTH 1.

| Treatment | No. of seeds fruit$^{-1}$ | | | Seed weight fruit$^{-1}$ (g) | | | Seed recovery (%) | | | Seed yield ha$^{-1}$ (kg) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $Y_1$ | $Y_2$ | Mean | $Y_1$ | $Y_2$ | Mean | $Y_1$ | $Y_2$ | Mean | $Y_1$ | $Y_2$ | Mean |
| T0 | 150 | 157 | 154 | 0.450 | 0.454 | 0.452 | 0.80 | 0.78 | 0.79 | 180.5 | 177.8 | 179.1 |
| T1 | 163 | 167 | 165 | 0.480 | 0.475 | 0.478 | 0.85 | 0.84 | 0.85 | 193.2 | 199.0 | 196.1 |
| T2 | 165 | 171 | 168 | 0.500 | 0.505 | 0.503 | 0.84 | 0.88 | 0.86 | 245.0 | 246.0 | 245.5 |
| T3 | 175 | 171 | 173 | 0.510 | 0.521 | 0.515 | 0.88 | 0.90 | 0.89 | 209.5 | 206.8 | 208.1 |
| T4 | 190 | 181 | 186 | 0.485 | 0.490 | 0.488 | 0.85 | 0.82 | 0.84 | 200.0 | 202.0 | 201.0 |
| T5 | 180 | 160 | 170 | 0.450 | 0.463 | 0.457 | 0.82 | 0.80 | 0.81 | 201.0 | 198.0 | 199.5 |
| T6 | 165 | 160 | 162 | 0.475 | 0.471 | 0.473 | 0.83 | 0.83 | 0.83 | 216.0 | 218.0 | 217.0 |
| T7 | 175 | 183 | 179 | 0.460 | 0.466 | 0.463 | 0.85 | 0.83 | 0.84 | 219.0 | 222.0 | 220.5 |
| T8 | 160 | 169 | 164 | 0.475 | 0.471 | 0.473 | 0.83 | 0.85 | 0.84 | 209.5 | 212.5 | 211.0 |
| T9 | 185 | 190 | 188 | 0.540 | 0.537 | 0.538 | 1.00 | 1.03 | 1.02 | 248.0 | 252.0 | 250.0 |
| Mean | 171 | 171 | 171 | 0.483 | 0.485 | 0.484 | 0.85 | 0.86 | 0.86 | 212.2 | 213.4 | |
| | T | Y | T × Y | T | Y | T × Y | T | Y | T × Y | T | Y | T × Y |
| $CD_{0.05}$ | 0.544 | NS | 0.769 | 0.0012 | 0.0005 | 0.0016 | 0.0030 | NS | 0.0089 | 0.98 | 0.44 | 1.39 |

$Y_1$ = 1st year ; $Y_2$ = 2nd year.

**Table 3.** Effect of micro-nutrients on 100-seed weight, germination and vigour index in the male parent of tomato hybrid CoTH 1.

| Treatment | 100-Seed weight (g) | | | Germination (%) | | | Vigour index | | |
|---|---|---|---|---|---|---|---|---|---|
| | $Y_1$ | $Y_2$ | Mean | $Y_1$ | $Y_2$ | Mean | $Y_1$ | $Y_2$ | Mean |
| $T_0$ | 183 | 185 | 184 | 87 (69.2)* | 90 (72.0) | 89 (72.0) | 1028 | 979 | 1003 |
| $T_1$ | 211 | 220 | 215 | 90 (72.0) | 91 (73.1) | 91 (72.6) | 1323 | 1303 | 1313 |
| $T_2$ | 232 | 230 | 231 | 92 (74.2) | 93 (75.2) | 93 (74.7) | 1240 | 1221 | 1230 |
| $T_3$ | 234 | 235 | 235 | 91 (73.1) | 91 (73.1) | 91 (73.1) | 1225 | 1235 | 1230 |
| $T_4$ | 214 | 216 | 215 | 95 (78.0) | 94 76.5) | 95 (77.2) | 1216 | 1285 | 1251 |
| $T_5$ | 215 | 218 | 217 | 93 (75.1) | 95 (78.0) | 94 (76.6) | 1287 | 1245 | 1266 |
| $T_6$ | 206 | 205 | 206 | 91 (73.1) | 96 (80.4) | 94 (76.8) | 1267 | 1197 | 1222 |
| $T_7$ | 202 | 210 | 206 | 89 (71.1) | 91 (73.1) | 90 (72.1) | 1337 | 1342 | 1340 |
| $T_8$ | 219 | 225 | 222 | 94 (76.5) | 96 (80.4) | 95 (78.5) | 1213 | 1265 | 1239 |
| $T_9$ | 240 | 240 | 240 | 96 (80.4) | 95 (78.0) | 96 (79.2) | 1423 | 1460 | 1442 |
| Mean | 216 | 218 | | 92 (74.3) | 93 (76) | 93 (75.1) | 1256 | 1253 | |
| | T | Y | T × Y | T | Y | T × Y | T | Y | T × Y |
| $CD_{0.05}$ | 0.8 | 0.3 | 1.1 | 1.468 | 0.115 | 0.363 | 20.99 | NS | 29.68 |

*Figures in parentheses indicate arc sine values.

$Y_1$ = 1st year; $Y_2$ = 2nd year.

by Dordas (6) in cotton and Dordas *et al.* (8) in sugar beet. This has great significance in the production of parental line seeds, as is the case of breeder and foundation seeds where the quality of the resultant seeds is a concern. These results could be useful in all situations of seed production rather than only in hybrid seed production. The seed quality parameters like 100-seed weight and germination per cent were having significant improvement due to soil and foliar application of borax during both the years. The vigour index showed significant improvement due to soil and foliar application of borax. The enhanced vigour potential might be due to integrity of membranes and accumulation of more reserves, which would contribute for the synthesis of more food materials. The protein content of seeds was altered by micronutrient treatments in both years. Among the treatments, borax applied through soil and foliage proved its supremacy over other treatments. Thus, based on the results of the present investigation, application of borax through soil and foliage can be recommended for increased flower production, pollen viability, seed yield and quality in tomato.

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