

EXPERIMENT - 2
(PHYSIOLOGICAL STUDIES)

INTRODUCTION

All cultivars are characterized by certain unique traits. These may involve earliness in flowering, earliness in yield, superior quality of the produce, growth habit, high yielding capacity etc. In recent years, great accent has been put on evolving varieties of crop plants which can grow under adverse soil and climatic conditions and yield well. And nowadays it is quite common to find crop cultivars which can tolerate high temperature, low temperature, salinity drought etc. Disease and pest resistant varieties, acidity and alkalinity tolerant varieties of different crop plants are also there. In other words, for almost every kind of soil and climatic condition there is a variety of every crop.

In generation of such biotic and abiotic stress tolerant cultivars, lines of particular variety are exposed to specific stress conditions and selection as well as traditional breeding methods are utilized to give rise to stress tolerant cultivars. Molecular biological methods as well as genetic engineering have also been geared to this end in recent years. As a result, the different cultivars of a crop show differential response to a given kind of stress and as such the differential tolerance can often be used as an identifying trait of crop cultivars to a certain extent and this used in conjunction with other methods often go a long way in solving the problem of identification of cultivars of crop plants.

The twin scourges of drought and salinity have been plaguing the Indian agriculture since long and the crop loss incurred due to the two above problems every year is enormous.

According to Abrol and Bhumbra (1971) about 7 million hectares of land in India alone have been rendered unproductive or less productive of major crops like rice and wheat through salt accumulation and poor water quality. As good quality irrigation water is becoming less and less available and besides crops other than wheat and rice are also grown the total hectareage of land affected by soil salinity today must be higher than the estimate of Abrol and Bhumbra.

Water scarcity is widely prevalent in India and much more serious than salinity problem and for many tracts of India there is the adage 'water is the only fertilizer needed for good crop production'. The Indian rainfall calender shows that excepting the southern India, the rest of India receives monsoon rainfall during the months of July to October. Southern India is fortunate in having two monsoons - the normal monsoonal rainfall as in the rest of the India and winter monsoonal rainfall. Not to speak of rainless months, even in the monsoon period crops suffer from intermittent drought due to wide spacing of rains. Lack of irrigation or limited development of irrigation has made the problem of successful crop cultivation more difficult.

Natural selection as well as human intervention has led to generation of both salinity and water stress tolerant

cultivars of crop plants. It has also been found out that crops are differently affected by these two stresses at different phases of their growth cycle.

Germination, which launches the seed on its new life cycle has been found to be greatly affected by salinity as well as moisture stress. Cultivar difference in stress tolerance at germination phase has been noted by many workers (Prisco and O'Leary, 1970; Srivastava et al., 1975; Gorg, 1976; Bal and Chattopadhyay, 1985, 1987).

In view of the above, the germination behaviour of 9 tomato (Lycopersicon esculentum Mill.) cultivars under moisture and salinity stresses was studied.

MATERIALS AND METHODS

Healthy uniform tomato seeds (previously surface sterilized with 0.1% mercuric chloride and repeatedly washed with distilled water) of cultivars Marglobe Supreme, Pusa Ruby, Pusa Early Dwarf, Roma, Perfection, Oxheart, Moneymaker, Punjab Chuhara and Best of All were used for germination study under moisture and salinity stresses.

For studying germination under moisture stress, PEG (polyethylene glycol of 6,000 molecular weight) solutions of -0.2, -0.4, -0.6 and -0.8 MPa were prepared according to the method of Mexal et al. (1975).

Germination study under salinity stress was conducted in NaCl solutions of 5, 10, 15 and 20 EC, prepared according to the method of Chu et al. (1976).

In both the germination studies, double distilled water was used as control. Separate laboratory observations showed that 5, 10, 15 and 30 EC solutions gave -0.2, -0.4, -0.6 and -0.8 MPa osmotic concentrations.

One hundred healthy seeds were placed on sterilized petri dishes containing discs of filter paper soaked in uniform amounts of desired osmotic solutions (to impart moisture stress) as well as NaCl solutions of different concentrations (to impart salinity stress).

Each treatment was replicated thrice. Petri dishes were incubated in dark at constant $28^{\circ}\pm 1^{\circ}\text{C}$ in a BOD incubator. Germination count was taken after 7 days. Seeds were considered to have germinated when the length of the radicle had reached 2 mm or more.

For statistical analysis of the germination data per cent germination data were first subjected to angular transformation (converted to arc-sin values) and then worked upon using completely randomized design.

R E S U L T S

E x p e r i m e n t : 2.1

Effect of moisture stress on germination of tomato cultivars :

Seed germination data of different cultivars of tomato, their arc-sin values and ANOVA table are given in Tables 2.1 to 2.3. From Table 2.1, it is seen that germination even in control varied with Marglobe Supreme showing 92.00 per cent germination at one end and Punjab Chuhara showing 61.33 per cent germination at the other end. With increase in moisture stress, there was a decrease in germination but the extent of germination decrement differed. At -0.2 MPa, the decrease in germination percentage was minimal in the cultivars Pusa Ruby, Pusa Early Dwarf, Roma, Perfection and Moneymaker. Actually, there was a slight increase in germination percentage of cv Perfection. However, the decline in seed germination was much more in other tomato varieties. At -0.4 MPa, more than 80% germination was registered (in terms of control) in only two cultivars - Pusa Early Dwarf and Perfection. The variety particularly affected by moisture stress was Punjab Chuhara. At -0.6 MPa, Marglobe Supreme, Pusa Ruby and Pusa Early Dwarf gave relative germination of more than 25 per cent in terms of control while Punjab Chuhara and Best of All registered zero germination. At -0.8 MPa only slight germination was noted in Pusa Early Dwarf, Perfection and Marglobe Supreme. All other varieties did not show any seed germination.

Table 2.1
Per cent seed germination under moisture stress.

| Cultivars | LEVELS OF MOISTURE STRESS | | | |
|------------------|---------------------------|-------------------|------------------|------------------------------------|
| | Control (0 MPa) | -0.2 MPa | -0.4 MPa | -0.6 MPa -0.8 MPa |
| Marglobe Supreme | 92.00 (100) | 69.33 (75.35) | 51.33 (55.79) | 28.00 (30.43) 1.33 (1.44) |
| Pusa Ruby | 88.00 (100) | 81.33 (92.42) | 66.67 (75.76) | 28.67 (43.18) 0. |
| Pusa Early Dwarf | 97.33 (100) | 92.67 (95.21) | 86.67 (89.04) | 38.00 (39.04) 6.00 (6.16) |
| Roma | 77.00 (100) | 73.33 (95.23) | 32.67 (42.42) | 5.33 (6.92) 0 |
| Perfection | 82.00 (100) | 83.33 (101.62) | 66.67 (81.30) | 20.67 (25.20) 3.67 (4.47) |
| Oxheart | 68.67 (100) | 47.67 (69.41) | 25.33 (36.88) | 0.67 (0.97) 0 |
| Moneymaker | 71.33 (100) | 63.67 (89.26) | 27.33 (38.31) | 8.00 (11.21) 0 |
| Punjab Chuhara | 61.33 (100) | 39.33 (64.12) | 3.67 (5.98) | 0 |
| Best of All | 64.67 (100) | 38.00 (58.75) | 16.67 (25.77) | 0 |

Figures in parentheses give relative value in terms of control which has been taken as 100.

Table 2.2

Angular transformation of germination data under moisture stress (Mean arc-sin value)

| Cultivars | LEVELS OF MOISTURE | | | | | Mean |
|------------------|--------------------|------------------|------------------|------------------|-----------------|-------|
| | Control | 5 EC | 10 EC | 15 EC | 20 EC | |
| Marglobe Supreme | 73.56 (92.00) | 56.38 (69.34) | 45.77 (51.34) | 31.91 (27.94) | 3.85 (0.45) | 42.29 |
| Pusa Ruby | 69.77 (88.04) | 64.66 (81.68) | 54.76 (66.70) | 32.35 (28.63) | 0 | 44.31 |
| Pusa Early Dwarf | 82.56 (98.32) | 74.67 (93.01) | 68.67 (86.77) | 38.04 (37.97) | 13.84 (5.72) | 55.56 |
| Roma | 61.39 (77.07) | 58.96 (73.41) | 34.84 (32.64) | 13.17 (5.19) | 0 | 33.67 |
| Perfection | 64.97 (82.10) | 65.67 (83.03) | 54.89 (66.92) | 27.03 (20.65) | 10.86 (3.55) | 44.68 |
| Oxheart | 55.97 (68.68) | 43.66 (47.66) | 30.22 (25.33) | 2.71 (0.22) | 0 | 26.51 |
| Money-maker | 57.65 (71.37) | 52.94 (63.68) | 31.47 (27.25) | 16.35 (7.92) | 0 | 31.68 |
| Punjab Chuhara | 51.56 (61.35) | 38.83 (39.31) | 11.02 (3.65) | 0 | 0 | 20.28 |
| Best of All | 53.54 (64.69) | 38.05 (37.99) | 23.98 (16.52) | 0 | 0 | 23.11 |
| Mean | 63.44 | 54.87 | 39.48 | 17.95 | 3.17 | |

Figures in parentheses relate to the percentage figures obtained from the back transformation of angular values.

| | S.E. of Mean | C.D. at probability level |
|---------------------|--------------|---------------------------|
| | | 0.05 |
| | | 0.01 |
| Variety | 0.71 | 1.99 |
| Treatment | 0.53 | 1.49 |
| Variety X Treatment | 1.59 | 4.46 |
| | | 2.64 |
| | | 1.97 |
| | | 5.90 |

Table 2.3
A N O V A T A B L E

| Source of variation | df | SS | MSS | Calculated value of F | Table value of F 5% | Table value of F 1% |
|---------------------|----|----------|----------|-----------------------|---------------------|---------------------|
| Replication | 2 | 16.00 | 8.00 | - | - | - |
| Variety | 8 | 16403.99 | 2050.49 | 271.63 | 2.04 | 2.72 |
| Treatment | 4 | 68178.56 | 17044.64 | 2257.37 | 2.47 | 3.54 |
| Variety X Treatment | 32 | 2407.78 | 75.24 | 9.97 | 1.59 | 1.92 |
| Error | 88 | 664.29 | 7.55 | | | |

From the angular transformation data in Table 2.2, it is seen that mean seed germination of the different tomato cultivars varied significantly. Highest mean seed germination was noted in Pusa Early Dwarf followed in descending order by Perfection, Pusa Ruby, Marglobe Supreme, Roma, Moneymaker, Oxheart, Best of All and Punjab Chuhara. With increase in water stress, seed germination was also significantly decreased. Variety X treatment interaction was also found to be highly significant statistically.

E x p e r i m e n t : 2.2

Effect of salinity (stress on germination of tomato cultivars :

Germination data of seeds of different cultivars of tomato, their arc-sin values and ANOVA table are given in Tables 2.4 to 2.6. From Table 2.4, it is quite clear that tomato seed germination was severely affected by salinity. Beyond 10 EC, there was very little germination and once again the cultivars differed in their tolerance to salinity at the germination phase.

Angularly transformed data in Table 2.4 show that the mean germination percentage of seeds of different tomato cultivars over all the salinity treatment levels varied significantly. The highest germination was noted in cv Perfection followed by Pusa Early Dwarf though the difference was not statistically significant. Next in germination were Pusa Ruby and Marglobe Supreme which showed almost similar mean germination. The other varieties showed less germination with lowest

Table 2.4
Per cent seed germination under salinity stress

| Cultivars | LEVELS OF SALINITY | | | | |
|------------------|--------------------|------------------|------------------|----------------|-------|
| | Control (0 EC) | 5 EC | 10 EC | 15 EC | 20 EC |
| Marglobe Supreme | 92.00 (100) | 47.33 (51.44) | 11.33 (12.31) | 0 | 0 |
| Pusa Ruby | 88.00 (100) | 52.67 (59.85) | 14.00 (15.91) | 0 | 0 |
| Pusa Early Dwarf | 97.33 (100) | 64.00 (65.67) | 4.00 (4.11) | 0 | 0 |
| Roma | 77.00 (100) | 48.00 (62.34) | 6.67 (8.66) | 0 | 0 |
| Perfection | 82.00 (100) | 62.00 (75.61) | 26.67 (32.52) | 0.67 (0.82) | 0 |
| Oxheart | 68.67 (100) | 44.00 (64.07) | 13.33 (19.41) | 0 | 0 |
| Moneymaker | 71.33 (100) | 45.67 (64.03) | 4.67 (6.55) | 0 | 0 |
| Punjab Chuhara | 61.33 (100) | 29.00 (47.29) | 7.33 (11.95) | 0 | 0 |
| Best of All | 64.67 (100) | 38.67 (59.80) | 6.67 (10.31) | 0 | 0 |

Figures in parentheses give relative values in terms of control which has been taken as 100.

Table 2.5

Angular transformation of germination data under salinity stress (Mean arc-sin value)

| Cultivars | LEVELS OF SALINITY | | | | | Mean |
|------------------|--------------------|------------------|------------------|----------------|-------|-------|
| | Control (0 EC) | 5 EC | 10 EC | 15 EC | 20 EC | |
| Marglobe Supreme | 73.65 (92.08) | 43.47 (47.33) | 19.62 (11.27) | 0 | 0 | 27.35 |
| Pusa Ruby | 69.77 (88.04) | 46.53 (52.67) | 21.84 (12.84) | 0 | 0 | 27.63 |
| Pusa Early Dwarf | 82.56 (98.32) | 53.15 (64.03) | 11.28 (3.83) | 0 | 0 | 29.40 |
| Roma | 61.39 (77.07) | 43.85 (47.99) | 14.85 (6.57) | 0 | 0 | 24.02 |
| Perfection | 64.97 (82.09) | 51.95 (62.01) | 30.94 (26.43) | 2.71 (0.22) | 0 | 30.11 |
| Oxheart | 55.97 (68.68) | 41.54 (43.98) | 21.40 (13.31) | 0 | 0 | 23.78 |
| Moneymaker | 57.65 (71.37) | 42.51 (45.66) | 12.36 (4.58) | 0 | 0 | 22.50 |
| Punjab Chuhara | 51.56 (61.35) | 32.57 (28.98) | 15.42 (7.07) | 0 | 0 | 19.91 |
| Best of All | 53.54 (64.69) | 38.45 (38.67) | 14.90 (6.61) | 0 | 0 | 21.38 |
| Mean | 63.48 | 43.78 | 18.07 | 0.30 | 0 | |

Figures in parentheses relate to the percentage figures obtained from the back transformation of angular values.

| | S.E. of Mean | | C.D. at probability level | |
|---------------------|--------------|------|---------------------------|------|
| | 0.05 | 0.01 | 0.05 | 0.01 |
| Variety | 0.56 | 1.58 | 1.58 | 2.10 |
| Treatment | 0.42 | 1.18 | 1.18 | 1.56 |
| Variety X Treatment | 1.26 | 3.53 | 3.53 | 4.68 |

Table 2.6

ANUVA TABLE

| Source of variation | df | SS | MSS | Calculated value of F | Total value of F | |
|---------------------|----|----------|----------|-----------------------------|---------------------|------|
| | | | | | 5% | 1% |
| Replication | 2 | 10.87 | 5.42 | | | |
| Variety | 8 | 1582.51 | 197.81 | 41.72 | 2.04 | 2.72 |
| Treatment | 4 | 84084.32 | 21021.08 | 4433.89 | 2.47 | 3.54 |
| Variety X Treatment | 32 | 2839.32 | 88.73 | 18.72 | 1.59 | 1.92 |
| Error | 88 | 417.19 | 4.74 | | | |

being recorded in Punjab Chuhara. With the increase in salinity level, there was significant reduction in seed germination. Variety X treatment interaction was also found to be highly significant.