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# Heterosis and stress susceptibility index for fruit yield and contributing traits in tomato *(Lycopersicon esculentum)**

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The commercial exploitation of heterosis is considered to be an outstanding application of genetics in the plant breeding. The estimation of heterosis is of wide use for hybrid tomato production. Heterobeltiosis is useful in deciding the direction and prospect of specific further improvement programme. This might be more promising than the conventional breeding programmes. The extent of heterosis depends on the magnitude of non-additive gene action and wide genetic diversity among parents. However, there are reports that in self-pollinated crops, crosses with high magnitude of additive × additive (ie good × good GCA parents) gene action effects give better segregants. The superiority of hybrid over better parent (heterobeltiosis) may be either due to dominance, epitasis or over dominance or combined effects of two or more of these phenomenons (Birchler *et al.* 2010). The objective of heterosis studies in this investigation was to identify best cross combinations which need to be utilized for selection in succeeding segregating generation and serve as the potential donor for specific or a group of traits in further breeding programmes aimed at yield and stress (salinity)-tolerant genotypes.

Material for the present investigation comprised 10 genetically diverse tomato varieties collected from Division of Vegetable Science, IARI, New Delhi, with varying degree of salt tolerance namely IIVR-Sel 2, Arka Vikas, Sel 7, Azad T 2, Punjab Upma, DARL 64, BSS 368, Himsona, Tom 187 and CO-3. These varieties were crossed in all possible combinations excluding reciprocals to generate 45 $F_1$s. All crosses along with parents were evaluated in randomized block design with three replications in each of two environments *viz.* normal ($E_1$, *pH* = 7.6 and ECe 2.349 dS/m) and saline ($E_2$, *pH* = 8.3 and ECe = 4.329 dS/m) and irrigated with water having pH = 7.7 and ECe 3.679 dS/m at Research farm during *rabi* 2008–09. The salinity of the saline soil and irrigated water is above the threshold limit of salinity (above 2.5 dS/m) for tomato, hence considered to be saline. Plot size was single row of 3m long with 50cm row spacing and 30cm plant-to-plant spacing. The observations were recorded on various traits. Magnitude of heterosis was calculated in terms of two parameters, over mid parent (heterosis) and over better parent (heterobeltiosis) as suggested by Fonseca and Patterson (1968). Stress Susceptibility Index (SSI) for salinity was calculated for fruit yield and other attributes over saline (stress) and normal (non-stress) environments by using the formula given by Fischer and Maurer (1978).

$SSI = (1-Y_D / Y_P) / D$

Where,

$Y_D$ = mean of the genotype in saline environment

$Y_P$ = mean of the genotype in normal environment

$$D = \text{Salt intensity} = 1- \left[ \frac{\text{mean } Y_D \text{ of all genotypes}}{\text{mean } Y_P \text{ of all genotypes}} \right]$$

In the present investigation, the parent vs crosses component of variance was significant for most of the traits in different environments as well as over the environment (Table 1), indicated presence of sufficient heterosis.

Heterosis (H) Heterobeltiosis (HB) and were estimated and presented in Table 2.

The maximum range of heterosis in $E_1$ environment of different characters were –10.03 to 9.66 (days to 50% flowering), –20.39 to 38.40 (days to first fruit), –48.28 to 34.95 (plant height), –86.24 to 77.03 (number of fruits/plant), –28.82 to 290.94 (fruit yield/plant), –71.19 to 45.89 (average fruit weight), –72.02 to 60.83 (fruit volume), – 89.46 to 26.78 (leaf area) and -97.43 to -96.41 (chlorophyll content at 45 days). Whereas, in $E_2$ environment, the range of heterosis was –12.09 to 7.51 (days to 50% flowering),

*Short note

Based on complete information of Ph D thesis of the first author submitted to Rajasthan Agriculture University during 2009.

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Table 1 Analysis of variance for fruit yield and its contributing characters under normal ($E_1$) and saline ($E_2$) environment

| Source of variation | d f | Environ-ments | Characters-wise mean sum of squares | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Days to 50% flowering | Days to first fruit | Plant height | Number of fruits/ plant | Fruit yield/ plant | Average fruit weight | Frui volume | Leaf area | Chlorophyll content at 45 days |
| Replication | 2 | $E_1$ | 17.73 | 2.13 | 24.73** | 15.36 | 472.93** | 4.62 | 1.11 | 9.09 | 0.0001 |
| | | $E_2$ | 12.16 | 26.28 | 30.65** | 6.26 | 4 456.95** | 14.35 | 51.02** | 0.59 | 0.0002 |
| Genotypes | 54 | $E_1$ | 15.22** | 76.93** | 247.45** | 26.17** | 21 123.96** | 66.79** | 66.86** | 246.09** | 0.02** |
| | | $E_2$ | 15.86** | 273.37** | 126.56** | 15.06** | 15 621.48** | 52.15** | 48.39** | 44.25** | 0.08** |
| Parents | 9 | $E_1$ | 18.36** | 41.91** | 367.57** | 16.41** | 13 657.44** | 53.59** | 44.67** | 72.88** | 0.05** |
| | | $E_2$ | 17.10** | 367.13** | 22.84** | 2.87 | 1 105.26** | 38.69** | 28.37** | 10.86 | 0.15** |
| $F_1$s | 44 | $E_1$ | 14.82** | 81.70** | 108.33** | 28.71** | 23 123.57** | 69.90** | 69.26** | 277.48** | 0.01** |
| | | $E_2$ | 15.16** | 260.41** | 145.79** | 17.22** | 18 591.99** | 56.08** | 51.98** | 44.12** | 0.06** |
| Parents | 1 | $E_1$ | 664.69** | 2 803.72** | 6 851.30** | 371.62** | 49 047.41** | 393.54** | 458.77** | 817.25** | 0.10** |
| v/s $F_1$s | | $E_2$ | 715.35** | 1 556.76** | 1 448.36** | 166.10** | 88 245.11** | 265.34** | 449.60** | 395.65** | 0.01** |
| Error | 108 | $E_1$ | 5.78 | 24.23 | 13.47 | 3.14 | 442.24 | 3.11 | 2.74 | 3.47 | 0.0001 |
| | | $E_2$ | 6.07 | 14.86 | 10.86 | 1.35 | 590.43 | 2.19 | 2.56 | 0.41 | 0.0002 |

*, $P=0.05$, **, $P=0.01$

–14.16 to 49.69 (days to first fruit), –56.08 to 49.44 (plant height), –93.36 to 85.66 (no. of fruits/plant), –84.99 to 379.45 (fruit yield/plant), –84.94 to 72.87 (average fruit weight), –82.108 to 56.14 (fruit volume), –86.61 to 73.31 (leaf area) and –98.86 to 98.77 (Chlorophyll content at 45 days). However, significant and desirable heterosis was exhibited by some promising crosses (in both the environments) for days to 50% flowering (IIVR-Sel 2 × ArkaVikas, IIVR-Sel 2 × Sel 7, IIVR Sel 2 × BSS 368, Sel 7 × Azad T 2, Sel 7 × PunjabUpma and Sel 7 × BSS 368); days to first fruit (Sel 7 × BSS 368 and Himsona × Tom 187); plant height (Sel 7 × BSS 368); number of fruits/plant ((Sel 7 × BSS 368 and Himsona × Tom 187); fruit yield/plant (Sel 7 × BSS 368 and Himsona × Tom 187); average fruit weight (Sel 7 × BSS 368 and Himsona × Tom 187); fruit volume (Sel 7 × BSS 368 and Himsona × Tom 187); leaf area (Sel 7 × BSS 368, Sel 7 × Himsona and Himsona × Tom 187) and chlorophyll content at 45 days (Sel 7 × BSS 368 and Himsona × Tom 187 in $E_2$ only) (Table 2).

Maximum desirable heterobeltiosis in both the environment for most of the characters was exhibited by Sel 7 × BSS 368 for plant height, number of fruits/plant, fruit yield/plant, average fruit weight, fruit volume and Himsona × Tom 187 for days to fruits fruit, number of fruits plant and fruit volume. Both of these crosses also showed significant desirable heterobeltiosis in $E_2$ for leaf area and chlorophyll content at 45 days (because heterobeltiosis was significant only in $E_2$) (Table 2). Crosses showing desirable heterobeltiosis for most of characters in both the environments were considered promising for their use in yield improvement in general and particularly in saline environment. Similar results in environments varying for salinity regimes for studied characters in tomato for heterotic effects were also reported by Baishya *et al.* (2001), Fageria *et al.* (2001), Mohanty and Prusti (2002) Tiwari and Lal (2004) Cuartero *et al.* (2006) Kriger *et al.* (2010).

*Stress susceptibility index*

The salinity tolerance is a complex phenomenon depending upon the interaction between plant genotype and environment for the material used in the study and one could expect different results under variable salinity regimes also (Witcomb *et al.* 2008). Salinity tolerance ranking was done for parents and $F_1$s. Thus, based upon ranks for different trait, an overall ranking was done for each genotype to identify the level of tolerance for salinity and hence, these might be used subsequently in the plant breeding programmes aimed at development of salinity tolerance genotypes in tomato. According to SSI as given by Fischer and Maurer (1978), a zero value indicates no difference in the mean value of the normal and stress environment thus will be desirable, similarly a positive value indicates suitability in normal environment and a negative value indicates suitability to a stress environment.

The SSI values for the parents and the crosses have been worked out for each of the trait and ranked as per the above criterion. The overall ranking indicated that AkraVikas followed by Himsona and BSS-368 are the desirable ones for saline environment. Similarly, Azad Ta2 followed by DARL 64 and IIVR-Sel 2 are desirable for normal environment (Table 3). Among the crosses, IIVR-Sel 2 × Azad T 2, IIVR-Sel 2 × Himsona and Azad T 2 × Himsona are the desirable crosses for the normal environment while, Himsona × Tom 187, DARL 64 × BSS 368 and Himsona × CO 3 are the desirable for saline environment (Table 3).

Table 2 Magnitude of heterosis and heterobeltiosis for yield and related trait of tomato in normal ($E_1$) and saline ($E_2$) environment

| ProgenY | Days to 50% flowering | | | | Days to first fruit | | | | Plant height | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $E_1$ | | $E_2$ | | $E_1$ | | $E_2$ | | $E_1$ | | $E_2$ | |
| | H | HB | H | HB | H | HB | H | HB | H | HB | H | HB |
| IIVR-Sel 2 × Arka Vikas | –10.3** | –9.25** | –10.54** | –10.23** | –12.85** | –16.85** | 21.67** | 25.14** | 0.31 | –7.75 | –32.16** | –37.94** |
| IIVR-Sel 2 × Sel. 7 | –9.85** | –7.96** | –7.33** | –4.24 | 3.80 | 4.37 | 32.00** | 40.00** | –12.98 | –21.97** | –26.50** | –30.91** |
| IIVR-Sel 2 × Azad T 2 | –1.75 | 1.21 | –5.99** | –0.64 | 16.24** | 22.89** | 18.95** | 29.11** | –2.19 | –8.31 | –17.81** | –21.14* |
| IIVR-Sel 2 × Punjab Upma | –3.25 | 0.61 | –1.49 | 3.22 | 18.97** | 26.99** | 38.37** | 49.69** | –13.17* | –17.91** | –27.35** | –30.50** |
| IIVR-Sel 2 × DARL 64 | 4.14* | 8.64** | –9.47** | –5.56* | 10.09** | 17.90** | 1.44 | 8.64* | –12.63 | –17.16** | –17.19** | –21.50** |
| IIVR-Sel 2 × BSS 368 | –6.39** | –4.17 | –7.23** | –1.28 | 15.58** | 21.13** | 44.28** | 37.69** | –2.30 | –8.93* | –19.92* | –22.69* |
| IIVR-Sel 2 × Himsona | 2.34 | 5.42* | 0.60 | 7.05** | 17.95** | 24.69** | 36.66** | 49.36** | –20.18** | –25.18** | –21.65* | –24.36* |
| IIVR-Sel 2 × Tom 187 | –1.19 | 3.75 | 0.59 | 6.33** | 8.99* | 17.50** | 44.61** | 56.96** | –18.48* | –22.25** | –11.87 | –15.44 |
| IIVR-Sel 2 × CO 3 | 8.61** | 13.67** | 3.73* | –2.89 | 22.54** | 31.68** | 38.55** | 43.35** | –34.62** | –37.83** | –22.44** | –28.67 |
| ArkaVikas × Sel. 7 | 2.25 | 5.20* | –0.59 | 1.82 | 9.37** | 18.03** | 40.58** | 60.61** | –46.66** | –51.15** | –22.32** | –25.33* |
| ArkaVikas × Azad T 2 | 5.02** | 7.23** | 5.74** | 10.76** | 27.51** | 45.18** | 12.43** | 31.65** | –19.42** | –22.77** | –31.83** | –32.59** |
| ArkaVikas × Punjab Upma | 1.19 | 4.30 | –0.60 | 3.78 | 6.13 | 22.09** | 13.21** | 32.08** | –23.48** | –26.01** | –27.76** | 29.30** |
| ArkaVikas × DARL 64 | 2.09 | 5.56* | –5.07** | –1.86 | –3.21 | 11.79** | 7.49* | 24.07** | 28.58** | –30.74** | –27.69** | –29.88** |
| ArkaVikas × BSS 368 | 1.46 | 2.98 | 0.30 | 5.77* | 9.47** | 23.81** | 41.30** | 66.67** | –48.25** | –50.71** | –36.15** | –36.92** |
| ArkaVikas × Himsona | –0.29 | 1.81 | 0.91 | 6.41* | –2.65 | 10.84** | 40.76** | 66.03** | –28.22** | –31.21** | –33.68** | –34.49** |
| ArkaVikas × Tom 187 | 3.90* | 8.13** | –5.74** | –1.27 | 3.76 | 20.63** | 2.16 | 19.62** | –34.02** | –35.63** | –48.68** | –49.62** |
| ArkaVikas × CO 3 | 1.79 | 5.99** | –5.78** | –5.78* | 9.38** | 26.71** | 35.07** | 50.29** | –48.02** | –49.44** | –49.32** | –52.36** |
| Sel. 7 × Azad T 2 | –5.44** | –0.60 | –10.85** | –3.80 | –3.50 | 7.83 | 1.38 | 16.46** | –25.60** | –34.47** | –33.43** | –42.91** |
| Sel. 7 × Punjab Upma | –5.78** | 0.00 | –8.19** | –1.26 | 3.80 | 17.18** | 2.19 | 16.98** | –31.59** | –42.09** | –41.47** | –49.93** |
| Sel. 7 × DARL 64 | –1.45 | 4.94* | –10.73** | –4.94* | –0.82 | 12.35** | 2.45 | 16.05** | –29.89** | –40.49** | –46.18** | –54.32** |
| Sel. 7 × BSS 368 | –1.99 | 2.38 | –7.97** | 4.90* | –13.48** | –14.88** | –14.16** | –20.52** | 34.95** | 45.59** | 49.44** | 56.41** |
| Sel. 7 × Himsona | –8.31** | –3.62 | –10.92** | –3.21 | –8.36* | –2.41 | –8.59** | –5.77 | –0.50 | –16.39** | –21.64* | –32.44** |
| Sel. 7 × Tom 187 | 4.96** | 12.50** | –6.16** | 1.27 | 10.14** | 25.63** | 16.80** | 34.18** | –26.15** | –37.00** | –28.12** | –38.35** |
| Sel. 7 × CO 3 | –1.74 | 4.97* | –7.87** | –5.20* | 14.21** | 29.81** | 7.94** | 17.92** | –5.84 | –19.88** | –56.08** | –63.69** |
| Azad T 2 × Punjab Upma | 7.60** | 8.59** | –1.54 | 0.63 | 24.19** | 30.68** | 18.58** | 17.90** | –34.31** | –34.51** | –43.28** | –44.14** |
| Azad T 2 × DARL 64 | 3.05 | 4.32 | –4.27* | –3.09 | 28.07** | 35.19** | 11.69** | 17.90** | –31.90** | –32.31** | –50.06** | –50.37** |
| Azad T 2 × BSS 368 | 0.00 | 0.60 | –4.35* | –1.28 | 26.44** | 30.95** | 13.09** | 21.79** | –19.16* | –20.12** | –36.75** | –38.29** |

*Continued*

| Progeny | Days to 50% flowering | | | | Days to first fruit | | | | Plant height | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $E_1$ | | $E_2$ | | $E_1$ | | $E_2$ | | $E_1$ | | $E_2$ | |
| | H | HB | H | HB | H | HB | H | HB | H | HB | H | HB |
| Azad T 2 × Himsona | –1.21 | –1.21 | 3.11 | 6.41* | 23.70** | 28.92** | 14.29** | 23.08** | –25.33* | –25.78** | –39.50** | –40.98** |
| Azad T 2 × Tom 187 | 5.52** | 7.50* | –4.94** | –2.53 | 23.71** | 32.50** | 8.28** | 15.82** | –31.24** | –32.07** | –31.68** | –32.92** |
| Azad T 2 × CO 3 | –2.14 | –0.62 | –12.09** | –10.24** | 4.40 | 10.56* | –0.85 | 1.16 | –29.23** | –29.88** | –29.85** | –31.67** |
| Punjab Upma × DARL 64 | –0.92 | –0.61 | –4.62** | –4.32 | 5.09 | 14.82** | 26.55** | 38.27** | –35.34** | –43.43** | –38.31** | –46.02** |
| Punjab Upma × BSS 368 | 8.76** | 10.43** | 7.21** | 9.62** | 12.78** | 20.85** | 21.84** | 35.89** | –39.27** | –46.02** | 36.02** | –44.91** |
| Punjab Upma × Himsona | 3.34 | 4.30 | –2.19 | 0.00 | 11.73** | 20.49** | 21.84** | 35.89** | –33.27** | –41.44** | 38.49** | 47.04** |
| Punjab Upma × Tom 187 | 2.17 | 3.11 | 1.56 | 3.17 | 9.66** | 20.63** | 46.29** | 62.03** | –31.60** | –40.46** | –42.67** | –50.39** |
| Punjab Upma × CO 3 | 2.47 | 3.11 | –7.34** | –4.91* | 20.11** | 31.68** | 9.04** | 15.08** | –35.39** | –43.61** | –44.88** | 50.37** |
| DARL 64 × BSS 368 | 7.28** | 9.23** | 0.00 | 1.92 | 9.14** | 17.26** | 10.03** | 23.08** | –40.71** | –46.62** | –22.47** | –32.41** |
| DARL 64 × Himsona | –1.22 | 0.00 | –4.40* | 2.56 | 5.85 | 14.46** | –0.29 | 11.54** | –40.93** | –47.09** | –38.65** | –46.92** |
| DARL 64 × Tom 187 | –1.86 | –1.29 | 1.88 | 3.17 | 11.62** | 23.13** | 5.41* | 17.09** | –36.18** | –43.76** | –38.01** | –45.66** |
| DARL 64 × CO 3 | –2.17 | –1.86 | –9.25** | –6.17* | 10.74** | 21.74** | –4.92 | 0.58 | –40.78** | –47.66** | –30.83** | –36.69** |
| BSS 368 × Himsona | 0.00 | 0.60 | –2.47 | 1.28 | 7.69* | 22.29** | –5.18 | 11.54** | –21.78** | –25.57** | –32.43** | –37.54** |
| BSS 368 × Tom 187 | 4.88** | 7.50** | –7.36** | –4.43 | 20.22** | 39.38** | 15.99** | 35.44** | –30.89** | –35.66** | –32.36** | –31.12** |
| BSS 368 × CO 3 | 5.17** | 7.45** | –7.92** | –6.55** | 11.83** | 29.18** | 4.69 | 16.19** | –26.80** | –31.34** | –40.13** | –41.89** |
| Himsona × Tom 187 | –4.91** | –6.88** | –1.24 | –1.27 | –20.39** | –31.25** | –9.83** | –20.25** | –14.06* | –17.50 | –17.30 | –13.29 |
| Himsona × CO 3 | 2.75 | 4.35 | –9.74** | –7.83** | 38.41** | 49.69** | 6.37** | 10.99** | –37.31** | –40.00** | –15.55 | –21.85* |
| Tom 187 × CO 3 | 9.66** | 10.00** | 7.51** | 11.88** | 33.90** | 45.96** | 31.13** | 37.57** | –26.20** | –34.04** | –40.09** | –48.09** |
| SEd | 1.70 | 2.45 | 1.74 | 2.47 | 3.48 | 4.42 | 2.73 | 3.86 | 2.59 | 3.49 | 2.33 | 3.30 |
| | No. of fruits/plant | | | | Fruit yield/plant | | | | Average fruit weight | | | |
| IIVR-Sel 2 × Arka Vikas | –80.23** | –88.98* | –91.44** | –95.20** | 52.50** | –0.53 | –53.43** | –69.54** | –55.75** | –69.94* | –56.96* | –70.86* |
| IIVR-Sel 2 × Sel. 7 | –69.64** | –83.06* | –92.91* | –96.00** | 119.77** | 45.43* | –74.07 | –83.27** | 58.37** | –72.13** | –66.52* | –76.97** |
| IIVR-Sel 2 × Azad T 2 | –80.64** | –89.04** | 88.62* | –93.54* | 19.89 | –22.54 | –53.99** | –70.59** | 70.18** | –79.52** | –59.09* | –71.52* |
| IIVR-Sel 2 × Punjab Upma | –78.72** | –87.98* | –91.79* | –95.34** | 2.87 | –33.80 | –66.71** | –78.69** | –70.67** | –79.76** | –62.89* | –74.21* |
| IIVR-Sel 2 × DARL 64 | –65.07** | –80.25* | –87.77* | –93.09* | 92.60** | –23.27 | –44.66** | –64.44** | –58.04** | –70.99** | –57.14* | –70.37* |
| IIVR-Sel 2 × BSS 368 | –58.35* | –76.55* | –92.78** | –95.89* | 199.19** | 93.84** | –71.55** | –81.86** | –46.09** | –63.09* | –65.14* | –75.64** |
| IIVR-Sel 2 × Himsona | –80.13** | –88.79** | –92.55** | –95.77** | 14.44 | –26.05 | –56.36** | –72.18** | –64.91** | –75.90** | –47.71 | –63.46* |
| IIVR-Sel 2 × Tom 187 | –56.73* | –75.50* | 92.86** | –95.95** | 224.18** | 107.75** | –64.19** | –71.11** | –47.75** | –63.75* | –54.55* | –68.35* |

*Continued*

| Progeny | Days to 50% flowering | | | | Days to first fruit | | | | Plant height | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $E_1$ | | $E_2$ | | $E_1$ | | $E_2$ | | $E_1$ | | $E_2$ | |
| | H | HB | H | HB | H | HB | H | HB | H | HB | H | HB |
| IIVR-Sel 2 × CO 3 | –85.73** | –91.93** | –92.79** | –95.96** | –1.24 | –36.62 | –60.05** | –79.94** | –60.54** | –72.67** | –56.60* | –70.52* |
| Arka Vikas × Sel. 7 | –80.69** | –89.62** | –90.15** | –94.67* | 109.26** | 52.50* | –39.12* | –57.00* | –44.21** | –64.48* | –51.63* | –68.49* |
| Arka Vikas × Azad T 2 | –76.20** | –87.11* | –88.59* | –93.79* | 87.28** | 32.50 | –20.79 | –44.75 | –66.67** | –78.31** | –46.15 | –64.56* |
| Arka Vikas × Punjab Upma | –66.97** | –82.09* | –87.73* | –93.33* | 213.32** | 120.50** | –23.79 | –46.75* | –30.52 | –54.60* | –52.15* | –68.56* |
| Arka Vikas × DARL 64 | –72.92** | –85.31* | –87.26* | –93.09* | 67.26** | 17.50 | –44.13* | –60.65 | 64.15** | 76.54** | –69.81* | –80.25** |
| Arka Vikas × BSS 368 | –81.08** | –89.76 | –87.75* | –93.33* | 67.96** | 19.25 | –51.79** | –66.50** | –53.21** | 69.64* | –69.90* | –80.13** |
| Arka Vikas × Himsona | –75.97** | –86.99* | –87.28* | –93.08 | 146.64** | 74.50** | –50.35** | –65.50 | 33.33 | 56.63* | –71.85** | –81.41** |
| Arka Vikas × Tom 187 | –82.74** | –90.63** | –89.29* | –94.18* | 60.71** | 12.50 | –50.18** | 65.25 | –43.81** | –63.13* | –65.38* | –77.22** |
| Arka Vikas × CO 3 | –84.21** | –91.43** | –88.44* | –93.76* | 11.23 | –22.00 | 51.13** | –65.00** | 67.67** | –78.88** | 78.47** | –86.13** |
| Sel. 7 × Azad T 2 | –76.12** | –86.87* | –88.09 | –93.42* | 179.80** | 94.16** | 53.24** | –67.99** | 42.45** | –63.25* | –79.52** | 82.91** |
| Sel. 7 × Punjab Upma | –71.94** | –84.53* | 92.02** | –95.60** | 150.42** | 72.90** | –42.76* | –60.74* | –31.10* | –55.82** | –55.12* | –97.07 |
| Sel. 7 × DARL 64 | –63.27** | –79.75* | –91.94* | 95.56** | 136.61** | 63.08** | –61.02** | –73.13** | –53.85** | –70.37** | –59.62** | –74.07 |
| Sel. 7 × BSS 368 | 77.03** | 87.38** | 85.66* | 96.03** | 290.94** | 112.57** | 379.45** | 227.10** | 45.89** | 46.43* | 72.87** | 83.59** |
| Sel. 7 × Himsona | –59.69* | –77.83* | 73.58* | –85.39* | 229.30** | 107.89** | 3.49** | 32.10 | 38.49* | –41.57 | 49.56* | –64.10* |
| Sel. 7 × Tom 187 | –66.93** | –81.75* | –88.72* | –93.79* | 165.59** | 80.38** | 14.67 | –21.50 | –39.81* | –61.25* | –44.12 | –63.92* |
| Sel. 7 × CO 3 | 77.93** | –87.82* | –91.98* | –95.61** | 115.62** | 48.37* | –39.76* | –57.71* | 32.37* | –56.52* | –57.99** | –73.43* |
| Azad T 2 × Punjab Upma | –86.24** | –91.90** | –90.84* | –94.59* | –28.82 | –58.46* | –65.43** | –79.90** | 59.40** | –68.71* | –59.10* | –69.70** |
| Azad T 2 × DARL 64 | –63.31* | –78.39* | –92.45** | –95.56** | 86.95** | 9.03* | –76.25** | –86.15** | 45.97** | –58.64* | –72.10* | –79.01** |
| Azad T 2 × BSS 368 | –63.82* | –78.81* | –92.64** | –95.66** | 29.84* | –23.89 | –82.32** | –89.74** | –55.91** | –66.67* | 78.55** | –83.33** |
| Azad T 2 × Himsona | –60.16* | –76.63 | –91.34* | –94.87* | 34.62* | –21.23 | –78.96** | –87.80** | –55.56** | –66.27* | –72.58** | –81.41** |
| Azad T 2 × Tom 187 | –57.20* | –74.75 | –93.36** | –96.08** | 55.42** | –9.54 | –84.99** | 91.28** | –51.22** | –62.50* | –78.51** | –87.34** |
| Azad T 2 × CO 3 | –42.25 | –65.96 | –87.91* | –92.95* | 153.87** | 47.89* | –69.51** | 82.05** | 45.75** | –58.39* | –76.03** | –83.24** |
| Punjab Upma × DARL 64 | –62.58* | –78.15* | –91.54** | –95.06** | 68.50** | –0.75 | –82.92** | –89.91** | 55.65** | –67.28* | 83.61** | –88.89** |
| Punjab Upma × BSS 368 | –85.04** | –91.31 | –91.48** | –95.00** | –6.60 | –44.51 | –58.02* | –75.34** | –43.67** | –58.93* | –71.61** | –62.82* |
| Punjab Upma × Himsona | –72.67** | –84.09 | –88.86* | –93.46* | –10.21 | –46.75* | –62.29** | –77.80** | –71.19** | –78.92** | 84.94** | –75.00* |
| Punjab Upma × Tom 187 | –69.44** | –83.13* | –93.36* | –94.24* | 12.55 | –33.63 | –62.48** | –77.92** | –56.96** | –68.13* | 50.22* | –71.52* |
| Punjab Upma × CO 3 | –82.36** | –89.69 | –88.81* | –93.53* | –7.12 | –45.18* | –54.37** | –72.76** | –57.14** | –68.32* | –61.70* | –72.63* |
| DARL 64 × BSS 368 | –81.65** | –88.93** | 68.97* | –81.03 | 0.41 | –39.09 | –21.82 | –27.03 | –55.66** | –70.83* | –62.40* | –71.80* |

*Continued*

| Progeny | Days to 50% flowering | | | | Days to first fruit | | | | Plant height | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $E_1$ | | $E_2$ | | $E_1$ | | $E_2$ | | $E_1$ | | $E_2$ | |
| | H | HB | H | HB | H | HB | H | HB | H | HB | H | HB |
| DARL 64 × Himsona | –70.52** | –82.17** | –89.10* | –93.33* | 83.44** | 11.04 | –34.32* | –60.66** | –47.03** | –65.06* | –49.28* | –66.03* |
| DARL 64 × Tom 187 | –70.84** | –82.25* | –83.63* | –93.97* | 68.99** | 1.65 | –52.43** | –71.45** | –41.78** | –61.25* | –57.35* | –71.92* |
| DARL 64 × CO 3 | –81.82** | –88.94** | –91.34 | –94.79* | 12.54 | –32.23 | –59.21** | 75.13** | –50.47** | –67.08* | –61.95 | –75.15** |
| BSS 368 × Himsona | –68.64** | –82.17* | –88.14* | –93.21* | 33.60* | –14.31 | –27.86 | –54.34* | 67.89** | –78.92** | –50.96 | –67.31* |
| BSS 368 × Tom 187 | –58.56* | –76.50* | –70.13* | –82.91 | 207.90** | –95.91** | 69.13** | 7.33 | –26.42 | –51.25* | –44.76 | –63.29* |
| BSS 368 × CO 3 | –72.36** | –54.23* | 87.54* | –92.95* | 98.12** | 26.24 | –25.00 | –51.45* | –41.78** | –61.49* | –62.67* | –75.72** |
| Himsona × Tom 187 | 76.60** | 85.88** | 72.55* | 87.34* | 36.98* | 18.56 | 79.29** | 56.38* | 44.14** | 41.25* | 62.67* | 52.66* |
| Himsona × CO 3 | –83.52** | –90.06 | –86.61* | –92.02* | –9.63 | –46.22** | –50.34** | –70.09** | –56.95** | –70.19* | 71.92** | –80.93** |
| Tom 187 × CO 3 | –79.93** | –88.08** | –91.94* | –95.26** | –11.49 | –46.70* | –59.42** | –75.25** | –63.06** | –74.53** | –69.23* | –79.19** |
| SEd | 1.25 | 1.50 | 0.82 | 1.17 | 14.87 | 22.73 | 17.19 | 24.30 | 1.25 | 1.63 | 1.05 | 1.48 |
| | Fruit volume | | | | Leaf area | | | | Chlorophyll content at 45 days | | | |
| IIVR-Sel 2 × Arka Vikas | 38.53** | 22.41** | –62.23** | –24.14 | –66.74** | –74.79* | –71.34* | –78.37* | –97.43** | –98.69 | –98.66** | –98.32 |
| IIVR-Sel 2 × Sel. 7 | –54.36** | 65.17 | –74.89** | –51.22** | –64.38* | –73.51* | –75.25** | –80.94* | –97.24* | –98.61 | –97.80 | –98.88 |
| IIVR-Sel 2 × Azad T 2 | –51.78** | –6.89 | –63.89** | –32.75* | –43.40 | –56.50* | –69.15* | –75.87 | –97.18* | –98.57 | –98.48** | –98.22 |
| IIVR-Sel 2 × Punjab Upma | –53.85** | –12.07 | 64.06** | –32.75* | –69.67** | –76.54* | –77.97** | –82.81* | –97.10* | –98.53 | –98.81** | –98.40 |
| IIVR-Sel 2 × DARL 64 | –50.95** | –6.89 | –51.82** | –8.62 | –15.12 | –34.20 | –72.18** | –78.43* | –97.25* | –98.59 | –98.39** | –98.18 |
| IIVR-Sel 2 × BSS 368 | –48.67** | 0.00 | –65.42** | –36.21* | 26.68 | –3.04 | –72.21** | –78.16* | –97.19* | –98.58 | –97.48 | –98.72 |
| IIVR-Sel 2 × Himsona | –50.03** | –3.45 | –66.36** | 37.93* | 1.95 | –21.65 | –68.05* | –74.89 | –97.19* | –97.57 | –97.62 | –98.79 |
| IIVR-Sel 2 × Tom 187 | 44.04** | 5.17 | –42.60* | –6.89 | –65.68** | –73.28* | –81.00** | –85.14** | –96.85 | –97.40 | –97.70 | –98.83 |
| IIVR-Sel 2 × CO 3 | –35.16** | 22.41** | –54.98** | –10.35 | –82.16** | –86.15** | –77.08** | –52.63* | –97.22* | –98.60 | –97.97 | –98.97 |
| Arka Vikas × Sel. 7 | 51.81** | 5.56 | –61.64** | –22.22 | –65.09 | –86.15** | –67.06* | –77.38 | –97.22* | –98.59 | –98.49** | –98.75 |
| Arka Vikas × Azad T 2 | 34.55** | 33.33** | –59.43** | –20.37 | –33.67 | –76.67* | –83.05 | –88.22** | –97.08* | –98.52 | –97.10 | –98.53 |
| Arka Vikas × Punjab Upma | 23.50* | 13.70* | –49.30** | 0.00 | –53.44* | –54.65 | –77.59** | –84.45** | –97.14* | –98.55 | –97.20 | –98.58 |
| Arka Vikas × DARL 64 | –49.07** | 1.85 | –75.93** | –51.85** | 50.73 | –67.91* | –77.63** | –84.56** | –97.24* | –98.60 | –97.98 | –98.98 |
| Arka Vikas × BSS 368 | 45.95** | 1.11 | –56.19** | –14.82 | 58.47* | –65.99* | –83.03** | –88.16** | –97.43** | –98.69 | –97.46 | –98.86 |
| Arka Vikas × Himsona | –50.91 | 0.00 | –53.33** | –9.29 | 0.13 | 71.62* | –75.69** | –83.05** | –97.06* | –98.51 | –98.25** | –99.12 |
| Arka Vikas × Tom 187 | 32.71** | 33.33** | –82.08** | –64.82** | –42.00 | –31.25 | –59.09* | –71.57 | –96.66 | –98.31 | –98.86** | –98.42 |

*Continued*

*Table 2 Concluded*

| Progeny | Days to 50% flowering | | | | Days to first fruit | | | | Plant height | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $E_1$ | | $E_2$ | | $E_1$ | | $E_2$ | | $E_1$ | | $E_2$ | |
| | H | HB | H | HB | H | HB | H | HB | H | HB | H | HB |
| Arka Vikas × CO 3 | –47.91** | 3.70 | –67.40** | –31.48* | 69.25** | –59.83* | –74.32** | –82.58* | –96.68 | –98.32 | –98.18* | –98.08 |
| Sel. 7 × Azad T 2 | –37.82** | 2.78 | –58.26** | –33.33* | –40.71 | –78.73** | –74.74** | –81.80* | –97.09* | –98.53 | –97.62 | –98.79 |
| Sel. 7 × Punjab Upma | –32.77** | 9.72 | –61.90** | 38.88* | –70.25** | –57.91* | –86.61** | –90.37** | –97.02* | –98.49 | –97.97 | –98.97 |
| Sel. 7 × DARL 64 | –47.01** | –13.89* | –56.41** | –29.17 | –75.00 | –78.77** | –77.98** | –84.25** | –97.17* | –98.57 | –98.31** | –97.14 |
| Sel. 7 × BSS 368 | 60.83** | 34.72** | 56.14** | 32.56* | –57.52* | –82.12** | 73.25** | 86.19** | –97.27* | –98.92* | 98.15* | 99.06* |
| Sel. 7 × Himsona | 28.57** | 18.06* | –51.75** | –23.61 | –54.58* | –69.95* | 72.70** | 85.78** | –97.21* | –98.59 | –98.29* | –98.13 |
| Sel. 7 × Tom 187 | –54.31** | –26.39** | –64.35** | –43.01** | –89.46** | –67.76* | –75.50** | –82.35* | –96.67 | –98.31 | –98.67** | –98.32 |
| Sel. 7 × CO 3 | –53.65** | –25.00** | –73.88** | –55.56** | –50.63 | –92.44** | –84.40** | –89.06** | 96.68 | –98.32 | –97.48 | –98.72 |
| Azad T 2 × Punjab Upma | –49.12** | –10.77 | –61.61** | –33.85* | –72.28** | –64.63* | –67.12* | –76.47 | –96.41 | –98.18 | –98.13* | –98.05 |
| Azad T 2 × DARL 64 | –63.87** | 36.92** | –80.62** | –66.19** | –71.93** | –80.31** | –66.63* | –76.26 | –97.21* | –98.58 | –98.59** | 98.29 |
| Azad T 2 × BSS 368 | –54.51** | –18.46* | –73.76* | –55.38** | –64.59* | –80.03** | –65.72* | –75.33 | –97.00* | –98.48 | –98.58** | –98.28 |
| Azad T 2 × Himsona | –43.73** | 0.00 | –59.28** | –30.77* | –64.91* | –75.07** | –65.80* | –75.39 | –97.19* | –98.58 | –98.09* | –98.03 |
| Azad T 2 × Tom 187 | –30.67** | 20.00** | –81.37** | –67.69** | –62.36* | –75.22** | –63.67* | –73.96 | –97.02* | –98.49 | –97.74 | –98.85 |
| Azad T 2 × CO 3 | –67.26** | 43.92** | –80.67** | –64.62** | –51.47 | –73.12** | –63.48* | –74.91 | –96.99 | –98.48 | –97.64 | –98.81 |
| Punjab Upma × DARL 64 | –57.66** | 21.67** | –71.17** | –46.67** | –58.51* | –65.40* | –65.22* | –77.58 | –97.10* | –98.53 | –97.89 | –98.93 |
| Punjab Upma × BSS 368 | 37.75** | 18.33* | –50.93** | –11.67 | –76.40** | –73.25** | –52.54 | –69.14 | –97.08* | –98.53 | –97.26 | –98.61 |
| Punjab Upma × Himsona | –46.91** | 0.00 | –67.59** | –41.67* | –67.21** | –78.97** | –62.50* | –75.62 | –97.17 | –98.57 | –97.69 | –98.83 |
| Punjab Upma × Tom 187 | –40.91** | 8.33 | –66.06** | –38.33* | –73.78** | –83.05** | –61.31 | –74.92 | –96.98 | –98.47 | –98.31** | –98.14 |
| Punjab Upma × CO 3 | –56.56** | –20.00** | –68.24** | –38.33* | –61.64* | –75.23** | –56.27 | –72.22 | –96.37 | –98.16 | –97.35 | –98.66 |
| DARL 64 × BSS 368 | –72.02** | –94.67** | –72.29* | –57.33** | –78.08** | –84.51** | –50.99 | –64.59 | –97.27* | –98.62 | –97.79 | –98.88 |
| DARL 64 × Himsona | –44.40** | –10.67* | –50.64** | –24.00 | –64.65* | –74.93** | –71.84* | –79.65* | –97.26* | –98.61 | –97.66 | –98.82 |
| DARL 64 × Tom 187 | 27.66** | 13.33* | –54.50** | –29.33 | –52.64 | –66.05* | –64.54 | –74.48 | –97.39** | –98.68 | –97.57 | –98.77 |
| DARL 64 × CO 3 | –57.63** | –33.33** | –38.70 | 1.33 | –61.50* | –72.45** | –49.91 | –64.91 | –97.10* | –98.53 | –98.30** | –98.14 |
| BSS 368 × Himsona | –62.73** | –24.07** | –39.05 | 18.52 | –48.43 | –65.18* | –74.70** | –82.63* | –97.20* | –98.58 | –98.08* | –98.54 |
| BSS 368 × Tom 187 | –27.10** | –44.44** | –40.57 | 16.67 | –38.43 | –58.03* | –41.43 | –59.94 | –97.14* | –98.55 | –97.72 | –98.84 |
| BSS 368 × CO 3 | 41.39** | 26.29** | –61.33** | –18.52 | –70.27** | –79.76** | –62.41 | –74.89 | –97.18* | –98.57 | –98.27* | –98.11 |
| Himsona × Tom 187 | 55.00** | 32.50** | 50.82** | 30.75* | –71.35** | –82.22** | 73.31** | 78.79* | –97.12* | –98.93* | 98.77** | 99.00* |
| Himsona × CO 3 | –56.02** | –33.79** | –77.87 | –65.00** | –73.21** | –83.42** | –54.99 | –72.52 | –97.20* | –98.56 | –97.54 | –98.75 |
| Tom 187 × CO 3 | –65.04** | 49.45** | –70.54** | –55.29** | –67.95** | –78.55** | –76.78** | –84.73** | –96.36 | –98.15 | –97.72 | –98.85 |
| SEd | 1.17 | 1.63 | 1.13 | 1.60 | 1.32 | 1.40 | 0.45 | 0.64 | 0.0004 | 0.0006 | 0.0005 | 0.0006 |

* $P$=0.05, ** $P$=0.01

Table 3 Stress susceptibility index of parents and $F_1$s of tomato for fruit yield and its contributing characters

| Progeny | Days to 50% flowering | | Days to first fruit | | Plant height | | No. of fruits/ plant | | Fruit yield/ plant | | Average fruit weight | | Fruit volume | | Leaf area | | Chlorophyll content at 45 days | | Over all rank |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SSI | Rank | SSI | Rank | SSI | Rank | SSI | Rank | SSI | Rank | SSI | Rank | SSI | Rank | SSI | Rank | SSI | Rank | |
| IIVR-Sel 2 | 1.24 | 6 | 5.65 | 10 | 0.90 | 5 | 1.11 | 7 | 1.09 | 6 | 1.34 | 7 | 0.80 | 3 | 1.18 | 9 | 0.89 | 7 | 8 |
| Arka Vikas | –0.42 | 2 | –0.51 | 4 | 0.83 | 4 | 0.45 | 1 | 0.80 | 2 | 0.58 | 3 | 0.65 | 2 | 1.06 | 5 | 0.83 | 5 | 1 |
| Sel. 7 | 3.59 | 10 | 0.00 | 6 | 0.49 | 1 | 0.83 | 3 | 0.60 | 1 | –1.26 | 1 | 1.22 | 8 | 1.17 | 8 | 0.86 | 6 | 5 |
| Azad T 2 | 1.76 | 7 | –0.30 | 5 | 1.10 | 8 | 1.22 | 8 | 1.10 | 7 | 1.26 | 5 | 0.98 | 7 | 1.24 | 10 | 2.60 | 10 | 10 |
| Punjab Upma | 0.89 | 5 | –0.99 | 2 | 1.29 | 2 | 1.00 | 4 | 1.07 | 5 | 1.69 | 10 | 0.92 | 5 | 0.58 | 2 | 2.46 | 9 | 6 |
| DARL 64 | 0.00 | 3 | 3.59 | 8 | 1.50 | 10 | 1.11 | 7 | 1.12 | 8 | 1.43 | 8 | 1.41 | 10 | 1.11 | 6 | –0.41 | 2 | 9 |
| BSS 368 | 2.61 | 2 | –1.55 | 1 | 0.99 | 6 | 0.50 | 2 | 0.81 | 3 | 1.32 | 6 | 0.90 | 4 | 0.59 | 3 | 0.77 | 4 | 3 |
| Himsona | 2.20 | 8 | 0.36 | 7 | 0.72 | 3 | 1.01 | 5 | 0.92 | 4 | 0.82 | 4 | 0.61 | 1 | 0.41 | 1 | 0.47 | 3 | 2 |
| Tom 187 | 0.45 | 4 | –0.71 | 3 | 0.55 | 2 | 1.25 | 9 | 1.07 | 5 | 0.53 | 2 | 0.96 | 6 | 0.95 | 4 | 1.83 | 8 | 4 |
| CO 3 | –2.72 | 1 | 5.11 | 9 | 1.08 | 7 | 1.06 | 6 | 1.12 | 8 | 1.53 | 9 | 1.38 | 9 | 1.15 | 7 | –1.43 | 1 | 7 |
| IIVR-Sel 2 × Arka Vikas | 0.00 | 6 | 2.70 | 31 | 4.08 | 41 | 1.01 | 22 | 1.08 | 20 | 0.09 | 10 | 1.26 | 28 | 0.47 | 23 | 1.39 | 32 | 25 |
| IIVR-Sel 2 × Sel. 7 | 0.44 | 10 | 6.71 | 38 | 2.58 | 32 | 1.41 | 35 | 1.38 | 31 | 1.15 | 24 | 1.63 | 37 | 1.25 | 31 | 0.84 | 20 | 35 |
| IIVR-Sel 2 × Azad T 2 | 1.16 | 24 | 0.00 | 23 | 2.32 | 31 | 0.79 | 12 | 0.97 | 15 | –1.46 | 4 | 0.92 | 19 | 1.67 | 33 | 1.43 | 33 | 19 |
| IIVR-Sel 2 × Punjab Upma | –0.11 | 5 | 4.80 | 34 | 2.23 | 30 | 1.12 | 25 | 1.05 | 19 | –1.09 | 5 | 0.78 | 14 | 1.01 | 29 | 1.79 | 37 | 21 |
| IIVR-Sel 2 × DARL 64 | 2.32 | 42 | –2.52 | 10 | 0.67 | 18 | 1.17 | 29 | 1.11 | 21 | –0.09 | 9 | 0.06 | 5 | 2.39 | 40 | 1.26 | 29 | 23 |
| IIVR-Sel 2 × BSS 368 | 0.77 | 16 | 6.60 | 37 | 2.71 | 33 | 1.50 | 39 | 1.41 | 33 | 1.74 | 31 | 1.20 | 26 | 2.81 | 44 | 0.48 | 6 | 38 |
| IIVR-Sel 2 × Himsona | 0.81 | 17 | 4.03 | 33 | 0.64 | 17 | 1.16 | 28 | 0.97 | 15 | –1.91 | 3 | 1.19 | 25 | 2.48 | 41 | 0.60 | 10 | 17 |
| IIVR-Sel 2 × Tom 187 | –0.22 | 3 | 10.23 | 42 | –0.94 | 8 | 1.50 | 39 | 1.38 | 31 | 0.62 | 20 | –0.06 | 4 | 1.60 | 32 | 0.84 | 21 | 22 |
| IIVR-Sel 2 × CO 3 | 1.46 | 31 | 5.44 | 35 | –2.97 | 5 | 0.83 | 13 | 0.92 | 13 | –0.71 | 6 | 0.89 | 18 | –1.23 | 8 | 0.67 | 14 | 7 |
| ArkaVikas × Sel. 7 | 1.37 | 29 | 7.27 | 39 | –4.83 | 2 | 0.96 | 19 | 1.12 | 22 | 0.90 | 23 | 0.88 | 17 | 0.45 | 22 | 2.50 | 40 | 25 |
| ArkaVikas × Azad T 2 | 0.30 | 8 | –4.39 | 3 | 2.16 | 29 | 0.97 | 21 | 0.91 | 12 | –2.50 | 1 | 1.34 | 29 | 2.67 | 42 | 0.18 | 2 | 9 |
| ArkaVikas × PunjabUpma | 0.52 | 11 | 1.77 | 29 | 0.87 | 19 | 1.14 | 26 | 1.18 | 23 | 1.46 | 28 | 1.16 | 23 | 1.87 | 34 | 0.15 | 1 | 19 |
| Arka Vikas × DARL 64 | 1.25 | 27 | 3.54 | 32 | –0.16 | 11 | 0.95 | 20 | 1.04 | 18 | 0.71 | 21 | 1.75 | 38 | 1.94 | 36 | 0.82 | 19 | 27 |
| Arka Vikas × BSS 368 | 0.82 | 18 | 8.02 | 40 | –2.41 | 7 | 0.71 | 11 | 1.12 | 22 | 1.76 | 33 | 0.78 | 14 | 2.17 | 39 | 0.57 | 8 | 18 |
| ArkaVikas × Himsona | 0.32 | 9 | 13.07 | 44 | 1.34 | 21 | 0.90 | 16 | 1.25 | 25 | 2.69 | 38 | 0.31 | 7 | 2.72 | 43 | 1.33 | 30 | 30 |
| ArkaVikas × Tom 187 | 1.75 | 36 | –0.66 | 21 | 2.90 | 35 | 0.69 | 10 | 1.08 | 20 | 1.75 | 32 | 2.45 | 41 | 1.07 | 30 | 1.95 | 38 | 36 |
| ArkaVikas × CO 3 | 0.73 | 15 | 8.80 | 41 | –0.16 | 11 | 0.39 | 5 | 0.86 | 10 | 1.32 | 26 | 1.13 | 22 | 0.43 | 21 | 1.23 | 28 | 14 |
| Sel. 7 × Azad T 2 | 1.40 | 31 | 0.89 | 25 | 1.67 | 23 | 0.94 | 18 | 1.30 | 26 | 2.51 | 38 | 1.17 | 24 | 2.09 | 38 | 0.65 | 12 | 32 |
| Sel. 7 × PunjabUpma | 0.65 | 12 | –0.84 | 17 | 2.01 | 27 | 1.30 | 32 | 1.20 | 24 | 1.62 | 30 | 1.47 | 33 | 1.98 | 37 | 0.98 | 23 | 32 |
| Sel. 7 × DARL 64 | 1.67 | 34 | 1.06 | 26 | 2.97 | 36 | 1.40 | 34 | 1.30 | 26 | 0.56 | 19 | 0.59 | 10 | 0.42 | 20 | 1.20 | 27 | 29 |

*Continued*

*Table 3 Concluded*

| Progeny | Days to 50% flowering | | Days to first fruit | | Plant height | | No. of fruits/ plant | | Fruit yield/ plant | | Average fruit weight | | Fruit volume | | Leaf area | | Chlorophyll content at 45 days | | Over all rank |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SSI | Rank | SSI | Rank | SSI | Rank | SSI | Rank | SSI | Rank | SSI | Rank | SSI | Rank | SSI | Rank | SSI | Rank | |
| Sel. 7 × BSS 368 | 1.65 | 33 | –0.83 | 18 | 3.27 | 39 | –1.37 | 1 | –0.96 | 1 | 0.10 | 11 | –0.21 | 3 | –0.16 | 14 | 1.08 | 25 | 8 |
| Sel 7 × Himsona | 1.00 | 21 | –0.94 | 16 | 3.08 | 37 | 0.68 | 9 | 0.87 | 11 | 1.90 | 34 | 1.17 | 24 | 0.01 | 15 | 1.26 | 29 | 20 |
| Sel. 7 × Tom 187 | 1.98 | 39 | 1.76 | 28 | 0.43 | 15 | 1.19 | 30 | 0.88 | 12 | 0.36 | 14 | 0.75 | 12 | –4.64 | 1 | 1.79 | 37 | 16 |
| Sel. 7 × CO 3 | 0.52 | 11 | –0.77 | 20 | 6.56 | 42 | 1.10 | 24 | 1.11 | 21 | 1.54 | 29 | 1.35 | 30 | 2.37 | 39 | 0.53 | 7 | 28 |
| Azad T 2 × PunjabUpma | 1.71 | 35 | –1.81 | 13 | 1.88 | 24 | 0.62 | 8 | 0.80 | 8 | –0.35 | 8 | 0.86 | 16 | –0.59 | 12 | 1.48 | 35 | 13 |
| Azad T 2 × DARL 64 | 1.26 | 28 | –4.10 | 5 | 3.41 | 40 | 1.43 | 37 | 1.36 | 29 | 2.22 | 36 | 1.54 | 35 | –0.67 | 11 | 1.45 | 34 | 34 |
| Azad T 2 × BSS 368 | 1.39 | 30 | –4.37 | 4 | 3.14 | 38 | 1.45 | 38 | 1.35 | 28 | 2.41 | 37 | 1.51 | 34 | 0.29 | 19 | 1.65 | 36 | 37 |
| Azad T 2 × Himsona | –0.21 | 4 | –3.29 | 7 | 2.74 | 34 | 1.42 | 36 | 1.31 | 27 | 2.17 | 35 | 1.02 | 20 | 0.24 | 18 | 1.09 | 26 | 24 |
| Azad T 2 × Tom 187 | 1.86 | 38 | –4.39 | 3 | 0.16 | 13 | 1.52 | 40 | 1.41 | 33 | 3.00 | 41 | 2.43 | 40 | 0.15 | 16 | 0.77 | 18 | 33 |
| Azad T 2 × CO 3 | 1.22 | 26 | –0.54 | 22 | –0.36 | 9 | 1.40 | 34 | 1.37 | 30 | 2.55 | 39 | 1.26 | 28 | 0.74 | 25 | 0.47 | 5 | 26 |
| Punjab Upma × DARL 64 | 0.66 | 13 | 6.55 | 36 | 0.58 | 16 | 1.39 | 33 | 1.40 | 32 | 2.97 | 40 | 1.06 | 21 | 0.57 | 24 | 0.79 | 19 | 31 |
| Punjab Upma × BSS 368 | 0.89 | 19 | 1.42 | 27 | –0.26 | 10 | 0.84 | 14 | 0.86 | 10 | 0.72 | 22 | 0.84 | 15 | –3.19 | 4 | 0.40 | 4 | 6 |
| Punjab Upma × Himsona | 1.46 | 31 | 1.92 | 30 | 1.22 | 20 | 1.10 | 24 | 0.91 | 13 | –0.51 | 7 | 1.39 | 31 | –0.32 | 13 | 0.68 | 15 | 11 |
| Punjab Upma × Tom 187 | 0.22 | 7 | 10.47 | 43 | 2.13 | 28 | 1.29 | 31 | 1.04 | 18 | 0.53 | 17 | 1.43 | 32 | –1.64 | 6 | 1.35 | 31 | 24 |
| Punjab Upma × CO 3 | 1.18 | 25 | –1.97 | 11 | 1.53 | 22 | 0.58 | 7 | 0.78 | 7 | 0.35 | 13 | 0.76 | 13 | –0.73 | 10 | 0.66 | 13 | 5 |
| DARL 64 × BSS 368 | 1.81 | 37 | –0.82 | 19 | –3.40 | 4 | –1.06 | 2 | –0.31 | 3 | 0.46 | 16 | 0.19 | 6 | –3.99 | 2 | 0.76 | 17 | 2 |
| DARL 64 × Himsona | 1.10 | 22 | –2.70 | 9 | –0.14 | 12 | 1.16 | 28 | 1.00 | 17 | 0.39 | 15 | 0.50 | 9 | 0.84 | 27 | 0.58 | 9 | 10 |
| DARL 64 × Tom 187 | –0.56 | 1 | –1.95 | 12 | 0.43 | 15 | 1.16 | 28 | 1.12 | 22 | 1.23 | 25 | 1.25 | 27 | 0.92 | 28 | 0.21 | 3 | 15 |
| DARL 64 × CO 3 | 0.67 | 14 | –3.60 | 6 | –2.63 | 6 | 0.89 | 15 | 0.98 | 16 | 0.85 | 22 | –1.73 | 2 | –1.31 | 7 | 1.09 | 26 | 4 |
| BSS 368 × Himsona | 0.96 | 20 | –4.58 | 2 | 2.05 | 28 | 1.15 | 27 | 0.73 | 6 | –2.05 | 2 | –1.86 | 1 | 1.89 | 35 | 2.08 | 39 | 14 |
| BSS 368 × Tom 187 | 2.17 | 41 | –1.29 | 14 | 0.35 | 14 | 0.51 | 6 | 0.70 | 5 | 1.15 | 24 | 0.64 | 11 | 0.20 | 17 | 0.62 | 11 | 7 |
| BSS 368 × CO 3 | 1.65 | 33 | –1.08 | 15 | 1.96 | 25 | 0.93 | 17 | 0.96 | 14 | 1.45 | 27 | 1.95 | 39 | –1.18 | 9 | 1.01 | 24 | 23 |
| Himsona × Tom 187 | 1.14 | 23 | –3.06 | 8 | –4.55 | 3 | –1.05 | 3 | –0.48 | 2 | 0.22 | 12 | 0.31 | 7 | –3.40 | 3 | 0.69 | 16 | 1 |
| Himsona × CO 3 | 1.59 | 32 | –6.52 | 1 | –5.11 | 1 | 0.25 | 4 | 0.69 | 4 | 1.41 | 26 | 1.57 | 36 | –2.77 | 5 | 0.19 | 3 | 3 |
| Tom 187 × CO 3 | –0.30 | 2 | 0.41 | 24 | 1.97 | 26 | 1.03 | 23 | 0.83 | 9 | 0.55 | 18 | 0.39 | 8 | 0.83 | 26 | 0.96 | 22 | 12 |

Conclusively, the genotypes which have highly significant and desirable heterosis and heterobeltiosis with satisfactory level of salinity tolerance might be used subsequently in the plant breeding programmes aimed at development of salinity tolerance genotypes in tomato.

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## SUMMARY

Heterosis for fruit yield and components traits was studied using diallel analysis among 10 genetically diverse genotypes along with their 45$F_1$ in normal and salt stress condition. Heterotic hybrids were identified in both the environment for most of the characters, viz. Sel 7 × BSS 368 for plant height, number of fruits/plant, fruit yield/plant, average fruit weight, fruit volume and Himsona × Tom 187 for days to fruits fruit, number of fruits plant and fruit volume. According to SSI, the parents, AkraVikas, followed by Himsona and BSS 368 and crosses Himsona × Tom 187, DARL 64 × BSS 368 and Himsona × CO 3 were desirable for saline environment. The genotypes which have highly significant and desirable heterosis and heterobeltiosis with satisfactory level of salinity tolerance might be used subsequently in the plant breeding programmes aimed at development of salinity tolerance genotypes in tomato.

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