Electronic Journal of Plant Breeding, 1(4):706-711 (July 2010)

**Research Article**

# Implications of heterosis and combining ability among productive Single cross hybrids in tomato

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**Abstract**

Ten tomato commercial and productive single cross hybrids extensively grown in Northern Transitional Zone of Karnataka were planted in the field at UAS, Dharwad following RBD design with three replications. A 10 x 10 diallel set was generated by crossing these single cross hybrids in all possible combinations (excluding reciprocals) and 45 double cross hybrids were planted during February, 2007 with three replications with a view to estimate heterosis and combining ability to facilitate identification of heterosis combinations for all the ten characters studied. The range of heterosis (%) over mid parent and better parent was wide for number of clusters per plant and number of locules per fruits as compared to other characters. The number of significant heterosis hybrids in desirable direction for both mid parent (28 hybrids) and better parent( 24 hybrids) was highest for number of locules per fruit followed by number of cluster per plant (mid parent-17 hybrids, better parent-11 hybrids). The overall gca and sca status for SCH and DCH respectively revealed that among single cross hybrids JK-Desi was the best general combiner for yield and most of the traits followed by Pragathi and Maharani. Out of top five double cross hybrids, only two hybrids viz., JK-Desi x Sasya and JK-Desi x Shivaji expressed significant high positive heterosis over mid-parent and better parent along with better performance in term of yield per plant. It is noteworthy to mention that three of the five top double cross hybrids had JK-Desi as one of the common parent which is potential donor for yield per plant, number of fruits per plant, number of branch per plant, plant height and pericarp thickness.

**Key words**: Combining ability, Double cross hybrid, Heterosis, Single cross hybrid Tomato, additive and non additive gene action

## Introduction

In India, tomato occupies an area of 5.213 lakh ha with production of 90.64 lakh mt and productivity of 17.387 t/ha. Tomato being a moderate nutritional crop is considered as a important source of Vitamin A and C and minerals which are important ingredients for table purpose, sambar preparation, chutney, pickles, ketchup, soup, juice puree etc. There is an urgent need to initiate multiple cross breeding programme to satisfy dominance hypothesis with accumulation of maximum number of favourable dominant alleles. One possible way to achieve is to use the potential $F_1$ possessing all the consumer's requirements to develop double cross hybrids. Once, double cross hybrids are produced, they could be utilized for recovering transgressive segregants for further development of potential varieties or used directly. Hence, a study was initiated to elicit information on the nature of heterosis and combining ability for yield and its height (cm), number of branches per plant, days to 50 percent flowering, number of locules per fruit, pericarp thickness (mm), number of clusters per plant, number of flowers per cluster, number of fruits per plant, average fruit weight(g), and yield(g) per plant were recorded on five randomly selected plants in each plot. The heterosis (%) over mid-parent and better parent was estimated for each character studied. The combining ability analysis was computed following Model-1, Method-2 of Griffing (1956).

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## Results and Discussion

The parameters of heterosis, relative magnitude of additive ($\sigma^2$ gca) and non additive ($\sigma^2$ sca) variance for yield and its component among 45 single cross hybrids in tomato provided in Table 1. indicated that mean heterosis over mid-parent was highest for number of cluster per plant (2.05) followed by pericarp thickness(1.41) and days to 50% flowering (0.85) while mean heterosis over better parent was very less in general with days to 50% flowering expressing highest heterosis(0.14). The range of heterosis (%) over mid-parent was wide among number of clusters per plant (-24.16 to 103.5%) and number of locules per fruit (-35.45 to 82.29%). Almost, a similar trend in range of heterosis (%) over better parent was observed with wider range in case of number of clusters per plant (-33.71 to 100.00%) and number of locules per fruit (-40.20 to 72.53%).

The number of significant heterotic hybrids in desirable direction for both mid-parent (28 hybrids) and better parent (24 hybrids) was highest for the trait number of locules per fruit followed by number of clusters per plant (Mid-parent-17 hybrids, better parent-11 hybrids).

The combining ability is the measure of nature of gene action. General combining ability variances largely involve additive gene action, while specific combining ability variances indicate presence of non-additive gene action which offers good scope for exploitation of heterosis. In the present study, the estimation of specific combining ability variances were slightly predominant for all the characters studies as revealed by the ratio of gca and sca variance (Table 1). This indicated predominance of non-additive gene action in respect of number of fruits per plant, plant height and number of branches per plant. Similar reports were also reported by Dharmatti (1995), Dod *et al* (1995) and Patil (2003) Contrary to this, operation of both additive and non additive gene action was evident in respect of number of flowers per inflorescence, fruit weight, yield per plant and days to 50% flowering and same observation were found in the studies of Singh and Nandapuri (1974), Singh and Singh (1980), Prabhushankar (1990) and Dundi (1991).

Among the single cross hybrids, JK-Desi was the best general combiner as it showed highly significant gca effects for yield per plant, number of fruits per plant and plant height in desirable direction.

The next best general combiner was Pragathi which expressed high significant positive gca effect (38.49) for yield per plant and also number of branches per plant and number of clusters per plant. On the other hand, although Maharani expressed positive significant gca effect for yield per plant but it was not so good general combiner for most of the yield components except for number of clusters per plant. Higher gca effects in parents was also reported by Dixit *et al.,* (1980) and Sidhu et al. (1981) for seed yield per plant; for number of branches per plant by Singh and Nandapuri (1974); for number of fruits per plant by Prabhushankar (1990), Dundi (1991) and Dharmatti (1995) and for plant height by Patil (2003). The hybrid MHTM-256 was the best general combiner for early flowering with maximum negative gca effect indicating its role in breeding early duration double cross hybrids. High gca effects of parents for this trait in negative direction was also reported by Ghosh et al. (1997).

The overall gca status of the single cross hybrid (parents) and overall sca status of the double cross hybrid were computed following the procedure of Arunachalam and Bandyopadyya (1979). The top five double cross hybrids were identified on the basis of their better performance for grain yield are listed in Table 3. Out of five double cross hybrids, only two hybrids JK-Desi x Sasya and JK-Desi x Shivaji expressed significant high positive heterosis over mid-parent and better parent along with better performance in terms of yield per plant. It is noteworthy to mention that three of five double cross hybrids had JK-Desi as one of the common parent which is the potential donor for yield per plant, number of fruits per plant, number of branches per plant and plant height. Further, JK-Desi has highest pericarp thickness which is a novel contributing character towards better transportation and marketing purpose. All the five double cross hybrids except JK-Desi x MHTM-256 were classified as crosses with high overall sca status indicating thereby that gene action in these crosses is predominant of non-additive gene action type. However, all the double cross hybrids had parents involving H x L or H x A general combiners except MHTM-256 x Sasya and similar trend was also observed by Singh and Singh (1993).

JK-Desi x MHTM-256 in the cross where the simple selection is expected to result in identifying types with higher yield, since expression of this cross for most the yield components is due to additive gene action and further it has the parents with contrasting high and low combiners nicking well towards advantage side and also such type of cross is expected to generate high segregation and even transgressive segregation which are amenable for better selection.

The high or low heterosis and better expression in the other hybrids involved may not be amenable for simple selection schemes due to predominance of non-additive gene action as shown by the high overall sca status of these hybrids. Methods like recurrent relation and bi-parental mating (Dabholkar, 1992) should be used for recovering high yielding lines in these hybrids for exploitation of non-additive gene action.

It could be concluded from the present study that two double cross hybrids of tomato viz., JK-Desi x Sasya and JK-Desi x Shivaji are promising and noteworthy from The genetic assessment which could be further exploited commercially after conforming their performance in different environments.

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**Table 1. Heterosis and relative magnitude of additive ($\sigma^2$ gca) and non additive variance ($\sigma^2$ sca) for yield and its components among 45 single cross hybrids in tomato.**

| Characters | Mean heterosis | | Range of Heterosis (%) | | Number of significant heterotic hybrids in desirable direction | | ($\sigma^2$ gca) / ($\sigma^2$ sca) |
|---|---|---|---|---|---|---|---|
| | MP | BP | MP | BP | MP | BP | |
| 1. Plant height (cm) | -0.76 | -2.82 | -39.49 to 39.65 | -43.48 to 30.76 | 3 | 1 | 0.097 |
| 2. No. of branch/plant | -8.37 | -8.82 | -29.29 to 33.74 | -34.69 to 22.47 | 2 | 0 | 0.069 |
| 3. Days to 50% flowering | 0.85 | 0.14 | -10.67 to 18.61 | -17.43 to 17.56 | 7 | 10 | 0.026 |
| 4. No. of locules/fruit | 0.66 | 0.05 | -35.45 to 82.29 | -40.20 to 72.53 | 28 | 24 | 0.066 |
| 5. Pericarp thickness (mm) | 1.41 | -0.96 | -24.64 to 55.90 | -33.33 to 44.83 | 7 | 3 | 0.047 |
| 6. No. of cluster/plant | 2.05 | 0.00 | -24.16 to 103.5 | -33.71 to 100.00 | 17 | 11 | 0.056 |
| 7. No. of flowers/cluster | 0.79 | -1.43 | -19.46 to 31.27 | -22.90 to 21.14 | 10 | 5 | 0.057 |
| 8. No. of fruits/plant | -8.41 | -10.12 | -48.72 to 68.22 | -50.82 to 28.57 | 2 | 1 | 0.149 |
| 9. Avg. fruit weight (g) | -9.56 | -13.39 | -44.88 to 15.99 | -54.89 to 12.23 | 0 | 0 | 0.042 |
| 10. Yield/plant (g) | -11.64 | -16.18 | -64.50 to 56.98 | -67.30 to 23.40 | 2 | 2 | 0.027 |

MP= Mid parent, BP= Better parent

**Table 2. General combining ability (GCA) effects for different traits in tomato**

| Genotype | Plant height (cm) | No. of branches/ plant | Days to flowering | No. of locules/ fruit | Pericarp thickness (mm) | No. of clusters/ plant | No. of flowers/ cluster | No. of fruits/ plant | Average fruit weight (g) | Yield/ plant |
|---|---|---|---|---|---|---|---|---|---|---|
| US-1080 | -0.139 | 0.043 | 0.160 | -0.360* | -0.010 | -0.190 | 0.017 | -0.541 | -2.380** | -52.790** |
| Pragathi | 5.142** | 0.481** | 0.860** | -0.080 | -0.060** | 3.490** | 0.080 | 0.359 | 0.840 | 38.490* |
| JK- Desi | 8.788** | -0.110 | 0.007 | 0.060 | 0.010 | -1.420** | 0.010 | 5.734** | -0.240 | 186.790** |
| Maharani | -4.560** | -0.010 | 0.208 | 0.280 | -0.020* | 1.050** | 0.030 | -2.023** | -0.240 | 76.710** |
| NS-2535 | 0.007 | -0.360** | -1.070** | 0.340* | 0.008 | -0.190 | -0.170** | -1.482** | 2.960** | 6.650 |
| MHTM-256 | -0.450 | -0.130 | -0.387* | -0.130 | 0.030** | 2.250** | 0.040 | -0.924 | 0.160 | -22.070 |
| BSS-610 | -4.169** | 0.040 | 0.020 | 0.010 | -0.020 | -1.360** | 0.220** | -1.430** | -1.360 | -66.810** |
| NP-5005 | 0.761 | -0.090 | -0.720 | 0.010 | 0.018 | -2.570** | 0.080 | 0.442 | -1.040 | -6.620 |
| Shivaji | -1.529 | -0.018 | 0.290 | 0.030* | 0.016 | 0.090 | -0.160** | -0.835 | -0.080 | -21.790 |
| Sasya | -3.843** | 0.017 | 0.560** | -0.160** | 0.011 | -1.140** | -0.140** | 0.699 | 1.390 | 14.850 |
| SE m± | 0.412 | 0.064 | 0.07 | 0.008 | 0.005 | 0.170 | 0.020 | 0.245 | 0.490 | 8.830 |
| CD@5% | 1.646 | 0.257 | 0.314 | 0.033 | 0.021 | 0.696 | 0.100 | 0.979 | 1.980 | 35.300 |
| CD@1% | 2.156 | 0.337 | 0.412 | 0.043 | 0.027 | 0.911 | 0.130 | 1.282 | 2.590 | 46.230 |

* - Significant at 5% level ** - Significant at 1% level

**Table 3. Relevant genetic information of top double cross hybrids in tomato.**

| Double cross hybrids | Overall *sca* status of double cross hybrids | Overall *gca* status of single cross hybrids (parents) | Heterosis% for yield over | | Fruit yield per plant (g) |
|---|---|---|---|---|---|
| | | | MP | BP | |
| 1) JK-Desi X Sasya | High | H X L | 56.98** | 23.40** | 1341.33 |
| 2) JK-Desi X Shivaji | High | H X L | 49.04** | 21.44** | 1320.00 |
| 3) JK-Desi X MHTM-256 | Low | H X L | -19.24 | -28.61** | 776.00 |
| 4) MHTM-256 X Sasya | High | L X A | 3.33 | -9.85 | 752.67 |
| 5) Pragathi X Sasya | High | H X A | -21.04* | -40.26** | 724.00 |

MP= Mid parent, BP= Better parent

* - Significant at 5% level ** - Significant at 1% level