Improvement of weight fruit and yield in super strain-B cultivar of tomato (*Lycopersicon esculentum* Mill) by Mass selection

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Abstract: Mass selection for increasing of weight fruit (g) and total yield/plant (kg) in super strain-B cultivar of tomato was carried out for three cycles. The selected and unselected base population (M_0) were evaluated in two consequetive seasons. Weight fruit (g) and number of fruits/ plant (kg) were significantly increased as a response to mass selection. These increments were 11.48%, 19.13% and 33.49% for weight fruit (g) and 5.11%, 9.79% and 15.64% for number of fruit/plant (kg) after the first (M_1), second (M_2) and third cycle (M_3), respectively. Furthermore, there was a significant increase in number of cluster/plant in the first (19.19%, second (35.3%) and the third (46.99%) cycle in the respect to base population (M_0). Both marketable yield/plant (kg) and total yield/plant (kg) were significantly increased after the M_1, M_2 and M_3 cycle of mass selection. The increments in marketable yield/plant (kg) were 2.52%, 5.95% and 11.67%, respectively, while in total yield/ plant (kg) were 7.70%, 16.20%, 24.13%, respectively. Correlation coefficient in M3 populations showed highly significant positive among total population showed highly significant positive among total yield fruit/plant (kg) character and each of number of cluster/plant (r=0.951), number of flowers/plant (r=0.941), number of fruits/ plant (0.994) weight fruit (g) (r=0.964) and Marketable of yield/ plant (kg) (r=0.957). Results of the study confirm that the total yield/plant in tomato plant can be increased by increasing of some yield components such as fruit weight (g), number of fruits/plant, number of clusters/plant and number of flowers/plant, this can be achieved by the mass selection, this also refers to the possibility of further increase and improvement of these traits repeat selection cycles and study of correlation.
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1. Introduction

Fruit weight (g) is one of the important components of yield in tomato fruit crops. Relationship between fruit weight (g) and yield was studied by Prasad and Mathur (1999), Lakshmi and Mani (2004), Singh and cheema (2005). Donald (1968) concluded that breeders attempting to achieve superior yield should design and test model plants (ideotypes) on an architectural and physiological basis. Coyne (1980) suggested that the most useful strategy now is to selected parents (plants) with superior morphological and physiological traits associated with yield and to utilize these parents in breeding programs with other high – yielding germplasm. Improving crop plants through breeding procedures depends upon the presence of genetic differences among the plants. An understanding of the mode of inheritance of the yield components is prerequisite for the effective choice of breeding methodology for developing elite varieties. Much work has been done towards understanding the inheritance of yield and yield components in tomato.

Bodend (2002) reported that fruit yield and number of fruits were directed responsible for the determination of fruit yield in tomato. Jayder *et al.* (2007) also observed that fruit weight exerted high positive and direct effect on fruit yield (plant. Hidaytullah *et al.* (2008) reported that number of fruits/plant average fruit weight exhibited positive as well as high direct effect. Another study by Jitendra and Devendra (2011) found that fruit weight showed positive indirect effect on fruit yield through days from setting to green mature stage (0.70) and fruit setting to red ripe stage (0.068) and also, stated that fruit weight showed high positive correlation with fruit yield/ plant. Therefore, the fruits with higher weight should be considered in selection criteria for increasing fruit yield/plant.

Most of these studied indicated that the fruit weight (g) was more closely related to yield and the rate of fruit weight was more closely related to cultivar differences in final fruit weight. Different selection methods and techniques were used to improve of tomato by several authors such as Kansouh (2003), Metwally (2004), Zakher (2005), Salib (2006), Bhnan (2008).

In Egypt, total cultivated of this crop was estimated at 212946/ha for tomato fruit yield in 2013 with a mean 40.07 tones/ ha= 16.83 tones/fed. (FAOSTAT, 2015). Considered productive feddan of tomato crop in Egypt is low compared to cultivated area, as well as the diversity of the Egyptian climate and cultivation of tomatoes in most of the year among

the governors of the north. In summer and south in winter, and also compared to other countries. There are reasons for the low crop assistance including 1- the absence of continuous genetic improvement to produce new varieties and maintaining the qualities of old varieties 2- bring the seeds of hybrids and cultivated 3- various environmental factors.

The objective of this investigation was to improve the fruit weight (g) and yield characters in "super strain B" cultivar of tomato by mass selection technique for three cycles.

2. Materials and Methods

Seed material:

Seeds of "super strain B" cultivar were obtained by the Egyptian agricultural organization.

Selection procedure

Three cycles of mass selection procedure practiced in the recommended planting date during 2010; 2011 and 2012 winter seasons under condition south valley.

Mass selection populations (M_1, M_2 and M_3) and the unselected base population (M_0) as a control were evaluated during 2013/2014 and 2014/2015 winter seasons at the experimental farm of the faculty of Agriculture, South Valley University. Soil is sand loamy and Ec water was (5.53 ds/m).

Seeds were sown in nursery on first September every season. Transplants were set on one side of the ridge 1 meter width and 5m long, with 30 cm between transplants. Each experimental unit consisted of 4 ridges as the plot area was 20 m^2 (1/180) feddan. The common recommended cultural practices for the commercial production of tomato were carried out whenever they were necessary.

Data recorded:

1- Number of cluster/plait.
2- Number of flowers/plait.
3- Number of fruits/plant.
4- Weight of fruit (g).
5- Marketable yield/ plait (kg).
6- Total yield/ planit (kg).

Statistical analysis:

Data were statistically analyzed and separate as well as combined analysis variance were carried out. Comparison among means were done according to Gomez and Gomez (1984).

3. Results and Discussion

Mean performance of the selected population:

Separate and combined analysis for all studied traits in unselected (control M_0) and selected population in "super strain B" cultivar are presented in Tables (1, 2 and 3). The mean squares for all populations (M_0, M_1, M_2 and M_3) Table 2 under study as well as the variance among the selected populations (M_1, M_2 and M_3) Tables were highly significant for all characters studied, indicating the wide diversity between all population and among the selected populations in this study and the presence of true differences between and among the populations Tables 1, 2 and 3. Average for all studied traits in three cycles (M_1, M_2 and M_3) ranged from 27.25 M_1 to 33.375 M_3 clusters/plant, 73.125 to 78.625 flowers/plant, 29.125 to 34.875 fruits/plant, 89.875 to 98.875 weight fruit (g), 1004.740 to 1094375 marketable yield/plait (kg) and 1325.00 to 1562.875 total yield/plant (kg) with an average of 30.208, 75.625, 31.708, 98.875, 1045.00 and 1427.083 compared with unselected (M_0) with average of 22.625, 74.375, 30.375, 92.188, 980.00 and 1380.622 Table 4, Respectively These results indicated again that the application of mass selection method was more effective in improving for these traits by increasing the desired gene frequency. Similar results have been reported by Mishra and Mishra (1995), Pujari *et al.* (1995), Singh *et al.* (1997), Padmini and Vadivel (1997), Phookan *et al.* (1998), Prasad and Rai (1999), Pradee Pkumar *et al.* (2001), Bharti *et al.* (2002), Singh *et al.* (2002), Mariame *et al.* (2003), and Haydar *et al.* (2007). Also, Ghosh et al. (2010) found that high heritability coupled with high genetic advance in percent mean was observed for fruit cluster/plant, fruits/ plant, fruits/ clusters, individual fruit weight and yield/plant suggested that effective section may be done for these characters.

Response to selection:

- Weight of fruit (g).
- Number of fruits/ plait.

Weight of fruit (g) was significant increased after the first, second and third cycles (M_1, M_2 & M_3) of mass selection Table 4, the M_1, M_2 and M_3 of mass selection relative to the base populations (M_0) were 105.11, 109.97 and 115.64%, respectively. Similar trend was found in number of fruits/ plants especially after the M_1, M_2 and M_3 of mass selection, i.e., 111.48, 119.13 and 133.49% of the base population, respectively. Genetic variability and selection parameters for yield and quality attributes in tomato were studied by Ara *et al.* (2009) who suggested that characters Viz., average fruit weight (g) fruit size and number of fruits/plant and extended harvested duration should be given priority over other traits for selection high yielding genotypes.

Anther study by El-Sayed *et al.* (2010) found that there were significant differences between Castle Rock and super strain-B cultivars in number of fruits/plait and total yield/plait. Also these results were in coincidence with those of Kansouth (2002), Zanata (2002) and Zakher (2010) who found significant difference among lines and studied cultivars for average fruit weight. Similar results were recorded by

Gustavo and Guillermo (2006), Ghosh *et al.* (2010), Jasmina *et al.* (2011), Singh *et al.* (2011), Meseret *et al.* (2012) and Kashif et al. (2013) who pointed that breeding for fruit weight and number of fruits/plant on the plant had a major role in improving the total yield of the plant in tomato.

* Number of cluster/plant.
* Number of flowers/ plant.

Number of cluster/plant exhibited high increase after the M_1 to M_3 of mass selection this increase ranged from 119.91 to 146.99 compared of the M_0 population, respectively Table 4. with respect of number of flowers/plant exhibited slight in increase after the M_1 to M_3 of mass selection, this increase ranged from 103.54 to 111.52 of the M_0 population Table4 , respectively.

Both Marketable yield/ plant (kg) and total yield/ plant (kg) was significantly increased after the second an third cycles (M_2 and M_3) of mass selection Table 4, the M_2 and M_3 of mass selection for marketable yield/ plant relative to the base population were 105.95% and 111.67% Table 4 respectively. The total yield (kg) for the M_2 and M_3 were 116.20 and 124.13% Table 4 respectively. Developing fresh market tomato lines by selection were studied by Zakher (2010) who found that significant differences between the evaluated breeding lines for early yield/ plant (kg) and total yield/ plant (kg). Similar results were recorded by Christakis and Fasoulas (2002), Zakher (2005) and Bhnan (2008) who found that some tomato lines were early yield than the check cultivar.

Table 1: Mean square of the separate analysis of variance for all studied traits in (Selected and unselected populations) after three cycles.

Source of variance	D.F	Years	Number of cluster/ plant	Number of flowers/ plant	Number of fruits/ plant	Weight of fruit	Marketable yield/ plant	Total yield/ plant
Replication	3	y_1	1.083	2.417	1.000	1.167	83.00	1016.667
		y_2	0.833	0.750	0.417	1.729	35.667	222.917
Populations	3	y_1	84.417**	47.750**	57.00**	115.167**	10120.833**	68716.667**
		y_2	82.833**	43.750**	50.917**	136.896**	9485.667**	63418.75**
Error	9	y_1	1.472	0.583	0.556	1.00	59.722	466.667
		y_2	1.556	0.917	1.083	1.174	42.111	490.972

* and ** are significant at 0.05 and 0.01 level of probability, respectively.

Table 2: Mean square of the combined (Selected and unselected populations) analysis of variance for all studied traits after three cycles.

Source of variance	D.F	Number of cluster/ plant	Number of flowers/ plant	Number of fruits/ plant	Fruit weight	Marketable yield/ plant	Total yield/ plant
Year (y)	1	0.125	0.000	0.125	0.281	112.50	253.125
Error (a)	6	0.958	1.583	0.708	1.448	59.500	619.792
Populations (p)	3	167.125**	91.333**	107.792**	251.531**	19600.75**	132042.708**
P.y	3	0.125	0.167	0.125	0.531	5.75	92.708
Error (b)	18	1.514	0.75	0.819	1.087	50.917	478.819

* and ** are significant at 0.05 and 0.01 level of probability, respectively.

Table 3: Mean square of the combined (Selected populations) analysis of variance for all studied traits after three cycles.

Source of variance	D.F	Number of cluster/ plant	Number of flowers/ plant	Number of fruits/ plant	Fruit weight	Marketable yield/ plant	Total yield/ plant
Year (y)	1	0.042	0.042	0.042	1.042	66.667	37.5
Error (a)	6	0.653	1.264	0.486	0.819	78.778	498.611
Populations (p)	2	78.167**	62.000**	68.167**	162.667**	16399.042**	81538.542**
P.y	2	0.167	0.167	0.167	0.167	6.542	21.875
Error (b)	12	1.778	0.639	0.944	1.361	45.903	549.653

* and ** are significant at 0.05 and 0.01 level of probability, respectively.

Table 4: Mean performance of (unselected and selected populations) for all studied traits after three cycles.

Seasons:	2013 / 2014			2014 / 2015						
Character / Entry	1- Number of clusters/ plant						Combined average			Relative to M_0%
	U.P	U.S	U.S.P	U.P	U.S	U.S.P				
M_0 (bas pop.)	22.75		22.75	22.50		22.50	22.625		22.625	100
M_1		27.00	27.00		27.25	27.25		27.125	27.125	119.91
M_2		30.25	30.25		30.00	30.00		30.125	30.125	135.33
M_3		33.50	33.50		33.25	33.25		33.375	33.375	146.99
Average	22.75	30.25	28.375	22.50	30.16	28.25	22.625	30.208	28.313	
L.S.D 0.05			2.85			2.93		2.88	2.68	
L.S.D 0.01			4.13			4.22		4.01	3.69	
	2- Number of flowers/ plant									
M_0	70.5		70.5	70.75		70.75	70.625		70.625	100
M_1		73.25	73.25		73.00	73.00		73.125	73.125	103.54
M_2		75.00	75.00		75.25	75.25		75.125	75.125	106.56
M_3		78.75	78.75		78.50	78.50		78.625	78.625	111.52
Average	70.5	75.66	74.375	70.75	75.58	74.375	74.375	75.625	74.375	
L.S.D 0.05			1.79			2.23		1.65	1.89	
L.S.D 0.01			2.57			3.25		2.37	2.56	
	3- Number of fruits / plant									
M_0	26.00		26.00	26.25		26.25	26.125		26.125	100
M_1		29.00	29.00		29.25	29.25		29.125	29.125	111.48
M_2		31.00	31.00		31.25	31.25		31.125	31.125	119.13
M_3		35.00	35.00		34.75	34.75		34.875	34.875	133.49
Average		31.66	30.25	30.25	31.75	30.375	30.375	31.708	30.313	
L.S.D 0.05			1.73			2.45		2.09	1.96	
L.S.D 0.01			2.47			3.54		2.93	2.69	
	4- Weight fruit (g)									
M_0	86.00		86.00	85.50		85.50	85.75		85.75	100
M_1		89.75	89.75		90.00	90.00		89.875	89.875	105.11
M_2		93.75	93.75		94.00	94.00		93.875	93.875	109.79
M_3		98.50	98.50		99.250	99.250		98.875	98.875	115.64
Average	86.00	94.00	92.00	85.50	94.41	92.188	92.188	94.208	92.094	
L.S.D 0.05			2.36			2.53		2.52	2.27	
L.S.D 0.01			3.40			3.69		3.54	3.11	
	5- Marketable yield/ plant (kg)									
M_0	977.5		977.5	982.50		982.50	980.00		980.00	100
M_1		1002.50	1002.50		1007.00	1007.00		1004.75	1004.75	102.52
M_2		1036.25	1036.25		1040.50	1040.50		1038.375	1038.375	105.95
M_3		1093.75	1093.75		1095.00	1095.00		1094.375	1094.375	111.67
Average	977.5	1044.16	1027.50		1047.50	1031.25		1045.00	1029.375	
L.S.D 0.05			18.25			15.29		14.75	15.73	
L.S.D 0.01			26.53			22.25		20.69	21.52	
	6- Total yield/ plant (kg)									
M_0	1222.50		1222.50	1237.50		1237.50	1230.00		1230.00	100
M_1		1322.50	1322.50		1327.50	1327.50		1325.00	1325.00	107.70
M_2		1430.00	1430.00		1428.75	1428.75		1429.375	1429.375	116.20
M_3		1525.00	1525.00		1528.75	1528.75		1562.875	1562.875	124.13
Average	1222.50	1425.83	1375.00	1237.50	1428.33	1380.622	1380.622	1427.083	1377.81	
L.S.D 0.05			51.01			52.27		51.05	48.27	
L.S.D 0.01			74.21			76.05		71.61	66.05	

U.P = Unselect Population, S.P = Select Population, U.S. P = Unselect population and Select Population.- Marketable yield/ plant (kg)
- Total yield/ plant (kg)

Simple correlation:

For the M_3 population, the simple correlation among total yield/ plant (kg) and each of number of cluster/plant, number of flowers/ plant, fruit weight (g), number of fruits/ plant and marketable yield/ plant (kg) were highly significant and positive in all traits Table 6. These results were in coincidence with those of Meseret *et al.* (2012) who reported that a positive

correlation between marketable yield and clusters/ plant (r=0.76), fruits/ cluster (r=0.51), total number of fruit/ plant (r= 0.35) and fruit yield/ plant (r=0.98), also, stated that positive correlation exists between total yield and clusters/ plant (r=0.83), fruits/ clusters (r=050), fruit weight/ plant (r=0.98) and total number of fruits/ plant (r=0.43). Similar results were recorded by Kashif *et al.* (2013) who found that number of fruit clusters/ plant had maximum direct effect on firsh fruit yield followed by fruit weight and number of fruit/ plant. Further confirmation was reported by Mohanty (2002), Harer *et al.* (2003), Mohanty (2003), Hayder *et al.* (2007) and Hidaytullah *et al.* (2008).

Table 5: Correlation coefficient between total yield/ plant (kg) and its components in M_3 populations of tomato.

Character	Number of clusters/plant	Number of flowers/plant	Number of fruits/ plant	Weight of fruits (g)	Marketable of yield/ plant (kg)
1- Number of clusters/ plant					
2- Number of flowers/ plant	0.911**				
3- Number of fruits/ plant	0.924**	0.959**			
4- Weight of fruits (g)	0.975**	0.925**	0.941**		
5- Marketable of yield/ plant (kg)	0.932**	0.940**	0.954**	0.963**	
6- Total yield/ plant (kg)	0.951**	0.948**	0.954**	0.964**	0.957**

Conclusions:

The obtained results indicated that fruit weight and some traits of the yield in tomato can be achieved by mass selection .

References:

1. Ara, A; R. Narayan; A. Nazeer, and S.H. Khan. 2009. Genetic variability and selection parameters for yield and quality attributes in tomato. Indian Journal of Horticulture. Volume: 66**(1):73-78.**
2. Haydra, A; Mandal, M.A; Ahmed, M.B; Hannan, M.M; Karim, R; Razvy, M.A; Roy, U.K; and M. Salahin. 2007. studies on genetic variability and interrelationship among the different traits in tomato. Middle East Journal of Scientific Research 2(3-4): 139-142.
3. 2003. study on variability in tomato germplasma under conditions of central Ethiopia. Vegetable Crops Research Bulletin 58: 41-50.
4. Singh, J.K; Singh, J.P; Jain. S.K and A. Joshi. 2002. studies on genetic variability and its importance in tomato (*Lycopersicon esculentum* Mill.). Progressive Horticulture 34: 1, 77-79.
5. Bharti, A; Jain, B.P and A.K. Verma. 2002. Genetic variability, heritability and genetic advance in tomato (*Lyzopersicon esculentum* Cl.) Karst). Journal of Research 14(2): 294-252.
6. Pradeepkumar, T; Bastian, D; Joy, M; Radhakrishnan, N.V and K. C., Aipe. 2001. Genetic variation in tomato for yield and resistance to bacterial wilt. Journal of Tropical Agriculture 39(1): 157-158.
7. Prasad, V.S.R.K. and M. Rai. 1999. Genetic variation, component association and direct and indirect selections in some exotic tomato germplasm. Indian Journal of Horticulture 56 (3): 262-266.
8. Padmini, K; and E. Vadivel. 1998. Studies on genetic variability and heritability in F_2 generation of tomato (*Lycopersicon esculentum* Mill.). South Indian Horticulture 45 (1-2): 1-4.
9. Phookan, D.B; Talukdar, P. Shadeque. A and B.K. Chakravarty. 1998. Genetic variability and heritability in tomato (*Lycopersicon esculentum* Genotypes during summer season under plastic house conditions. Indian Journal of Agricultural Sciences 68(6): 304-306.
10. Singh, D.N; Sahu. A. and A.K. Parida. 1997. Genetic variability and correlation studies in tomato (*Lycopersicon esculentum* Mill). Environment and Ecology 15(1): 117-121.
11. Pujari, C.V; Wagh, R.S. and P.N. Kale. 1995. Genetic variability and heritability in tomato journal of Maharashtra. Agricultural universities 20(1): 15-17.
12. Mishra, S.N. and N.C Mishra. 1995. Genetic Parameters and varietal performance of tomato in North Eastern Ghat zone of orissa. Environment and Ecology 13(1): 182-187.
13. Ghosh, K.P; Islam. A.K.M; Mian, M.A.K. and M.M. Hossain. 2010. Variability and character Association in F_2 segregating population of different commercial hybrids of tomato (*Solanum Lyzopersicon* L.). J. Appl. Sci. Environ. Manage. 14(2): 41-95.

14. Lakshmi, K. and V. P. Mani. 2004. Association and contribution of different characters towards fruit yield in tomato (*Lycopersicon esculentum* Mill.). Indian Journal of Botany. 40(2): 627-635.
15. Singh, H. and D.S. Cheema. 2005. Studies on genetic variability and heritability for quality traits of tomato (*Lycopersicon esculentum* Mill.). under heat stress condations. Journal of Applied Horticulture 7(1): 55-57.
16. Donaled, C. M. 1968. The breeding of crop ideotypes. Euphytica 17: 385-403.
17. Coyne, D.P. 1980. Modification of plant Horticulture and crop yield by breeding. Hortscience 15: 244-247.
18. Bodund, J.G. 2002. Path co-efficient and correlation studies in tomato (*Lycopersicon esculentum* Mill.). Moor Journal of Agricultural research. 61(4): 327-330.
19. Hidaytullah, S.A; Ghafoor and Mohamod. 2008. Path coefficient analysis of yield components in tomato (*Lycopersicon esculentum* Mill.). Pakistan Journal of Botany 40(2): 627-635.
20. Jitendra. T. and U. Devendra. 2011. correlation and Path-coefficient studies in tomato (*Lycopersicon esculentum* Mill.).
21. Kansouh, A. M. 2002. Developing high yielding line of tomato (*Lycopersicon esculentum* Mill.). by selection. 2nd inter. Conf. Hort. Sci., Kafrel. Sheikh, Tanta Univ., Egypt 10-12 Spt., Vol. 28 (3/1): 152-164.
22. Metwally, E.L.; H.M.M. Ghobary and M.H. Kassam. 2004. Production of local tomato hybrids high yielding ability and heat tolerance. J. Agric. Sci. Mansoura university., 29 (12): 7321-7338.
23. Salib, F.S. 2006. Introducing new frosh market line of tomato. Egypt J. Appl. Sci., 21 (10B): 631-642.
24. Bhnan, E. Y. 2008. Development of some new tomato lines for fresh market by selection. Egypt. J. of Appl. Sci. 23 (4A) 168-178.
25. Zakher, A. G. 2005. Comprative studies on advanced segregated generations of some tomato hybrids. Ph.D. Thesis, Fac. Agric., Ain Shams university, Egypt.
26. El-Sayed, H. A; M.M.B. Shokr and M.A.A. El-Shrebini. 2010. Some agronomical practices for improving tomato (*Lycopersicon esculentum* Mill.). productivity under high temperature condations. J. plant production, Mansura university. 1 (9): 1283-1297.
27. Zanata, O.A. 2002. Heterosis in tomato (*Lycopersicon esculentum* Mill.). and possibilities of producing F_1 hybrids of commercial. Ph.D. thesis, Fac. Agric., Mansoura university, Egypt.
28. Zakher, A. G. 2010. Developing fresh market tomato lines by selection. Egypt J. plant Breed. 14 (1): 321-332.
29. Gustavo, R.R. and R.P. Guillermo. 2006. Recombinat lines obtained and interspecific cross between Lycopersicon species selected by fruit weight and fruit shelf life. J. Amer. Soc. Hort. Sci. 31 (5): 651-656.
30. Jasmina, Z; P. Nenad; G. Zdenka; B. Milkan and D.C. And. 2011. Generation mean analysis of yield components and yield tomato (*Lycopersicon esculentum* Mill.). Pak. J. Bot., 43 (3): 1575-1580.
31. Singh, B; R.K., Susheal Kaul; A. Goswami; O.D.Sharma and S.K. Singh. 2011. Genetic heritability and genetic advance of yield and its components in tomato (*Lycopersicon esculentum* Mill.). Plant Archives 11(1): 521-523.
32. Mesert, D. R; M. Ali and B. Kassahum. 2012. Evaluation of tomato (*Lycopersicon esculentum* Mill.). Genotypes for yield and yield components. The African Journal of Plant Science and Biotechnology.
33. Kashif, N; M. Muneeb and S.C. Ahmed. 2013. Genetic Architecture and Association of fruit yield and quality traits in tomato (*Solanum Lycopersicon* L.). Universal Journal of Agricultural Research. 1(4): 155-159.
34. Chrisakis, P.A. and A.C. Fasoules. 2002. The effects of the genotypes by environmental interaction on the fixation of heterosis in tomato. J. of Agric. Sci., Cambridge. 139: 55-60.
35. Mohanty, B.K. 2002. Variability, heritability correlation and Path coefficient studies in tomato. Haryana Journal of Horticultural Sciences 31(3-4): 230-233.
36. Mohanty, B.K. 2003. genetic variability, correlation and Path coefficient studies in tomato. Indian Journal of Agricultural research 37(1): 68-71.
37. Harer, P.N; D.B. Lad and T.J. Bhor. 2003. Correlation and Path analysis studies in tomato. Journal & Maharashtra Agricultural Universities. 27 (3): 302-303.

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