International Journal of Statistics and Applied Mathematics 2024; SP-9(1): 228-231

International Journal of Statistics and Applied Mathematics

ISSN: 2456-1452
Maths 2024; SP-9(1): 228-231

https://www.mathsjournal.com
Received: 02-11-2023
Accepted: 03-12-2023

Syeda Farwah
Division of Vegetable Science, SKUAST-Kashmir, Shalimar, Jammu and Kashmir, India

Baseerat Afroza
Division of Vegetable Science, SKUAST-Kashmir, Shalimar, Jammu and Kashmir, India

Asima Amin
Division of Vegetable Science, SKUAST-Kashmir, Shalimar, Jammu and Kashmir, India

Berjis Zehra
Division of Vegetable Science, SKUAST-Kashmir, Shalimar, Jammu and Kashmir, India

Rakshanda Anayat
Division of Horticulture, Faculty of Agriculture, SKUAST-Kashmir, Wadura, Jammu and Kashmir, India

Rizwan Rashid
Division of Vegetable Science, SKUAST-Kashmir, Shalimar, Jammu and Kashmir, India

Rani Shamma
Division of Vegetable Science, SKUAST-Kashmir, Shalimar, Jammu and Kashmir, India

Corresponding Author:
Asima Amin
Division of Vegetable Science, SKUAST-Kashmir, Shalimar, Jammu and Kashmir, India

Heterosis studies in tomato (*Solanum lycopersicum* L.)

Syeda Farwah, Baseerat Afroza, Asima Amin, Berjis Zehra, Rakshanda Anayat, Rizwan Rashid and Rani Shamma

Abstract
In present study, the experimental material consisted of 12 diverse lines of tomato and one standard check (Shalimar Tomato Hybrid-2). Sixty-six F_1 crosses were generated form these twelve diverse lines through 12 x 12 diallel mating design during the *kharif* season, 2020. The 12 parents and 66 F_1crosses along with the check were evaluated in Randomized Block Design during the *kharif* season, 2021 at three locations to elicit information on heterosis. Heterosis was estimated over the standard check *viz*., Shalimar Hybrid-2 for each trait. The results revealed the wide range of heterotic patterns for different traits. SKAU-T-914108 x SKAU-T-164334, SKAU-T-914108 x SKAU-T-617047, SKAU-T-914106 x SKAU-T-617047 and SKAU-T-914103 x SKAU-T-620438 were found best cross combinations on the basis of heterosis.

Keywords: Tomato, diallel, heterosis

Introduction

Tomato (*Solanum lycopersicum* L.) belongs to family Solanaceae with chromosome number 2n = 24 (Peralta *et al*., 2005) [13]. After potatoes and sweet potatoes, tomatoes are the third most important vegetables produced in the world, but they are the most popular among canned food. Tomato is one of the most popular vegetables in India as well. Due to its increasing commercial and dietary value and wide adaptability, it is becoming more and more well-liked on a global scale. A need-based crop development programme in this crop needs to receive the proper attention. Prior to beginning a hybridization programme, choosing parents solely on the basis of their combining ability, and extent of heterosis for important traits is a useful tool. This is in contrast to the common approach of selecting parents based on *per se* performance, which does not always result in fruitful results (Allard, 1960) [1]. The choice of the best genotypes and the appropriate breeding technique for the creation of improved varieties and hybrids depend heavily on this knowledge. One of these methods that is used only for the estimate of genetic parameters is the diallel analysis. The data gathered using this method is put to use in order to better comprehend the level of heterosis present in F_1 hybrids. Knowing this information is useful for maximising heterosis for commercial objectives.

Materials and Methods

This investigation was undertaken at Division of Vegetable Science, SKUAST-Kashmir to generate information on heterosis for yield and yield attributing traits in twelve diverse lines of tomato (*Solanum lycopersicum* L.) after crossing them in a diallel fashion as per the Method II and Model I of Griffing (1956 a, b) [3, 4], to generate sixty-six crosses (Excluding reciprocals). These sixty-six crosses were evaluated along with the twelve parents at three locations *viz*. E_1: Vegetable Experimental Farm, Division of Vegetable Science, SKUAST-Kashmir, Shalimar; E_2: Vegetable Seed Multiplication Farm, SKUAST-Kashmir, Shuhama and E_3: Faculty of Agriculture, SKUAST-Kashmir, Wadura. The observations were recorded on yield traits. Heterosis (pooled over environments) was estimated in relation to standard check.

Results and Discussions

The crop improvement through plant breeding can be achieved through better understanding and proper exploitation of heterosis.

Heterosis is evinced through pronounced vigor of F_1's over the parents resulting in higher yields through the contributing characters. Tomato breeding has been shifted towards the development of hybrids to meet the specified demands (*viz*., earliness, disease or pest resistance, desirable fruit quality for processing industries, etc.) along with the high yields. However, it is practical to develop one hybrid which can have maximum number of desirable traits, keeping yield and quality as primary concern.

In the present investigation, the heterosis was estimated over the standard check *viz*., Shalimar Tomato Hybrid-2 for each trait. The results revealed the wide range of heterotic patterns for different traits. For number of fruits plant^{-1}, thirty-one crosses exhibited desirable significant heterosis with maximum in SKAU-T-914103 x SKAU-T-620438 (42.28), followed by SKAU-T-02 x SKAU-T-914091 (41.42) and SKAU-T-165690 x SKAU-T-145057 (40.40); for average fruit weight, thirty one crosses exhibited desirable significant heterosis with maximum in SKAU-T-914106 x SKAU-T-617047 (46.89) followed by SKAU-T-914108 x SKAU-T-617047 (41.73) and SKAU-T-914108 x SKAU-T-164334 (33.26); for fruit yield hectare^{-1}, thirty-one crosses exhibited desirable significant heterosis with maximum in SKAU-T-914106 x SKAU-T-617047 (55.48) followed by SKAU-T-914103 x SKAU-T-620438 (45.94) and SKAU-T-914108 x SKAU-T-617047 (44.40); for seed yield plant^{-1}, seventeen crosses exhibited desirable significant heterosis with maximum in SKAU-T-01 x SKAU-T-914108 (42.19) followed by SKAU-T-617047 x SKAU-T-164334 (41.43) and SKAU-T-165690 x SKAU-T-914108 (40.69). Similar findings with respect to heterosis were also reported by Droka *et al.* (2012) [2], Nosser *et al.* (2012) [12], Kumar *et al.* (2012) [2], Muttappanavar *et al.* (2014) [11], Kumar *et al.* (2016) [7], Kumar *et al.* (2017) [6], Kumar *et al.* (2018) [5], Rehana *et al.* (2019) [14], Kumar *et al.*(2019)[8] and Sah *et al.* (2020) [15], Liu *et al.* (2021)[10].

The best cross combinations on the basis of heterosis (SKAU-T-914108 x SKAU-T-164334, SKAU-T-914108 x SKAU-T-617047, SKAU-T-914106 x SKAU-T-617047 and SKAU-T-914103 x SKAU-T-620438) could be tested further for commercial cultivation.

Table 1(a): Estimation of heterosis (%) over standard check for yield attributing traits in Tomato (*Solanum lycopersicum* L.)

Crosses	No. of fruits plant^{-1}	Average fruit weight	Crosses	No. of fruits plant^{-1}	Average fruit weight
SKAU-T-01 x SKAU-T-914103	8.95	7.31	SKAU-T-620438 x SKAU-T-914106	16.81	6.50
SKAU-T-01 x SKAU-T-914113	-24.29	-30.65	SKAU-T-620438 x SKAU-T-617047	-54.43	-53.49
SKAU-T-01 x SKAU-T-620438	-48.64	-43.72	SKAU-T-620438 x SKAU-T-914091	-61.78	-62.55
SKAU-T-01 x SKAU-T-165690	-56.60	-26.23	SKAU-T-620438 x SKAU-T-145057	-17.90	-63.05
SKAU-T-01 x SKAU-T-914108	3.48	7.75	SKAU-T-620438 x SKAU-T-164334	1.25	5.18
SKAU-T-01 x SKAU-T-02	-57.49	-12.14	SKAU-T-165690 x SKAU-T-914108	25.15	1.39
SKAU-T-01 x SKAU-T-914106	-33.56	-27.60	SKAU-T-165690 x SKAU-T-02	5.62	1.67
SKAU-T-01 x SKAU-T-617047	3.26	29.67	SKAU-T-165690 x SKAU-T-914106	-63.37	-63.99
SKAU-T-01 x SKAU-T-914091	-23.39	-32.06	SKAU-T-165690 x SKAU-T-617047	2.65	33.16
SKAU-T-01 x SKAU-T-145057	-38.26	-8.37	SKAU-T-165690 x SKAU-T-914091	-29.37	-33.40
SKAU-T-01 x SKAU-T-164334	-38.73	-39.20	SKAU-T-165690 x SKAU-T-145057	40.40	1.65
SKAU-T-914103 x SKAU-T-914113	-50.97	-1.34	SKAU-T-165690 x SKAU-T-164334	-38.73	-60.48
SKAU-T-914103 x SKAU-T-620438	42.28	2.57	SKAU-T-914108 x SKAU-T-02	-30.36	-22.22
SKAU-T-914103 x SKAU-T-165690	36.02	0.80	SKAU-T-914108 x SKAU-T-914106	13.01	3.71
SKAU-T-914103 x SKAU-T-914108	-62.70	-49.70	SKAU-T-914108 x SKAU-T-617047	1.89	41.73
SKAU-T-914103 x SKAU-T-02	-4.22	-9.71	SKAU-T-914108 x SKAU-T-914091	2.84	30.17
SKAU-T-914103 x SKAU-T-914106	29.02	1.67	SKAU-T-914108 x SKAU-T-145057	-16.62	-46.01
SKAU-T-914103 x SKAU-T-617047	-25.28	-66.66	SKAU-T-914108 x SKAU-T-164334	5.40	33.26
SKAU-T-914103 x SKAU-T-914091	-52.44	-54.18	SKAU-T-02 x SKAU-T-914106	-26.46	-6.70
SKAU-T-914103 x SKAU-T-145057	6.42	9.84	SKAU-T-02 x SKAU-T-617047	7.57	29.29
SKAU-T-914103 x SKAU-T-164334	9.97	25.81	SKAU-T-02 x SKAU-T-914091	41.42	1.71
SKAU-T-914113 x SKAU-T-620438	-51.45	-24.53	SKAU-T-02 x SKAU-T-145057	-50.85	-50.04
SKAU-T-914113 x SKAU-T-165690	-37.81	-64.49	SKAU-T-02 x SKAU-T-164334	6.14	3.79
SKAU-T-914113 x SKAU-T-914108	-52.00	-48.45	SKAU-T-914106 x SKAU-T-617047	5.85	46.89
SKAU-T-914113 x SKAU-T-02	3.87	1.81	SKAU-T-914106 x SKAU-T-914091	2.43	11.72
SKAU-T-914113 x SKAU-T-914106	3.20	32.16	SKAU-T-914106 x SKAU-T-145057	-12.82	-50.30
SKAU-T-914113 x SKAU-T-617047	-38.26	-13.51	SKAU-T-914106 x SKAU-T-164334	-43.24	-68.65
SKAU-T-914113 x SKAU-T-914091	-34.20	-67.06	SKAU-T-617047 x SKAU-T-914091	21.09	9.65
SKAU-T-914113 x SKAU-T-145057	-46.50	-42.09	SKAU-T-617047 x SKAU-T-145057	2.30	17.90
SKAU-T-914113 x SKAU-T-164334	-3.58	-13.95	SKAU-T-617047 x SKAU-T-164334	7.83	31.77
SKAU-T-620438 x SKAU-T-165690	37.90	3.67	SKAU-T-914091 x SKAU-T-145057	-57.65	-21.34
SKAU-T-620438 x SKAU-T-914108	39.98	2.07	SKAU-T-914091 x SKAU-T-164334	0.96	8.09
SKAU-T-620438 x SKAU-T-02	-46.88	-65.86	SKAU-T-145057 x SKAU-T-164334	-28.51	-41.45

Table 1(b): Estimation of heterosis (%) over standard check for yield attributing traits in Tomato (*Solanum lycopersicum* L.)

Crosses	Fruit yield hectare^{-1}	Seed yield plant^{-1}	Crosses	Fruit yield hectare^{-1}	Seed yield plant^{-1}
SKAU-T-01 x SKAU-T-914103	16.92	-4.74	SKAU-T-620438 x SKAU-T-914106	24.40	-5.16
SKAU-T-01 x SKAU-T-914113	-47.49	-33.80	SKAU-T-620438 x SKAU-T-617047	-78.80	-65.84
SKAU-T-01 x SKAU-T-620438	-71.10	-55.09	SKAU-T-620438 x SKAU-T-914091	-85.69	-61.80
SKAU-T-01 x SKAU-T-165690	-67.98	-64.76	SKAU-T-620438 x SKAU-T-145057	-69.67	-23.08
SKAU-T-01 x SKAU-T-914108	11.51	42.19	SKAU-T-620438 x SKAU-T-164334	6.49	-17.80
SKAU-T-01 x SKAU-T-02	-62.65	-65.49	SKAU-T-165690 x SKAU-T-914108	26.90	40.69
SKAU-T-01 x SKAU-T-914106	-51.90	-46.05	SKAU-T-165690 x SKAU-T-02	7.39	-1.05
SKAU-T-01 x SKAU-T-617047	33.90	-9.71	SKAU-T-165690 x SKAU-T-914106	-86.81	-65.69
SKAU-T-01 x SKAU-T-914091	-47.96	-33.02	SKAU-T-165690 x SKAU-T-617047	36.69	-16.65
SKAU-T-01 x SKAU-T-145057	-43.42	-46.01	SKAU-T-165690 x SKAU-T-914091	-52.96	-42.65
SKAU-T-01 x SKAU-T-164334	-62.75	-46.43	SKAU-T-165690 x SKAU-T-145057	42.72	22.76
SKAU-T-914103 x SKAU-T-914113	-51.63	-54.07	SKAU-T-165690 x SKAU-T-164334	-75.79	-38.78
SKAU-T-914103 x SKAU-T-620438	45.94	24.35	SKAU-T-914108 x SKAU-T-02	-45.83	-39.11
SKAU-T-914103 x SKAU-T-165690	37.10	35.92	SKAU-T-914108 x SKAU-T-914106	17.20	5.87
SKAU-T-914103 x SKAU-T-914108	-81.24	-67.39	SKAU-T-914108 x SKAU-T-617047	44.40	14.54
SKAU-T-914103 x SKAU-T-02	-13.51	-22.23	SKAU-T-914108 x SKAU-T-914091	33.87	9.19
SKAU-T-914103 x SKAU-T-914106	31.18	-3.31	SKAU-T-914108 x SKAU-T-145057	-54.99	-16.68
SKAU-T-914103 x SKAU-T-617047	-75.09	-48.67	SKAU-T-914108 x SKAU-T-164334	40.46	38.24
SKAU-T-914103 x SKAU-T-914091	-78.21	-55.45	SKAU-T-02 x SKAU-T-914106	-31.39	-26.51
SKAU-T-914103 x SKAU-T-145057	16.90	-0.30	SKAU-T-02 x SKAU-T-617047	39.09	7.50
SKAU-T-914103 x SKAU-T-164334	38.35	23.63	SKAU-T-02 x SKAU-T-914091	43.84	14.82
SKAU-T-914113 x SKAU-T-620438	-63.36	-57.55	SKAU-T-02 x SKAU-T-145057	-75.44	-60.09
SKAU-T-914113 x SKAU-T-165690	-77.91	-41.74	SKAU-T-02 x SKAU-T-164334	10.15	-7.20
SKAU-T-914113 x SKAU-T-914108	-75.25	-52.03	SKAU-T-914106 x SKAU-T-617047	55.48	25.60
SKAU-T-914113 x SKAU-T-02	5.75	-9.18	SKAU-T-914106 x SKAU-T-914091	14.43	-16.84
SKAU-T-914113 x SKAU-T-914106	36.39	16.01	SKAU-T-914106 x SKAU-T-145057	-56.67	-34.66
SKAU-T-914113 x SKAU-T-617047	-46.60	-49.87	SKAU-T-914106 x SKAU-T-164334	-82.21	-50.37
SKAU-T-914113 x SKAU-T-914091	-78.32	-34.24	SKAU-T-617047 x SKAU-T-914091	32.77	-1.68
SKAU-T-914113 x SKAU-T-145057	-69.02	-59.90	SKAU-T-617047 x SKAU-T-145057	20.61	-4.16
SKAU-T-914113 x SKAU-T-164334	-17.03	-21.71	SKAU-T-617047 x SKAU-T-164334	42.08	41.43
SKAU-T-620438 x SKAU-T-165690	42.96	20.58	SKAU-T-914091 x SKAU-T-145057	-66.69	-62.97
SKAU-T-620438 x SKAU-T-914108	42.88	13.65	SKAU-T-914091 x SKAU-T-164334	9.13	-5.42
SKAU-T-620438 x SKAU-T-02	-81.87	-36.97	SKAU-T-145057 x SKAU-T-164334	-58.14	-6.23

Conclusion

Heterosis was estimated over the standard check *viz.*, Shalimar Tomato Hybrid-2 for each trait. The results revealed the wide range of heterotic patterns for different traits. For number of fruits plant^{-1}, thirty-one crosses exhibited desirable significant heterosis; for average fruit weight, thirty one crosses exhibited desirable significant heterosis with maximum in SKAU-T-914106 x SKAU-T-617047 (46.89); for fruit yield hectare^{-1}, thirty-one crosses exhibited desirable significant heterosis with maximum in SKAU-T-914106 x SKAU-T-617047 (55.48); for seed yield plant^{-1}, seventeen crosses exhibited desirable significant heterosis with maximum in SKAU-T-01 x SKAU-T-914108 (42.19).

The best cross combinations on the basis of heterosis (SKAU-T-914108 x SKAU-T-164334, SKAU-T-914108 x SKAU-T-617047, SKAU-T-914106 x SKAU-T-617047 and SKAU-T-914103 x SKAU-T-620438) could be tested further for commercial cultivation.

References

1. Allard RW. Principles of plant breeding. New York: John Wiley and Sons, Inc.; c1960.
2. Droka D, Kumar R, Joshi S, Yadav RK. Genetic studies of quality traits in tomato (*Solanum lycopersicum* L.) under low temperature. Vegetable Science. 2012;39(2):189-191.
3. Griffing B. A generalized treatment on the use of diallel cross quantitative inheritance. Heredity. 1956a;10:31-50.
4. Griffing B. Concept of general and specific combining ability in relation to diallel crossing systems. Australian Journal of Biological Sciences. 1956b;9:463-493.
5. Kumar K, Shamra D, Singh J, Sharma TK, Kurrey VK, Minz RR, *et al*. Combining ability analysis for yield and quality traits in tomato (*Solanum lycopersicum* L.). Journal of Pharmacognosy and Phytochemistry. 2018;7(6):1002-1005.
6. Kumar P, Singh N, Singh PK. A Study on Heterosis in Tomato (*Solanum lycopersicum* L.) for Yield and its Component Traits. International Journal of Current Microbiology and Applied Sciences. 2017;6(7):1318-1325.
7. Kumar R, Sharma HR, Kumar M. Heterosis for post-harvest and nutritional quality traits in tomato (*Solanum lycopersicum* L.). Journal of Applied and Natural Science. 2016;8(4):1987-1991.
8. Kumar R, Srivastava K, Kumar V, Saroj SK, Sharma SK, Singh RK, *et al*. Heterosis analysis in tomato (*Solanum lycopersicum* L.) for Lycopene, TSS, Titratable acidity and Ascorbic acid. Electronic Journal of Plant Breeding. 2019;10(4):1547-1553.
9. Kumar R, Srivastava K, Somappa J, Kumar S, Singh RK. Heterosis for yield and yield components in Tomato (*Lycopersicon esculentum* Mill.). Electronic Journal of Plant Breeding. 2012;3(2):800-805.
10. Liu Z, Jiang J, Ren A, Xu X, Zhang H, Zhao T, *et al*. Heterosis and Combining Ability of Fruit Yield, Early Maturity and Quality in Tomato. Agronomy. 2021;11(4):807.

11. Muttappanavar RD, Sadashiva AT, Vijendrakumar RC, Roopa BN, Vasantha PT. Combining ability analysis of growth, yield and quality traits in cherry tomato (*Solanum lycopersicum* var. cerasiforme). Molecular Plant Breeding. 2014;5(4):18-23.
12. Nosser MA. Heterosis and inbreeding depression in tomato. Egyptian Journal of Plant Breeding. 2012;16(1):1-17.
13. Peralta IE, Spooner DM, Knapp S. New species of wild tomatoes (*Solanum* section *Lycopersicum*: Solanaceae) from northern Peru. Systematic Botany. 2005;30(2):424-434.
14. Rehana S, Ullah MZ, Zeba N, Narzis N, Husna A, Siddique AB, *et al*. Estimation of heterosis for yield and yield attributing traits in tomato crossed with line and tester method. Progressive Agriculture. 2019;30(2):179-185.
15. Sah SK, Singh AK, Singh BK, Barman K, Pal AK, Kumar A, *et al*. Heterosis Studies for Growth and Yield Traits in Tomato (*Solanum lycopersicum* L.). International Journal of Current Microbiology and Applied Sciences. 2020;9(10):2732-2738.