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Pushpendra Kumar
Department of Vegetable Science, Narendra Deva University of Agriculture & Technology, Kumarganj, Faizabad, Uttar Pradesh, India

CN Ram
Department of Vegetable Science, Narendra Deva University of Agriculture & Technology, Kumarganj, Faizabad, Uttar Pradesh, India

Shiva Nath
Department of Genetics and Plant Breeding, Narendra Deva University of Agriculture & Technology, Kumarganj, Faizabad, Uttar Pradesh, India

DK Gautam
Department of Vegetable Science, Narendra Deva University of Agriculture & Technology, Kumarganj, Faizabad, Uttar Pradesh, India

AK Singh
Department of Vegetable Science, Narendra Deva University of Agriculture & Technology, Kumarganj, Faizabad, Uttar Pradesh, India

AM Choudhary
Department of Genetics and Plant Breeding, Narendra Deva University of Agriculture & Technology, Kumarganj, Faizabad, Uttar Pradesh, India

Shubham Yadav
Department of Horticulture, Dr. Ram Manohar Lohiya Awadh University Faizabad, Uttar Pradesh, India

JK Yadav
Department of Plant Pathology, Narendra Deva University of Agriculture & Technology, Kumarganj, Faizabad, Uttar Pradesh, India

Correspondence
Pushpendra Kumar
Department of Vegetable Science, Narendra Deva University of Agriculture & Technology, Kumarganj, Faizabad, Uttar Pradesh, India

Heritability (narrow sense) and genetic advance for yield and quality attributing traits in tomato [(*Solanum lycopersicon* (Mill.) Wettsd.)]

Pushpendra Kumar, CN Ram, Shiva Nath, DK Gautam, AK Singh, AM Choudhary, Shubham Yadav and JK Yadav

Abstract
The present study was carried out during *Rabi* seasons of 2016-17 and 2017-18 at Main Experiment Station of Department of Vegetable Science, Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumarganj), Faizabad (U.P.) India. The experimental materials of the study comprised of 54 treatments of tomato [40 F_1's and 14 parental lines (10 lines *viz*., NDT-1, NDT-2, NDT-3, NDT-4, NDT-5, NDT-6, NDT-7, NDT-8, Azad T-6, Arka Saurabh and 4 testers *viz.*, Pusa Ruby, Punjab Chhuhara, Arka Vikash and Arka Meghali]. The 14 parents were involved in a crossing programme to develop a line × tester set (10 lines + 4 testers + 40 F_1's). The experimental materials (40 F_1's and 14 parental lines) were evaluated in Randomized Complete Block Design (RBD) with three replication having each experimental unit with spacing of 60cm × 50cm with plot size of 1.2m ×3.0m.The observations were recorded on eighteen characters, *viz*., days to 50 % flowering, days to first fruit set, days to first fruit harvest, plant height (cm), number of primary branches per plant, number of fruits per cluster, number of fruits per plant, fruit weight per plant (kg), average fruit weight (g), fruit length (cm), fruit girth (cm), number of locules per fruit, pericarp thickness (mm), total soluble solids (TSS), ascorbic acid (mg/100g fresh fruit) total fruit yield per plant (kg). Fifty four genotypes were grouped into 8 different non over lapping clusters. The predictability ratio was lesser than (<1) for all the characters under study in both the years and pooled. Estimate of high heritability in narrow-sense was recorded for plant height followed by ascorbic acid and number of fruits per plant in both years and pooled. Estimate of high genetic advance in per cent of mean (>20%) was observed for plant height in both years and pooled.

Keywords: Heritability (narrow sense) and genetic advance for yield and quality attributing traits in tomato [(*Solanum lycopersicon* (Mill.) Wettsd.)]

1. Introduction
Tomato (*Solanum lycopersicon* (Mill.) Wettsd.), 2n=2x=24, a member of the family Solanaceae and the genus *Solanum*, is an herbaceous, annual and sometimes perennial in nature, prostrate and sexually propagated vegetable crop plant with bisexual flowers. The family Solanaceae once considered poisonous and inedible, has become one of the most popular and extensively consumed vegetable. There are four to eight flowers in each compound inflorescence. There is a light protective anther cone surrounding the stigma leading to self-pollination. Anthesis occurs at about 6-8 A.M. in summer and 9-11 A.M. in winter. Based on growth habit tomato plants are of two types, determinate and indeterminate. Determinate type tomato plants are bushy and inflorescences occur almost at every inter-node but in indeterminate type, inflorescences are formed after every 3 leaves and the terminal bud does not set fruits. Indeterminate type tomato varieties are suitable for the greenhouse cultivation.

It is originated in Peru Ecuador and Bolivia region of Andes in South America (Rick, 1969) [17]. It is one of the most popular and widely cultivated vegetable throughout the world in open field conditions as well as protected conditions. Because of its economic importance the area under cultivation is increasing every year. India ranks third in terms of production after China and USA. In India, total area under tomato cultivation is 0.808 million hectares with production of 19.69 million tonnes and its productivity is 24.4 tonnes per hectare, whereas, the UP have occupied an area 0.020 million hectares with production of 0.826 million tonnes and their productivity is 41.3 tonnes per hectare.

In India the leading tomato growing states are, Karnataka, West Bengal, Maharashtra, Uttar Pradesh, Haryana, Punjab, Gujarat and Bihar.

Tomato is a short duration crop of about three to four months. It is a day neutral warm season crop reasonably resistant to heat and drought and grows under wide range of soil and climatic conditions. Though tomato is a self-pollinated crop, the unusual high heterosis observed in it, has been attributed to the fact that, originally tomato was a highly out crossing genus which has later evolved into a self-pollinated one (Rick, 1965) [17] and edible part is botanically known as berry (Kalloo *et al.*, 2001) [6]. It is globally cultivated for its fleshy fruits and known as protective food. Under Indian condition, the fruits mainly consumed either as raw or in the preparation of sambar, chatni, pickles etc.

Tomato is also rich in medicinal value. The pulp and juice are digestible, mild aperients, a promoter of gastric secretion and blood purifier. It is reported to have antiseptic properties against intestinal infestations. In the present days, it is gaining more medicinal importance because of the antioxidant property of ascorbic acid and lycopene content. It is also an important source of β-carotene and valued for their colour and flavour. Thus, today it is one of the important raw materials for multimillion food industries. Tomatoes are also called as "Poor man's apple". In many countries it is considered as "poor man's orange" because of its attractive appearance and nutritive value (Singh *et al.*, 2004) [22]. Apart from these, lycopene is valued for its anti-cancerous property (Tiwari *et al.*, 2002) [24]. It acts as an antioxidant and scavenger of free radicals, which is often associated with carcinogenesis. Thus, lycopene has great beneficial effects on human health (Khachik *et al.*, 1995) [8].

Without regular infusion of genetic variability and selection in tomato, through hybridization it is not feasible to make advances in productivity and production. Various breeding techniques advocated considering the breeding behaviour of the crop. Heterosis breeding as a tool for genetic improvement in tomato has been advocated by several workers (Bhatt *et al.*, 1999; Premalakshme *et al.*, 2005; Fageria *et al.*, 2001; Thakur *et al.*, 2004 and Duhan *et al.*, 2005) [2, 15, 4, 23, 3]. For obtaining high yield as well as quality fruits which are important for realizing economic gain. The commercial exploitation of hybrid vigour in tomato has received greater importance because of several advantages of hybrids over pure line varieties with response to marketable fruit yield and its component traits as well as resistance to biotic and abiotic stresses. That is why large number of commercial hybrids developed in the country in this crop. With increasing popularity of F_1 hybrids in tomato, it is imperative, to obtain such hybrids that have excellent qualities and yield coupled with resistance to diseases. Identification of high yielding and stable varieties and the development of F_1 hybrids will help the farmers to adopt variety/hybrid for successful commercial cultivation of tomatoes. In view of such an importance the tomato crop has gained, increasing the productivity per unit area by even lesser degree assumes greater significance. This increase in production assumes significance because the production of tomato is not sufficient to meet the requirement of fresh market and processing industries. Breeder can no longer depend upon use of basic stock of the breeding material unless there is a wide genetic diversity for the characters. Hence, selection of parents for hybridization could be more dependable as decided by the appropriate methods for genetic diversity. Non hierarchical Euclidean analysis is a valuable tool for obtaining quantitative estimate of divergence between biological populations. The predictability ratio was lesser than (<1) for all the characters under study in both the years and pooled. Estimate of high heritability in narrow-sense was recorded for plant height followed by ascorbic acid and number of fruits per plant in both years and pooled. Estimate of high genetic advance in per cent of mean (>20%) was observed for plant height in both years and pooled.

2. Material and method

The present study was carried out during *Rabi* seasons of 2016-17 and 2017-18 at Main Experiment Station of Department of Vegetable Science, Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumarganj), Faizabad (U.P.) India. The experimental materials of the study comprised of 54 treatments of tomato [40 F_1's and 14 parental lines (10 lines *viz*., NDT-1, NDT-2, NDT-3, NDT-4, NDT-5, NDT-6, NDT-7, NDT-8, Azad T-6, Arka Saurabh and 4 testers *viz.*, Pusa Ruby, Punjab Chhuhara, Arka Vikash and Arka Meghali]. The 14 parents were involved in a crossing programme to develop a line × tester set (10 lines + 4 testers + 40 F_1's). The experimental materials (40 F_1's and 14 parental lines) were evaluated in Randomized Complete Block Design (RBD) with three replication having each experimental unit with spacing of 60cm × 50cm with plot size of 1.2m ×3.0m.The observations were recorded on eighteen characters, *viz*., days to 50 % flowering, days to first fruit set, days to first fruit harvest, plant height (cm), number of primary branches per plant, number of fruits per cluster, number of fruits per plant, fruit weight per plant (kg), average fruit weight (g), fruit length (cm), fruit girth (cm), number of locules per fruit, pericarp thickness (mm), total soluble solids (TSS), ascorbic acid (mg/100g fresh fruit) total fruit yield per plant (kg). Heritability in narrow sense (h^2ns) was calculated as suggested by Kempthorne (1957) [7]. Expected genetic advance (Ga) was estimated by the formula suggested by Johnson *et al.* (1955) [5].

3. Result and discussion

The knowledge of heritability of a character is important to the breeder since it indicates the possibility and extent to which improvement is possible through selection (Robinson *et al.*, 1949) [19]. Heritability, which denotes the proportion of additive genetic variance to the total variability, is a measure of genetic relationship between parents and progeny and has been widely used in determining the degree to which character may be transmitted from parent to offspring. Singh *et al.* (2005) [21] pointed out that the heritability in combination with intensity of selection and amount of variability present in the population influences the gains to be obtained from selection. Since the genetic gain is yet another important selection parameter which is although independent and represents the expected genetic gain under selection. It measures the differences between the mean genotypic values of the selected lines and mean genotypic value of base population from which these lines were selected. Thus, it is necessary to utilize the heritability in conjunction with selection differential, which would indicate the expected genetic gain. The estimate of heritability with genetic advance as per cent of mean provides a better picture to the breeders during the process of selection.

In this study high estimate of heritability in narrow-sense was recorded for plant height followed by ascorbic acid, number of fruits per plant, total fruit yield per plant, fruit weight per plant and number of fruits per cluster in Y_1, plant height followed by ascorbic acid, number of fruits per plant, total

fruit yield per plant, fruit weight per plant and number of fruits per cluster in Y_2 and pericarp thickness followed by plant height, number of primary branches per plant, ascorbic acid, total fruit yield per plant, number of fruits per plant, number of fruits per cluster, days to first fruit harvest, fruit girth, fruit weight per plant and number of locules per fruit in over pooled (Table-1), suggested that selection would be highly effective and efficient. Similar finding for high estimate of narrow sense heritability for different tomato traits have been also reported by Lush (1947) [12], Omora *et al*. (1988) [14], Shahu and Mishra (1993) [20] and Kumar *et al*. (2006) [9]. Moderate estimate of heritability in narrow sense was observed for pericarp thickness followed by number of primary branches per plant, average fruit weight, number of locules per fruit, days to first fruit harvest and fruit girth in Y_1, pericarp thickness followed by number of primary branches per plant, average fruit weight, number of locules per fruit, days to 50 % flowering, days to first fruit harvest and fruit girth in Y_2 and average fruit weight followed by days to 50 % flowering, days to first fruit set, fruit length and total soluble solids in over pooled. Similar finding for moderate estimate of narrow sense heritability for different tomato traits have been also reported by previous workers (Kumari *et al*., 2007 and Meena *et al.,* 2014) [11, 13].

High estimate of genetic advance in per cent of mean (>20%) was observed for plant height in both the years and over pooled. Moderate estimate of genetic advance in per cent of mean was observed for ascorbic acid in both the years and over pooled. Similar results had also been reported by earlier workers (Pujari *et al*., 1995; Kumar *et al.,* 2004 and Meena *et al*., 2014) [16, 10, 13].

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Table 1: Components of genetic variance, average degree of dominance, predictability ratio and heritability in narrow sense for 16 characters in tomato over two years and pooled

Characters \ Parameters	gca variance (σ^2g)			sca variance (σ^2s)			Average degree of dominance $\sqrt{\sigma^2s/2\,\sigma^2g}$			Predictability ratio $2\sigma^2g/2\,\sigma^2g+\sigma^2s)$		
	Y_1	Y_2	Pooled	Y_1	Y_2	Pooled	Y_1	Y_2	Pooled	Y_1	Y_2	Pooled
Days to 50 % flowering	0.15	0.20	0.24	1.98**	1.52**	2.19**	0.15	0.27	0.22	0.13	0.21	0.18
Days to first fruit set	0.08	0.08	0.17	1.28**	1.28**	1.90**	0.12	0.12	0.17	0.11	0.11	0.15
Days to first fruit harvest	0.16*	0.16*	0.24	0.92*	0.92*	1.48**	0.34	0.34	0.32	0.25	0.25	0.24
Plant height (cm)	360.82**	377.00**	368.98**	56.20**	62.50**	59.64**	12.84	12.06	12.37	0.93	0.92	0.92
Number of primary branches per plant	0.02**	0.02**	0.03	0.03	0.03	0.07**	1.54	1.56	0.75	0.61	0.61	0.43
Number of fruits per cluster	0.04**	0.04**	0.05	0.09*	0.09*	0.14**	0.97	0.93	0.72	0.49	0.48	0.42
Number of fruit per plant	7.89**	7.89**	7.93**	8.74**	8.74**	9.07**	1.80	1.80	1.75	0.64	0.64	0.64
Fruit weight per plant (kg)	0.01**	0.01**	0.01	0.05**	0.04**	0.05**	0.62	0.61	0.60	0.38	0.38	0.38
Average fruit weight (gm)	8.36*	8.38*	8.45	47.10**	47.06**	47.63**	0.35	0.36	0.35	0.26	0.26	0.26
Fruit length (cm)	0.01	0.01	0.02	0.18**	0.18**	0.23**	0.13	0.13	0.17	0.12	0.12	0.14
Fruit girth (cm)	0.05	0.06*	0.09	0.34*	0.34*	0.59**	0.31	0.33	0.31	0.24	0.25	0.23
Number of locules per fruit	0.04*	0.04*	0.05	0.23**	0.23**	0.29**	0.39	0.39	0.37	0.28	0.28	0.27
Pericarp thickness (mm)	0.02**	0.02**	0.02*	0.01	0.00	005**	6.94	7.53	0.90	0.87	0.88	0.47
Total soluble solid (TSS)	0.01	0.01	0.02	0.22**	0.22**	0.26**	0.10	0.10	0.13	0.09	0.09	0.12
Ascorbic acid (mg/100 g fresh fruit)	29.76**	28.66**	29.02**	16.02**	22.37**	17.82**	3.72	2.56	3.26	0.79	0.72	0.76
Total fruit yield per plant (kg)	0.02**	0.02**	0.03**	0.04**	0.03**	0.05**	1.10	1.53	0.07	0.52	0.60	0.52

Table 1: Contd.....

Characters \ Parameters	σ^2A			σ^2D			Heritability (h^2ns %)			Genetic advance in per cent of mean		
	Y_1	Y_2	Pooled	Y_1	Y_2	Pooled	Y_1	Y_2	Pooled	Y_1	Y_2	Pooled
Days to 50 % flowering	0.30	0.40	0.48	1.98	1.52	2.19	9.59	14.42	22.44	0.35	0.50	0.68
Days to first fruit set	0.15	0.15	0.33	1.28	1.28	1.90	6.05	6.05	22.38	0.20	0.20	0.56
Days to first fruit harvest	0.31	0.31	0.48	0.92	0.92	1.48	13.11	13.11	46.34	0.42	0.42	0.97
Plant height (cm)	721.63	754.00	737.95	56.20	62.50	59.64	92.32	91.89	92.43	53.17	54.22	53.80
Number of primary branches per plant	0.04	0.04	0.06	0.03	0.03	0.07	27.64	27.58	76.03	0.22	0.22	0.42
Number of fruits per cluster	0.09	0.08	0.10	0.09	0.09	0.14	31.52	30.11	61.85	0.34	0.32	0.51
Number of fruit per plant	15.77	15.77	15.87	8.74	8.74	9.07	62.41	62.41	65.36	6.46	6.46	6.63
Fruit weight per plant (kg)	0.03	0.03	0.03	0.05	0.04	0.05	36.77	36.64	38.32	0.21	0.20	0.21
Average fruit weight (gm)	16.72	16.77	16.90	47.10	47.06	47.63	25.71	25.78	26.61	4.27	4.28	4.37
Fruit length (cm)	0.02	0.02	0.04	0.18	0.18	0.23	7.70	7.70	21.18	0.09	0.09	0.19
Fruit girth (cm)	0.11	0.11	0.18	0.34	0.34	0.59	11.42	12.15	43.41	0.23	0.24	0.58
Number of locules per fruit	0.09	0.09	0.11	0.23	0.23	0.29	20.53	20.53	35.64	0.28	0.28	0.40
Pericarp thickness (mm)	0.03	0.03	0.05	0.01	0.00	0.05	28.36	28.30	98.52	0.20	0.20	0.44
Total soluble solid (TSS)	0.02	0.02	0.04	0.22	0.22	0.26	6.75	6.75	16.12	0.08	0.08	0.16
Ascorbic acid (mg/100 g fresh fruit)	59.53	57.33	58.04	16.02	22.37	17.82	76.81	69.93	72.24	13.93	13.04	13.34
Total fruit yield per plant (kg)	0.05	0.05	0.05	0.04	0.03	0.05	40.64	44.69	68.89	0.28	0.31	0.39

Y_1=2016-17 and Y_2=2017-18

5. References

1. Anonymous. Data base Horticultural Statistics at a Glance India, 2017.
2. Bhatt RB, Biswas VR, Kumar N. Studies on heterosis for certain characters in tomato [*Lycopersicon lycopersicum* (L.) Karsten] under mid-hill condition. Progressive Horticulture. 1999; 31:1-2.
3. Duhan DV, Pratap PS, Rana MK, Dahiya MS. Heterosis study for quality character in a line X tester set of tomato. Journal of Horticultural Sciences. 2005; 34(3):371-375.
4. Fageria MS, Kohli UK, Dhaka RS. Studies on heterobeltiosis for fruit and yield attributing traits in tomato (*Lycopersicon esculentum* Mill.). Journal of Horticultural Sciences. 2001; 30(2):131-133.
5. Johnson HW, Robinson HW, Comstock RF. Estimates of genetic and environmental variability in *Soybeen.* Agron. J. 1955; 74:314.
6. Kalloo G, Banerjee MK, Tewari RN, Pachouri DC. Vegetable tuber crops and spices. Ist Edi. Directorate of information and Publication of Agricuture. I.C.A.R. New Delhi. 2001, 10-25.
7. Kempthorne O. An introduction to genetic statistics. John Wiley and sons, Inc., New York, 1957, 468-471.
8. Khachik F, Beecher GR, Smit JC. Lactin, lycopene and their oxidative metabolism in chemoprevention of cancer. Journal of Cell Biochemistry. 1995; 22:109-126.
9. Kumar R, Mishra NK, Singh J, Rai GK, Verma A, Rai M. Studies on yield and quality traits in tomato [*Solanum lycopersicon* (Mill.) Wettsd.]. Vegetable Science. 2006; 33(2):126-132.
10. Kumar S, Singh T, Singh B, Singh JP. Studies on heritability and genetic advance in tomato (*Lycopersicon esculentum* Mill.). Progressive Agriculture. 2004; 4(1):76-77.
11. Kumari N, Srivastava JP, Shekhavat AKS, Yadav JR, Singh B. Genetic variability and heritability of various traits in tomato (*Lycopersicon esculentum* Mill.). Progressive Agric. 2007; 7(1-2):80-83.
12. Lush JL. Family merit and individual merit as basis of selection. Amer. Natur. 1947; 81:241-261.
13. Meena O, Kumar MP, Bahadur V. Assissment of genetic variability, heritability and genetic advance among tomato (*Solanum lycopersicum* L.) germplasm. *The Bioscan,* 2014; 9(2):783-787.
14. Omara MK, Uounis SE, Sherif THI, Hussein MU, Arif MMEL. A genetic analysis of yield and yield component in the tomato (*Lycopersicon esculentum* Mill.). Assuit. Journal Agriculture Science. 1988; 19:227-238.
15. Premalakshme V, Thangaraj T, Veeraragavathatham D, Arumugam T. Heterosis and combining ability in tomato (*Solanum lycopersicon* L.). Vegetable Science. 2005; 32(1):47-50.
16. Pujari CV, Wagh RS, Kale PN. Genetic variability and heritability in tomato. Journal of Maharastra Agriculture University. 1995; 20(1):15-17.
17. Rick CM. Cytogenetics of the tomato. Advances in Genetics. 1965; 8:267-382.
18. Rick CM. Origin of cultivated tomato, current status of the problem. International Botanical Congress. 1969, 180.
19. Robinson HF, Comstock RE, Harvey PH. Estimation of heritability and the degree of dominance in corn. Agron. J. 1949; 41:353-359.
20. Shahu GS, Mishra RS. Genetic divergence in tomato. Mysore Journal Agriculture Science. 1993; 29:5-8.
21. Singh AK, Pan RS, Rai M. Combining ability studies of yield and its contributing traits in tomato (*Lycopersicon esculentum* Mill.). Vegetable Science. 2005; 32(1):82-83.
22. Singh NP, Bharadwaj AK, Kumar A, Singh KM. Modern technology on vegetable production. International Book Distributing Company. Lucknow, 2004, 84-98.
23. Thakur AK, Kholi UK, Joshi A. Evaluation of diallel progeny and heterosis for yield and yield components in tomato (*Lycopersicon esculentum* Mill.). Haryana Journal of Horticulture Science. 2004; 33(1-2):106-108.
24. Tiwari RN, Mishra M, Choudhary B, Palai SK. Tomato. In Vegetable Crops, (Eds. T.K. Bose, J. Kabir, T.K. Maity, V.A. Parthasarathy and M.G. Som). Naya Prokash, Calcutta. 2002; 1:1-154.