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Estimates of heritability in narrow sense and genetic gain for different characters in tomato (*Solanum lycopersicum* L.)

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Abstract
The investigations were carried out to evaluate the 47 genotypes (35 F_1 and 12 parental lines) of tomato (*Solanum lycopersicum* L.) at Main Experimental Station, Department of Vegetable Science, A.N.D. University of Agriculture and Technology, Kumarganj, Ayodhya (U.P.) in a set of seven lines and five testers during *Rabi* 2019-20 and 2020-2021. The experiments were laid out in Randomized Complete Block Design with three replications. The data were recorded for 17 characters including total fruit yield per plant and its component traits. High estimate of heritability in narrow-sense (>30) was recorded for total sugar in both the years and pooled while high genetic advance in per cent of mean (>20%) was observed for total fruit yield per plant followed by plant height, average fruit weight, number of locules per fruit in both the years. High heritability (narrow sense) coupled with high genetic advance as per cent of mean suggested that selection would be highly effective and efficient for these characters.

Keywords: Tomato, *Solanum lycopersicum* L., heritability, genetic advance

Introduction

Lentil (*Lens culinaris* Medik) is a member of Leguminaceae family and it is commonly known Tomato (*Solanum lycopersicum* L.) is one of the most important fruit vegetable and second most important vegetable crop after potato grown widely and consumed all over the world but tops the list of processed vegetables (Chaudhary, 1996) [9]. It is a member of the family Solanaceae and the genus *Solanum* having chromosome number of 2n=2x=24. It is grown as an annual and herbaceous plant, typically growing up to 1-3 meter tall, with a weak woody stem that usually scrambles over other plants. It is a sexually propagated crop plant with tap root, complete or perfect and hypogenous flowers. It is a day neutral plant and bears compound inflorescence having four to eight flowers in each cluster. The stigma surrounded by a light protective anther cone leading to self-pollination or autogamy, but it require certain isolation to avoid chance of contamination through cross pollination.

It is a very good source of income for small and marginal farmers and also contributes to the nutrition of the consumer (Singh *et al.*, 2010) [28]. The ripe fruits are taken as raw or made into salads, soups, preserve, pickles, ketchup, puree, paste and many other products (Chadha, 2001) [1]. Carotenoids attracted attention, because a number of epidemiological studies have revealed that an increased consumption of a diet rich in carotenoids is correlated with a diminished risk for several degenerative disorders, including various types of cancer, cardiovascular or ophthalmological diseases (Mayne, 1996) [20].

In India, total area was 0.781 million hectares with production 19.007 million tonnes and 24.34 tonnes per hectare productivity (Anonymous, 2019) with the leading tomato growing states *viz.*, Karnataka, West Bengal, Maharashtra, Uttar Pradesh, Haryana, Punjab, Gujarat and Bihar.

Presently, cultivation of tomato has become tremendously increased through improved varieties or hybrids comes under cultivation. So far efforts of many vegetable breeders have resulted in influential improvement in yield and other quality characters. As a result of such efforts, new cultivars have been developed to meet the diverse needs and adoptive for varied climatic conditions. Even though, further improvement in yield is necessary to feed the ever increasing population in future. Hence, a study was initiated to elicit information on the nature and magnitude of heritability in narrow sense and genetic advance as per cent of mean for yield and its component characters studied.

Material and Methods

The experimental materials comprised of hybrid population of 35 crosses developed by crossing 7 lines of tomato *viz*: NDT-6, 2012/TLCVRes-1-2, NDTH-11W-9-1-1-1, 2013/TODVAR-2-2, 2015/TODHyb-6-5-1, S_5 × NDT-3-2-1-1, S_5 × NDT-3-2-2-2 with 5 testers *viz.* NDT-2-2, NDT-7, NDT-4, NDT-5 and Arka Vikas using line × tester mating design. The 12 parental lines and their 35 hybrids were grown in a Randomized Complete Block Design (RBD) with three replications during *Rabi* 2019-20 and 2020-2021 at the Main Experiment Station (MES) of the Department of Vegetable Science, Acharya Narendra Deva University of Agriculture and Technology, Narendra Nagar, Kumarganj, Ayodhya (U.P.) India. Each hybrids and parents were grown in rows spaced at 0.60 meters apart with a plant to plant spacing of 0.50 meter. Thus, there were 10 plants in each entry per replication in both the years and all the cultural practices regarding tomatoes were followed as recommended. The data were recorded on 5 randomly selected healthy plants from each plot on seventeen characters, *viz*., days to 50% flowering, days to first fruit harvest, plant height (cm), number of primary branches per plant, number of fruits per cluster, number of fruits per plant, average fruit weight (g), pericarp thickness (mm), number of locules per fruit, polar diameter (cm), equitorial diameter (cm), total fruit yield per plant (kg), marketable fruit yield per plant (kg), total soluble solids (TSS), titrable acidity (%), ascorbic acid content (mg/100g) and total sugar (mg/100g). The data were recorded from 35 F_1's and 12 parental lines on seventeen characters were subjected to estimate nature and magnitude of heritability in narrow sense (Kempthorne, 1957) and genetic advance in per cent of mean (Johnson *et al.*, 1955).

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.*, 1964). Meena *et al.* (2014) pointed out that the high heritability and genetic gain, indicate the characters are under additive gene effects which are more reliable for effective selection. In the present investigation, the goal of estimation of nature and magnitude of heritability in narrow sense is important to determining whether phenotypic differences observed among various individuals are due to genetic changes or due to the effects of environmental factors. Heritability indicates the possibility and extent on which improvement can be brought about through selection while, genetic advance in per cent of mean is the product of heritability and selection differential expressed in terms of phenotypic standard deviation of that character. Heritability and genetic advance both are the components of direct selection parameters. It is necessary to utilize heritability estimates in conjunction with selection differential which indicates the expected genetic gain. In the present study, heritability and genetic advance as per cent of mean for seventeen characters in Y_1, Y_2 and pooled had given in Table- 1.

Table 1: Estimates of heritability in narrow sense and genetic advance in per cent of mean for seventeen characters in tomato over two years and pooled

S. No.	Parameters characters	Heritability (h^2ns %)			Genetic advance in per cent of mean		
		Y_1	Y_2	Pooled	Y_1	Y_2	Pooled
1	Days to 50% flowering	19.91	35.37	23.21	18.47	21.58	7.89
2	Days to first fruit harvest	11.14	18.86	9.02	14.31	14.75	4.34
3	Plant height (cm)	33.54	32.98	30.92	32.40	32.39	14.86
4	Number of primary branches per plant	32.94	38.19	26.29	14.20	13.83	5.16
5	Number of fruits per cluster	17.87	18.62	17.42	20.94	17.16	8.34
6	Number of fruits per plant	27.86	13.72	15.02	19.79	16.20	4.78
7	Average fruit weight (gm)	32.60	38.65	37.18	29.74	20.78	10.80
8	Pericarp thickness (mm)	13.95	15.63	18.43	19.70	21.05	3.73
9	Number of locules per fruit	34.99	28.86	27.75	29.66	30.27	14.60
10	Polar diameter (cm)	37.67	25.60	16.41	19.02	22.03	12.11
11	Equitorial diameter (cm)	32.81	15.09	14.16	23.09	17.57	8.61
12	Total fruit yield per plant (kg)	22.40	16.94	18.05	32.43	28.07	15.69
13	Marketable fruit yield per plant (kg)	19.20	19.91	21.73	18.39	23.39	10.18
14	Total soluble solid (%)	16.28	20.32	47.52	3.74	4.80	2.37
15	Titrable acidity (%)	29.34	29.34	35.81	15.84	17.77	8.36
16	Ascorbic acid content (mg/100g)	35.40	22.49	62.95	5.32	3.51	1.09
17	Total sugar (mg/100g)	41.75	41.35	68.46	6.59	6.19	3.79

Perusal of Table-1 revealed that nature and magnitude of heritability differed for different characters and over seasons. The estimates of heritability in narrow-sense (h^2ns) have been classified by Kempt Horne and Curnow (1961) into three categories *viz.*, high (> 30%), medium (10-30%) and low (<10%). In this study high estimate of heritability in narrow-sense was recorded for total sugars followed by plant height and average fruit weight in both the years and pooled while, diameter followed by ascorbic acid content, number of locules per fruit, number of primary branches per plant and equatorial diameter in Y_1, number of primary branches per plant and days to 50% flowering in Y_2 and ascorbic acid content followed by total soluble solids and titrable acidity in pooled. Therefore, additive components is predominant in the traits with high heritability. Similar finding for high estimate of narrow sense heritability for different tomato traits have been also reported by Ghobary and Ibrahim (2010) [12], Hasanuzzaman *et al.*, (2012) [13], Shalaby *et al.* (2013) [27], Meena *et al.*, (2014) [21], Amaefula *et al.*, (2014) [4], El-Gabry *et al.* (2014) [11], Basfore *et al.* (2020) [6], Kumar *et al.* (2020) [18] and Singh *et al.* (2020) [30].

Moderate estimate of heritability in narrow sense was observed for titrable acidity followed by number of fruits per plant, total fruit yield per plant, days to 50% flowering, marketable fruit yield, number of fruits per cluster, total soluble solids, pericarp thickness and days to first fruit harvest in Y_1, titrable acidity followed by number of locules per fruit, polar diameter, ascorbic acid content, total soluble solids, marketable fruit yield per plant, days to first fruit harvest, number of fruits per cluster, total fruit yield per plant, pericarp thickness, equitorial diameter and number of fruits per plant showed moderate estimate of heritability in narrow-sense (h^2_{ns}) in Y_2 and number of locules per fruit followed by number of primary branches per plant, days to 50% flowering, marketable fruit yield per plant, pericarp thickness, total fruit yield per plant, number of fruits per cluster, polar diameter and equitorial diameter in pooled. These results were in agreement with those reported by Ghobary and Ibrahim,

(2010) [12], Singh *et al.* (2011) [29], Hasanuzzaman *et al.*, (2012) [13], Akhtar and Hazra (2013) [3] and Kumar *et al.* (2020) [18] whereas, only one trait *viz.*, days to first fruit harvest showed low heritability in pooled. Similar finding for low estimate of narrow sense heritability for different tomato traits have been also previously reported by Hazra and Ansary (2008) [14] and Saleem *et al.* (2009) [26] and Kumar *et al.* (2020) [18].

High estimate of genetic advance in per cent of mean (>20%) was observed for total fruit yield per plant followed by plant height, average fruit weight, number of locules per fruit, equitorial diameter and number of fruits per cluster in Y_1, plant height followed by number of locules per fruit, total fruit yield per plant, marketable fruit yield per plant, polar diameter, days to 50% flowering, pericarp thickness and average fruit weight in Y_2 and none of the traits in pooled which are in conformity with the findings reported by Kumari *et al.* (2007) [19]; Singh *et al.* (2011) [29]; Ahirwar *et al.* (2013) [1]; Doddamani *et al.* (2017) [10]; Basfore *et al.* (2020) [6]; Kumar *et al.* (2020) [18] and Singh *et al.* (2020) [30] while, moderate estimate of genetic advance in per cent of mean was observed for number of fruits per plant followed by pericarp thickness, polar diameter, days to 50% flowering, marketable fruit yield per plant, titrable acidity, days to first fruit harvest and number of primary branches per plant in Y_1, titrable acidity followed by equitorial diameter, number of fruits per cluster, number of fruits per plant and days to first fruit harvest in Y_2 and total fruit yield per plant followed by plant height, number of locules per fruit, average fruit weight and marketable fruit yield per plant in pooled. The results are in harmony with the findings of earlier workers (Saleem *et al.*, 2009; Singh *et al.* (2011); Ahirwar *et al.* (2013); Meena *et al.*, 2014, Meitei *et al.*, 2014 and Ahmad *et al.*, 2017) [26, 29, 1, 21, 2].

High heritability in narrow-sense (h^2_{ns}) coupled with high genetic advance as per cent of mean was exhibited by plant height, average fruit weight, number of locules per fruit and equitorial diameter in Y_1, days to 50% flowering, plant height and average fruit weight in Y_2 and none of the traits were found high heritability as well as high genetic advance as per cent of mean in pooled. Moderate heritability in narrow-sense (h^2_{ns}) coupled with high genetic advance as per cent of mean was observed for total fruit yield per plant and number of fruits per cluster in Y_1, number of locules per fruit, total fruit yield per plant, polar diameter and pericarp thickness in Y_2. High heritability combined with high genetic advance indicates that additive gene action plays a major role in governing these traits and these traits can be improved by simple selection. The similar results have also been reported by earlier workers (Rani *et al.*, 2011; Patel *et al.*, 2013; Meitei *et al.*, 2014; Doddamani *et al.*, 2017; Bhandari *et al.*, 2017; Singh *et al.*, 2020; Basfore *et al.*, 2020 and Kumar *et al.*, 2020) [24, 23, 22, 10, 7, 30, 6, 18].

Conclusion

Based on the above findings the high heritability (narrow sense) coupled with high genetic advance as per cent of mean reflected that traits plant height, average fruit weight, number of locules per fruit and equatorial diameter were governed by additive gene action and therefore, selection may be highly effective for these characters.

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