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GENETIC VARIABILITY AND TRAIT RELATIONSHIP FOR YIELD AND ITS ATTRIBUTES TOMATO HYBRIDS UNDER WESTERN TRACK OF VINDHYAN PLATEAU OF MADHYA PRADESH, INDIA

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Abstract

The present investigation was conducted during late *kharif*, 2013 at Horticulture Research Farm, R.A.K. College of Agriculture, Sehore, (M.P) to study growth, yield parameters on twelve hybrids of tomato. Design of experiment was RBD with three replications. Observation on traits related to plant morphology, maturity and yield component were recorded to develop, evaluate, identify and recommend high yielding hybrids of tomato. High estimates of PCV, GCV, heritability and genetic advance as percentage of mean were observed for fruit yield per hectare(q/ha), plant height at final picking, number of flower clusters per plant, fruit yield per plot (kg) and days to fruit initiation. Thus these characters appear to be more promising for considering genetic improvement and can be utilized for developing high yielding tomato hybrids. Fruit yield per plot (kg.) showed a significant positive correlation with fruit yield/ha (0.900), weight of fruit (g) (0.749), whereas Fruit yield (q/h) had the significant positive correlation with trait fruit yield/plant (kg) (0.905). Over all conclusions from present investigation that characters like plant height, number of flower clusters per plant, number of flowers per cluster and number of fruits at 115 DAT appeared to major yield components therefore phenotypic selection on these traits will result development better high yielding hybrid tomato. Out of 12 tomato hybrids studied hybrid namely US-618, SHANTUNA-2131, VIGRO, ANIRUDH, BHUMIKA, VS-440, H-86, LAXMI NP-5005, NBH-1, PUSA RUBI, PAHUJA- 508, NTH-2530 are appeared to better ones as regards quality components.

Key words: Association analysis, Hybrid, Genetic parameter, Tomato.

Introduction

Tomato (*Solanum lycopersicum* L.) occupies the prime position among different vegetables and is an important vegetable cultivated in India (Shankarappa *et al*., 2008; Narolia *et al*., 2012). It belongs to the Solanaceae family with other frugally important crops such as pepper, eggplant and potato. Tomato is a rich source of vitamins (A and C), minerals (Ca, P and Fe) and a strong antioxidant against cancer and heart diseases (Dhaliwal *et al*., 2003; Anonymous, 2011b). Tomato is an important cash-generating crop for small scale farmers and also provides employment opportunities in production and processing industries. Considering the importance of tomato as one of the potential vegetable crop for domestic consumption as well as export markets, it is important to increase its productivity along with desirable attributes through genetic manipulation (Meena *et al*., 2015).

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Systematic study and evaluation of tomato germplasm is of great importance for current and future agronomic and genetic improvement of the crop (Renuka *et al*., 2017). Considering the potentiality of this crop, there is a need for improvement and to develop varieties suited to specific agro-ecological conditions and also for specific end use (Kumar *et al*., 2015). In respect to this, it is essential to assess the quantum of genetic variability, nature of character association, which would help plant breeders in planning a successful breeding programme. Genetic parameters like genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability and genetic advance are useful biometrical tools for determination of genetic variability (Islam *et al*., 2012). These genetic parameters provide information about the expected response of various characters to selection and it will help in developing optimum breeding procedure (Meena *et al*., 2015).

Yield is a complex trait and influenced by the other characters with varying degree of effects. To understanding of relationships among these components, association analysis is an important breeding approach. The estimates of different genetic parameters and the association of different characters are important for better understanding of the nature and the magnitude of genetic variability present in the breeding material (Kumar *et al*., 2015). The core objective of the present study was therefore, to estimate the extent of genetic variability and character association between yield and yield contributing traits and to set up a selection criterion for the isolation of promising crosses to develop commercial hybrid cultivars.

Material and Methods

The present investigation conduct at the Horticulture Research Farm, R.A.K. College of Agriculture, Sehore, (M.P) during late *kharif* season (2011). The experimental material comprised of twelve hybrids, which were collected from the market. The hybrids were transplanted after 30 DAS in randomized block design with three replications. Plants of each genotype were planted at a spacing of 60×50 cm. Standard cultural practices (Operations & Protection measures) were adopted to ensure a healthy crop growth. The hybrids were evaluated for some important character *viz*., plant height (cm), number of branch per plant at final picking, days to flower initiation, days to fruit initiation, days to first picking, number of flowers per cluster, number of flower clusters per plant, number of fruit per cluster, number of fruit per plant after final picking, number of fruits per picking, number of locules per fruit, fruit girth (cm), fruit length (cm), weight of fruit (g), fruit yield per plant (kg), fruit yield per plot (kg), fruit yield per ha (q/ha). The quality characters *viz*., type of plant, colour of fruit, fruit shape, T.S.S. (Brix) and keeping quality also recorded. Average data were subjected to analysis of variance following Panse and Sukhatme, (1967). Genotypic and phenotypic coefficient of variation calculated according to Burton, (1952). Broad sense heritability [h2(b.s)] was estimated according to Lush (1949), Johnson *et al*., (1955) and Hanson *et al*., (1956). Heritability values were categorized as low (<30%), moderate (30-60%) and high (>60%). The expected genetic advance (GA%) on 5% selection intensity was estimated and classified as low (<10%), moderate (10-20%) and high (>20%) following the method given by Lush, (1949). Correlation coefficients were further partitioned into components of direct and indirect effects by path analysis (Wright, 1921; Dewey and Lu, 1959).

Result and Discussion

Coefficient of variation

The experimental findings revealed that a greater phenotypic coefficient of variability (PCV) was observed than genotypic coefficient of the variation (GCV) for all the traits (Table 1) which indicated that the apparent variation is not only due to genotypes but also due to the

Table 1: Genetic parameters for fruit yield and its related components in tomato.

Characters	Means	Range		GCV	PCV	h^2	GA as % of Mean
		Min	Max				
Plant height at 30 DAT	41.56	25.00	50.80	13.87	21.82	40.4	18.16
Plant height at final picking	186.44	153.67	245.33	15.37	15.72	95.5	30.87
Number of Primary branches/plant at final picking	14.75	10.50	18.67	15.63	17.77	77.3	28.27
Days to flower initiation	37.22	33.33	41.33	5.98	7.70	60.4	9.59
Days to fruit initiation	56.52	52.00	64.00	7.13	7.83	82.9	13.37
Days to first picking	91.27	84.81	95.79	3.58	4.20	72.7	6.28
Number of flower clusters per plant	41.01	27.45	53.91	19.38	20.07	93.3	38.50
Number of flowers per cluster	5.53	3.67	7.08	17.20	17.52	96.4	34.90
Number of fruits per cluster	4.54	3.69	5.64	11.07	11.27	96.5	22.46
Number of fruits per plant at final picking	31.13	28.33	43.67	12.50	14.53	74.0	22.13
Number of fruits per picking(90 DAT	9.02	7.67	12.67	12.05	18.17	44.0	16.51
Number of fruits per picking(115 DAT)	11.50	10.00	17.00	14.62	18.44	62.9	23.91
Number of fruits per picking(140 DAT)	10.61	9.67	14.00	8.54	14.44	34.9	10.36
Length of fruit(cm)	6.74	5.99	8.02	6.70	9.32	51.7	9.94
Girth of fruit(cm)	6.09	5.10	7.26	10.18	10.43	95.3	20.52
Weight of fruit(g)	41.92	35.51	47.67	8.89	9.64	84.9	16.86
Fruit yield per plant(kg)	1.36	1.07	1.97	19.12	20.56	86.5	36.74
Fruit yield per plot(kg)	34.06	26.73	49.24	19.12	20.56	86.5	36.64
Fruit yield per hectare (q/ha.)	454.18	356.37	656.57	19.12	20.55	86.5	36.62

influence of environment. Therefore, selection for such traits sometimes might be misleading.

High phenotypic coefficient of variation and genotypic coefficient of variation were observed for characters such as plant height at 30 DAT followed by fruit yield per plot (kg), fruit yield per plant (g), fruit yield per ha (q), number of flower clusters per plant, number of fruits per picking (115 DAT), number of fruits per picking (90 DAT). High genotypic coefficient of variation was observed for number of flower clustrs per plant (19.38%), fruit yield/plant (19.12%) and fruit yield/plot (19.12%), followed by fruit yield/ha (19.12%), number of flowers per cluster (17.20%), indicating these characters offer greater scope for selection than other character having the low amount of phenotypic and genotypic coefficient of variation i.e. days to first picking. Similar results were reported by Sahu and Mishra, (1995); Verma *et al*., (1996); Das *et al*., (1998); Mohanty, (2002); Sashikala *et al*., (2002); Mohanty, (2003); Singh *et al*., (2004); Saleem *et al*., (2013) and Vyas *et al*., (2011) for the character number of branches per plant height.

In the present investigation low amount of genotypic and phenotypic coefficient of variation was observed for the characters *viz*., days to first picking, days to flower initiation, length of fruit and days to fruit initiation. These results are in agreement with Verma *et al*., (1996) and Shashikala *et al*., (2002).

Heritability

Heritability determines the relative amount of heritable proportion of variability. It was observed that all other characters had high to moderate heritability except number of fruits per picking (140 DAT). This indicating that there characters are less influenced by the environment.

High heritability estimates obtained for the characters *viz*. number of fruit per cluster, number of flowers per cluster, plant height at final picking, girth of fruit (cm), number of flower clusters per plant, fruit yield per plant (kg), fruit yield per plot(kg) fruit yield per hectare (q/ha), weight of fruit (g) and days to fruit initiation. It indicates that there is higher response to selection for the characters studied. Similar results were reported by Bora and Shadeque, (1993); Singh and Singh, (1993); Mohanty, (2002); Singh and Cheema, (2005); Krishna *et al*., (2007) and Vyas *et al*., (2011).

The low heritability was recorded in case of number of fruits per picking (140) DAT, plant height (30 DAT), number of fruits per picking (90 DAT) and length of fruit(cm), which is indicative of the fact that there characters are rather more influenced by the environment. Dudi *et al.,* (1983) are close harmony of the results of the present investigation.

Genetic Advance

Heritability estimates accompanied by genetic advance (Johanson *et al*., 1955) will provide better picture of gene action controlling traits. In the present study high value of genetic advance was observed for number of flower clusters per plant, fruit yield per plant, fruit yield per plot, fruit yield per hectare, number of flowers per cluster, followed by plant height at final picking, number of primary branches per plant at final picking, number of fruits per picking at 115 DAT, number of fruits per cluster, number of fruits per plant at final picking, girth of fruit. These high estimates are indicative of the fact that improvement could be quickly realized in these characters through selection. These findings are close harmony with Reddy and Reddy, (1992); Sahu and Mishra, (1995); Das *et al*., (1998); Vikram and Kohli, (1998); Sashikala *et al*., (2002) and Mohanty, (2002); Haydar *et al*., (2007).

Low genetic advance was recorded in fruit yield per plant (kg), length of fruit (cm) and number of fruits per cluster. Similar results were observed by Padda *et al*., (1971) and Krishna *et al*., (2007).

High estimates of PCV, GCV, heritability and genetic advance as percentage of mean were observed for fruit yield per hectare (q/ha), plant height at final picking, number of flower clusters per plant, fruit yield per plot (kg) and days to fruit initiation. Thus these characters appear to be more promising for considering genetic improvement and can be utilized for developing high yielding tomato hybrids.

Correlation

Correlation coefficient measures the relationship between two or more variables. They are helpful in determining component of a complex characters, yield is a complex character resulting from the interaction of a number of factors and the environment conditions, in order to develop a high yielding genotype, selection based on the performance of the yield is usually not very efficient but when it is based on the components characters it may give more efficient results.

Correlation coefficient studies revealed the existence of varying closeness of inter relationship among the characters under study. This indicated a strong genetic association between these traits. The present study also suggested that both genotypic and phenotypic correlations were similar in direction. Singh *et al*., (2015) also reported higher estimates of genotypic correlation than the corresponding phenotypic correlation coefficients between yield and yield components.

Table 2: Phenotypic (P) and genotypic (G) correlation coefficient of fruit yield and its components in tomato.

		Plant height at final picking	No. of primary branches/ plant at final picking	Days to flower initiation	Days to fruit initiation	Days to first picking	No of flower clusters / plant	Number of flowers / cluster	No of fruits/ cluster	No of fruits/ plant at final picking	No of fruits/ picking 90 DAT	No of fruits/ picking 115 DAT	No of fruits/ picking 140 DAT	Length of fruit (cm)	Girth of fruit (cm)	Weight of fruit (g)	Fruit yield/plot (kg)	Fruit yield (q/ha)	Fruit yield/ plant (kg)
Plant height at 30 DAT	P	0.185	-0.312*	0.044	0.07	-0.063	-0.361*	0.026	0.308*	-0.13	0.074	-0.285*	-0.068	0.007	-0.008	0.024	-0.004	-0.004	-0.004
	G	0.387	-0.314	0.141	-0.122	-0.093	-0.527	0.042	0.458	-0.182	-0.161	-0.12	-0.366	-0.409	-0.057	0.058	0.011	0.011	0.011
Plant height at final picking	P		0.386*	0.252*	-0.347*	0.135	-0.354*	0.311*	0.164	-0.034	0.047	0.034	-0.198	0.152	-0.209*	-0.339*	-0.136	-0.136	-0.136
	G		0.446	0.294	-0.377	0.171	-0.396	0.318	0.171	-0.042	0.134	0.031	-0.355	0.249	-0.217	-0.372	-0.146	-0.146	-0.146
No. of primary branches /plant at final picking	P			-0.164	0.208*	-0.062	0.328*	0.452*	-0.048	0.391*	0.324*	0.471*	0.157	0.511*	-0.496*	-0.049	0.108	0.108	0.108
	G			-0.171	0.212	-0.133	0.35	0.539	-0.0355	0.472	0.441	0.596	0.391	0.862	-0.57	-0.061	0.112	0.102	0.113
Days to flower initiation	P				-0.205*	-0.268*	-0.447*	-0.207*	0.052	-0.317*	-0.283*	-0.337*	-0.167	-0.364*	0.413*	-0.342*	-0.312*	-0.312*	-0.312*
	G				-0.214	-0.282	-0.579	-0.26	0.059	-0.379	-0.424	-0.402	-0.372	-0.651	0.59	-0.432	-0.357	-0.357	-0.357
Days to fruit initiation	P					-0.345*	0.051	-0.159	-0.384*	-0.088	-0.065	-0.123	-0.02	-0.111	-0.02	-0.163	-0.291*	-0.291*	-0.291*
	G					-0.457	0.054	-0.182	-0.435	-0.104	-0.076	-0.16	-0.06	-0.155	-0.237	-0.262	-0.343	-0.343	-0.342
Days to first picking	P						0.232*	0.478*	0.071	-0.13	-0.077	-0.087	-0.18	0.046	0.012	-0.153	-129	-0.129	-0.129
	G						0.238	0.547	0.085	-0.155	0.084	-0.164	-0.368	0.05	0.013	-0.214	-0.141	-0.141	-0.141
No of flower clusters/plant	P							0.269*	-0.226*	0.309*	0.161	0.361*	0.242*	0.295*	-0.535**	0.126	0.052	0.052	0.052
	G							0.283	-0.238	0.342	0.236	0.399	0.447	0.47	-562	0.162	0.069	0.069	0.069
Number of flowers / cluster	P								0.579**	0.058	0.021	0.129	-0.029	0.334*	-0.377*	0.103	0.098	0.098	0.098
	G								0.599	0.064	0.03	0.21	-0.124	0.478	-0.396	0.111	0.107	0.107	0.107
No of fruits/cluster	P									-0.084	-0.183	-0.014	-0.034	0.099	0.049	0.503*	0.362*	0.362*	0.362*
	G									-0.126	-0.289	-0.02	-0.158	0.132	0.058	0.574	0.369	0.369	0.369
No of fruits/ plant at final picking	P										0.842**	0.899**	0.808**	0.587**	-0.08	0.263*	0.746**	0.746**	0.746**
	G										0.939	0.9	0.905	0.992	-0.118	0.434	0.789	0.789	0.789
No of fruits / picking (90 DAT)	P											0.638**	0.535**	0.464*	-0.041	0.052	0.598**	0.598**	0.598**
	G											0.737	0.65	0.542	-0.05	0.254	0.701	0.701	0.701
No of fruits/picking (115 DAT)	P												0.880**	0.580**	-0.167	0.279*	0.681**	0.681**	0.681**
	G												0.973	0.631	-0.221	0.514	0.77	0.77	0.77
No of fruits/ picking (140 DAT)	P													0.634**	0.038	0.336*	0.620**	0.620**	0.621**
	G													0.909	-0.049	0.603	0.774	0.774	0.774
Length of fruit (cm)	P														-0.284*	0.334*	0.481*	0.481*	0.481*
	G														-0.377	0.542	0.776	0.776	0.776
Girth of fruit (cm)	P															0.055	0.217*	0.217*	0.216*
	G															0.058	0.219	0.219	0.219
Weight of fruit(g)	P																0.749**	0.749**	0.749**
	G																0.818	0.818	0.817
Fruit yield/plot(kg)	P																	0.900**	0.900**
	G																	0.995	0.995
Fruit yield (q/ha)	P																		0.905**
	G																		0.905

* Significant at 5% level, ** significant at 1% level

A significant and positive correlation of number of fruits per cluster was recorded with weight of fruit (0.503) and number of flowers per cluster (0.579). A significant positive correlation was noticed by number of fruit per picking 115 DAT with number of fruits per plant at final picking (0.899) and number of fruit per picking (0.880). A significant and positive correlation of number of fruits per picking at 140 DAT was recorded with length of fruit (cm) (0.643).

Fruit yield per plot (kg.) showed a significant positive correlation with fruit yield/ha (0.900), weight of fruit (g) (0.749), whereas Fruit yield (q/h) had the significant positive correlation with trait fruit yield/plant (kg) (0.905).

A significant and negative correlation number of flower per cluster per plant was observed with girth of fruit (-0.535).

It indicates that higher and positive association of these traits with yield per plant may be exploited for increasing fruit yield in tomato. These finding are supported by Alvorez and Torres, (1984); Bhutani and Kalloo, (1989); Supe and kale, (1992); Ghosh *et al*., (1994); Takae *et al*., (1995); Das *et al*., (1998); Mohanty, (2002); Raut *et al*., (2004); Indu Rani *et al*., (2008); Anjum *et al*., (2009) and Vyas *et al*., (2011).

Over all conclusions from present investigation that characters like plant height, number of flower clusters per plant, number of flowers per cluster and number of fruits at 115 DAT appeared to major yield components therefore phenotypic selection on these traits will result development better high yielding hybrid tomato.

Out of 12 tomato hybrids studied hybrid namely US-618, SHANTUNA-2131, VIGRO, ANIRUDH, BHUMIKA, VS-440, H-86, LAXMI NP-5005, NBH-1, PUSA RUBI, PAHUJA- 508, NTH-2530 are appeared to better ones as regards quality components.

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