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Review Article

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A Review on Genetic Diversity among Tomato (*Solanum lycopersicon* (MLL.) Wettsd.) Genotypes

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ABSTRACT

Tomato is one of the most widely grown vegetable crops throughout India with wide range of genetic diversity, which provides a tremendous scope for genetic improvement of economic traits. An improvement in yield and quality in self pollinated crop like tomato is normally achieved by selecting the genotypes with desirable character combinations exiting in nature or by hybridization. Hence, the information in a collection of some indigenous genotypes of tomato in order to formulate a sound breeding plan for it's improvement has been reviewed here.

Key words: *Tomato, Genetic diversity, Variability, Heritability, Genetic advance, Correlation and Path Coefficient*

INTRODUCTION

Vavilov[47] for the first time perceived the importance of genetic variability and advocated that the wide range of variability provides better scope of selecting desirable genotypes. Variation for different characters of commercial importance in tomato was first reported by Norton[30]. Tomato (*Lycopersicon esculentum* M., 2n=2x=24) is one of the Solanaceae fruit vegetable frequently eaten raw or cooked and processed whereas unripe green fruits are used for preparation of pickles and chutney[29]. All the species of tomato are native to Western South America[36]. Tomatoes are commonly used as a model crop for diverse physiological, cellular, biochemical, molecular and genetic studies because these are easily grown and have a short life cycle[18]. Mahalanobis[23] generalized distance has been used as an efficient tool in quantitative estimation of genetic diversity and a rational choice of potential parents for a breeding programme. Knowledge of interrelationship between yield and it's components is obvious for efficient selection of desirable plant type. Unlike the correlation coefficient values, which measure the extent of relationship, path coefficient[8,49] measure the magnitude of direct and indirect effects of characters on complex dependent characters like yield and thus enable the breeders to judge best about the important component characters during selection.

Genetic Variability Studies

The genetic variability is the raw material in the plant breeding industry on which selection act to evolve superior genotypes[43].

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Vavilov[47] for the first time perceived the importance of genetic variability and advocated that the wide range of variability provides better scope of selecting desirable genotypes.

Reddy and Lal[35] found that GCV was very high in number of fruit per plant followed by average fruit weight per fruit, fruit yield per plant and plant height indicate the presence of high degree of genetic variability for these character. Kale *et al*[15]., observed high values of GCV (23.08% and 29.32%) and PCV (23.60% and 45.54%) in varieties of tomato for plant height and number of fruit per plant, respectively. Kumar and Lal[21] recorded high PCV and GCV values for number of fruits/plant (GCV = 50.52%) followed by plant height (GCV 21.18%), days to 50% flowering (12.62%) and days to first fruit harvest (6.32%), respectively. High genotypic and phenotypic coefficients of variation for number of fruits per plant and average fruit weight were reported by Bora *et al*[5]., whereas plant height, number of fruits per cluster and fruit yield per plant recorded moderate values and days to first picking exhibited low genotypic and phenotypic coefficients of variation. In an experiment conducted by Singh and Singh[45], it is reported that genotypic and phenotypic coefficients of variation were higher for number of fruits per plant followed by fruit yield per plant, while low values were observed for fruit breadth, fruit length, plant height and pericarp thickness. In 1998, Das *et al*[6]. observed that the characters like fruit yield per plant, number of fruits per plant, fruit weight, fruit diameter, fruit length and locule number per fruit show high estimates of genotypic coefficients of variation in tomato. Again in 2003, Mariama *et al*[25]. reported significant genotypic variability among the genotypes for all the characters related to fruit yield and yield components. In general, the phenotypic coefficient of variation was higher than the genotypic coefficient of variation. Similarly, Singh and Narayan[40] reported high estimates of genotypic and phenotypic coefficients of variation for plant height, fruit length, number of fruits per plant and number of branches per plant. A study was conducted by Mahesha *et al*[24]., on 30 genotypes of tomato which revealed significant differences for all the characters under study. Further, wide range of variation was observed for plant height, number of branches per plant, fruit weight, fruit length, fruit diameter, number of locules per fruit, fruit set percentage, fruits per plant, fruit yield per plant, ascorbic acid content and total soluble solids. Similarly, Asati *et al*[3]. in 2008 also observed significant differences among different genotypes for all the character under study in tomato. In general, phenotypic coefficients of variation were higher than genotypic coefficient of variation indicating that the genotypic influence has been lessened under the influence of environment.

Heritability and Genetic Gain/ Genetic Advance

Genetic advance is a product of heritability and infers the potentiality of selection intensity; genetic advance when considered along with heritability gives resemblance assessment of the resultant effects of selection in breeding populations[12]. Reddy and Reddy[34] reported high heritability and genetic gain for number of fruits per plant, number of locules per fruit, yield per plant and plant height, while total soluble solids showed moderate heritability estimate and very low genetic advance. Similarly, Bora *et al*[5]., reported high heritability and high genetic advance for fruit weight, number of fruits per plant while high heritability with moderate genetic advance for plant height and yield per plant and moderate heritability with low genetic advance for number of fruits per cluster. High heritability with high genetic gain for number of fruits per plant and plant height was reported by Nair and Thamburaj[28], while number of locules per fruit showed high heritability with moderate genetic gain and total soluble solids recorded moderate heritability with low genetic gain. In 1995, Pujari *et al*[33]. reported high estimates of heritability with high genetic advance for number of fruits per plant, plant height and average fruit weight, thus suggesting that these traits could be used effectively in developing high yielding varieties in tomato through simple selection. Similarly, Sahu and Mishra[38] also observed high heritability and genetic gain for characters like number of fruits per plant, average fruit weight and plant height. High heritability estimates were recorded for fruit shape index followed by plant height, pericarp thickness, average fruit weight, number of locules per fruit and number of fruits per plant by Mittal *et al*[26]., and the characters like number of fruits per plant, number of locules per fruit, average fruit weight, pericarp thickness, plant height and fruit yield per plant also showed high heritability coupled with high genetic gain. Vikram and Kohli[48] in an experiment on variability observed high heritability coupled with high genetic gain for average fruit weight and yield per plant. Similarly, Joshi[13] also reported high heritability with high genetic gain for average fruit weight, fruit firmness and pericarp thickness, whereas low estimates for days to first picking were observed. High heritability for total soluble solids, pericarp thickness, fruit firmness, acidity and dry matter content in tomato was also reported by Singh and Cheema[41]. Genetic variability, heritability and expected genetic advance studied by Mahesha *et al*[24]., in 30 genotypes of tomato revealed significant difference for all the characters under study. Fruit weight, fruits per plant and plant height exhibited very high heritability values along with high genetic gain. Asati et *al*[3]., in an experiment revealed that the characters like plant height, number of primary branches, number of fruits per plant, fruit diameter, fruit weight, pericarp thickness, number of seeds per fruit, ascorbic acid and yield per plant have high heritability along with high genetic advance in tomato. Similarly, Anjum *et al*[1]., reported high heritability coupled with high genetic gain for all the characters except days to first picking, harvest duration and lycopene content which recorded high estimates of heritability and moderate genetic gain. Further, number of flowers per cluster possessed moderate estimates for both heritability and genetic gain in their studies on tomato. Kumar *et al*[19]., reported that the heritability estimates were high for all the characters except number of branches per plant which showed moderate heritability. The maximum heritability was observed for number of seeds per fruit and average fruit weight. High GCV and heritability coupled with high genetic advance was observed for fruit yield per plant followed by number of seeds per fruit indicating that they are governed by additive genes and could be effectively improved through selection. Similarly, Singh *et al*[43]., reported that high heritability along with high genetic advance in per cent of mean was estimated for all the traits except days to 50 per cent flowering. Fruit yield per plant followed by average fruit weight, number of locules per fruit, number of fruits per plant and plant height were the top five traits which showed high level of genetic advance indicating opportunity for better selection response. Ullah *et al*[46]., observed that high genotypic and phenotypic coefficients of variation were recorded for fruits per plant, locule number per fruit and fruit yield per plant. Heritability was observed high for flowers per cluster, fruits per plant, fruit weight and fruit length. High heritability associated with high genetic advance was observed for fruits per plant (52.30) and fruit weight (46.32) and flower per cluster (33.50). Selection for such traits might be effective for the fruit yield improvement of tomato.

Correlation Studies

The correlation coefficient analysis is an important tool which provides symmetrical measurement of nature of interaction between various quantitative traits to determinate the component characters on which selection can be based for genetic improvement in yield[37]. In 1988, Kale *et al*[15]., observed that yield was significantly and positively correlated with number of fruits per plant, total soluble solids and plant height. In another correlation study, Bhutani and Kalloo[4] observed positive and significant association of number of fruits per plant and pericarp thickness with yield, while number of locules per fruit had non-significant association with yield. Similarly, Fageria[10] reported that yield was positively correlated with fruit weight, whole fruit firmness and pericarp thickness and further, pericarp thickness also had significant positive correlation with whole fruit firmness. Correlation studies carried out in segregating generations of tomato by Kanthaswamy *et al*[16]., showed significant positive association of fruit weight, number of fruits per plant and total soluble solids with yield. Fageria and Kohli[9] reported that yield was positively correlated with fruit weight. Aruna and Veeraragavathatham[2] observed significant positive correlation of yield per plant with mean fruit weight, total soluble solids and number of fruits per plant whereas negative but non-significant correlation was observed for fruit weight with plant height. Similarly, Singh *et al*[44]., reported positive and highly significant correlation of average fruit weight with shelf life and indicated that larger fruits had better shelf life than smaller fruits. Singh *et al*[42]., in their studies observed that number of fruits per plant and number of fruits per cluster exhibited highly significant positive correlation with yield. They further recorded negative correlation between number of fruits per cluster and average fruit weight. Plant height was also found positively correlated with days to 50 % flowering, days to fruit set, number of fruits per plant and total soluble solids. Number of fruits per plant had significant and positive correlation with fruit yield per plant, whereas fruit acidity had significant and positive correlation with number of locules per fruit, in the experiments conducted by Kumar *et al*[20]. A positive and significant correlation of yield per plant with average fruit weight, fruit length, plant height and harvest duration was reported by Joshi *et al*[14]. The average fruit weight was positively correlated with fruit length, fruit breadth; stem end scar size, pericarp thickness, whole fruit firmness and shelf life. However, fruit weight was negatively correlated with number of fruits per plant, number of fruits per cluster and ascorbic acid content. A study conducted by Prashanth *et al*[32]., indicated the inverse relationship between growth and yield characters. Total yield per plant was positively and significantly correlated with early fruit yield per plant, equatorial diameter of the fruit, fruit volume, average fruit weight, polar diameter of the fruit, number of fruits per plant, percent fruit set, number of locules per fruit, pericarp thickness and number of seeds per fruit. But it was negatively and significantly correlated with number of flowers per cluster and number of fruits per cluster. In a correlation study Asati *et al*[3]., observed high significant and positive correlation of fruit yield with fruit diameter and pericarp thickness, while it was negative with plant height, number of locules per fruit and ascorbic acid. Similarly, correlation studies conducted by Anjum *et al*[1]., revealed that the economically important trait like fruit yield per plant in tomato have high positive significant correlation with fruit size, plant height, number of fruits per plant and number of primary branches per plant both at phenotypic as well as genotypic levels.

Path Coefficient Analysis

Path coefficient analysis generally reveals the magnitude of contribution made by different plant characters towards yield, thereby imparting confidence in selection of important yield attributes. Patil and Bojappa[31] reported that among quality traits, pericarp thickness had the positive direct effect on yield, whereas fruit shape index and total soluble solids had negative effects on yield. Again in 1989, Bhutani and Kalloo[4] reported that number of fruits per plant had the highest direct contribution to yield. Dev and Sharma[7] also reported that selection for increased yield should be based on improving fruit weight and pericarp thickness. Similarly, Vikram and Kohli[48] observed that number of fruits per plant was the most important yield contributing character followed by average fruit weight. Harer *et al*[11]., reported that number of fruits per cluster, average fruit weight and number of fruits per plant had maximum direct effect on fruit yield. The total soluble solids content had positive but indirect effect on yield, whereas ascorbic acid content had negative direct effect and association with fruit yield. Joshi[13] observed that average fruit weight and stem thickness contributed high positive direct effect towards yield per plant. Mohanty[27] reported that number of fruits per plant and average fruit weight exerted high positive direct effect on yield. Similarly, Singh *et al*[42]., observed high positive direct effect of number of fruits per plant on yield followed by fruit diameter, average weight per fruit, fruit length, days to 50 % flowering, number of fruits per cluster and days to first harvest. However, days to first fruit set, number of primary branches per plant, plant height, number of fruit clusters per plant and total soluble solids had direct negative effect on yield, in their studies. Prashanth *et al*[32]., observed that early yield and average fruit weight had high direct positive effects on total yield. Hence, direct selection for early yield and average fruit weight was suggested for yield improvement in tomato. A study of path analysis done by Asati *et al*[3]., indicated that the direct selection for days to first picking, fruit diameter, plant height, fruit weight, days to 75% flowering, ascorbic acid and number of primary branches could be used as selection criteria for further improvement in yield in tomato. Similarly, Anjum *et al*[1]., also reported that days to first picking had highest positive direct effect on fruit yield followed by harvest duration, number of fruits per plant, average fruit weight, plant height and number of flowers per cluster in tomato.

Genetic Divergence

Genetic divergence was assessed by Kurian and Peter[22] in 64 genotypes of tomato, which were grouped into 8 clusters. They reported that the distribution of genotypes from different geographical region into clusters was at random indicating that geographical isolation may not be the only factor causing genetic diversity. Among the 12 characters studied, maximum diversity (12.6 %) was contributed by locules per fruit followed by lycopene content (11.4 %) and insoluble solids (10.27 %). PH of the juice did not contribute to total diversity, whereas acidity had the lowest contribution (5.60 %). It is evident that in the selection of processing tomato line with fewer locules deserves primary attention. Similarly, Singh and Narayan[40] reported high estimates of genotypic and phenotypic coefficients of variation for plant height, fruit length, number of fruits per plant and number of branches per plant. Kohli *et al*[23]. studied genetic divergence for quantitative and qualitative traits in tomato. Maximum value of coefficient of variability was recorded for shelf life of fruits while minimum for days to first picking. In 2005, Karasawa *et al*[17]. studied genetic divergence among 70 tomato accessions by using multivariate analysis and cluster analysis. A significant variation among the accessions was recorded for total number of fruits, total fruit weight, fruit length, fruit diameter, number of days to germination, number of days to fruit set, number of flowers per inflorescence, soluble solid content, number of locules and number of days to flowering. Prashanth *et al*[32]., studied 67 tomato genotypes from different geographical origin to determine the value and magnitude of genetic divergence using Mahalanobis D2 statistics. A wide genetic diversity was observed among the genotypes which were grouped into seven clusters. Sekher *et al*[39]., assessed genetic divergence in tomato hybrids and opined that the average fruit weight and total soluble solids contributed maximum (20 %) towards genetic divergence followed by number of flowers per cluster (17.78), plant height and number of locules per fruit (13.33).

CONCLUSION

The literature reviewed in this paper highlighted the variability, heritability, genetic advance, correlation, path analysis and genetic divergence available in tomato genotypes. The studies on the extent of variability available in the germplasm offers a better opportunity to judge the scope for the selection of desirable genotypes and a subsequent estimates of heritability, genetic gain and inter relations among the different traits helps in making effective selection. However, if selection is not responsive, further, genetic divergence helps in selecting superior parents for hybridization programme resulting in better hybrids and desirable recombinants/ segregates. Hence, present investigation were planned to evaluate the introduced and available germplasm of tomato.

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