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Amrit Tamuly

Department of Plant Breeding
and Genetics, Assam
Agricultural University, Jorhat,
Assam, India

Prabalee Sarmah

Department of Plant Breeding
and Genetics, Assam
Agricultural University, Jorhat,
Assam, India

Joli Dutta

Department of Plant Pathology,
Assam Agricultural University,
Jorhat, Assam, India

Dibosh Bordoloi

Department of Plant Breeding
and Genetics, Assam
Agricultural University, Jorhat,
Assam, India

Shyamal Kumar Phukon

Department of Tea Husbandry
and Technology, Assam
Agricultural University, Jorhat,
Assam, India

Syed Wasifur Rahman

Department of Biotechnology,
Assam Agricultural University,
Jorhat, Assam, India

Palash Thengal

Department of Nematology,
Assam Agricultural University,
Jorhat, Assam, India

Milon Jyoti Konwar

Department of Agronomy,
Assam Agricultural University,
Jorhat, Assam, India

Correspondence**Amrit Tamuly**

Department of Plant Breeding
and Genetics, Assam
Agricultural University, Jorhat,
Assam, India

Study on correlation and path coefficient analysis among inter-specific crosses of *Solanum lycopersicum* L. and *Solanum pimpinellifolium*

Amrit Tamuly, Prabalee Sarmah, Joli Dutta, Dibosh Bordoloi, Shyamal Kumar Phukon, Syed Wasifur Rahman, Palash Thengal and Milon Jyoti Konwar

Abstract

The tomato *Solanum* species which includes the cultivated tomato *Solanum lycopersicum* L., and more than 10 related wild species, belongs to the family Solanaceae. Varieties under *Solanum lycopersicum* L. are poor in adaptability and other characteristics due to their narrow genetic base. *Solanum pimpinellifolium*, a closely related species of *Solanum lycopersicum* L., harbours a number of quality traits and yield attributes not present in our cultivated tomatoes. Parents for the inter-specific hybridization with *S. pimpinellifolium* carried out during Rabi 2014-15 comprised of six tomato varieties of *S. lycopersicum*. The parents as well as the inter-specific hybrids were evaluated for fruit quality and yield attributes in the field condition during Rabi 2015-16. All the varieties were cross compatible with *Solanum pimpinellifolium*. Yield per plant was positively correlated with fruit length and fruit breadth. Path analysis at genotypic level revealed that harvest duration followed by primary branches, fruit weight, and number of fruits per cluster exhibited maximum direct effect on fruit yield per plant

Keywords: wild, inter-specific, hybridization, compatible, cluster

Introduction

Cultivated tomato *Solanum lycopersicum* L., (formerly *Lycopersicon esculentum*, Miller), belongs to the family Solanaceae. The tomato *Solanum* species (*Solanum* subsection *Lycopersicon*) include the cultivated tomato, and more than 10 related wild species. It has a diploid genome with 12 pairs of chromosomes and a genome size of 950 Mb (Michaelson *et al.*, 1991). Varieties under the species *lycopersicum* are annual, typically day neutral and self pollinated. It contains abundant and well balanced nutrients consisting of vitamins (A,B,C), minerals, dietary fibres and lycopene (Toor *et al.*, 2006) [15].

Peru Ecuador region is considered as the centre of origin of tomato (Rick, 1969). India stands second in the production of tomato with 168.3 lakh MT production in an area of 8.6 lakh ha and with a productivity of 19.5MT/ha (Anonymous, 2011) [1]. The productivity in India as compared to China is very low. In Assam, its production account for 3.87 lakh tonnes sharing 2.30% of India's tomato production during 2010-11 (Anonymous, 2011) [1].

Species under the genus *Solanum* has both determinate and indeterminate growth. The wild species of tomato bear a wealth of genetic variability for morphological and biologically important characteristics. The wild species have been used for the improvement of simply inherited traits such as vertical disease resistance. The transfer of desirable genes from wild species into elite breeding lines should be associated with the elimination of undesirable exotic genes while maintaining and selecting for desirable characteristics. *Solanum pimpinellifolium*, a closely related species of *Solanum lycopersicum* L., harbours a number of quality traits and yield attributes not present in our cultivated tomatoes. In addition to resistance to various biotic (Foolad *et al.*, 2002; Foolad, 2005 and 2006) [8, 4, 6] and abiotic stresses (Foolad, 2004 and 2005) [3, 4]. *S. pimpinellifolium* also harbours other desirable yield attributing traits like clustering property of the fruits, high number of fruits per plant and other desirable quality traits (Foolad, 2007) [5] which has the potential to contribute to the improvement of the cultivars when combined with large sized fruits with high total solids from other elite cultivars. Hybrids between tomato and its close relative *S. pimpinellifolium* have been reported to behave cytologically like intra-specific tomato hybrids, suggesting little chromosomal differentiation

between these species. Because of the close phylogenetic relationships between the two species, there is little or no difficulty in initial crosses or in subsequent generations of prebreeding and breeding activities. The studies on the correlation of these traits with various yield attributes in the interspecific hybrids between *Solanum lycopersicum* L. and *S. pimpinellifolium* will help to broaden the genetic base of the cultivated varieties. Attempting inter-specific as well as reciprocal crosses will help to understand the success of the interspecific crosses as well as the maternal influence of the traits under consideration. The study of correlation of characters will help in simultaneous selection for more than one character. As yield is dependent on many component characters; the total correlation is insufficient to explain the true association between characters. So, it would be desirable to consider the relative magnitude of various characters. Correlation studies helps in formulating an efficient breeding program for improving the yield potential via its components (Frageria and Kokli, 1997) ^[9]. The technique of path coefficient analysis developed by Wright (1921) and demonstrated by Dewey and Lu (1959) ^[2] helps in separating direct and indirect contribution of various traits towards yield. Therefore, path coefficient analysis is an effective tool to aid correlation studies (Islam and Khan, 1991; Mc Giffen *et al.*, 1994) ^[10, 12].

Materials and methods

The present investigation was carried out in the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat. Geographically, it is located at 26°47'N latitude and 94°12'E longitude, having an elevation of 86.6 m above the mean sea level. The topography of the land was uniform. The soil of the experimental field was old alluvial sandy loam with pH 5.8.

Parents for the investigation comprised of six tomato varieties of *Solanum lycopersicum* and *Solanum pimpinellifolium*. The name and few characteristics of the varieties used in the experiment are presented in Table 1. Crosses of the *Solanum lycopersicum* varieties were made with *Solanum pimpinellifolium* and the parents as well as the inter-specific hybrids were evaluated for fruit quality and yield attributes in the field condition. The genotypes were sown at the Experimental Farm, Department of Horticulture, AAU, Jorhat for consecutive two seasons 2014-15 and 2015-16. In the first year of the investigation (Rabi 2014-15), the seeds of the six varieties of tomato (Arka Alok, Arka Abha, H-24, Punjab Chuhara, ARTH 2808, Singhimari local) along with *Solanum pimpinellifolium* were sown in raised nursery bed of 3m x 1.5m and 4- week-old seedlings were planted in a crossing block with spacing 60 X 50cm. The six varieties of tomato were crossed with *Solanum pimpinellifolium* as the pollen parent. The reciprocal crosses of these tomato varieties were made with *S. pimpinellifolium* as the seed parent (Table 2). In Rabi 2015-16, the parents and inter specific hybrids were evaluated in Randomized Block Design with 3 replications at Experimental Farm. Evaluation for the morpho-physiological characters of the parents and their inter-specific hybrids were made.

Results and Discussion

Fruit yield is a complex character and is the end product of various traits. A few of the component traits may be directly and positively associated with fruit yield and often prove to be useful selection criteria for crop improvement. Thus, knowledge regarding the association of fruit yield with its

component characters is valuable for understanding the correlated response to selection. Yield being a complex character is dependent upon a number of components. Knowledge on character association between yield and yield components will serve to identify characters for selection. In the present study, yield per se is not effective for inter-specific crosses when the cross exhibits the wild parent characteristics. So, selection of parents and promising crosses should be made based on yield attributing traits rather than concentrating only on the yield. Correlation coefficients of fruit yield with yield attributing characters and also among yield attributing characters are presented in Table 3.

In the present study, yield per plant was positively and significantly correlated with fruit length and fruit diameter and negatively correlated with days to 50% flowering and number of fruits per plant at both phenotypic and genotypic levels. A positive correlation of fruit yield per plant with fruit length and fruit diameter had also been reported by Rakesh *et al.* (2014) and Madhurina *et al.* (2012) ^[13] in tomato. In order to select high yielding tomato cultivars and to increase yield per plant, fruit length and fruit diameter should be taken into consideration. There was also significant negative genotypic correlation of number of fruits per plant, days to 50% flowering and plant height with fruit yield. This may be justified from the fact that inter-specific crosses yield very high number of small sized and light weight fruits which contributes less to yield. This character was inherited from the wild parent *Solanum pimpinellifolium*. The results of the correlation studies justified the need of path coefficient analysis so as to formulate a causal relationship facilitating determination of direct and indirect effects of the contributing characters towards fruit yield per plant.

Fruit yield is an ultimate product of interaction among its component traits under the influence of environment. These traits have indirect effect towards fruit yield apart from their direct contribution. Therefore, in addition to determining the inter relationship among the yield components on one hand and between yield and its component on the other, it is necessary to understand their direct and indirect effect on yield. Sometimes, contribution of a component showing high significant association with yield may get diluted through the interaction with other components. In inter-specific crosses the direct effect of many characters on yield may not be high if the cross exhibits the characteristics of the wild parent. In that case, selection via indirect effect of characters may be useful criteria for the improvement of tomatoes.

Path analysis provides an effective means of partitioning direct and indirect causes of association. It permits a critical examination of the specific forces to produce a given correlation. It also measures the relative importance of each causal factor and gives information for proper application in breeding programme. Path analysis at genotypic level revealed that harvest duration had the maximum positive direct effect on fruit yield per plant followed by number of primary branches, fruit weight, days of first picking and number of fruits per cluster respectively, while plant height had the maximum negative direct effect on fruit yield per plant followed by number of fruits per plant, fruit length, fruit diameter and days to 50% flowering respectively. To understand the cause effect relationship between yield attributes and fruit yield, path coefficient analysis was performed at genotypic levels are presented in Table 4.

Path analysis revealed that fruit length and fruit diameter both exhibit high positive direct effect on fruit yield per plant. Fruit length and fruit diameter also exhibited significant correlation

with fruit yield per plant both at phenotypic and genotypic levels. Thus could be considered as the most potent character contributing towards increasing fruit yield per plant and deserve top most priority for inclusion as selection criteria for improvement of tomato genotypes.

Conclusion

Among all the varieties (parents) used in the present investigation, bidirectional cross compatibility of *Solanum pimpinellifolium* was observed with Arka Abha, Arka Alok, H-24, Punjab Chuhara and ARTH 2808. All the crosses showed semi-determinate growth habits and good clustering habits of fruits. However, high negative correlation of fruits per plant and fruits per cluster with yield seems to be due to the fact that inter-specific crosses bore large number of plum sized fruits with less weight which resulted in low yield as a whole. So, selection criteria for inter-specific cross combination and parent's selection will deviate from those applied for inter-varietal cross combinations. Selection in inter-specific cross studies would be better if based on yield contributing characters rather than yield itself.

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