Genetic evaluation of different varieties of tomato (Solanum lycopersicum L.) under Prayagraj agro-climatic conditions

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Abstract
A field experiment was conducted during August to December 2019 at the Horticulture Research Farm, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology & Sciences, Prayagraj to study the “Genetic evaluation of different varieties of Tomato (Solanum lycopersicum L.) under Prayagraj Agro-climatic conditions”. The experiment was conducted in Complete Randomized Block Design having 15 various Varieties/Treatments in three replications. The allocation of treatments of the individual plots using random number in each replication. The plant height ranged from 92.98 to 177.46 cm. The minimum plant height (92.98 cm) was recorded in Pusa Hybrid (F1) which was significantly over all other treatments. Based on the results obtained, Days for 50 per cent flowering (31.92 days), maximum number of Fruit setting (66.18), maximum number of Cluster’s per plant (5.36) and maximum number of Fruits per plant (29.47) and maximum TSS (Brix) is (4.48) and maximum value of Ascorbic acid and acidity is (23.94) (0.214) and maximum fruit yield per hectare (17.42 ton/ha).

Keywords: Tomato genotypes, genetic variability, heritability, correlation, randomized block design

1. Introduction
Botanically, Tomato belongs to the genus Solanum and species Lycopersicum, which is further divided into two sub-families Solanoideae and Cestoidean. The Tomato S. lycopersicum L. 2n=2x=24. The Tomato is also known as the Wolf peach and Love of Apple is one of the most important vegetable in the world. It is a perennial herbaceous crop of the family Solanaceae. The primary center of Lycopersicum species is in the Andes Mountains in Peru- Ecuador-Bolivia region and eastern Andes is secondary region. Tomato is a warm season crop and both self- & cross-pollinated crop which is harvested at different stages of maturity depending upon the distance of the market and their utilization and consumed fresh or preserved through canning.

India ranks second world wide shares 8.6% of vegetable production. Agriculture and allied sectors accounted for 15.0% of the GDP in 2010 (Economic Survey of India, 2011). In India vegetables are grown in 7.96 million hectares with a production of 133.70 million tones with climatic conditions. The experiment was conducted in Prayagraj agro-climatic conditions. The experiment was conducted in Prayagraj agro-climatic conditions.

2. Objectives
- To find out the most suitable genotypes for fruit yield and quality of tomato.
- To access the qualitative and quantitative attributes of tomato.
- Estimation of genetic variability, heritability, genetic diversity for yield and its component characters in tomato.
- To study the correlation and estimate the direct and indirect effects of various yield components of tomato genotypes.
3. Materials and Methods

3.1 Experimental site
The experiment was conducted at Vegetable Research Farm, Department of Horticulture, Naini, Agricultural Institute, Sam Higgin bottom University of Agriculture, Technology & Sciences, PRAYAGRAJ (UP) during 2019-2020. All the facilities necessary for cultivation, including labor were made available in the department.

3.2 Experimental Material
The experimental plot was ploughed twice, harrowed and planked to remove weeds and crush the clods. Then it was made into required size plots and leveled after incorporation of FYM at the rate of 25 tons/ha. Then the individual plots of scheduled size are laid out as per the plan design (R.B.D) with intermittent bunds and irrigation channels. The spacing maintained between rows was 45 cm and between plants was 30 cm.

3.3 Seeds of tomato of different varieties are:

i. Arka Rakshak (F1 hybrid)
ii. Arka Sourabh
iii. Arka Vikas
iv. Arka Alok
v. Arka Meghali
vi. Kashi Abhiman (F1 hybrid)
vn. Kashi Anupam
vii. Kashi Vishesh
vii. Kashi Aman
ix. Kashi Adarsh
x. Pusa hybrid-4
xii. Pusa Ruby
xiv. Pusa Rohini
xv. P.K.M-1.

4. Results and Discussion’s
The experiment results of the present investigation entitled “Genetic evaluation of different varieties of Tomato (Solanum lycopersicum L.) under Prayagraj Agro climatic conditions” have been presented and the result obtained for genotypic and phenotypic coefficient of variation, heritability in broad sense, genetic advance, advance, genetic advance, genetic as percent of mean, correlation coefficient Genetic diversity (D2) analysis of these traits with yield have been discussed in light of research work reported with suitable cause of and effect reasoning.

4.1 Analysis of variance
Analysis of variance showed significant differences among the genotypes for the 15 characters studied. Analysis of variance showed significant difference among the genotypes for the different characters at 0.1% and 1% significance. The mean sum of squares due to genotype for different characters are presented in (Table 4.1).

4.2 Mean performance of the genotypes
The mean of the different traits for 15 genotypes of tomato have been presented in Table 4.2.

4.2.1 Plant height (cm)
The character plant height exhibited a wide range of variation 92.98 to 177.46 with a grand mean of 133.194. The highest plant height of genotype Arka Meghali (177.46). While lowest plant height was observed for Pusa Hybrid (F1) (92.98).

4.2.2 Number of primary branches
The character number of primary branches exhibited a wide range of variation 11.00 to 19.23 with a grand mean of 16.63. The highest number of primary branches of genotype Arka Meghali (19.23). While lowest number of primary branches was observed for PKM-1 (11.00).

4.2.3 Number of primary branches
The character number of primary branches exhibited a wide range of variation 11.00 to 19.23 with a grand mean of 16.63. The highest number of primary branches of genotype Arka Meghali (19.23). While lowest number of primary branches was observed for PKM-1 (11.00).

4.2.4 Days to first flowering
The character days to first flowering exhibited a wide range of variation 21.69 to 28.37 with a grand mean of (23.69). The highest days to first flowering Pusa Ruby (28.37). While lowest days to first flowering was observed for Arka Meghali (21.69).

4.2.5 Days to 50% flowering
The character days to 50% flowering exhibited a wide range of variation 29.44 to 33.74 with a grand mean of 31.92. The highest days to 50% flowering of genotype Kashi Abhiman (F1) (33.74). While lowest days to 50% flowering was observed for Arka Meghali (29.44).

4.2.6 Days to fruit setting
The character days to fruit setting exhibited a wide range of variation 52.20 to 72.66 with a grand mean of 66.18. The highest days to fruit setting of genotypes Arka Vikas (72.66). While lowest days to fruit setting was observed for Kashi Adarsh (52.20).

4.2.7 No. of fruit per cluster
The character no. of fruit per cluster exhibited a wide range of variation 10.53 to 18.78 with a grand mean of 12.56. The highest no. of fruit per cluster of genotypes Arka Meghali (18.78). While lowest no. of fruit per cluster was observed for PKM-1 (10.53).

4.2.8 No. of cluster per plant
The character No. of cluster per plant exhibited a wide range of variation 4.37 to 6.66 with a grand mean of 5.36. The highest No. of cluster per plant of genotypes Arka Meghali (6.66). While lowest No. of cluster per plant was observed for Pusa Ruby (4.37).

4.2.9 No. of fruit per plant
The character No. of fruit per plant exhibited a wide range of variation 19.12 to 42.94 with a grand mean of 29.47. The highest No. of fruit per plant of genotypes Arka Meghali (42.94). While lowest No. of fruit per plant was observed for Kashi Amrit (19.12).

4.2.10 Fruit set per cluster
The character fruit set per cluster exhibited a wide range of variation 3.92 to 6.24 with a grand mean of 5.43. The highest fruit set per cluster of genotypes Arka Meghali and Kashi Anupam (6.24). While lowest fruit set per cluster was observed for Kashi Amrit (3.92).
4.2.11. Fruit weight (gm)
The character fruit weight (gm) exhibited a wide range of variation 54.23 to 81.37 with a grand mean of 63.55. The highest fruit weight (gm) of genotypes Arka Meghali (81.37). While lowest fruit weight (gm) was observed for Pusa Ruby (54.23).

4.2.12 TSS (0Brix)
The character TSS (0Brix) exhibited a wide range of variation 3.81 to 5.05 with a grand mean of 4.48. The highest TSS (0Brix) of genotypes Arka Meghali (5.05). While lowest TSS (0Brix) was observed for Pusa Ruby (3.81).

4.2.13 Ascorbic acid
The character ascorbic acid exhibited a wide range of variation 20.05 to 26.29 with a grand mean of 23.94. The highest ascorbic acid of genotypes Arka Rakshak (F1) (26.29). While lowest ascorbic acid was observed for Kashi Amrit (20.05).

4.2.14 Acidity
The character acidity exhibited a wide range of variation 0.150 to 0.253 with a grand mean of 0.214. The highest acidity of genotypes Pusa Rohini (0.253). While lowest acidity was observed for Arka Rakshak (0.150).

4.2.15 Fruit yield per plot
The character fruit yield per plot exhibited a wide range of variation 10.60 to 32.58 with a grand mean of 17.41. The highest fruit yield per plot of genotypes Arka Meghali (32.58). While lowest fruit yield per plot was observed for Kashi Amrit (10.60).

4.2.16. Fruit yield per plant
The character fruit yield plant exhibited a wide range of variation 1.17 to 3.62 with a grand mean of 1.935. The highest total fruit yield plant of genotypes Arka Meghali (3.62). While lowest fruit yield plant was observed for Kashi Amrit (1.17).

Table 1: Analysis of variance for 15 characters in tomato genotypes

| Sl. No | Source of variation / characters | Replication D.f=2 | Treatments D.f=14 | Error D.f=28 |
|--------|---------------------------------|-------------------|-------------------|-------------|
| 01     | Plant height (cm)               | 280.286           | 2038.61**         | 970.57      |
| 02     | Number of primary branches per plant | 2.862           | 11.09**           | 4.59        |
| 03     | Days to first flowering         | 5.47              | 12.59**           | 4.59        |
| 04     | Days to 50% flowering           | 9.4               | 4.22**            | 1.782       |
| 05     | Days to fruit setting           | 38.42             | 66.280**          | 27.50       |
| 06     | No. of flowering per cluster    | 3.14              | 16.90**           | 13.45       |
| 07     | No. of cluster per plant        | 0.778             | 1.61**            | 0.757       |
| 08     | No. of fruit per plant          | 31.75             | 115.78**          | 69.79       |
| 09     | Fruit set per cluster           | 0.664             | 1.058**           | 0.955       |
| 10     | Fruit weight                    | 5.989             | 139.98**          | 90.42       |
| 11     | TSS                             | 0.228             | 0.342**           | 0.232       |
| 12     | Ascorbic acid                   | 1.34              | 7.52**            | 4.88        |
| 13     | Acidity                         | 0.001             | 0.0024**          | 0.0017      |
| 14     | Fruit yield per plot (kg)       | 18.88             | 96.80**           | 57.92       |
| 15     | Fruit yield per plant (kg)      | 0.233             | 1.195**           | 0.715       |

* Significant at 1%, ** Significant at 0.1%

Table 2: Mean performance of different genotypes various character

| Genotypes           | Plant height (cm) | Number of primary branches | Days to first flowering | Days to 50% flowering | Days to first flowering | No. of fruit per Cluster | No. of Cluster per Plant | No. of Fruit per Plant |
|---------------------|-------------------|----------------------------|-------------------------|------------------------|-------------------------|---------------------------|--------------------------|------------------------|
| Arka Rakshak(F1)    | 149.227           | 18.813                     | 22.510                  | 31.063                 | 69.600                  | 13.720                    | 6.539                    | 37.939                 |
| Arka Sourabh        | 119.760           | 17.520                     | 24.420                  | 32.260                 | 68.800                  | 11.070                    | 6.393                    | 34.731                 |
| Arka Vikas          | 113.683           | 16.667                     | 24.583                  | 33.417                 | 72.667                  | 10.767                    | 5.493                    | 27.285                 |
| Arka Alok           | 135.825           | 15.667                     | 24.187                  | 32.950                 | 67.867                  | 13.503                    | 4.970                    | 24.407                 |
| Arka Meghali        | 177.467           | 19.233                     | 21.693                  | 29.443                 | 61.200                  | 18.783                    | 6.663                    | 42.942                 |
| Kashi Abhiman(F1)   | 149.800           | 15.933                     | 22.150                  | 33.747                 | 65.733                  | 10.910                    | 5.040                    | 28.377                 |
| Kashi Amrit         | 157.493           | 16.467                     | 23.367                  | 31.720                 | 65.267                  | 12.243                    | 4.817                    | 19.124                 |
| Kashi Vishesh       | 116.403           | 18.677                     | 21.717                  | 31.637                 | 67.400                  | 16.480                    | 5.977                    | 31.622                 |
| Kashi Anupam        | 147.083           | 17.000                     | 22.563                  | 30.497                 | 68.067                  | 10.877                    | 5.109                    | 30.832                 |
| Kashi Aman          | 156.200           | 16.773                     | 22.210                  | 31.827                 | 64.400                  | 12.343                    | 5.147                    | 30.459                 |
| Kashi Adarsh        | 137.013           | 17.217                     | 22.608                  | 30.803                 | 52.200                  | 12.323                    | 5.623                    | 33.165                 |
| Pusa Hybrid(F1)     | 92.983            | 15.800                     | 25.620                  | 32.657                 | 67.000                  | 10.560                    | 4.832                    | 27.571                 |
| Pusa Ruby           | 95.693            | 15.733                     | 28.377                  | 32.570                 | 65.133                  | 10.940                    | 4.375                    | 22.264                 |
| Pusa Rohini         | 153.570           | 16.950                     | 22.193                  | 31.253                 | 67.733                  | 13.350                    | 5.127                    | 28.478                 |
| P.K.M-1             | 95.710            | 11.000                     | 27.280                  | 33.063                 | 69.667                  | 10.533                    | 4.395                    | 22.901                 |
| Mean                | 133.194           | 16.630                     | 23.699                  | 31.927                 | 66.182                  | 12.560                    | 5.367                    | 29.473                 |
| C.V.                | 23.390            | 12.892                     | 9.048                   | 4.182                  | 7.925                   | 29.205                    | 16.214                   | 28.347                 |
| F ratio             | 2.100             | 2.413                      | 2.379                   | 2.373                  | 2.410                   | 1.256                     | 2.127                    | 1.659                  |
| F Prob.             | 0.046             | 0.023                      | 0.011                   | 0.025                  | 0.023                   | 0.293                     | 0.043                    | 0.124                  |
| Genotypes          | Fruit set/ Cluster | Fruit weight (g) | TSS (0Brix) | Ascorbic acid | Acidity | Fruit yield per Plot | Fruit yield per plant |
|--------------------|--------------------|------------------|-------------|---------------|---------|----------------------|----------------------|
| Kashi Anupam(F1)   | 5.770              | 71.355           | 4.810       | 26.297        | 0.150   | 24.993               | 2.777                |
| Arka Sourabh       | 5.393              | 66.505           | 4.363       | 25.033        | 0.183   | 21.327               | 2.370                |
| Arka Vikas         | 4.963              | 61.890           | 4.373       | 22.643        | 0.177   | 15.218               | 1.691                |
| Arka Alok          | 4.893              | 65.483           | 4.303       | 22.683        | 0.202   | 14.325               | 1.592                |
| Arka Meghali       | 6.243              | 81.370           | 5.050       | 26.200        | 0.227   | 32.585               | 3.621                |
| Kashi Abhiman(F1)  | 5.660              | 66.970           | 4.253       | 23.327        | 0.203   | 17.175               | 1.908                |
| Kashi Anand        | 3.927              | 62.493           | 4.387       | 20.053        | 0.200   | 10.602               | 1.178                |
| Kashish Vishesh    | 5.180              | 57.937           | 5.040       | 24.357        | 0.233   | 18.299               | 2.033                |
| Kashi Anupam       | 6.240              | 58.200           | 4.553       | 25.007        | 0.213   | 16.123               | 1.791                |
| Kashi Aman         | 5.893              | 65.720           | 4.510       | 24.617        | 0.230   | 18.228               | 2.025                |
| Kashi Adarsh       | 5.887              | 62.327           | 4.620       | 23.743        | 0.220   | 18.764               | 2.085                |
| Pusa Hybrid(F1)    | 5.657              | 54.513           | 4.413       | 23.743        | 0.250   | 13.665               | 1.518                |
| Pusa Ruby          | 5.103              | 54.237           | 3.813       | 22.763        | 0.223   | 10.870               | 1.208                |
| Pusa Rohini        | 5.487              | 64.237           | 4.730       | 25.060        | 0.253   | 16.771               | 1.864                |
| P.K.M-1            | 5.227              | 60.150           | 4.037       | 23.707        | 0.247   | 12.335               | 1.371                |
| Mean               | 5.435              | 63.559           | 4.484       | 23.949        | 0.214   | 17.419               | 1.935                |
| C.V.               | 17.984             | 14.961           | 10.748      | 9.226         | 0.197   | 43.693               | 43.693               |
| F ratio            | 1.108              | 1.548            | 1.474       | 1.542         | 1.398   | 1.671                | 1.671                |
| F Prob.            | 0.393              | 0.158            | 0.185       | 0.160         | 0.218   | 0.120                | 0.120                |
| S.E.               | 0.564              | 5.490            | 0.278       | 1.276         | 0.024   | 4.394                | 0.488                |
| C.D. 5%            | -                  | -                | -           | -             | -       | -                   | -                    |
| C.D. 1%            | -                  | -                | -           | -             | -       | -                   | -                    |
| Range Lowest       | 3.927              | 54.237           | 3.813       | 20.053        | 0.150   | 10.602               | 1.178                |
| Range Highest      | 6.243              | 81.370           | 5.050       | 26.297        | 0.253   | 32.585               | 3.621                |

Table 2(a): Mean performance of different genotypes various character

**Conclusion**

On the basis of per se performance of 15 genotypes of Tomato, Arka Meghali (32.58 and 3.62) genotypes was found superior in terms of fruit yield per plot and plant. Large amount of variability existed in the genotypes for selection. Significant differences were recorded for all the characters. Like qualitative and quantitative character. However, since this is based on one-year experiment, further trials may be needed to substantiate the results.

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