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Study of the trait and fourth cumulants of tomato (*Lycopersicon esculentum* Mill.) population to detect additive epistasis and identify the nature of gene interaction

K. RAJAGURU, A. SADASAKTHI AND **M.N. KARTHIK**

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See end of the article for authors' affiliations

Correspondence to :

M.N. KARTHIK
Department of Horticulture, Agricultural College and Research Institute (T.N.A.U.), MADURAI (T.N.) INDIA

ABSTRACT

Genetic studies were done in tomato and parameters such as skewness and kurtosis were statistically analyzed for yield and physiological traits. Studies on skewness and kurtosis revealed that additive epistasis was present for number of fruits per plant, number of primary branches per plant and single fruit weight in cross III, cross IV and cross V. Studies on the nature of gene interaction are undoubtedly needed to increase the efficiency of selection and breeding programme.

Key words : Skewness, Kurtosis, Additive epistasis, F_2 generation

Tomato (*Lycopersicon esculentum* Mill.) is one of the important vegetable grown through out the world including tropical, sub tropical and temperate regions. Tomato begins its colourful and varied history in the entire globe. It occupies the top ranking in acceptance by every human race. It is a good source of vitamin A (320 IU per100 g), vitamin C (31 mg per 100 g) and minerals (680 mg per 100 g). It tops the list of industrial crops because of its outstanding processing qualities. Tomatoes are mainly used as a food ingredient. The fruits are consumed raw, cooked or processed as juice, ketchup, sauce, paste, puree etc.

A study was undertaken utilizing the intervarietal crosses of tomato (*Lycopersicon esculentum* Mill.) to select superior crosses and promising segregants in F_2 generation with the objectives to study the trait and fourth cumulants of tomato population to detect additive epistasis and identify the nature of gene interaction.

MATERIALS AND METHODS

The present study on tomato (*Lycopersicon esculentum* Mill.) was carried out at the Agricultural College and Research Institute, Madurai during 2005-2006 involving F_2 generation of six intervarietal crosses, with an aim to select the best crosses / families and promising progenies in each cross, for yield and physiological characters.

The experimental materials included were six crosses of F_2 *viz.*, P_3 x P_4 (CO 3 x Arka Meghali), P_3 x P_6 (CO 3 x CLN 1462 AG),P_4 x P_6 (Arka Meghali x CLN 1462 AG), P_4 x P_5 (Arka Meghali x Paiyur 1), P_4 x P_8 (Arka Meghali x H 24), P_5 x P_8 (Paiyur 1 x H 24) involving five parents *viz.,* P_3 (CO 3), P_4 (Arka Meghali), P_5 (Paiyur 1), P_6 (CLN 1462 AG) and P_8 (H 24). The selfed seeds of F_1 generation from the previous study conducted by Rahul Marik (2005) were used for raising the F_2 progenies.

Study of F_2 generation:

The F_2 generation was raised during June-October, 2005. A total of two hundred and fifty plants of each cross were maintained in all the six crosses. Forty plants in each of five parents involved in the above crosses were also maintained. The progenies were evaluated for eleven characters on single plant basis for yield and physiological contributions.

Selfing:

The selected F_2 progenies were selfed with an idea of forwarding them to the next generation. Care was taken to maintain a healthy crop by adopting all the recommended cultural practices. Observations were recorded on single plant basis in F_2 populations on plant height, number of primary branches per plant, number of fruits per plant, single fruit weight, fruit yield per plant, flowering duration and physiological characters *viz.*, style length, chlorophyll stability index, root length, dry matter accumulation, root/shoot ratio.

Skewness and kurtosis:

Formula by Choo and Rein berg (1994) was used

for estimating cumulants K_2, K_3, K_4 from 'n' samples of population. The sampling standard errors (SE) of g_1 and g_2 calculated using formula as suggested by Fisher (1950)

RESULTS AND DISCUSSION

The findings of the present study as well as relevant discussion have been summarized under following heads

Skewness (g_1) and kurtosis (g_2):

The non-normality of any distribution is measured by its skewness and kurtosis. These are called third and fourth degree statistic, respectively. The skewness (g_1) takes positive or negative sign according to whether there is an excess of individual low values close to mean with fewer higher values spread for above it or the reverse. In other words, the curve has a longer tail on the right side or the curve is more elongated to the left side.Karl Pearson's co efficient of skewness (g_1) measures the direction and the extent to which is to be distorted from symmetrical distribution.

Fourth degree statistic, kurtosis (g_2) is a stastical measurement of the relative peakedness (or flatness) of a distribution arrived by ($g_2 - 3$). When $g_2 = 3$ the curve shows normal distribution. When, the curve is more peaked than normal distribution then g_2 will greater than 3 and g_2- 3 will be positive and the curve is called leptokurtic. When the curve flatter than the bell shaped normal curve its g_2 will be less than 3 *i.e.*, g_2 - 3 will be negative and the curve is called platykurtic.

The present study material derived from a half-diallel experiment conducted by Rahul marik during 2005. In this experiment both additive and additive x additive genetic variances were estimated. When a significant amount of additive x additive genetic variance was found, one cannot study further the nature of gene interaction. Therefore, measures identifying nature of gene interaction should be useful. The graphical analysis could be used to detect interaction but several assumptions should be met in order to interpret the results of analysis correctly. Further more duplicate interaction is difficult to detect by graphical analysis (Mather, 1967).

In the present investigation the first fourth cumulants are used to detect additive epistasis and to identify the nature of gene interaction. Cumulants are very useful for assisting in the description of a distribution. The first cumulant (K_1), the mean (X) specifies where the distribution is center; the second cumulant (K_2), the variance (σ^2) describes the degree of concentration of a distribution above mean; the third cumulant, skewness (K_3) describes the degree of a departure of a distribution from symmetry; the fourth cumulant, kurtosis (K_4) describes the peakedness of a distribution. For a normal distribution $K_1 = X$; $K_2 = \sigma^2$; $K_3 = 0$; $K_4 = 0$

Table 1 : The coefficients of skewness (g_1) and kurtosis (g_2) of number of fruits per plant, number of primary branches per plant, single fruit weight and dry matter accumulation in tomato

Cross	Sample size	g_1	g_2
Number of fruits per plant			
$P_3 \times P_4$	10	-0.490	3.35*
$P_3 \times P_6$	10	-0.255	3.88*
$P_4 \times P_6$	10	0.376	0.258
$P_4 \times P_5$	10	0.334	2.10
$P_4 \times P_8$	10	0.524	1.74
$P_5 \times P_8$	10	-0.115	3.88*
Number of primary branches per plant			
$P_3 \times P_4$	10	-0.506	4.63**
$P_3 \times P_6$	10	-0.518	3.66*
$P_4 \times P_6$	10	0.245	24.85**
$P_4 \times P_5$	10	0.248	3.67*
$P_4 \times P_8$	10	0.027	-0.013
$P_5 \times P_8$	10	0.67	4.08*
Single fruit weight			
$P_3 \times P_4$	10	0.541	3.71*
$P_3 \times P_6$	10	-0.563	4.97**
$P_4 \times P_6$	10	0.312	2.21
$P_4 \times P_5$	10	0.016	1.73
$P_4 \times P_8$	10	0.332	2.06
$P_5 \times P_8$	10	-0.963	4.64**
Dry matter accumulation			
$P_3 \times P_4$	10	0.023	2.78
$P_3 \times P_6$	10	-0.013	2.76
$P_4 \times P_6$	10	-0.369	-8.22**
$P_4 \times P_5$	10	-0.006	2.94
$P_4 \times P_8$	10	-0.154	2.02
$P_5 \times P_8$	10	0.207	1.92

* and ** indicate significance of values at P=0.05 and 0.01, respectively

The coefficient of skewness for number of fruits per plant, number of primary branches per plant, single fruit weight and dry matter accumulation exhibited in all the six crosses were not significantly different from zero, indicating that additive epistasis appears to be absent. This conclusion is further substantiated by a non significant co efficient of kurtosis in cross III, IV and V for number of fruits per plant; for number of primary branches per plant in cross V; for single fruit weight in cross III, IV and V; for dry matter accumulation except in cross III all the remaining showed non significant co efficient of kurtosis.

Average complementary interaction was noticed for

number of fruits per plant in cross III, IV and V; for number of primary branches per plant in cross III, IV, V and VI; for single fruit weight in cross I, III, IV and V and for dry matter accumulation in cross I and VI. The value smaller than zero indicated the presence of duplicate gene interaction for number of fruits per plant in cross I, II and VI; for number of primary branches per plant in cross I and II ; for single fruit weight in cross II and VI and for dry matter accumulation in cross II, III, IV and V.

The fourth cumulant for dry matter accumulation in cross III was near zero indicating absence of gene interaction. However, the positive values of K_4 except for number of primary branches per plant in cross V and for dry matter accumulation in cross III suggested presence of gene interaction.

From fore going discussion it could be noticed that additive epistasis was present for number of fruits per plant, number of primary branches per plant and single fruit weight in cross III, IV and V. Studies on the amount, on the nature of gene interaction are undoubtedly needed to increase the efficiency of selection and breeding programme. If additive epistatic variance is indeed more important than breeding strategies aimed at fully utilizing additive epistasis, selection intensity would be higher under complementary than under duplication.

Conclusion:

From the studies on skewness and kurtosis it was concluded that the skewness had non significant value for all the selected four traits. For kurtosis, the cross P_3 x P_4 (Co 3 x Arka Meghali) and P_3 x P_6 (Co 3 x CLN 1462 AG) registered positive and signicant values of number of fruits per plant. For number of primary branches per plant except the cross P_4 x P_8 (Arka Meghali x H 24) all other crosses accounted positive and significant values. Whereas single fruit weight registered positive and significant value in the cross P_3 x P_4 (Co 3 x Arka Meghali), P_3 x P_6 (Co 3 x CLN 1462 AG) and P_5 x P_8 (Paiyur 1 x H 24). For dry matter accumulation the cross P_4 x P_6 (Arka Meghali x CLN 1462 AG) alone registered negative and significant value but other crosses were positive and non significant.

Authors' affiliations:
K. RAJAGURU AND A. SADASAKTHI, Department of Horticulture, Agricultural College and Research Institute (T.N.A.U.), MADURAI (T.N.) INDIA

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