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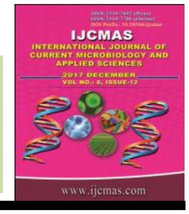

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Estimation of Heritability and Correlation for Fruit Yield and Traits Related to WUE in F_4 Generation of the Inter-Specific Cross EC 771612 × LA 2657 in Tomato

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A B S T R A C T

Study on genetic parameters in F_4 segregating population of the cross EC 771612 × LA 2657 during Rabi 2016 for fruit yield and its attributing traits was conducted in augmented design. Results obtained Analysis of variance indicates the presence of significant variability for all the characters among F_4 segregants which indicates the presence of sufficient variability. Hence the population was used estimation of variability parameters and correlation. Wider range has been observed for all the characters among the F_4 segregants which imply the presence of higher phenotypic variability. Further high GCV and PCV coupled with narrow difference between PCV and GCV were found for fruits per plant, fruit diameter, plant height, clusters per plant and fruit yield per plant indicating less environmental influence on expression of characters therefore individual plant selection can be followed for improvement of these characters. High heritability coupled with high genetic advancement as a *per cent* of mean was observed for fruits per plant, fruit diameter, plant height, and clusters per plant and fruit yield indicating the involvement of additive gene action for expression of these traits in crosses studied. Characters like fruits per plant, plant height, fruits per clusters, clusters per plant and fruit diameter shown the presence positive significant association with fruit yield among F_4 segregants which implies that fruit yield per plant could be improved up on improving some of the traits like fruits per plant, plant height, fruits per clusters, clusters per plant and fruit diameter

Introduction

Tomato (*Solanum lycopersicun*), belonging to family *solanaceae* is one of the most important vegetable crop in the world pertaining to nutrition, health and is an important source of sugars, vitamins, minerals and antioxidant compounds (Raiola *et al.*, 2014). Tomato ranks third in priority after potato and onion in India but ranks second after potato in the world where India stands second in terms of area and production. Total area harvested under tomato is 47, 25,417 thousand hectares (ha) with a production of 16, 39, 63,770 thousand metric tons and with productivity of 34.698 metric tons/ha in the year of 2013 (FAOSTAT, 2015).

In Karnataka, total area under tomato is 61.4 thousand ha with a production of 2,068.38 thousand metric tons with a productivity of 33.9 metric tons/ha (Indian Horticultural Database, 2014). Climate change worldwide is regarded as one of the greatest challenges for future food production. With climate change, the importance of drought in conjunction with high temperature and radiation has immensely increased. It is broadly accepted that breeding for drought tolerance has proven to be difficult due to very complex and till date sometimes poorly understood tolerance mechanisms (Van Bueren *et al.,* 2011).

Crop productivity and water availability are interdependent when water becomes limiting, crop yields are also reduced. Global climate change is influencing rainfall patterns, plant transpiration rates, and agricultural productivity (Walthall *et al.,* 2012), (Foolad *et al.,* 2003; Nahar and Ullah, 2011, 2012).

Traits that accurately quantify and reflect a plant's ability to perform under water stress are essential for effective crop breeding efforts (Richards, 2006; Tuberosa, 2012). Water-use efficiency (WUE) determines plant growth habits in water-limiting environments (Comstock *et al.,* 2005; Xu *et al.,* 2008). However, it is difficult to measure WUE rapidly therefore, surrogate traits are often taken into consideration which includes $\Delta^{13}C$, SPAD chlorophyll meter readings (SCMR) and Specific leaf area (SLA = leaf area/dry leaf mass) (Comstock *et al.,* 2005; Chen *et al.,* 2013; Martin *et al.,* 1999; Tuberosa, 2012). $\Delta^{13}C$ is negatively correlated with WUE (Farquhar and Richards, 1984).

High SLA has been reported to be associated with water-hungry plant growth (Deines *et al.,* 2011).

SPAD chlorophyll meter readings (SCMR) and Specific leaf area (SLA) and have early been reported as important surrogate traits for tolerance to drought in groundnut (Rao *et al.,* 2001; Leal-Bertioli *et al.,* 2012; Janila *et al.,* 2015, Xiong *et al.,* 2015).

Materials and Methods

For developing superior segregants for fruit pod yield with high water use efficiency the germplasm lines EC 771612 (*Solanum lycopersicum*) which is a high fruit yielding with drought susceptible and LA 2657 (*Solanum penellii*) an accession line which is low yielding but drought tolerant were selected from one hundred tomato germplasm accessions which were screened for drought stress in *rabi* 2015 in two separate experiments, one under well watered and second under water stress condition.

Water stress was imposed at 60days after transplanting in stress plot for 20 days and the well water condition experiment was given drip irrigation twice a week. Hybridization was made between these two contrasting germplasm lines to develop F_1 hybrid, selfing upon these hybrids was made to get F_2 plants and all F_2 plants were forwarded to get F_3 progenies. These F_3 progenies were subsequently forwarded to raise F_4 generation.

As a procedure of plant to row progeny method 90 F_4 superior segregants along with parents and checks were sown during *Rabi* 2016 in augmented design. Entire design was divided into five blocks and in each blocks parents and checks were replicated thrice to minimize environmental error.

All recommended agronomic practices and plant protection measures were followed during the crop growth period to ensure proper growth and good yield. The observations were recorded for all the plants.

Observations for individual plants was recorded for both WUE and fruit yield traits that includes Days to flowering (DFF), SPAD chlorophyll meter reading (SCMR), Specific leaf area (SLA), plant height (PH, cm), branches *per* plant, fruits *per* cluster (FRPP), clusters *per* plant (CPP), average fruit weight (AFW, g), fruit number *per* plant (FRT No.) and fruit yield *per* plant (Yld, g).

The genotypic and phenotypic co-efficient of variations was computed as suggested by Robinson *et al.,* (1949). Heritability and genetic advance were worked out as per the method outlined by Hanson *et al.*, (1956).Correlation co-efficient of each character between two generations was found out by calculating the phenotypic correlation coefficient exactly as described under taking the same character in both the generations.

Results and Discussion

Analysis of variance in F_4 segregating population of the cross EC 771612 × LA 2657 revealed significant differences (Table 1) among the lines for all the characters. Further, segregating progenies and checks also recorded presence of high variability for all the characters, which indicating the presence of enormous genetic variability and the choice of the material for the investigation is appropriate.

Genetic variability parameters

Data presented in the table 2 indicates the presence of wide range of the characters studied which implies availability of a higher magnitude of variability among the segregating population which is further confirmed by the presence of higher PCV and GCV for all the traits, therefore influence of environment on the expression of these characters is low.

High heritability coupled with high GAM was noticed for all the characters which implies that involvement of additive gene action on the expression of fruit yield and its attributes. Therefore individual plant selection for these traits could be practiced for selection of superior segregants from the F_4 generation.

Correlation of fruit yield per plant with growth parameters, traits related to WUE and yield component characters

Phenotypic correlation coefficients studies revealed that (Table 3) fruit yield per plant exhibited strong positive correlation with fruits per plant, clusters per plant, fruits per cluster, plant height and SCMR is indicating that improvement of above mentioned traits indirectly leads to improvement in fruit yield coupled with water use efficiency.

Significant negative association of fruit yield per plant with SLA was observed indicating that negative relationship of fruit yield per plant with SLA. Therefore selection plants which produce lower SLA and higher fruit yield would leads to development of superior segregants for high yielding and water use efficient in a single selection programme.

Comparison of correlation, regression and heritability among the F_4 segregants for traits related to fruit yield and WUE

Data presented in the table 4 indicates the presence of significant positive correlation coupled with high positive regression of fruit yield per plant with plant height, SCMR, clusters per plant, fruits per clusters, fruits per plant and average fruit yield.

High heritability with narrow range of above mentioned traits indicates the involvement of additive gene action on the expression of these traits.

Table.1 Analysis of variance of yield and yield related traits in F_4 segregeting population of the inter-specific cross EC-771612 x LA-2657 in Tomato

Source of variation	Df	Plant height (cm)	No Branches /plant	SCMR	SLA (cm^2g^{-1})	Clusters/ plant	Fruits/ cluster (FRPP)	No. of Fruits/ plant	Fruits yield/ plant (g)	Average fruit weight (g)
Block (eliminating Check+Var3.)		6.082	0.062	1.823	26.943**	0.063	0.250	25.016**	2.595	0.000
Entries (ignoring Blocks)	91	248.370**	4.695*	28.939**	1131.953**	36.514**	2.495**	2369.422**	6687.66**	1.059 **
Checks	3	36.417*	2.729*	138.149**	964.45**	17.229*	3.083**	67.000**	472.37**	0.206*
Varieties	87	187.586**	4.778**	25.702**	665.384**	37.185**	1.683*	2455.915**	6967.25**	0.998 **
Checks vs. Varieties	1	6172.449**	3.308	233.86**	523.68**	36.000**	71.336**	1751.750**	1009.12**	8.930 **
ERROR	9	8.028	1.229	1.418	1.926	2.729	0.417	0.661	13.40	0.048

Note: * Probability @ 0.05 ** Probability @0.01

Table.2 Estimation of genetic variability for yield and yield related traits in F_4 segregeting population of the inter-specific cross EC-771612 x LA-2657 in Tomato

Characters	Mean	Range	Max	Min	PCV (%)	GCV (%)	$h^2_{(bs)}$ (%)	GAM
Plant height (cm)	79.69	53.00	53.00	106.00	64.24	56.21	95.11	30.26
No Branches/plant	6.73	12.00	15.00	3.00	14.31	13.08	71.53	44.97
SCMR	42.76	55.45	61.23	22.50	10.003	9.664	90.25	20.21
SLA (cm^2g^{-1})	38.69	46.32	49.58	28.74	15.42	17.33	96.68	33.18
Clusters/plant	12.57	46.00	50.00	4.00	32.70	29.97	91.66	84.23
No. of Fruits/ clusters (FRPP)	4.82	7.00	9.00	2.00	11.51	11.10	72.56	35.62
No. of Fruits/ plant	63.63	442.00	453..00	11.00	36.73	36.07	99.80	145.61
Fruits yield/ plant (g)	143.27	511.70	545.64	33.94	63.25	49.84	98.70	112.75
Average fruit weight (AFW) (g)	2.22	3.79	4.83	1.04	10.26	8.26	80.50	77.65

Table.3 Correlation coefficient for yield and yield related traits in F_4 segregating population of the inter-specific cross EC-771612 x LA-2657 in Tomato

Characters	Plant height (cm)	Branches/ plant	SLA (cm^2g^{-1})	SCMR	Clusters/ plant	Fruits/ clusters	Fruits/ plant	Fruits yield/ plant (g)	Average fruit weight(g)
Plant height (cm)	1.00	0.04	-0.069	0.244*	0.12	0.32*	0.17	0.11	0.52**
No Branches/ plant		1.00	-0.022	0.266**	0.18	0.60**	0.13	0.64**	0.10
SLA (cm^2g^{-1})									
SCMR									
Clusters/plant					1.00	0.21*	0.88**	0.65**	0.26*
No. of Fruits/ clusters						1.00	0.59**	0.75**	0.16
No. of Fruits/ plant							1.00	0.84**	0.23*
Fruits yield/ plant (g)								1.00	0.36**
Average fruit weight (AFW) (g)									1.00

Table.4 Comparison of correlation regression and heritability for traits related to fruit yield and WUE in F_4 segregating population of the inter-specific cross EC-771612 x LA-2657 in Tomato

Characters	Correlation (r-value)	Regression (b-value)	Heritability $h^2_{(bs)}$ (%)	Range
Plant height (cm)	0.52**	0.66	95.11	53.00
No Branches/ plant	0.10	0.32	71.53	12.00
SLA (cm^2g^{-1})	-0.44**	-0.36	85.23	46.32
SCMR	0.52**	0.57	78.45	55.45
Clusters/plant	0.26*	0.44	91.66	46.00
No. of Fruits/ clusters	0.16	0.36	72.56	7.00
Fruits/ plant	0.23*	0.78	99.80	42.00
No. of Fruits yield/ plant (g)	0.40**	0.65	98.75	511.70
Average fruit weight (g)	0.36**	0.68	80.50	3.79

Further positive correlation coupled with high regression concludes the improvement of above mentioned traits would lead to improvement of fruit yield coupled with high water use efficiency. Hence these traits can be used as preferential criteria for selection of superior segregants for high fruit yield and high water use efficiency in a single breeding programme.

Selected superior segregants in F_4 segregating generations in the cross EC 771612 × LA 2657 of tomato

Top high fruit yielding progenies were selected from F_4 segregating population and they also recorded more number of fruits per plant, more number of clusters per plant, taller plant and higher SCMR value coupled with higher fruit yield over parents and checks. Further these selected superior progenies from F_4 generation are still segregating for many loci hence some more generation need to be selfed to achieve complete homozygosity for all loci before predicting their performance either for station trial or multi location trail.

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