

COMBINING ABILITY OF YIELD RELATED TRAITS AND GENE INTERACTION ON IN TOMATO (*Lycopersicon esculentum* Mill.) IN YOLA.

ABSTRACT

Field experiments ~~was were~~ conducted to estimate the combining ability and nature of gene action governing inheritance of characters in tomato (*Lycopersicon esculentum* Mill.) ~~under high temperature stress. The experiment was conducted~~ at the Teaching and Research Farm of Department of Crop Production and Horticulture Modibbo Adama University of Technology, Yola. (latitude 9° 18' N and long 12° 15' E) and the Teaching and Research Farm of Adamawa State University, Mubi. (latitude 10° 03' N and long. 13° 07' E) ~~all in Adamawa state of~~ Nigeria. Fourteen entries consisting of six parents and eight crosses developed by crossing two males (testers) and four females (lines) following line x tester design were evaluated in three replications in a Randomized Complete Block Design (RCBD) in two locations. Ten plants were randomly sampled for ~~recorded recording~~ observations. Data were collected from the following characters; Trichom ~~connt~~, plant height at 60DAT, number of leaves per plant at 60DAT, number of fruits per plant, weight of fruits per plant, % damaged fruits and number of days to final harvest. ~~Data were subjected to biometrical analysis.~~ Results of the analysis of variance indicated highly significant difference for all characters among entries except weight of fruits per plant. The results suggested the presence of genetic variability among the tomato genotypes under study. Significant difference were observed in the combining ability analysis of variance in all the agronomic characters under study except for trichome count suggesting both additive and non-additive genetic effects were important in governing ~~this~~ characters under study with more preponderance of additive effects. The cultivars, Cherry, Currant, UC28B, and RomaVF were identified as the best general combiners and the best yielders in ~~terms of number of fruits per plant~~ with appreciable tolerance to heat damage.

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key words: combining ability, gene action, inheritance and Tomato.

INTRODUCTION

Tomato (*Lycopersicon esculentum* mill) is an important and widely grown vegetable around the world and belong to the family of solanaceae. It ranks second, only after potato. According to Singh *et al.* (2011) tomato is referred as a “poor man’s orange” because of its attractive appearance and nutritive value. Cox (2000) said that tomato diversified first in peru, Mexico where it was domesticated from its ancestor *lycopersicon cerasiforme*. According to Cameroon (2009) world production of tomato is about 130million metric tones of fresh tomato from an estimated 4.7 million hectares of land. China, the largest producer

accounted for about one quarter of the global output, followed by united state and turkey. India stands fourth position in tomato producing countries of the world. In Nigeria, tomato is mostly produced in the Northern parts of the country in places such as Borno, Kano, Sokoto, Bauchi, Gombe and Adamawa states. F-A-O (2010) reported that about 1.4 million metric tones of tomato fruits were produced from 224,000 hectares of land in Nigeria in 2009. The crop is mainly produced during the dry season, facilitated by -irrigation. The inability of most tomato (*lycopersicosn esculentum* mill) cultivars to set fruit under high night and day temperatures has been a limiting factor for tomato production in the tropical and sub-tropical areas of the world. Although Ahmad (2002), reported that tomato plants Can be grown under a wide rang of climatic conditions, they are extremely sensitive to hot and wet conditions. El-Ahmadi (1979) also said that fruit setting in tomato is interrupted at temperature above 26°C and 20°C day/night and is often completely arrested at temperature above 38/27°C day/night. Tomato production in Nigeria is constrained by high temperature and relative humidity limiting it production to the short harmatan period. Therefore, it is difficult to advocate eradication of heat and the only way is to concentrate on the development of varieties that are tolerant to heat. Considering the spectrum of aforesaid requirements in tomato, the present investigation is done to estimate the combining ability and nature of gene action governing inheritance of characters in tomato under high temperature stress.

MATERIALS AND METHOD

The genetic materials used for the study consist of 6-six parents and 8-eight crossed seeds, aggregate of 14 entries generated during 2013 cropping season. These were evaluated in a Randomized Complete Block Design (RCBD) in two locations, Yola and -Mubi locations 0f of Adamawa State, Nigeria. The crossing nursery was established in June to October 2013 at the teaching and research Farm-farm of the Department of Crop Production and Horticulture Modibbo Adama University of Technology, Yola. After normal land preparation, 8-eight beds of 2m x 2m each waswere made. Each bed was planted with four stands of testers and 12 stands of lines. Giving-giving a total of 16 plants per bed. Crosses were made between the four exotic breeding lines (Roma VF, UC28B GoldenRoma and RioGrande) and the two non-commercially cultivated heat tolerant cultivars as testers (Cherry and Currant) thereby generating 8-eight crosses. These crosses were made by emasculating the flowers of the lines by removal of the anther from the female plants in the evening. Emasculatation involved selecting of flowers that was just about to show yellow color:- The anther cone was carefully

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removed making sure the stigma and style do not break, leaving intact the sepals, pistil and the pedicel parts. One day before maturation of the anthers, tomatoes are ready for pollination at this stage. The resultant F_1 progenies along with six parental cultivars making 14 genotypes were evaluated at both Yola and Mubi locations of Adamawa State during the dry season of 2013/ 2014 in a Randomized Complete Block Design (R.C.B.D) with three replications.

RESULTS AND DISCUSSIONS

Results of Mean-squares from the general analysis of variance for 8 characters in tomato combined across locations as presented in (Table 1) indicates that, there was no significant difference among the locations for all characters measured except for percentage damaged fruits. Highly significant difference was observed for all characters among the entries except for weight of fruits per plant. Similar results were also observed for parents and for crosses. The location by entries variance was noticed to be high for plant height at 60 days after transplanting as well as percentage of damaged fruits, number of flower cluster and number of days to final harvest. It is also clear that location by parents interaction was highly significant in characters such as plant height at 60 days after transplanting, percentage of damaged fruit, number of flower cluster, number of fruits per plant and number of days to final harvest. With regards to location by crosses, all characters showed highly significant differences except for number of trichome. Similar results were also observed for parents by crosses. The GCA variance were highly significant in characters such as plant height at 60 days after transplanting, number of leaves at 60 days after transplanting, number of fruit per plant and number of flower cluster. However, SCA variance showed significant differences for all characters except number of flower cluster, trichome count and number of days to final harvest. The GCA / SCA variance ratios were less than unity with respect to trichome count and number of fruits per plant. While, it was positive and greater or equal to unity for all the remaining characters. Highly significant difference observed in the mean squares for location among the genotypes for percentage of damaged fruits is an indication that performance of the entries differs in difference locations in terms of temperature stress. Highly significant difference observed in the mean squares for parents and for crosses for all character except weight of fruits per plant indicates the existence of genetic variability between the parents and their respective crosses implying that the materials could be used for varietal improvement or could respond to selection pressure. This is in accordance with Falconer (1981) that the amount of improvement that is

obtained by selection among a number of cross is dependent on the level of genetic variance between the crosses and the intensity of selection applied. Highly significant mean squares for location and entries interaction noticed on most characters further, suggested that difference genotypes used in this study, behaved differently in the respective locations with respect to agronomic characters such as plant height at 60 days after transplanting, number of flower cluster percentage damaged fruits and number of days to final harvest. Highly significant differences observed in all characters except trichome count for location x crosses and parents x crosses interaction had also suggested that the genotypes used in this study performed differently in different locations. This is similar to the report of Hannan and Kulkarni (1998) on tomato. They found significant difference in genotypes by environmental interaction for number of fruits damaged by heat. They stated that genotypes and environmental effect is important for heat tolerance in tomato. This finding suggested that more than one test environment might be needed to obtain reliable information on the characters among the parents and crosses. This is also similar to the report of Kenga *et al.* (2004). Significant differences observed in the general combining ability (GCA) variances in all the agronomic characters under study except trichome count indicates the importance of additive gene actions in governing characters in tomato. This is in accordance with the report of Ghosh and Syamal (1993). The significant difference observed in the specific combining ability in most characters under study except trichome count and number of days to final harvest indicate the importance of non-additive gene action in controlling these characters in tomato. ~~Less than unity~~ The GCA:SCA ratio less than unity observed with respect to for number of fruits per plant and trichome count suggests the preponderance of non-additive component of variances in the control of these characters, this also conformed to the findings of Rao (1978) in number of fruits per plant. Greater than unity ~~GCA:SCA ratio observed in~~ most characters indicates additive gene actions while unity ratio observed in characters such as number of leaves at 60 days after transplanting and number of flower cluster indicates these characters are controlled by both gene actions.

The estimate of general combining ability effects of parents combined across locations for all the characters studied are presented in Table 2. The result revealed that ~~the parent C~~urrent was the ~~highest-best~~ general combiner, because it showed significant positive GCA effects with respect to all the characters except percentage of damaged fruits where negative values are preferable. Cherry, the second ~~high-best~~ general combiner had significant positive GCA effects in all characters studied except weight of fruits per plant. This genotype however,

recorded negative GCA effects for percentage of damaged fruits. Among the lines, Romavf RomaVF is the best general combiner, because it recorded positive GCA effects for plant height, number of leaves at 60 days after transplanting, number of fruits per plant, number of flower clusters and high negative GCA effect for number of days to final harvest which shows earliness. It was closely followed by UC28B as it has high positive GCA effects for number of leaves at 60 days after transplanting, number of fruits per plant and number of flower clusters. It also recorded high negative GCA effect with respect to percentage of damaged fruits. The remaining lines are the least general combiners because they have low GCA effects. In the present study cherry, currant, UC28 and Romavf-RomaVF has been identified as the best general combiners for all agronomic characters under study. The positive general combining ability shown by these genotypes for all characters under study except for percentage damaged fruits where negative is preferable, indicated that these genotypes are good testers and lines that had shown superiority of their hybrids where they are both used as parents or one of the parent. The negative general combining ability (GCA) shown by these genotypes in case of percentage of damaged fruits is an indication of tolerance to heat damage. The parent with good general combining ability (GCA) also exhibited good per se performance. This is true with respect to cherry Cherry, Currant, UC28B and Romavf-RomaVF for all characters under study. This suggested that combining ability of parent used in this study can be judge accurately by their per se performance. Similar results were reported by Dhaliwal *et al* (2000) in brinjal. Low gca effect was recorded for all characters under study except for percentage damaged fruits for the lines Golden Roma and RioGrande indicating that their hybrids performed below average. The high positive general combining ability (GCA) for percentage damaged fruits indicated their high level of susceptibility to heat. Ajjappalavara and Dharmatt (2008); noticed—reported that the segregation of population to the inheritance of heat tolerance was 3 (tolerance): 1 (susceptible) ratio and suggested single gene inheritance for heat tolerance. Hannan *et al.* (2007) and Signh *et al.* (2011) had also observed some tomato genotypes with good general combining ability in-for number of flower clusters, plant height at 60 days after transplanting and number of fruits per plant.

Specific combining ability effects for-theof eight hybrids; for the-eight characters studied across locations are presented in Table 3+. Four hybrids showed positive SCA effects for plant height, while others showed negative SCA effects. Among these hybrids Currant x UC28B showed the highest positive SCA effects for plant height and was followed by

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Currant x RioGrande. Currant x Golden Roma recorded the highest positive SCA effects for weight of fruits per plant, while least positive SCA effect was shown by Currant x RioGrande. In terms of number of leaves at 60 DAT, Currant x GoldenRoma recorded the highest SCA value while the lowest was shown by Currant x UC28B. Five hybrids exhibited positive SCA values for number of fruits per plant. Among these are Cherry x GoldenRoma which recorded the highest SCA value and the lowest was recorded by Currant x RioGrande. Three hybrids exhibited significant positive SCA Values for number of flower cluster while four hybrids showed negative. Among the significant positive SCA values, Currant x GoldenRoma registered the highest values closely followed by Cherry x GoldenRoma and Cherry x UC28B, had the lowest. Four hybrids showed negative SCA values for % damaged fruits. Among these, Cherry x RioGrande recorded the highest negative value closely followed by Currant x ~~Romavf-RomaVF~~ while Currant x UC28B and Cherry x Golden Roma recorded the lowest negative SCA values for percentage damage fruits. Negative SCA values were shown by three hybrids for number of days to final harvest. Among these, Currant x ~~Romavf-RomaVF~~ exhibited the highest negative SCA values followed by Currant, UC28B and Cherry x RioGrande had the lowest negative SCA values with respect to number of days to final harvest. Other hybrids recorded moderate positive SCA values with respect to this same character. Estimates of specific combining ability effects are usually used to identify the best hybrids. However, specific combining ability (SCA) effects are reported not to contribute much to the improvement of self-pollinated crops (Hannan *et al.* 2007). Hannan *et al.* (2007) and Griffings (1956); stated that the crosses showing desirable specific combining ability could be utilized in breeding programs, such programs would be more effective if one of the parents is a good combiner and the other one is poor combiner. In such a situation, they are expected to produce desirable transgressive segregantes if the additive genetic system in the good combiner and complementary epistatic effect act in the same direction as to increase desirable genes of interest. The present study however revealed that the best hybrids in terms of SCA effects involved at least one of the high general combiners namely; currant, cherry, UC28B, and ~~RomavfRomaVF~~. However, poor general combiners such as GoldenRoma and RioGrande gave good hybrids when they were crossed with high general combiners such as observed from cherry x GoldenRoma for number of fruit per plant, number of flower clusters and percentage damaged fruits respectively. Similar results on SCA obtained by Kadam (2000) on wheat population Kenga *et al.* (2004) on grain sorghum and Bello (2010) on malting sorghum showed that inter-crossing of such materials could generate a large gene pool which could break linked gene through mass selection. Crosses with good specific

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combining ability estimate were equally having parents with good mean performance in most cases, for one character or the other. Crosses such as ~~currant-Currant~~ x GoldenRoma and Cherry x GoldenRoma in terms of number of flower cluster and percentage damaged fruits

Conclusion

This study had widely evaluated and established important genetic information in tomato based on the existence of genetic variability among the tomato genotypes under consideration. Genotypes such as Cherry, Currant and ~~Romavf-RomaVF~~ and UC28B are genotypes that had registered high performance in all the characters under consideration. The testers, Cherry and Currant showed greater performance in terms of yield ~~and heat tolerance~~ are not commercially acceptable due to their small fruited sizes. However, lines such as UC28B, RomaVF and are good commercially acceptable genotypes, farmers can depend for commercial cultivation. Furthermore, segregates such as cherry x UC28B, Currant x UC28B and cherry x ~~Romavf-RomaVF~~ are identified as desirable direction for development of agronomically acceptable tomatoes through back crossing.

Table 1: ~~Mean square from the a~~Analysis of variance for ~~8-eight~~ characters in tomato ~~combined~~ across locations.

Source of Variation	DF	Plant height at 60 DAT (cm)	Weight of fruits Per plant (kg)	Number of leaves at 60 DAT	Number of fruits per plant	Number of flower cluster	Trichome count	Percentage damaged fruits	Number of days to final harvest
Location	1	178.06NS	73.90NS	180.07NS	183.01NS	92.68NS	4.10NS	668.83*	2.09NS
Rep x location	3	875.32**	108.21NS	210.16	158.43	26.90	1.63NS	78.45NS	0.44NS
Entries	1	684.84**	6.82NS	1466.26**	17663.55**	352.54**	4.326**	601.12**	
Parents	5	1351.13**	9.83NS	1562.33**	25936.31*	324.41*	6.56**	438.21*	498.23**

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Crosses	7	322.34*	4.08 NS	1455.39**	12744.25*	380.12*	3.00**	173.51*	544.64**
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NS = not significant

* = Significant at 0.05 Probability

** = Significant at 0.01 Probability

DAT=Days after ~~Transplanting~~
Transplanting

Table 2: Estimates of general combining ability effects of parents for height characters measured on tomato combined across locations

Parents	Plant height at 60 DAT (cm)	Weight of fruits Per plant (kg)	Number of leaves at 60 DAT	Number of fruits per plant	Number of flower cluster	Trichome count	Percentage damaged fruits	Number of days to final harvest
Testers								
Cherry	9.44**	0.65	11.98**	17.02*	5.50**	0.45	- 0.81	15.62**
Currant	9.55**	0.92*	11.18**	17.27*	5.03**	0.42	- 1.35	13.80*
S.E. ±	3.28	0.86	3.45	10.44	1.42	0.18	1.11	1.48
Lines								
UC28B	0.41	0.13	3.86	16.30*	1.22*	0.18	- 1.23	0.04
;gtf	1.24*	0.02	5.69	11.61	2.25*	0.05	- 0.81	- 4.71
Roma VF								
Golden	1.30*	- 0.25	- 4.03	- 13.73	- 3.45**	- 0.16	0.22	2.71
Roma								
Rio	2.06*	0.26	- 7.93	- 23.84*	- 2.53**	- 0.38	3.54	- 4.04
Grande								
S.E ±	1.29	2.11	8.6	15.12	1.11	2.00	5.00	6.21

* = Significantly different at 5% level of probability

Table 3: Estimates of specific combining ability (SCA) effects of hybrids for agronomic characters in tomato combined across locations.

	Plant height at 60DAT (cm)	Weight of fruits Per plant (kg)	Number of leaves at 60 DAT	Number of fruits per plant	Number of flower cluster	Trichome count	Percentage damaged fruits	Number of days to final harvest
Cherry x UC28B	- 0.62	0.06	- 0.04	0.99	1.43*	0.10	0.12	1.95
Currant x UC28B	2.99*	- 0.06	0.11	- 0.98	- 1.42	- 0.10	- 0.12	- 1.94
Cherry x 0.02*		0.07	0.22	0.90	- 0.04	0.02	0.33	178

** = Significantly different at 1% level of probability.

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