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

ABSTRACT

Field experiments was conducted to estimate the combining ability and nature of gene action governing inheritance of characters in tomato (*Lycopersicon escullentum* 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 9^0 18^1 N and long 12^0 15^1 E) and the Teaching and Research Farm of Adamawa State University, Mubi (latitude 10^0 03^1 N and long. 13^0 07^1 E) all in Adamawa state of Nigeria. Fourteen entries consisting of six parents and eight croses 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 where randomly sampled for recorded observation. 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. Result of the analysis of variance indicated highly significant difference for all characters among entries except weight of fruits per plant. The result 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.

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

INTRODUTION

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

ne quarter of the global output, followed by united state and turkey. India stands fourth on in tomato producing countries of the world. In Nigeria, tomato is mostly produced in the orthern parts of the country in places such as Borno, Kano, Sokoto, Bauchi, Gombe and mawa 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 ing the dry season, facilitated by -irrigation. The inability of most tomato (*lycopersicosn lentum* mill) cultivars to set fruit under high night and day temperatures has been a limiting ctor for tomato production in the tropical and sub-tropical areas of the world. Although d (2002), reported that tomato plants can be grown under a wide range 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 mpletely arrested at temperature above 38/27°C day/night. Tomato production in Nigeria is onstrained by high temperature and relative humidity limiting it production to the short tan period. Therefore, it is difficult to advocate eradication of heat and the only way is to centrate 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 mperature stress.

MATERIALS AND METHOD

The genetic materials used for the study consist of 6 parents and 8 crossed seeds, aggregate of 14 entries generated during 2013 cropping season. These were evaluated in a Randomized omplete Block Design (RCBD) in two locations, Yola and Mubi locations of Adamawa . The crossing nursery was established in June to October 2013 at the teaching and research arm of the Department of Crop Production and Horticulture Modibbo Adama University of echnology, Yola. After normal land preparation, Crosses were made between the four exotic breeding lines (Roma VF, UC28B, GoldenRoma and RioGrandei) and the two non-ally cultivated heat tolerant cultivars as testers (Cherry and Currant) thereby generating 8 ses, each line was crossed with the four exotic lines to generate 8 crosses.These crosses were made by emasculating the flowers of the lines by removal of the anther from the female s in the evening. Emasculation involved selecting of flowers that was just about to show w color, The anther cone was carefully removed making sure the stigma and style do not k, leaving intact the sepals, pistilate and the pedicel parts. One day before maturation of the

Comment [Memo1]: What kind of lines and testers did you use on each bed? Why did you proceed thus?

Comment [Memo2]: Did the lines and testers used for crossing come from beds?

nthers, tomatoes are ready for pollination at this stage. The resultant $8F_1$s progenies along h six parental cultivars making 14 genotypes were evaluated on a 2m x 2m bed containing plants at both Yola and Mubi locations of Adamawa State during the dry season of 2013/ 4 in a Randomized Complete Block Design (R.C.B.D) with three replications. Each n has 14plots for each cross and parents

RESULTS AND DISCUSSIONS

Results of Mean squares from the general analysis of variance for 8 characters in to combined across locations as presented in Table1 indicates that, there was no significant fference among the locations for all characters measured except for percentage damaged s. 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 anting as well as percentage damaged fruits, number of flower cluster and number of days o 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 damaged fruit, mber 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 ance 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 wer 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 / A 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. hly significant difference observed in the mean squares for location among the genotypes for percentage damaged fruits is an indication that performance of the entries differ in difference locations in terms of temperature stress. Highly significant difference observed in the mean quares for parents and for crosses for all character except weight of fruit per plant indicates e existence of genetic variability between the parents and their respective crosses implying at the materials could be used for varietal improvement or could respond to selection . 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 he 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 haracters such as plant height at 60 days after transplanting, number of flower cluster age damaged fruits and number of days to final harvest. Highly significant differences ed in all characters except trichome count for location x crosses and parents x crosses ion had also suggested that the genotypes used in this study performed differently in different locations. This is similar to the report of Hannan and Kulkami (1998) on tomato. They found significant difference in genotypes by environmental interaction for number of fruits d 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 tain 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 g ability (GCA) variances in all the agronomic characters under study except trichome count ndicates 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 different observed in the specific combining ability in most characters under study except trichome count and ber of days to final harvest indicate the important of non-additive gene action in controlling his charactres in tomato. Less than unity GCA:SCA observed with respect to number of fruits per plant and trichome count suggest the preponderance of non-additive component of ces in the control of these characters, this also conformed to the findings of Rao (1978) in mber of fruits per plant. Greater than unity ratioobserved in most characters indicate additive gene actions while unity ratio observed in characters such as number of leaves at 60 days r 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 currant was the st general combiner, because it showed significant positive GCA effects with respect to all e characters except percentage damaged fruits where negative values are preferable. Cherry, he second high general combiner had significant positive GCA effects in all characters d except weight of fruits per plant. This genotype however, recorded negative GCA effects r percentage damaged fruits. Among the lines, Romavf is the best general combiner, because it recorded positive GCA effects for plant height, number of leaves at 60 days after ing, number of fruits per plant, number of flower clusters and high negative GCA effect for

umber 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 damaged fruits. The remaining lines are the least general combiners cause they have low GCA effects. In the present study cherry, currant, UC28 and Romavf has been identified as the best general combiners for all agronomic characters under study. The ositive general combining ability shown by these genotypes for all characters under study ept 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 d as parents or one of the parent. The negative general combining ability (GCA) shown by ese genotypes in case of percentage damaged fruits is an indication of tolerance to heat ge. The parent with good general combining ability (GCA) also exhibited good perse ance. This is true with respect to cherry, Currant, UC28B and Romavf for all characters under study. This suggested that combining ability of parent used in this study can be judge ely by their perse performance. Similar results were reported by Dhaliwal *et al* (2000) in al. Low gca was recorded for all characters under study except for percentage damaged fruits for the lines Golden Roma and RioGrandei indicating that their hybrids performed below rage. The high positive general combining ability (GCA) for percentage damaged fruits ated their high level of susceptibility to heat. Ajjappalavara and Dharmatt (2008), noticed that the segregation of population to the inheritance of heat tolerance was 3 (tolerance): 1 tible) 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 ility in number of flower clusters, plant height at 60 days after transplanting and number of uits per plant.

Specific combining ability effects for the eight hybrids, for the eight characters d across locations are presented in Table 3: Four hybrids showed positive SCA effects for nt 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 Currant x Grandei. Currant x Golden Roma recorded the highest positive SCA effects for weight of ts per plant, while least positive SCA effect was shown by Currant x RioGrandei. In terms of number of leaves at 60 DAT, Currant x GoldenRoma recorded the highest SCA value while he lowest was shown by Currant x UC28B. Five hybrids exhibited positive SCA values for umber of fruits per plant. Among these are Cherry x GoldenRoma which recorded the highest

SCA value and the lowest was recorded by Currant x RioGrandei. Three hybrids exhibited gnificant positive SCA Values for number of flower cluster while four hybrids showed ve. 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. r hybrids showed negative SCA values for % damage fruits. Among these, Cherry x dei recorded the highest negative value closely followed by Currant x Romavf while Currant x UC28B and Cherry x Golden Roma recorded the lowest negative SCA values for e damage fruits. Negative SCA values were shown by three hybrids for number of days to al harvest. Among these, Currant x Romavf exhibited the highest negative SCA values ed by Currant, UC28B and Cherry x RioGrandei had the lowest negative SCA values with pect 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 y used to identify the best hybrids. However, specific combining ability (SCA) effects are orted 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 ombining ability could be utilized in breeding programs, such programs would be more ive if one of the parents is a good combiner and the other one is poor combiner. In such a ation, they are expected to produce desirable transgressive segregates if the additive genetic ystem 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 Romavf. However, poor general combiners such as GoldenRoma and oGrandei gave good hybrids when they were crossed with high general combiners such as served from cherry x GoldenRoma for number of fruit per plant, number of flower clusters d percentage damaged fruits respectively. Similar results on SCA obtaind by Kadams (2000) on wheat population Kenga et al (2004) on grain sorghum and Bello (2010) on malting um 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 combining ability mate were equally having parents with good mean performance in most cases, for one er or the other. Crosses such as 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

ato based on the existence of genetic variability among the tomato genotypes under tion. Genotypes such as Cherry, Currant and Romavf and UC28B are genotypes that had stered high performance in all the characters under consideration. The testers, Cherry and rant showed greater performance in terms of yield and heat tolerance are not commercially ceptable due to their small fruited sizes. However, lines such as UC28B, RomaVF and are od commercially acceptable genotypes, farmers can depend for commercial cultivation. ermore, segregates such as cherry x UC28B, Currant x UC28B and cherry x Romavf are tified as desirable direction for development of agronomically acceptable tomatoes through back crossing.

Table 1: Mean square from the analysis of variance for 8 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	73.90 NS	180.07 NS	183.01 NS	92.68NS	4.10NS	668.83**	2.09 NS
Rep x location	3	875.32 **	108.21 NS	210.16	158.43	26.90	1.63 NS	78.45 NS	0.44 NS
Entries	1	684.84 **	6.82 NS	1466.26**	17663.55**	352.54 **	271.16**	601.12 **	
Parents	5	1351.13**	9.83 NS	1562.33**	25936.31**	324.41**	6.56**	438.21**	498.23**
Crosse		322.34			12744.25*		3.00**	173.51*544.64	

NS = not significant

* = Significant at 0.05 Probability

** = Significant at 0.01 Probability

DAT=DaysafterTransplanting

Table 2: Estimate of general combining ability effects of parents for 8 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 Roma	1.24*	0.02	5.69	11.61	2.25*	0.05	- 0.81	- 4.71
Golden Roma	1.30*	- 0.25	- 4.03	- 13.73	- 3.45**	- 0.16	0.22	2.71
Rio Grandei	2.06*	0.26	- 7.93	- 23.84*	- 2.53**	- 0.38	3.54	- 4.04
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: Estimate 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 B	- 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	0.07	0.22	0.90	- 0.04	0.02	0.33	178
x 0.02*							

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

References

Ahmad. S. (2002). Genetics of fruit set and related traits in tomato under hot humid conditions. Ph D thesis. Bangabandhu Sheikh Mujibur Rahman Agricultural University, Salna, Gazipur, pp1-236

Ajjapalavara, A. and Dharmatti, P.R., (2008) Varietal differences of heat tolerance tomato. *Tomato genetics cooperative report* 40:23-24.

Bello, D.,(2010). Studies on Combining ability and heterosis for *Agronomic* characters and malting Quality traits of sorghum (*Sorghum bicolor (L)* Moench). Ph.D Thesis*Federal University of Technology Yola.*

Cameron, P. J. Walker, G. P., Herman, T. J.B., and Walluce, A. R. (2009).Development of economic thresholds and monitoring systems for H. Armigera *(Lepidoptera noctudae*) in tomatoes.*Journal of economic entomology 94.pp67-89*

Cox, D.J. and Frey, K.J. (2000). Combining ability and selection of parents for interspecific tomato mating*Crop Sci* 24: 963-967

Dhaliwal, M. S., Singh, S. And Cheema D. S., (2000) Estimating combining ability effects of the genetic male sterile lines of tomato for their use in hybrid breeding. *Journal. Genet. Plant. Breeding*.,54:199-205

El-Ahmadi, A. B. And M. A. Stevens. (1979b). Genetics of high temperature fruit set in the tomato. *Journal. American. Society. Horticulture. Science.* 104:691-696

Falconer, D. S.,(1981). Introduction to quantitative genetics *2nd edition longman New York*

Food and Agriculture Organization.FAO (2010).Production year book. Series 38: Rome. 164pp

Ghosh, P. and Syamal, K., (1993) Combining ability studies with positional male sterile lines in tomato. *Journal. Maharashtra Agriculture. University.*, 13:261-262.

Griffings J. B.(1956). Concept of general and specific combining ability in relation to diallel crossing system. *Australian Journal. of Biological. Science*. 9pp 463-473.

Hannan, K., Conti, S.And Briggle, L. W., (2007).Research on heterosis and components of phenotypic variance in long fruited tomato hybrids.*Rivista Agronomica*, 8:383-391

Kadams, A.M. (2010). Genetic variability.A vital tool for crop improvement. 9th*Inaugural lecture* pp15

Kenga, R., Alabi S. O. and Gupta S. C. (2004). Combining ability studies in tropical sorghum (*Sorghum bicolor* (L.) Moench). *Field Crops Research* 88:251-260

Rao, N., Rajput, Y. S., AND Singh, A. K., (1978). Genetics divergence in tomato using non-hierarchical clustering approach. *Vegetable. Science*., 25(2):133-135

Singh B., S.K. Singh, R.K. Naresh, K.V. Singh S.K. Bantnagar and A. Kumar.(2011). l combining ability analysis of yield and its contributing traits in tomato *n esculentum* Mill). Plant Achieves volume 11(1):201-204