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Heterosis and Combining ability Studies for Sugar content in Sweet corn (*Zea mays saccharata L.*)

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Abstract- The present investigation has been undertaken in sweet corn to carry out the combining ability analysis and to estimate heterosis of yield and yield contributing characters. Eight divergent parents were selected and crossed in diallel fashion excluding reciprocals during kharif, 2010. The resulting 28 crosses along with parents and a standard check Sugar 75 and Madhuri were evaluated in Randomized Block Design replicated thrice, during rabi, 2010-11 at Agricultural Research Institute, Rajendranagar, Hyderabad. The data were collected on various agronomic characters in which emphasis was given to sugar content in the kernel in percentage. The combining ability analysis revealed importance of both additive and non-additive gene actions in governing the characters but non-additive gene action was found predominant. The parental lines 6072-3 and 6069 were contributed maximum favourable genes for character under study and can be given status of good combiners. The hybrids, 6072-3 x 6100-2, 6072-3 x 6069, 6104 x 6082 and 6127 x 6100 were the good specific combiners for sugar content in the kernel. Estimates of heterosis, heterobeltiosis and standard heterosis were variable among crosses in desirable direction and some of them turned out to be best specific crosses. The hybrids 6072-3 x 6069, 6072-3 x 6100-2, 6069 x 6122-1, 6122-1 x 6127, 6072-3 x 6127 and 6104 x 6082 performed well over standard Madhuri for sugar content in kernel. The identified four superior cross combinations (6072-3 x 6100-2, 6072-3 x 6069 and 6104 x 6082) in the present investigation, based on heterosis and combining ability, which performed well for sugar content in the kernel may be used as single cross hybrids after evaluation in multi-location trials.

Index Terms- Combining ability, Heterosis, Madhuri, Sugar content, Sugar75.

I. INTRODUCTION

Sweet corn (Zea mays L. saccharata) is one of the most popular vegetable in countries like USA and Canada. It is characterized by translucent, horny appearance of kernel when matures and wrinkled when it dries. The research reports indicate that the sweet corn has arisen as a mutant from field corn in the 19th century. Sweet corn is consumed in immature stage of the cob. Total sugar content in sweet corn at milky stage ranges from 25-30% as compared to 2-5% of normal corn.

Sweet corn varies from normal corn essentially for gene(s) that affect starch synthesis in the seed endosperm wherein one or more simple recessive alleles in the seed endosperm elevate the level of water soluble polysaccharides (sugars) and decrease starch (Dinges et al., 2001). In earlier history of sweet corn, corn lines with only the sugary (su1) allele on chromosome 4 used to be referred to as sweet corn. Currently, several endosperm genes affect carbohydrate synthesis in the endosperm are being used either singly or in combination for the development of sweet corn varieties (Tracy 1997). Four most useful mutants are shrunken2 (sh2), brittle (bt), sugary (su1) and sugary enhancer (se). Sweet corn is becoming increasingly popular in India and other Asian countries. Especially it is popular in star hotels in preparations like soups, jams. It is also consumed as raw or boiled. Sweet corn cultivation has increased in areas surrounding big towns and cities of different states of India. To establish a sound basis for any breeding programme, aimed at achieving higher yield, breeders must have information on the nature of combining ability of parents i.e., general and specific combining ability and their performance in hybrid combinations for yield and yield attributes. Keeping in view the growing importance of sweet corn in India, it is felt necessary to do research in this aspect by evaluation of germplasm and choosing elite parents for developing high potential single cross hybrids.

II. MATERIAL AND METHODS

The eight elite sweet corn inbreds were raised at Maize Research Centre, Agricultural Research Institute, Rajendranagar, Hyderabad during Kharif, 2010. All the 8 inbreds were crossed in a half diallel fashion to obtain 28 cross combinations. Reciprocal crosses were not attempted presuming that practically there are no cytoplasmic influences in the material concerned. Evaluation of single cross hybrids, parents and check was done in Rabi, 2010-11 at Maize Research Centre, Agricultural Research Institute, Rajendranagar, Hyderabad. The observations were recorded for various characters in which emphasis was given mainly on Sugar content in seed at milky stage (%).

For combining ability studies the data obtained from F1s and parents were analyzed as per Method II (F1s + parents) and Model -I (fixed effect) of Griffing (1956) for combining ability.

Estimates of heterosis were calculated according to Fonseca and Patterson (1968) and Standard heterosis according to Virmani et al. (1982). The significance of heterosis, was tested by using‘t’ test.

III. RESULTS AND DISCUSSION

The data were recorded for sugar content in the kernel. Studies on heterosis, heterobeltiosis, standard heterosis and combining ability effects were carried out in the present investigation for 8 inbreds and their 28 hybrids for sugar content in grains. The data was analyzed using diallel mating design for precise estimation of gene action.

Combining ability analysis:

The mean sum of squares of gca and sca was found to be significant for the character studied that means considerable variation was present in the material studied. The ratio of gca to sca for sugar content in the kernel was less than one which indicates that all these characters were predominantly governed by non-additive gene effects (Table 1).

In sweet corn, findings of Has (2007), Zhao YuanZeng et al. (2002) and Jyothi Kumari et al. (2008) revealed the primary role of non-additive gene action in respect of total soluble sugar content in kernel and kernel chemical composition. The relative importance and combined effect of additive and non-additive gene actions was reported for sugar content in sweet corn kernel. Considering the sugar content in the kernel for selecting the parents, 6069 and 6072-3 inbred lines were considered as good general combiner for sugar content. Hence, these parents may be inter crossed to pool the genes in desirable direction to improve sugar content in the kernel. The general combining ability (gca) effects for sugar content in the kernel in percentage was estimated and was presented in Table 2.

In case of specific combining ability among the cross combinations, 6072-3 x 6100-2, 6072-3 x 6069, 6104 x 6082 and 6127 x 6100 were considered as good specific combiners for sugar content in the kernel suggesting the scope of genetic improvement of kernel sugar concentration (non-additive gene action) independent of grain yield. Asbish Khanduri et al. (2010), Zhao YuanZeng et al. (2002), Bordallo et al. (2005) observed predominant role of specific combining ability for sugar content and carbohydrate accumulation pattern in kernel.

Hence, these high sugar yielding hybrids with good attributes can be checked under different field trials and can be developed as commercial hybrids. The results on specific combining ability (sca) effects of 28 hybrids studied in present analysis were presented in Table 3.

Heterosis:

Heterosis was estimated for sugar content in the kernel in 28 hybrids and expressed as increase or decrease over mid parental value (heterosis), over better parent (heterobeltiosis) and over standard checks (standard heterosis). Standard heterosis for grain sugar composition was studied over the standard check i.e. Sugar 75. The results of heterosis, heterobeltiosis and standard heterosis were presented in the Table 4.

The cross combinations, 6072-3 x 6069, 6072-3 x 6100-2, and 6069 x 6122-1 recorded significant positive values for sugar content in the kernel, when compared to standard check (Sugar 75). Heterotic crosses for sugar content had also been reported by Zhao YuanZeng et al. (2002), Qi Xin et al. (2008), Asbish Khanduri et al. (2010).

Considering the overall perusal of results in the present investigation, high general combining ability effects for sugar content in the kernel was noticed in the inbred lines 6069 and 6072-3. The cross combinations 6072-3 x 6100-2, 6072-3 x 6069, 6069 x 6122-1, 6122-1 x 6127 and 6104 x 6082 were found to be superior specific combiners for sugar content and have potential application in the crop improvement programmes.

The combining ability effects and heterosis revealed the superiority of the cross combinations (6072-3 x 6100-2, 6072-3 x 6069 and 6104 x 6082) for sugar content in the kernel. These crosses may be advanced for isolation of transgressive segregants or homozygous lines for use in breeding programmes.

REFERENCES

[1] Asbish Khanduri, B. M. Prasanna, Firoz Hossain and P. C. Lakhera, "Genetic analyses and association studies of yield components and kernel sugar concentration in sweet corn". Indian Journal of Genetics and Plant Breeding. 2010. 70:3, 257-263. 17ref.

[2] Bordallo, M. G. Pereira , A.T. Amaral Junior and A.P.C. Gabriel, "Diallel analysis of sweet and regular corn genotypes for agronomic characters and total protein content". Horticultura Brasileira. 2005. 23-1: 123-127. 17ref.

[3] C.D. Boyer, Shannon, J. C, "The use of endosperm genes for sweet corn improvement". In.Janic J (Ed) Plant Breeding Reviews (Vol 1), John Wiley and Sons, Inc. 1984.193-161.

[4] J. R. Dinges, , C. Colleoni, A. M. Myers, and M. G. James, "Molecular structure of three mutations at the maize sugary 1 locus and their allele specific phenotypic effects". Plant Physiol. 2001. 125: 1406-1418.

[5] S. Fonesca, and F. L. Patterson, "Hybrid vigour in a seven parent diallel cross in common wheat (Triticum aestivum L.)". Crop Science. 1968. 8: 85-88.

[6] B. Griffing, "Concepts of general and specific combining ability in relation to diallel crossing system". Australian Journal of Biological Sciences. 1956. 9: 463-493.

[7] V. Has, 2007. "Genetic analysis of some yield and kernel quality in sweet corn". Natural Products II. 437-452. 35ref.

[8] Jyothi kumari., R. N. Gadag, and G. K. Jha, "Combining ability and heterosis in field x sweet corn hybrids using line by tester mating design". Indian Journal of Agricultural Sciences. 2008. 78 (3): 261-264.

[9] A. K. Nagda, R. B. Dubey, and N. K. Pandiya, "Heterosis and combining ability for grain ability and its components in maize (Zea mays L.)". Crop Research. 1995. 10: 297-301.

[10] Qi Xin., Quan JiBin., Jiang Shuo. and Wang YuLan, "Breeding report of super sweet corn hybrid "Jitian 9". Journal of Jilin Agricultural University. 2008. 30:6, 774-775, 778. 8ref.

[11] F. Rodrigues, R. H. Pinho, C. J. B. Albuquerque, E. M. Faria Filho, and J de C. Goulart, "Combining ability of inbred lines of sweet corn". Bragantia. 2009. 68:1, 75-84. 18ref.

[12] W. F. Tracy, "History, genetics and breeding of supersweet (shrunken2) sweet corn". In: Janic J (Ed) Plant Breeding Reviews. 1997. (Vol 14), John Wiley and Sons, Inc, 189-236.

[13] S. S. Virmani, R. O. Aquino, and G. S. Khush, "Heterosis breeding in Rice (Oryza sativa L.)". Theoretical and Applied Genetics. 1982. 63: 373-380.

[14] Zhao YuanZeng., Wang YuLan., Zhao RenGui. and Chen ZhanYu.. "Study on the combining ability of dissolvable total sugar trait in super- sweet corn". Journal of Jilin Agricultural University. 2002. 24:1, 11-14.

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Table 1: Combining Ability Analysis for Sugar content

Source	d.f	Sugar content in percentage
GCA	7	1.12**
SCA	28	0.91**
Error	70	0.21
σ^2 gca		0.09
σ^2 sca		0.69
σ^2 gca/σ^2 sca		0.12

Table 2: General combining ability effects for sugar content in eight elite sweet corn inbreds

Parents	Sugar content in percentage
6072-3	0.35*
6104	-0.44**
6069	0.58**
6122-1	0.09
6127	-0.13
6100	-0.16
6100-2	-0.04
6082	-0.25
Range	-0.44 to 0.58
SE (gi)	0.13
SE (gi-gj)	0.20

Table 3: Specific combining ability for sugar conten in 28 single cross sweet corn hybrids

Crosses	Sugar content in percentage
6072-3 x 6104	0.37
6072-3 x 6069	1.41**
6072-3 x 6122-1	-1.37**
6072-3 x 6127	0.51
6072-3 x 6100	-1.46**
6072-3 x 6100-2	1.70**
6072-3 x 6082	0.52
6104 x 6069	-0.58
6104 x 6122-1	-0.16
6104 x 6127	-0.43
6104 x 6100	-0.60
6104 x 6100-2	0.80
6104 x 6082	1.42**

6069 x 6122-1	1.04*
6069 x 6127	-0.87*
6069 x 6100	-0.51
6069 x 6100-2	-0.65
6069 x 6082	-1.67**
6122-1 x 6127	1.27**
6122-1 x 6100	0.11
6122-1 x 6100-2	-0.71
6122-1 x 6082	-1.16*
6127 x 6100	1.42**
6127 x 6100-2	0.83
6127 x 6082	-0.39
6100 x 6100-2	0.30
6100 x 6082	0.28
6100-2 x 6082	-0.37
Range	-1.67 to 1.70
SE (Sij)	0.42
SE(Sii-Sjj)	0.51
SE(Sji-Sik)	0.62
SE(Sij-Skl)	0.58

Table 4: Per cent Mid parent heterosis, Heterobeltiosis and Standard Heterosis for sugar content in 28 single cross sweet corn hybrids.

Crosses	**Sugar content in percentage**			
	H	**HB**	**S.H. (S 75)**	**S.H.(M)**
6072-3 x 6104	6.62	2.66	2.11	8.42
6072-3 x 6069	8.19*	1.49	15.22**	22.33**
6072-3 x 6122-1	-7.41*	-9.62*	-5.60	0.22
6072-3 x 6127	6.15	5.53	4.97	11.45*
6072-3 x 6100	-9.12*	-10.84**	-7.82	-2.13
6072-3 x 6100-2	14.19**	13.71**	13.11**	20.09**
6072-3 x 6082	4.73	4.67	4.23	10.66*
6104 x 6069	-5.19	-14.15**	-2.54	3.48
6104 x 6122-1	-1.24	-7.09	-2.96	3.03
6104 x 6127	-1.39	-4.52	-6.13	-0.34
6104 x 6100	-5.25	-10.43*	-7.40	-1.68
6104 x 6100-2	7.32	3.75	2.33	8.64
6104 x 6082	9.43*	5.31	4.86	11.34*
6069 x 6122-1	2.04	-2.05	11.21**	18.07**
6069 x 6127	-7.88*	-14.06**	-2.43	3.59
6069 x 6100	-8.09*	-12.20**	-0.32	5.84
6069 x 6100-2	-6.13	-12.29**	-0.42	5.72
6069 x 6082	-13.89**	-19.18**	-8.25	-2.58
6122-1 x 6127	6.67	3.54	8.14	14.81**
6122-1 x 6100	-3.26	-3.74	0.53	6.73
6122-1 x 6100-2	-5.36	-8.00	-3.91	2.02
6122-1 x 6082	-9.64**	-11.74**	-7.82	-2.13
6127 x 6100	0.31	-2.15	1.16	7.41
6127 x 6100-2	-3.06	-3.22	-4.55	1.35
6127 x 6082	-2.67	-3.29	-3.70	2.24

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6100 x 6100-2	-2.35	-4.60	-1.37	4.71
6100 x 6082	-1.04	-2.86	0.42	6.62
6100-2 x 6082	-1.76	-2.23	-2.64	3.37
Range	-13.89 to 14.19	-14.15 to 13.71	-8.25 to 15.22	-2.58 to 22.33

- **H-** Heterosis; **H.B.-** Heterobeltiosis; **S.H.**- Standard Heteosis
- **S 75-** Sugar 75; **M-** Madhuri.