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Heterosis in Quality Protein Maize

Agriculture

KEYWORDS :
Quality Protein Maize, Tryptophan, Lysine, Heterosis

ANUSHEELA.V	Centre for plant breeding and genetics, Tamil Nadu agricultural university, Coimbatore-003
A.R.MUTHIAH	Centre for plant breeding and genetics, Tamil Nadu agricultural university, Coimbatore-003
A.JOHNJOEL	Centre for plant breeding and genetics, Tamil Nadu agricultural university, Coimbatore-003

ABSTRACT

With an objective to identify potential parents and hybrids for quality and other traits for maize improvement, an investigation was carried out with Line x Tester analysis involving five lines (UQPM 5,UQPM 11, UQPM 12, UQPM 13, UQPM 15) and three testers (UQPM 9, UQPM 10,UQPM 14) . Eight parents and their fifteen hybrids obtained from crosses were evaluated for twelve quantitative traits viz., days to silking, plant height, ear height, number of leaves per plant, leaf length, leaf breadth, cob length, number of grain rows per cob, hundred grain weight, grain length, grain breadth, grain width and grain yield per plant and three qualitative traits namely grain protein, grain tryptophan, and grain lysine. In the Line x Tester analysis, significant variability was observed among the genotypes for fifteen traits. Four hybrids viz., UQPM 13 X UQPM 14, UQPM 5 X UQPM 9, UQPM 15 X UQPM 10 and UQPM 12 X UQPM 10 were observed to be potential hybrids for exploitation of yield heterosis and utilizing them in pedigree breeding will also result in potential inbreds.

INTRODUCTION:

Maize (*Zea mays* L.; 2n=20) occupies a prominent position in global agriculture and is grown for both feed and fodder purpose. Maize protein is characterized by high level of glutamic acid and leucine. Lysine (1.2 per cent of protein) and tryptophan (0.4 per cent) are limiting amino acids in maize. This is due to the fact that major storage protein is a prolamine fraction zein, which forms up to 50-60 per cent of the storage protein. Zein consists of a group of hydrophobic proteins, completely devoid of lysine and tryptophan (Inglett, 1970). Hence genetic manipulation for improved nutritional value, particularly, protein quality was considered as a noble goal. This effort was stimulated by the 1963 discovery that a little known mutant maize contained proteins that are nearly twice as nutritious as those found in normal maize called "*opaque 2* maize", its protein had a nutritive value about 90 per cent of that of proteins found in skim milk. The discovery of this mutant and subsequently its modifier were considered remarkable and lead to the concept of "Breeding for Quality Protein Maize (QPM)" (Vassal, 1999). The lysine levels in normal and QPM maize average 2.0 per cent and 4.0 per cent of total protein respectively, but range across genetic backgrounds from 1.6 - 2.6 per cent in normal maize and 2.7 - 4.5 per cent in their *o2* converted counterparts (Moro *et al*., 1996) The lysine content of QPM in whole grain is about 0.33 per cent to 0.54 per cent, with the average 0.38 per cent, and is 46 per cent higher than normal maize. The tryptophan content is 0.08 per cent, 66 per cent higher than normal maize. (Ortega *et al*., 1986; Sproule *et al*., 1988; Osei *et al*., 1999). Normal maize contributes up to a third or more of the crude protein content of chicken diets. On the other hand, maize is low in protein in addition to its general deficiency in essential amino acids, particularly lysine and tryptophan. An understanding of the genetic architecture of parents and their mode of inheritance will greatly assist the breeder to formulate appropriate breeding methodologies to incorporate the traits in question into an otherwise desirable variety. Various biometrical approaches are available to asses the breeding value of the traits under transfer. Line X tester analysis is one of those employed by which the genetic architecture of given character, the combining ability and heterosis could be understood.

MATERIALS AND METHODS:

Eight inbreds listed in Table 1

Table 1. Details of parent

S.No	Inbreds	Grain type	Source
1	UQPM-5	Yellow, Flint	TNAU, Coimbatore
2	UQPM-11 (8655-6)	Yellow, Dent	TNAU, Coimbatore
3	UQPM-12 (DMR 1024)	Yellow, Flint	DMR, New Delhi
4	UQPM-13 (DMR 1026)	Yellow, Flint	DMR, New Delhi
5	UQPM-15 (DMR 1021)	Yellow, Flint	DMR, New Delhi
6	UQPM-9 (8664-8)	Yellow, Flint	TNAU, Coimbatore
7	UQPM-10 (8654-10)	Yellow ,Dent	TNAU, Coimbatore
8	UQPM-14 (DMR 1161)	Yellow, Dent	DMR, New Delhi

UQPM –University Quality protein Maize
TNAU- Tamil Nadu Agricultural University
DMR- Directorates of Maize Research

obtained from Department of Millets, centre for Plant Breeding and Genetics (CPBG), TamilNadu Agricultural University (TNAU), Coimbatore formed the parent material of the present study. The parents numbered 1 to 5 (Table 1) were used as female parents (Lines) and 6 to 8 were used as male parent (Tester). Five lines and three testers were crossed in L x T fashion, to incorporate QPM character. Fifteen hybrids obtained from Line X Tester crossing fashion using five lines and three testers. All the hybrids were evaluated along with eight parents and with the normal commercial hybrid COH (M) 5. Eight parents and their fifteen hybrids obtained from crosses were evaluated for twelve quantitative traits *viz.,* days to silking, plant height, ear height, number of leaves per plant, leaf length, leaf breadth, cob length, number of grain rows per cob, hundred grain weight, grain length, grain breadth, grain width and grain yield per plant and three qualitative traits namely grain protein, grain tryptophan, and grain lysine.

RESULT AND DISCUSSION:

All the hybrids were found to be earlier, shorter and with desirable ear height when UQPM 5. Lengthier cobs, higher cob girth and grain protein when UQPM 9 was used as male parent.

When UQPM 15 and UQPM 11 (desirable donor parents for improvement of grain protein, grain lysine and grain tryptophan (Fig no. 1)) were used as female parents in the study, hybrids were found to possess higher grain tryptophan and grain lysine. Among the fifteen hybrids,

Fig. 1. Superior Hybrid for grain yield, Protein, Lysine and Tryptophan

nine hybrids have recorded significant and positive relative heterosis, heterobeltiosis and standard heterosis for grain yield. Six hybrids were desirable for grain protein. seven hybrids were desirable for grain tryptophan and grain lysine (Table2a-2e)

Table 2 a.Percentage of relative heterosis (di), heterobeltiosis (dii) and standard heterosis (diii) for days to silking, plant height and ear height

S.No	Hybrid	Days to silking			Plant height			Ear height		
		di	dii	diii	di	dii	diii	di	dii	diii
1	L1 X T1	-17.03**	-19.49**	-12.16**	54.31**	43.98**	-4.09**	46.46**	36.92**	-5.20**
2	L1 X T2	-8.06**	-8.79**	-6.39**	42.29**	16.76**	5.08**	41.01**2.8	18.68**	4.58**
3	L1 X T3	-7.25**	-9.89**	-7.53**	10.74**	-9.96**	-17.02**	6*	-15.69**	-20.57**
4	L2 X T1	-9.86**	-11.82**	-3.80*	50.11**	37.98**	9.63**	67.13**	65.54**	14.62**
5	L2 X T2	-5.35**	-6.87**	-2.83 ns	38.92**	30.78**	17.70**	69.79**	50.34**	32.48**
6	L2 X T3	-2.14	-5.69**	-1.60 ns	32.34**	23.22**	13.56**	53.70**	32.25**	24.60**
7	L3 X T1	-10.85**	-13.69**	-5.83**	57.90**	50.66**	0.36 ns	76.71**	65.41**	14.53**
8	L3 X T2	-2.18	-2.73	-0.64 ns	35.22**	13.07**	1.75 ns	48.88**	25.44**	10.54**
9	L3 X T3	-0.86	-3.47*	-1.40 ns	39.96**	15.93**	6.85**	34.89**	10.67**	4.27**
10	L4 X T1	-9.57**	-13.49**	-5.62**	43.50**	37.83**	-0.32 ns	63.58**	56.25**	8.17**
11	L4XT2	-4.60**	-5.24**	-4.31*	41.53**	27.64**	14.87**	73.13**	48.47**	30.84**
12	L4 XT3	4.21**	2.71	2.33 ns	23.81**	10.49**	1.83 ns	46.92**	22.59**	15.50**
13	L5 XT1	-5.63**	-9.51**	-1.28 ns	32.22**	27.297**	-15.21**	46.96**	36.63**	-5.40**
14	L5XT2	-8.16**	-8.55**	-7.65**	53.68**	29.47**	16.52**	81.72**	52.21**	34.13**
15	L5XT3	-2.09	-3.73*	-3.61*	39.05**	16.03**	6.94**	45.13**	18.39**	11.55**

* - Significant at 5%, ** - Significant at 1%, ns- Non-Significant

Table 2 b.Percentage of relative heterosis (di), heterobeltiosis (dii) and standard heterosis (diii) for Cob length, Cob girth and Kernels/row

S.No	Hybrid	Cob length			Cob girth			Kernels/row		
		di	dii	diii	di	dii	diii	di	dii	diii
1	L1 X T1	53.39**	37.10**	13.65*	23.29**	13.18**	-3.06**	37.01**	27.81**	24.64**
2	L1 X T2	67.00**	44.01**	29.73**	43.78**	43.42**	3.20**	10.67*	5.34	-1.59 ns
3	L1 X T3	20.94**	-0.34	0.41 ns	28.48**	15.04**	4.15**	3.79	-10.92*	4.96 ns
4	L2 X T1	46.65**	39.01**	28.63**	14.10**	12.68**	-1.02*	11.47**	1.71	20.24**
5	L2 X T2	23.93**	22.29**	13.16*	19.78**	8.95**	-4.30**	-5.67	-15.56**	-0.18 ns
6	L2 X T3	20.13**	15.23**	16.10**	15.31**	13.59**	2.84**	-15.64**	-15.77**	-0.44 ns
7	L3 X T1	46.14**	42.88**	18.45**	15.58**	10.37**	-5.46**	31.33**	29.49**	26.28**
8	L3 X T2	16.81**	9.76	-1.12 ns	20.01**	15.42**	-10.05**	11.84**	11.04**	5.25 ns
9	L3 X T3	28.71**	14.94**	15.82**	24.68**	16.01**	5.03**	6.05	-4.32	12.74*
10	L4 X T1	55.47**	53.69**	27.41**	31.79**	24.06**	6.26**	11.45**	1.88	-0.64 ns
11	L4XT2	50.23**	42.66**	28.51**	38.59**	35.26**	2.26**	16.65**	8.76	1.61 ns
12	L4 XT3	11.16	0.26	1.02 ns	14.42**	4.98	-4.95**	40.50**	18.41**	39.53**
13	L5 XT1	10.35	6.64	-11.59*	29.57**	17.34**	0.51 ns	35.07**	34.82**	31.96**
14	L5XT2	39.36**	29.49**	16.65**	47.47**	44.93**	4.30**	21.91**	19.13**	16.61**
15	L5XT3	38.20**	22.13**	23.06**	30.63**	15.44**	4.52**	-9.49*	-17.15**	-2.38 ns

* - Significant at 5%, ** - Significant at 1%, ns- Non-Significant

Table 2 d.Percentage of relative heterosis (di), heterobeltiosis (dii) and standard heterosis (diii) for Grains breadth, Grain width and Grain yield

S.No	Hybrid	Grains breadth			Grain width			Grain yield		
		di	Dii	diii	di	dii	diii	di	dii	diii
1	L1 X T1	27.91**	19.07**	-33.70**	29.87**	21.95**	-21.87**	632.77**	524.27**	102.32**
2	L1 X T2	28.15**	11.23**	-27.47**	20.00**	19.27**	-22.66**	181.71**	101.404**	6.89*
3	L1 X T3	-4.43	-27.38**	-32.97**	-9.76*	-27.06**	-24.22**	95.69**	26.99**	-2.73 ns
4	L2 X T1	-4.65	-14.58**	-39.93**	3.57	-9.37*	-32.03**	141.25**	82.69**	15.07**
5	L2 X T2	-3.24	-6.77*	-34.43**	-1.67	-8.33*	-31.25**	40.64**	29.57**	-18.39**
6	L2 X T3	8.55**	-4.36	-11.72**	6.55	-8.27*	-4.69 ns	32.28**	20.53**	-7.68*
7	L3 X T1	47.94**	42.10**	-20.88**	58.62**	57.53**	-10.16**	295.05**	251.70**	46.03**
8	L3 X T2	24.52**	11.23**	-27.47**	16.66**	9.63*	-28.81**	199.57**	166.97**	41.69**
9	L3 X T3	23.46**	-3.96	-11.36**	21.35**	-6.01	-2.34 ns	53.01**	17.98**	-9.63**
10	L4 X T1	42.38**	41.44**	-21.25**	44.68**	41.66**	-20.31**	259.74**	223.10**	31.50**
11	L4XT2	25.61**	15.73**	-24.54**	30.26**	19.27**	-22.66**	187.47**	153.96**	34.78**
12	L4 XT3	6.46*	-15.07**	-21.61**	-3.96	-27.06**	-24.22**	177.93**	112.80**	63.00**
13	L5 XT1	45.86**	41.35**	-16.12**	25.33**	20.51**	-26.56**	260.15**	246.88**	21.36**
14	L5XT2	25.88**	20.22**	-21.61**	26.70**	22.89**	-20.31**	242.04**	183.76**	50.60**
15	L5XT3	-1.93	-19.44**	-25.64**	5.21	-16.54**	-13.28**	79.70**	30.89**	0.25 ns

* - Significant at 5%, ** - Significant at 1%, ns- Non-Significant

Table 2 e.Percentage of relative heterosis (di), heterobeltiosis (dii) and standard heterosis (diii) for Crude protein, Grain tryptophan and Grain lysine

S.No	Hybrid	Crude protein			Grain tryptophan			Grain lysine		
		di	dii	diii	di	dii	diii	di	dii	diii
1	L1 X T1	-1.43**	-9.83**.	38.43**	-9.59**	-16.98**	69.28**	-9.62**	-17.02**	69.28**
2	L1 X T2	-12.13**	18.17**	4.22**	32.49**	21.07**	106.54**	32.47**	21.13**	106.68**
3	L1 X T3	7.76**	6.67**	38.67**	13.81**	9.57**	101.96**	13.97**	9.79**	102.17**
4	L2 X T1	28.08**	26.73**	98.75**	-3.63**	-6.41**	90.85**	-3.62**	-6.38**	90.98**
5	L2 X T2	1.00**	-14.11**	34.69**	25.49**	8.84**	109.15**	25.46**	8.85**	109.35**
6	L2 X T3	-10.75**.	-18.39**	27.98**	-20.13**	-21.76**	50.33**	-20.17**	-21.87**	50.25**
7	L3 X T1	2.17**	-5.93**	44.42**	6.52**	-5.76**	92.16**	6.56**	-5.72**	92.32**
8	L3 X T2	-8.43**	-18.72**	15.19**	22.36**	16.25**	82.35**	22.32**	16.27**	82.47**
9	L3 X T3	-12.71**	-16.32**	18.59**	0.00	-7.44**	70.59**	0.04	-7.34**	70.62**
10	L4 X T1	0.63**	-8.77**	40.06**	2.82**	-12.50**	78.43**	2.64	-12.60**	78.30**
11	L4XT2	8.65**	2.15**	27.50**	20.00**	19.17**	70.59**	19.81**	18.97**	70.62**
12	L4 XT3	-1.76**	-3.72**	25.16**	5.78**	-6.02**	73.20**	5.60**	-6.07**	72.95**
13	L5 XT1	18.63**	16.35**	78.63**	-13.70**	-18.26**	66.67**	-13.74**	-18.33**	66.61**
14	L5XT2	17.41**	2.40**	51.17**	27.27**	12.90**	105.88**	27.28**	13.00**	106.01**
15	L5XT3	7.18**	0.77**	48.78**	9.09**	8.51**	100.00**	9.33**	8.79**	100.33**

* - Significant at 5%, ** - Significant at 1%, ns- Non-Significant

CONCLUSION:

It is observed from this study, that the two top most high yielding hybrids are from the dent x flint combination. Based on sca significant reciprocal effects were shown by five hybrids for days to silking; three hybrids for plant height; four hybrids for ear height; no hybrids for cob length; seven hybrids for cob girth, three hybrids for number of kernels per row, three hybrids for number of grains per cob; three hybrids for 100 grain weight, four hybrids for grain length; two hybrids for grain breadth; one hybrids for grain width; six hybrids for grain yield; seven hybrids for grain protein and seven hybrids for grain tryptophan and six hybrids for grain lysine, indicating the maternal influence in hybrid combinations.

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