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Evaluation of newly developed inbred lines for heterosis for yield and its component in maize

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Abstract

An investigation was carried out at of Agricultural Botany section College of Agricultural, Nagpur. During the year 2015-16 to assess extent of heterosis-over standard check (Rajarshi) for grain yield plant^{-1} and yield contributing characters in maize (*Zea mays* L.). Thirteen crosses obtained by diallel mating, six parents and two checks were raised in Randomized Block design with three replications. The data were recorded on randomly five plants grown on days to 50% tasseling, days to 50% silking, days to maturity, plant height (cm), cob girth (cm), cob length (cm), number of grains cob^{-1}, 100 grain weight (g), grain yield plant^{-1} (g), and grain yield plot^{-1} (kg). The data were subjected to statistical and biometrical analyses. Considerable variability existed among the genotypes for all the characters studied as observed from the significant mean squares due to genotypes. The crosses DC-3 x DC-7, NAUM-8 x DC-3 and NAUM-8 x DC-7 had high mean performance for grain yield plant^{-1}. The mean squares due to interaction effects of parents vs. crosses were found to be significant for days to 50% silking, days to maturity, plant height (cm), cob girth (cm), number of grains cob^{-1}, 100 grain weight (g), grain yield plant^{-1} (g), and grain yield plot^{-1} (kg) indicating the choice of exploitation of heterosis. These three crosses also exhibited significant standard heterosis for grain yield plant^{-1}. The cross also had significant *per se* performance for their respective characters. Hence it is inferred that there three crosses -3 x DC-7, NAUM-8 x DC-3 and NAUM-8 x DC-7 having high heterosis and high mean could be exploited commercially for higher yield in maize.

Keywords: diallel, heterosis, maize

Introduction

Maize (*Zea mays* L.) is the third most important crop of India belonging to the family poaceae and tribe Maydeae. It has assumed greater significance due to its demand for food, feed and industrial utilization. Nearly 49 % of the maize produce is being utilized as a raw material in the poultry feed industry. Maize has wide adaptability, as it can be grown from MSL to 3000 M above and from 58^0 N to 40^0 S latitude. Maize being a C-4 plant and fertilizer responsive, has very high yielding ability coupled with higher amount of cross pollination. Hence, offers tremendous scope for the plant breeders for genetic improvement and exploitation of hybrid vigour.

Material and Methods

Six lines viz. NAUM-21, NAUM-14, NAUM-8, NAUM-26, DC-7 and DC-3 were used to cross in full diallel mating design to produce 30 crosses during 2015-16. Crossed seeds of these 30 crosses along with 6 parents and check (Rajashi) were planted in randomized block design with 3 replications in *kharif* 2016-17 for evaluation with a spacing 60 cm x 20 cm at the experimental farm of Botany section, College of Agriculture, Nagpur for evaluation. Observations were recorded on randomly five plants grown on days to 50% tasseling, days to 50% silking, days to maturity, plant height (cm), cob girth (cm), cob length (cm), number of grains cob^{-1}, 100 grain weight (g), grain yield plant^{-1} (g), and grain yield plot^{-1} (kg). The data were subjected to the statistical analyses suggested by Panse and Sukhatme (1954). Useful heterosis were estimated by using mean values of F_1, check and mid parent by following standard procedure.

Results and Discussion

The mean squares due to genotypes were significant for all the 10 characters (Table 1) under study indicating substantial genetic variability among the genotypes for all the traits studied. The variation due to genotypes was further partioned into variation due to parents, crosses and parent vs crosses. Parents exhibited significant difference for all characters except for 100 grain weight. The mean squares due to crosses exhibited significant difference for all characters. The mean squares due to parent vs crosses exhibited significant difference for all characters except for days to 50% tasseling and cob length. Similar results were also observed by Prasad and Singh (1987), Mohammad *et al* (2013) [13], Mir and Ahmad *et al.* (2015). The above scientists concluded the presence of variability among genotypes from the significant mean squares due to genotypes, crosses, parent vs crosses observed by them. This result also revealed the suitability of data for estimation of heterosis. In accordance with these results, Wali *et al.* (2010), Premlatha and Kalamani (2010) [9] and Patil (2011) has reported significant mean squares for parent vs. crosses for all the characters studied in maize.

On the basis of per se performance (Table 2) studied for grain yield plant^{-1} and yield contributing characters among 30 crosses, the cross DC-3 x DC-7 was identified as superior cross as it performed significantly superior over check Rajarshi for grain yield plant^{-1} (117.73 g) and plant height (171.13 cm).

Considerable amount of heterosis was observed for all the characters under study however, the magnitude varied with characters (Table 2). In the present investigation six crosses recorded significant negative standard heterosis for day to 50% tasseling. The cross NAUM-26 x NAUM-14 (-10.26%) recorded maximum negative significant standard heterosis for this trait. Four crosses DC-7 x NAUM-14 (-9.09%), NAUM-26 x NAUM-14 (-9.69%), NAUM-8 x NAUM-14 (-7.27%) and NAUM-26 x NAUM-8 (-6.06) recorded significantly negative standard heterosis for days to 50% silking. Cross DC-7 x NAUM-14 (-12.95%) recorded maximum significantly negative standard heterosis for days to maturity.

The cross NAUM-8 x NAUM-21 (39.78%) recorded maximum significantly positive standaed heterosis for plant height. Two crosses namely DC-7 x NAUM-26 (28.48%) and DC-7 x DC-3 (22.10%) recorded maximum significantly positive standard heterosis for cob length (cm). For number of grains cob^{-1}, cross NAUM-8 x NAUM-21 (7.66%) recorded maximum positive and significant standard heterosis. For 100 grain weight, four crosses viz. NAUM-26 x NAUM-21 (20.38), NAUM-8 x NAUM-21 (13.77%), DC-3 x NAUM-8 (13.77%) and NAUM-8 x NAUM-14 (12.67%) recorded positive and significant standard heterosis. The crosses, DC-3 x NAUM-8 (22.21%), NAUM-26 x NAUM-21 (22.14%), NAUM-8 x NAUM-21 (16.05%) and DC-3 x NAUM-8 (8.23%) recorded highest significant and positive standard heterosis for grain yield plant^{-1}. The cross DC-3 x DC-7 (55.03%) recorded highest significant and positive standard heterosis for grain yield plot^{-1}.

Among thirteen crosses, one cross namely DC-3 x DC-7 (22.21%) was identified as superior cross as it recorded maximum, significant and positive standard heterosis for grain yield plant^{-1}. The level of heterosis observed in this cross justified the development of commercial hybrid in maize. Such potential of maize crosses for commercial exploitation of heterosis have been reported by many maize breeders like Beck *et al.* (1989) [4], Kabdal and Verma (2003), Kage *et al.* (2013) and Kumar *et al.* (2015) [7] in maize.

The overall study of heterosis and per se performance indicated that the cross combination DC-3 x DC-7 was found to be outstanding in respect of plant height (cm), no of grains cob^{-1}, 100 grain weight (g), grain yield plant^{-1} and grain yield plot^{-1} (kg). These may exploited commercially after critical evaluation for its superiority in performance with stability across the location over years.

Table 1: Analysis of variance for heterosis

Source of variation	D.F	Days to 50% tasseling	Days to 50% Silking	Days to maturity	Plant height (cm)	Cob length (cm)	Cob girth (cm)	Number of grains cob^{-1}	100 grain weight (g)	Grain yield plant^{-1}	Grain yield plot^{-1}
Replicates	2	41.56	8.67	28.58	87.89	4.21	0.75	128.60	27.28	4.91	0.025
Genotypes	37	21.58**	21.47**	117.77**	743.11**	15.17**	1.86**	12782.28**	24.7**	1033.66**	0.18**
Parents	7	21.46*	26.45**	89.55**	1101.47**	14.24**	3.69**	12318.00**	10.34	1088.67**	0.22**
Crosses	29	23.39**	22.40**	110.43**	626.56**	16.25**	1.35**	13764.53**	27.95**	1068.53	0.18**
Parent Vs. crosses	1	5.80	4.09*	355.26**	2349.58**	4.93	4.50**	2009.12**	42.89*	246.17**	0.12**
Error	74	9.2	1.5	7.61	15.43	1.84	0.41	33.74	8.34	6.09	0.01

*, ** = significant at 5% and 1% level respectively

Table 2: Performance of crosses for mean and standard heterosis (SH)

Crosse	Days 50%to 50% tasseling		Days 50% to 50% silking		Days to maturity	
	Mean	SH	Mean	SH	Mean	SH
DC-7XDC-3	52.67	1.28	55.33	0.60	90.67	-2.16*
DC-7XNAUM-8	54.67	5.13 **	57.67	4.84**	94.33	1.79
DC-7XNAUM-26	54.00	3.85 *	57.00	3.63*	94.33	1.79
DC-7XNAUM-14	47.33	-8.97 **	50.00	-9.09**	80.67	-12.95**
DC-7XNAUM-21	51.00	-1.92*	47.33	-0.60	94.00	1.43
DC-3 X DC-7	54.00	3.85 *	57.00	3.63*	92.33	-0.36
DC-3 X NAUM-8	52.67	1.28	55.67	1.21	92.00	-0.72
DC-3 X NAUM-26	53.00	1.92	56.33	2.42	91.33	-1.44
DC-3 X NAUM-14	51.00	-1.92	53.67	-2.42	94.23	1.79
DC-3 X NAUM-21	53.00	1.92	56.33	2.42	95.67	3.23*
NAUM-8 X DC-7	53.33	2.56	56.33	2.42	100.3	8.26**
NAUM-8 X DC-3	50.00	-3.85 *	53.33	-3.03	104.3	12.58**
NAUM-8 X NAUM-26	53.33	2.56	55.67	1.21	92.67	-0.0036
NAUM-8 X NAUM-14	48.33	-7.05 **	51.00	-7.27**	97.33	5.03**
NAUN-8 X NAUM-21	55.00	5.77 **	57.67	4.84**	104.3	12.58**
NAUM-26 X DC-7	54.00	3.85 *	57.00	3.63*	105.3	13.66**
NAUM-26 X DC-3	53.67	3.21	57.33	4.24*	93.00	0.35
NAUM-26 X NAUM-8	49.67	-4.49 *	51.67	-6.06**	96.67	4.31**

NAUM-26 X NAUM-14	46.67	-10.26**	49.67	-9.69**	97.33	5.03**
NAUM-26 X NAUM-21	52.33	0.64	56.33	2.42	92.00	-0.72
NAUM-14 X DC-7	53.33	2.56	56.00	1.81	86.33	-6.83**
NAUM-14 X DC-3	50.67	-2.56	53.33	-3.03	97.67	5.39**
NAUM-14 X NAUM-8	54.00	3.85 *	56.33	2.42	95.33	2.87*
NAUM-14 X NAUM-26	54.67	5.13 **	58.00	5.45**	94.67	2.15*
NAUM-14 X NAUM-21	54.00	3.85 *	57.00	3.63*	95.67	3.23**
NAUM-21 X DC-7	53.67	3.21	54.00	-1.81	94.33	1.79*
NAUM-21 X DC-3	51.33	-1.28	54.67	-0.60	92.00	-0.72**
NAUM-21 X NAUM-8	51.00	-1.92	54.00	-1.81	86.33	-6.83**
NAUM-21 X NAUM-26	55.00	5.77 **	54.33	-1.21	103.0	11.14**
NAUM-21 X NAUM-14	51.33	-1.28	54.33	-1.21	105.3	13.66**
S.E.(d)	1.75	2.24	0.71	0.78	1.59	2.15

*, ** = significant at 5% and 1% level respectively

Table 2: Contd.

Crosse	Plant height (cm)		Cob length (cm)		Cob girth (cm)	
	Mean	SH	Mean	SH	Mean	SH
DC-7XDC-3	160.47	11.74**	19.13	22.10**	13.33	-7.85
DC-7XNAUM-8	155.60	8.35**	18.80	19.97**	12.40	-14.30 *
DC-7XNAUM-26	175.73	22.37**	20.13	28.48**	13.07	-9.69
DC-7XNAUM-14	160.33	11.65**	13.73	-12.35	11.60	-19.83 **
DC-7XNAUM-21	160.67	11.88**	17.80	13.59*	12.47	-13.84 **
DC-3 X DC-7	171.13	19.17**	16.60	5.93	15.53	-6.47
DC-3 X NAUM-8	165.47	15.22**	18.27	16.57*	12.60	-12.92
DC-3 X NAUM-26	164.40	14.48**	16.13	2.95	12.93	-10.61
DC-3 X NAUM-14	155.47	8.26**	15.07	-3.85	12.67	-12.46
DC-3 X NAUM-21	171.20	19.22**	16.00	2.10	12.93	-10.61
NAUM-8 X DC-7	176.27	22.74**	17.67	12.74*	12.93	-10.61
NAUM-8 X DC-3	156.13	8.72**	16.53	5.50	12.20	-15.68*
NAUM-8 X NAUM-26	169.73	18.19**	16.60	5.93	12.53	-13.38
NAUM-8 X NAUM-14	163.93	14.15**	13.33	-14.91*	11.80	-18.45**
NAUN-8 X NAUM-21	200.73	39.78**	18.33	16.99*	14.47	-0.02
NAUM-26 X DC-7	160.27	11.60**	19.07	21.67**	11.93	-5.55
NAUM-26 X DC-3	142.20	-0.97	15.20	-2.99	13.00	-10.61
NAUM-26 X NAUM-8	163.67	13.97**	14.93	-4.70	14.60	0.89
NAUM-26 X NAUM-14	185.13	28.92**	17.47	11.46	13.33	-7.85
NAUM-26 X NAUM-21	148.67	3.52**	17.80	13.59*	13.73	-5.09
NAUM-14 X DC-7	151.80	5.71**	15.87	1.25	13.00	-10.15
NAUM-14 X DC-3	128.13	-10.77**	10.53	-32.78**	11.93	-17.53*
NAUM-14 X NAUM-8	159.47	11.04**	15.53	-0.87	13.73	-5.09
NAUM-14 X NAUM-26	163.0	13.50**	17.07	8.91	12.93	-10.61
NAUM-14 X NAUM-21	136.80	-4.73**	15.27	-2.57	11.67	-19.37**
NAUM-21 X DC-7	148.20	3.20**	16.47	5.08	13.13	-9.23*
NAUM-21 X DC-3	149.33	3.99**	13.07	-16.61*	13.77	-4.86
NAUM-21 X NAUM-8	144.67	0.74	12.47	-20.44**	12.60	-12.92**
NAUM-21 X NAUM-26	163.0	13.50**	14.00	-10.65	12.87	-11.08**
NAUM-21 X NAUM-14	151.20	5.29**	15.73	0.40	13.47	-6.93
S.E.(d)	2.27	2.78	0.78	1.13	0.37	0.46

*, ** = significant at 5% and 1% level respectively

Table 2: Contd...

Crosse	Number of grains cob^{-1}		100 grain weight (g)		Grain yield plant^{-1} (g)		Grain yield plot^{-1} (kg)	
	Mean	SH	Mean	SH	Mean	SH	Mean	SH
DC-7XDC-3	324.5	-14.46 **	22.93	-5.23	76.10	-21.00 **	0.96	-9.11
DC-7XNAUM-8	320.0	-15.63 **	23.67	-2.20	77.40	-19.65 **	1.00	-5.66
DC-7XNAUM-26	331.4	-12.65 **	26.47	9.36*	89.33	-7.26 **	1.16	9.74
DC-7XNAUM-14	123.7	-67.38 **	18.27	-24.51**	44.73	-53.56 **	0.67	-36.79 **
DC-7XNAUM-21	286.2	-24.54 **	25.13	3.85	74.00	-23.18 **	0.96	-9.43
DC-3 X DC-7	395.1	4.14 **	26.73	10.46 *	117.7	22.21 **	1.64	55.03 **
DC-3 X NAUM-8	369.4	-2.63 **	27.53	13.77**	104.2	8.23 **	1.25	17.92 **
DC-3 X NAUM-26	367.3	-3.18**	23.87	-1.37	88.17	-8.47 **	1.05	-0.62
DC-3 X NAUM-14	323.4	-14.74 **	24.93	3.03	82.17	-14.70 **	1.07	0.62
DC-3 X NAUM-21	281.2	-25.88 **	23.87	-1.37	66.20	-31.27 **	0.85	-20.12 **
NAUM-8 X DC-7	394.4	3.97 **	27.00	11.57**	117.7	3.77**	1.40	32.07 **
NAUM-8 X DC-3	298.9	-21.20 **	22.53	-6.88	117.7	-27.19 **	0.89	-15.72 **
NAUM-8 X NAUM-26	273.2	-27.99 **	22.40	-7.43	62.67	-34.94 **	0.85	-19.81 **
NAUM-8 X NAUM-14	254.6	-32.89 **	27.27	12.67**	75.17	-14.70 **	0.97	-8.49

NAUN-8 X NAUM-21	408.4	7.66 **	27.53	13.77 **	111.8	16.05 **	1.56	46.85 **
NAUM-26 X DC-7	367.87	-3.03**	25.33	4.68	91.73	-4.77 **	1.19	11.94
NAUM-26 X DC-3	266.0	-29.87 **	24.93	3.03	65.20	-32.31 **	0.90	-15.09 *
NAUM-26 X NAUM-8	324.3	-14.51 **	25.67	6.06	93.87	-2.55*	1.30	22.32 **
NAUM-26 X NAUM-14	330.6	-12.86 **	25.87	6.88	98.13	1.87	1.05	-0.62
NAUM-26 X NAUM-21	353.8	-6.72 **	29.13	20.38 **	117.6	22.14 **	1.54	45.28 **
NAUM-14 X DC-7	311.8	-17.81**	24.13	-0.27	75.40	-21.72 **	0.90	-15.09 *
NAUM-14 X DC-3	226.9	-40.18 **	21.87	-9.64*	52.27	-45.74 **	0.67	-36.79 **
NAUM-14 X NAUM-8	328.3	-13.45 **	26.00	7.43	85.13	-11.62 **	1.18	11.32
NAUM-14 X NAUM-26	285.8	-24.67 **	23.20	-4.13	64.27	-33.28 **	0.83	-22.01 **
NAUM-14 X NAUM-21	356.0	-16.44 **	22.47	-7.16	70.70	-26.60 **	0.98	-7.23
NAUM-21 X DC-7	347.4	-8.43 **	24.67	1.92	85.50	-11.24 **	1.19	11.94
NAUM-21 X DC-3	312.6	-17.58 **	24.07	-0.55	74.87	-22.28 **	0.96	-9.74
NAUM-21 X NAUM-8	255.7	-32.59 **	22.47	-7.16	57.73	-40.06 **	0.83	-21.38 **
NAUM-21 X NAUM-26	354.8	-6.46 **	26.73	10.46 *	84.80	-11.96 **	1.16	9.74
NAUM-21 X NAUM-14	356.0	-6.15 **	24.27	0.27	87.87	-8.78 **	1.18	11.32
S.E.(d)	3.35	5.32	1.67	2.39	1.42	2.04	0.05	0.0739

*, ** = significant at 5% and 1% level respectively

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