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Genetic analysis of xenia effects in high oil maize lines

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Abstract

Twenty high oil inbred lines and three normal maize testers were mated in a Line x Tester mating design and 60 crosses were developed to study the xenia effect of high oil inbred lines on the three normal maize testers and the gene action. Xenia analysis of F_1 seeds along with the parents and checks was carried out. Mean squares due to parental seeds and F_1 seeds were found significant for all characters. Additive gene action was found important for embryo weight and endosperm weight whereas dominance gene action was found important for protein content and in case of oil content both additive and dominance gene action were of equal importance. Six lines *viz*., L_{11}, L_{12}, L_{16}, L_{17}, L_6 and L_3 were observed to be good combiners for oil content along with tester T_3. Oil content and protein content of the F_1 seeds was higher than the check hybrid Buland. Ratio of endosperm weight/embryo weight of these F_1 seeds was less than the check hybrid Buland. Present studies revealed that use of high oil pollinators lead to improvement in oil content of F_1 seed.

Key words: *Zea mays* L., line x tester, xenia effect and oil content

Introduction

With the increased importance of globalization of trade and food processing, the quality parameters have attracted due attention of the agriculture sector. Maize oil has wider acceptance on account of having polyunsaturated fatty acids considered to be heart friendly for human population.Maize grain is composed of six different parts, *viz*., tip cap, hull (pericarp), horny glutinous part (aleurone), horny starchy part (horny endosperm), white starchy endosperm (soft starch) and germ. Three of them i.e. germ (80-84%), aleurone (12%) and endosperm (5%) contain oil.Initially germ was a waste byproduct in glucose factories but presently it is in demand because of its high oil content and high oil corn is an attractive animal feed because of its greater energy value than normal corn. It has also found application in the preparation of soaps and detergents. Maize having oil content of more than 6 per cent is called high-oil maize [1].

The relative effects of ear-bearing parent and source of pollen (xenia effect) upon the oil content of the grain produced has been studied. Pollen parent also influences the oil content of the seed parent called as xenia effect. Xenia can be defined as the immediate effect of the genes from the pollen parent on the development of the fruit or the seeds. Xenia effect has been exploited for harvesting high oil content [2]. Several attempts to develop high-oil maize hybrids have met with limited success, because of the negative association of oil level and grain yield. Generally, high-oil hybrids have high oil kernels but with reduced starch levels, smaller endosperm, and reduced kernel size. But a recent study [3] indicated that the male gametophyte of the high oil population has additive or dominant gene action causing the germ size of the normal oil hybrid to increase slightly and also increases the concentration of oil in the germ with little change in grain yield.

When used as pollen parent, certain inbred lines were found to differ significantly in their effects on the weight of kernels in F_1s [4]. Factors influencing the oil and protein content of the maize grain were studied. Results indicated that the genotype of the ear bearing parent has the predominant influence on the oil percentage of the grain produced. Source of pollen (xenia effect), however, had a consistent though small effect in all comparisons [2]. The kernels pollinated by high-oil source had the heaviest germ and the kernels pollinated by the low-oil source had the lightest germ. Moreover the per cent of oil in the entire kernel showed a pronounced effect of source pollen [5].

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Oil content of the grain of six maize single crosses was modified by xenia like effects induced by pollen from high and low oil stocks [6]. A significant increase in yield was reported of a long season genotype using pollen from a short season genotype in one year of a two year study. It was concluded that genotype and environment control xenia effect [7]. In reciprocally intercrossed strains (differing for grain filling rates) to a large (LG) and a small kernel (SM) strain, the pollen from the LG, compared to SM strain increased kernel dry weight, kernel water content and cob piece dry weight when averaged across replications, times, sucrose concentrations and plant types. The kernels pollinated with LG pollen had shorter lag phases, grew faster and were heavier at maturity than kernels pollinated with SM pollen. The pollen sources interacted with environments for grain yield and grain moisture concentration [8, 9].

In a factorial and a diallel mating design, xenia was demonstrated through a significant male effect, female x male interaction, and cross fertilization advantage. The level of expression of xenia depended not only on the male genotype but also on the female genotype. Some genes expressed during the grain-filling period could have their activities stimulated by heterosis at the level of the embryo or the endosperm [10]. The increase in oil levels of the normal hybrids pollinated by a high oil pollinator was the result of a small increase in germ weight, an increased concentration of oil in the germ, and a reduction in the percentage of endosperm. The changes in the kernel traits did not reduce grain yields of the normal hybrids, but increased oil levels. The consequence of this procedure was to trick the sporophyte into producing greater amount of oil in the germ [3]. Oil percentage and caloric content of grain from the high oil pollinator resulted in an overall increase in oil content without reducing grain yield. Interplanting high-oil males among male-sterile females in a ratio of as little as 7-8 per cent of the population resulted in increased oil content without affecting the grain yield of the hybrid [11]. Xenia through a significant male effect, female x male interaction, and cross fertilization advantage was detected for all the traits studied [12]. The present study was carried out with the objective to study the xenia effect of high oil inbred lines on the normal maize testers as well as to study the gene action controlling these traits.

Materials and methods

The experimental material comprised 60 single cross hybrids and their parents. These single cross hybrids were developed by pollinating 3 testers (T_1 to T_3) with 20 high oil inbred lines (L_1 to L_{20}) in a line x tester mating system during kharif 2004 at PAU, Ludhiana. Pedigree, colour and type of these lines and testers is given in Table 7. The resulting 60 F_1 seed sample of crosses and selfed seed of parents (used in these crosses) were used for the estimation of quality parameters. Following parameters were studied in three replications from each F_1 seed sample entry:

1. Embryo weight (mg)

Twenty five seeds from each sample were taken. These seeds were soaked in water and kept in oven at 50°C for 7-8 hours. Then embryos were removed using needle and forceps. These were then oven dried at 50°C for 7-8 hours and finally weight was measured in milligrams.

2. Endosperm weight (mg)

After removing the embryos, the remaining part of the seeds including pericarp was oven dried at 50°C for 7-8 hours and finally weight was measured in milligrams.

3. Protein content (%)

Seeds were oven dried at 50°C for two hours and then ground to fine powder with Cemotec 1090 grinder. Then nitrogen was estimated by Micro-kjeldahl procedure. By multiplying the percentage of nitrogen with the factor 6.25, the percentage of crude protein was estimated.

4. Oil content (%)

The oil content of the seeds was estimated by Nuclear Magnetic Resonance (NMR) Spectroscopy (Newport Analyzer, Model MKIIIA). The NMR was standardized by the use of 2g seeds having known oil content. The clean seed samples were first dried in oven at 50°C for two hours and then these were ground to powder with Cemotec 1090 grinder. Two grams of this ground sample was then used to take readings of the NMR. Three readings were taken for each sample and averaged. The values were expressed as oil percentage. The material was also evaluated at two agroclimatically diverse environments *viz*., Ludhiana and Gurdaspur during Rabi 2004-05. The data were recorded for grain yield and yield related traits to know the relationship between grain yield and oil content.

Results and discussion

The analysis of experimental design for the experiment conducted at Cereal Quality Laboratory is presented in Table 1. Mean squares due to parents were significant for all characters. Among parents, females differed

significantly for all characters except for oil content while males differed significantly for all the characters. Females vs males were significant for all characters except protein content. Mean squares due to F_1 seeds were also significant for all the characters. Analysis of variance of combining ability for different characters is presented in Table 2. Mean squares due to females, males and females x males were significant for all characters. Based on the relative proportion of additive (σ^2_A) and dominance variances (σ^2_D), embryo weight and endosperm weight were controlled by preponderance of additive gene action while protein content was controlled by dominance gene action. However in case of oil content both additive and dominance gene action were found to be of equal importance.

Among the male lines, the line Lie exhibited the highest significant positive *gca* effects (3.58) followed by L_{19}, L_{18}, L_{14}, L_{20}, L_{12}, L_{11} and L_5 (Table 3). Among the testers T_1 showed highest *gca* effects (6.16). On the other hand, lines L_1, L_2, L_3, L_4, L_6, L_7, L_8, L_9, L_{13}, L_{17} and testers T_2 and T_3 exhibited significant negative *gca* effects for embryo weight, indicating these genotypes as poor general combiners for embryo weight. Line L_1 showed the highest significant negative *gca* effects (-13.17). The same trend was also observed in case of lines L_2, L_5, L_6, L_8, L_9, L_{10}, L_{11}, L_{15}, L_{17} and tester T_2. On the other hand, lines L_4, L_7, L_{12}, L_{14}, L_{16}, L_{18}, L_{19}, L_{20} and testers T_1 and T_3 showed significant positive *gca* effects. Line L_{20} exhibited the maximum significant positive *gca* effects for protein content. Similar effects were also shown by lines L_3, L_6, L_7, L_{12}, L_{13}, L_{19}, L_{20} and tester T_2. Contrary to this, lines L_4, L_{10}, L_{14}, L_{15}, L_{16}, L_{17}, L_{18} and tester T_3 exhibited significant negative *gca* effects. Parental lines L_{11}, L_{12}, L_{16}, L_{17}, L_6 and L_3 exhibited significant positive *gca* effects along with the tester T_3. On the other hand, lines L_1, L_4, L_9, L_{13}, L_{15}, L_{19} and tester T_1 exhibited significant negative *gca* effects.

Cross combination T_1 x L_{11} showed the maximum (4.81) significant positive *sca* effect for embryo weight (Table 9). Other cross combinations showing significant

Table 1. ANOVA for experimental design

Source of variation	d.f.	Mean sum of squares			
		Embryo weight (mg)	Endosperm weight (mg)	Protein content (%)	Oil content (%)
Replications	2	26.62**	3499.95**	4.52**	0.002
Parents	22	43.96**	1893.66**	4.42**	0.66**
Females (F)	2	40.42**	4092.63**	5.36**	0.01
Males (M)	19	45.11**	1634.03**	4.53**	0.49**
F vs M	1	29.25**	2428.73**	0.51	5.13**
F_1 seeds	59	95.30**	3468.97**	4.64**	0.32**
Parents vs F_1 seeds	1	2566.88**	73893.75**	73.17**	4.56**
Error	164	0.05	2.07	0.26	0.06

Table 2. ANOVA for combining ability

Source of variation	d.f.	Mean sum of squares			
		Embryo weight (mg)	Endosperm weight (mg)	Protein content (%)	Oil content (%)
Replications	2	24.34**	2874.93**	2.81**	0.01
Females (F)	2	2084.87**	77461.59**	2.81**	1.12**
Males (M)	19	31.42**	749.64**	6.00**	0.49**
F x M	38	22.52**	934.29**	4.05**	0.19**
Error	118	0.04	1.84	0.26	0.06
s^2_A	60.04	2212.83	0.02	0.04	
s^2_D	7.49	310.82	1.26	0.04	

* and **denote significance at 5 and 1 per cent levels, respectively

Table 3. Estimate of *gca* effects of high oil lines and testers for various characters

Lines	Embryo weight (mg)	Endosperm weight (mg)	Protein content (%)	Oil content (%)
L_1	-1.45**	-13.17**	0.18	-0.16*
L_2	-0.70**	-2.05**	0.32	-0.15
L_3	-2.66**	0.33	0.47**	0.19*
L_4	-1.60**	6.69**	-0.84**	-0.23**
L_5	0.49**	-1.99**	-0.11	0.10
L_6	-1.45**	-4.24**	0.57**	0.20*
L_7	-0.55**	4.80**	1.20**	0.04
L_8	-1.45**	-6.36**	-0.11	0.11
L_9	-0.59**	-7.15**	-0.11	-0.31**
L_{10}	0.00	-7.63**	-1.18**	0.03
L_{11}	1.03**	-7.45**	0.08	0.45**
L_{12}	1.23**	3.31**	0.42*	0.37**
L_{13}	-2.28**	0.81	1.10**	-0.40**
L_{14}	1.95**	4.77**	-1.14**	-0.05
L_{15}	-0.08	-8.97**	-0.84**	-0.29*
L_{16}	3.58**	3.16**	-0.70**	0.21**
L_{17}	-2.52**	-12.60**	-0.99**	0.20*
L_{18}	2.33**	20.91**	-0.75**	-0.06
L_{19}	3.26**	9.56**	1.20**	-0.24**
L_{20}	1.46**	17.24**	1.25**	-0.01
S.E.	0.07	0.45	0.17	0.08
T_1	6.16**	35.09**	-0.07	-0.12**
T_2	-5.59**	-36.72**	0.24**	-0.02
T_3	-0.56**	1.62**	-0.17*	0.15**
S.E.	0.03	0.18	0.07	0.03

* and **Significant at 5 and 1% levels, respectively

positive *sca* effects for embryo weight were T_1 x L_3, T_1 x L_6, T_1 x L_{10}, T_1 x L_{12}, T_1 x L_3, T_1 x L_4, T_1 x L_{19}, T_1 x L_{20}, T_2 x L_2, T_2 x L_4, T_2 x L_5, T_2 x L_8, T_2 x L_9, T_2 x L_{13}, T_2 x L_{16}, T_2 x L_{17}, T_3 x L_1 T_3 x L_7, T_3 x L_8, T_3 x L_9, T_3 x L_{15}, T_3 x L_{16}, T_3 x L_{18} and T_3 x L_{19}. Maximum negative *sca* effect for endosperm weight was shown by cross combination T_1 x L_{20} (-25.72). Other crosses exhibiting significant negative *sca* effect foe endosperm weight include T_1 x L_1, T_1 x L_4 T_1 x L_5, T_1 x L_7, T_1 x L_8, T_1 x L_9, T_1 x L_{10}, T_1 x L_{16}, T_1 x L_{17}, T_1 x L_{18}, T_1 x L_{19}, T_2 x L_1, T_2 x L_2, T_2 x L_3, T_2 x L_6, T_2 x L_7, T_2 x L_8, T_2 x L_{11}, T_2 x L_{12}, T_2 x L_{13}, T_2 x L_{14}, T_2 x L_{15}, T_2 x L_{19}, T_3 x L_2, T_3 x L_3, T_3 x L_4, T_3 x L_5, T_3 x L_6, T_3 x L_{10}, T_2 x L_{11}, T_2 x L_{13}, T_2 x L_{14}, T_2 x L_{17} and T_3 x L_{20}.

Among crosses, the cross combination T_2 x Li_8 exhibited the maximum (1.85) significant positive *sca* effects for protein content. Similar effects were also shown by crosses T_1 x L_1, T_1 x L_2, T_1 x L_9, T_1 x L_{10}, T_1 x L_{11}, T_1 x L_{12}, T_2 x L_{14}, T_2 x L_{15}, T_2 x L_{16}, T_2 x L_{17}, T_2 x L_{18}, T_3 x L_5, T_3 x L_6, T_3 x L_9, T_3 x L_{10} and T_3 x L_{15}. Cross combination T_3 x L_{13} showed maximum significant positive *sca* effects (0.48) for oil content. Similar effects were also exhibited by crosses T_1 x L_1, T_1 x L_5, T_1 x L_{12}, T_1 x L_{16}, T_2 x L_2, T_2 x L_3, T_2 x L_4, T_2 x L_{19}, T_3 x L_{11}, T_3 x L_{13}, T_3 x L_{14} and T_3 x L_{15}.

Top twenty F_1 seeds based on the *sca* effects said *per se* performance basis for oil content have been presented in Table 5 and 6 respectively. It was observed that twelve out of twenty F_1 seeds were common in both the cases indicating close association between *per se* performance of the F_1 seeds and their *sca* effects. However, the *per se* performance was always not good indicator for superior combining ability. This was presumably because of combining ability often depends on complex interaction among genes.

It was also revealed that the oil content of all these F_1 seeds is higher than that of check hybrid Buland. The possibility of such findings was also expected by several workers [5, 11]. Protein content of most of these FI seeds is also higher than the check hybrid Buland. Ratio of endosperm weight/ embryo weight of all these twenty FI seeds is less than that of the check hybrid Buland indicating larger embryo size, which leads to higher oil content. These findings are in confirmation with the findings of other workers [5, 13, 14]. Two cross combinations T_3 x L_{15} and T_3 x L_6 outyielded the check hybrid Buland on the basis of *per se* performance for grain yield. Yield of the remaining hybrids was less than the check hybrid Buland. This indicated that in most of the cases there was a negative association between oil content and yield but in some cases there may be positive association too as in the case of FI seeds T_3 x L_{15} and T_3 x L_6. Such an association was also obtained in other studies [3, 11].

Present studies revealed that use of high oil pollinators lead to improvement in oil content of F_1 seed and two hybrids i.e. T_3 x L_{15} and T_3 x L_6 are significantly better yielder than the check hybrid Buland. These two hybrids need further testing over locations and years to assess their superiority and stability of performance.

Table 4. Estimates of *sca* effects for different characters

Lines	Embryo weight (mg)			Endosperm weight (mg)			Protein content (%)			Oil content (%)		
	Testers			Testers			Testers			Testers		
	T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3
L_1	-1.92**	-1.09**	3.01**	-9.78**	-14.06**	23.84**	0.51**	0.19	-0.70**	0.21*	-0.22*	0.01
L_2	0.08	0.66**	-0.74**	19.10**	-17.34**	-1.76**	0.36*	0.05	-0.41*	0.00	0.37**	-0.37**
L_3	1.68**	-0.24**	-1.44**	22.43**	-8.80**	-13.62**	-0.22	-0.10	0.32	-0.21*	0.46**	-0.25**
L_4	-2.77**	3.52**	-0.75**	-5.93**	8.64**	-2.70**	0.22	-0.10	-0.12	-0.05	0.21*	-0.16
L_5	-1.55**	3.07**	-1.52**	-13.01**	17.92**	-4.90**	-0.51**	,0.05	0.46*	0.21*	0.11	-0.32**
L_6	0.91**	0.10	-1.02**	13.68**	-1.03*	-12.65**	-0.32	-0.63**	0.95**	0.08	0.05	-0.12
L_7	-1.63**	-0.24**	1.87**	-7.76**	-1.47**	9.23**	-0.08	-0.10	0.17	0.15	-0.19*	0.04
L_8	-1.48**	1.10**	0.38**	-2.36**	-4.59**	6.95**	-0.08	0.05	0.03	0.00	0.07	-0.07
L_9	-3.58**	1.03**	2.54**	-18.89**	2.60**	16.30**	0.80**	-1.70**	0.90**	0.02	0.16	-0.18*
L_{10}	2.18**	0.05	-2.23**	-1.45**	2.88**	-1.42**	1.72**	-3.26**	1.53**	0.12	-0.21*	0.09
L_{11}	4.81**	-0.35**	-4.46**	34.54**	-12.34**	-22.20**	0.75**	-0.15	-0.61**	0.00	-0.20*	0.20*
L_{12}	3.41**	-3.06**	-0.35**	5.78**	-10.30**	4.52**	0.99**	-0.92**	-0.07	0.25**	-0.29**	0.04
L_{13}	1.18**	0.41**	-1.59**	14.79**	-7.88**	-6.90**	0.31	0.00	-0.31	-0.32**	-0.15	0.48**
L_{14}	4.13**	-1.38**	-2.74**	18.39**	-9.96**	-8.42**	-0.37*	1.51**	-1.14**	-0.13	-0.13	0.26**
L_{15}	-0.14*	-1.94**	2.08**	0.86	-9.94**	9.08**	-2.41**	1.22**	1.19**	-0.13	-0.27**	0.40**
L_{16}	-4.80**	2.20**	2.60**	-16.52**	11.41**	5.11**	-1.24**	1.07**	0.17	0.23*	-0.10	-0.14
L_{17}	-0.42**	2.00**	-1.59**	-1.36**	10.17**	-8.81**	-0.08	1.36**	-1.29**	-0.22*	0.08	0.14
L_{18}	-2.16**	-1.25**	3.41**	-18.58**	-0.10	18.68**	-0.32	1.85**	-1.53**	0.01	0.15	-0.16
L_{19}	0.98**	-3.94**	2.96**	-8.20**	-1.87**	10.07**	-0.22	-0.10	0.32	-0.28**	0.26**	0.02
L_{20}	1.07**	-0.65**	-0.42**	-25.72**	46.09**	-20.37**	0.17	-0.29	0.12	0.06	-0.14	0.09
S.E.	0.07	0.07	0.07	0.48	0.48	0.48	0.18	0.18	0.18	0.09	0.09	0.09

* and **denote significance at 5 and 1 per cent levels, respectively

Table 5. Top 20 F_1 seeds on the basis of *sca* for oil content

Cross	Oil content weight (mg)	Protein content (%)	Embryo weight (mg)	Endosperm weight (mg)	Endospermweight/ embryo weightper	Grain yield per plant (g)
$T_3 \times L_{13}$	6.60	13.12	20.15	174.22	8.6462	139.17
$T_2 \times L_3$	7.00	13.12	16.08	133.50	8.3022	120.83
$T_3 \times L_{15}$	6.63	12.69	26.01	180.42	6.9366	166.67
$T_2 \times L_2$	6.57	13.12	18.95	122.58	6.4686	92.50
$T_2 \times L_{19}$	6.37	13.85	18.32	149.66	8.1692	123.33
$T_3 \times L_{14}$	6.73	10.06	23.22	176.66	7.6081	128.33
$T_1 \times L_{12}$	6.87	13.85	35.38	222.86	6.2990	141.67
$T_1 \times L_{16}$	6.70	10.50	29.52	200.42	6.7893	131.67
$T_1 \times L_1$	6.30	13.12	27.37	190.82	6.9719	131.67
$T_2 \times L_4$	6.33	11.81	20.91	157.30	7.5227	118.33
$T_1 \times L_5$	6.57	11.81	29.68	198.78	6.6974	135.00
$T_3 \times L_{11}$	7.17	11.81	20.59	150.66	7.3171	139.17
$T_2 \times L_9$	6.20	10.94	19.43	137.42	7.0726	124.17
$T_2 \times L_{18}$	6.43	13.85	20.07	162.78	8.1106	135.83
$T_1 \times L_7$	6.43	13.56	28.56	210.82	7.3817	145.00
$T_3 \times L_{l7}$	6.87	10.06	19.91	158.90	7.9809	150.00
$T_1 \times L_{10}$	6.40	12.98	32.91	204.70	6.2200	121.67
$T_2 \times L_5$	6.57	12.69	22.54	157.90	7.0053	114.17
$T_3 \times L_{10}$	6.63	12.69	21.78	171.26	7.8632	130.83
$T_3 \times L_{20}$	6.60	13.71	25.05	177.18	7.0731	140.00

Table 6. Top 20 F_1 seeds on *per se* oil basis

Lines	Embryo weight (mg)	Endosperm weight (mg)	Endosperm weight/ embryo weight	Protein content (%)	Oil content (%)	Grain yield per plant (g)
$T_3 \times L_{11}$	20.59	150.66	7.3171	11.81	7.17	139.17
$T_2 \times L_3$	16.08	133.50	8.3022	13.12	7.00	120.83
$T_3 \times L_{12}$	24.89	188.14	7.5589	12.69	6.93	135.83
$T_1 \times L_{12}$	35.38	222.86	6.2990	13.85	6.87	141.67
$T_3 \times L_{17}$	19.91	158.90	7.9809	10.06	6.87	120.83
$T_3 \times L_{14}$	23.22	176.66	7.6081	10.06	6.73	136.67
$T_1 \times L_{11}$	36.57	240.86	6.5863	13.27	6.70	134.17
$T_1 \times L_{16}$	29.52	200.42	6.7893	10.50	6.70	131.67
$T_2 \times L_{17}$	18.48	139.54	7.5509	13.12	6.63	120.83
$T_3 \times L_{10}$	21.78	171.26	7.8632	12.69	6.63	130.83
$T_3 \times L_{15}$	26.01	180.42	6.9366	12.69	6.63	166.67
$T_2 \times L_6$	17.64	136.70	7.7494	12.69	6.60	119.17
$T_2 \times L_{11}$	19.67	122.18	6.2115	12.69	6.60	125.00
$T_3 \times L_6$	21.54	163.42	7.5868	13.85	6.60	156.67
$T_3 \times L_7$	25.33	194.34	7.6723	13.71	6.60	138.33
$T_3 \times L_{13}$	20.15	174.22	8.6462	13.12	6.60	139.17
$T_3 \times L_{16}$	30.20	188.58	6.2444	11.81	6.60	138.33
$T_3 \times L_{20}$	25.05	177.18	7.0731	13.71	6.60	140.00
$T_1 \times L_5$	29.68	198.78	6.6974	11.81	6.57	135.00
$T_2 \times L_2$	18.95	122.58	6.4686	13.12	6.57	92.50
Checks						
Buland	18.12	163.96	9.0486	12.25	5.03	151.67
Sheetal	13.96	142.36	10.1977	10.06	4.93	138.34

Table 7. Pedigree, colour and type of seeds used in the study

Lines	Pedigree	Colour of seed	Type of seed (dent/ flint)
L_1	HO 742 # #-xb-xb-xb-x-1-1	Orange	Flint
L_2	HO RHORYD # #-x b-xb-xb-1	Orange	Flint
L_3	HO RHORYD # #-xb-xb-xb-7-1	Orange	Flint
L_4	HO RHORYD # #-xb-xb-xb-13-1	Orange	Flint
L_5	HO R802A # #-xb-xb-xb-20-1	Orange	Flint
L_6	HO R802A # #-xb-x b-xb-28-1	Orange	Flint
L_7	HO R802A # #-xb-x b-xb-38-1	Orange	Flint
L_8	HO Temp X Trop HO QPM C14 #-xb-xb-xb-14-1	Orange	Flint
L_9	Tallar HO-xb-xb-xb-xb-7-1	Orange	Flint
L_{10}	Tallar HO-xb-xb-xb-xb-17-1	Orange	Flint
L_{11}	Tallar HO-x-b-xb-xb-xb- 18-1	Orange	Flint
L_{12}	Tallar HO-xb-xb-xb-xb-19-1	Orange	Flint
L_{13}	Tallar HO-xb-xb-xb-xb-24-1	Orange	Flint
L_{14}	Tallar HO-xb-xb-xb-xb-28-1	Orange	Flint
L_{15}	Tallar HO-xb-xb-xb-xb-29-1	Orange	Flint
L_{16}	Tallar HO-xb-xb-xb-xb-32-1	Orange	Flint
L_{17}	Tallar HO-xb-xb-xb-xb-33-1	Orange	Flint
L_{18}	Tallar HO-xb-xb-xb-xb-38-1	Orange	Flint
L_{19}	Tallar HO-xb-xb-xbTxb-53-1	Orange	Flint
L_{20}	Tallar HO-xb-xb-xb-xb-56-1	Orange	Flint
Testers			
T_1	MS Pool C_2IC_2-5- 1-2-1 -1-1 -2-1 f	Yellow orange	Flint
T_2	(JS2 x J3022)H.S.43-2-1-1-1-2-#-F.S.-2-##-i-#b-#	Dull orange	Flint
T_3	TuxC_2IC_3-7-1-1-2-1-1-1-1-1-1-1	Orange yellow	Flint

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