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An approach to establish inbreeding tolerant base population in maize (*Zea mays* L.)

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Abstract

Hybrid maize breeding is dependent upon the extraction of good and vigorous inbreds from the source populations. However, progress is impeded more often owing to chronic inbreeding depression. The present investigation aimed to form an inbeeding tolerant base population through the use of the genetic parameter of inbreeding depression (ID). In this endeavour, the nine crosses which showed non-signifiant inbreeding depression with better mean performance in the F_2 generation were selected to constitute the base population for an important trait namely performance index (PI).

Key words : Hybrid maize, inbreeding tolerance, F_2 generation, performance index

Introduction

Hybrids are considered to possess a high degree of biological fitness for a given situation. Inbreeding tends to disrupt this fitness. Crosses (F_1 hybrids) which tolerate this stress on inbreeding are desirable from the standpoint of forming an inbreeding tolerant base population for a given trait. Development of inbred-based populations which are heterotic to each other is considered one of the primary goals for sustaining hybrid maize programme. It is a general fact that a vast reservoir of germplasm does not ensure the materials to be ideally suited for the hybrid breeding because of chronic inbreeding depression (ID). To ensure extraction of vigorous and productive inbreds more often from such populations, it is imperative to improve them for inbreeding tolerance (IT). The present investigation, aimed to establish an inbreeding tolerant base population by using inbreeding depression (ID) as a tool.

Materials and methods

DH8644 and Jogia Local were taken as the base populations for the present study. These two populations were grown in isolated plots of size 30m × 10m during *kharif* 1993. Each plot was sub-divided into five equal grids. At flowering, ten plants based on their vigour, disease reaction, silk-tassel characteristics and the likes were marked for selfing. The sample size was kept small to reduce ensuing complexity. After harvest, further selection pressure was applied for economic characters and only one out of ten "selfs" was chosen. Thus a total of ten S1-lines (five from each populations) were selected. The following season, all the ten selfs were grown and crossed in a diallel fashion at flowering so that a total of forty-five F_1 hybrids could be produced. All these hybrids were reared in the next cropping season to produce forty-five respective F_2 populations by bulk-sib mating. Finally, a research trial comprising a total of 90 treatments (45 F_1s and 45 F_2s) was conducted following randomized complete block design (RCBD) at the Dholi research farm under RAU, Pusa during *rabi* season, 1994-95. The plot size for each entry was 7.5 square metres (5.0m × 1.5m). The entries were raised at optimum agronomic and plant protection practices recommended for north Bihar conditions. The data were recorded for two important characters namely, ear-height and performance index (PI). The performance index (PI) which is considered an important physiological trait in maize is in fact a ratio of two independent characters. It was calculated according to the formula suggested by Sullivan and Kannenberg [1].

PI = grain yield per plot (0.0 % moisture)/ per cent grain moisture at harvest

Inbreeding depression (ID) was used to assess crosses for inbreeding tolerance (IT). The lower value of ID for a cross was used as an index for higher IT and vice-versa.

Results and discussion

The analysis of variance (Table 1) indicated highly significant differences amongst the treatments for the two traits under consideration. On further partitioning,

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Table 1. Analysis of variance of crosses and respective F_2 populations

Source of variation	df	Mean squares	
		Ear height	Performance index (PI)
Treatments	89	237.5**	10829.9**
a. F_1s	44	329.1**	10359.4**
b. F_2s	44	151.2**	5023.4**
c. F_1s vs. F_2s	01	0.1	287017.7**
Error	178	37.9	1279.3
CV (%)		09.2	11.8

**Significant at P = 0.01

mean squares due to the crosses and the F_2 populations were also found significant for both the characters. However, mean square due to F_1s vs F_2s variation which is a measure of average ID appeared significant only for performance index (PI). This necessiated further to sort out specific crosses and the respective F_2 populations which could be ascribed to be the real cause for significance of F_1s vs. F_2s mean squares for PI. This measure of ID was nonsignificant for ear height, thus indicating that majority of crosses were having higher extent of IT. Consequently, no further analysis was needed for this trait.

Mean performance of crosses and the respective F_2 populations : The mean performance of crosses ranged from 203 (P7 × P10) to 490 (P2 × P6) with an overall mean value of 337.43 for PI. The lowest performing was constituted from S1- lines which had been derived from the same source population. Conversely, the best cross was obtained from the S1-lines having diverse origin. It was not unexpected because maximum magnitude of heterosis is usually displayed by the cross whose parents are genetically diverse (within limits).

A total of eleven F_2 populations of the respective crosses (Table 2) was observed with PI more than 300. The best performer was P4 × P8 for which the numerical value was 355 in the F_2 generation. The cross P7 × P10 proved as poorest* of the poor in the same inbred generation. Two F_2-populations slightly exceeded their respective F_1 hybrids (P8 × P10 and P3 × P9), however, numerical values of ID were statistically nonsignificant. Since PI is a ratio of grain yield and moisture per cent, the negative values of ID stemmed from relatively low ID (12.08% and 9.00% respectively) for grain yield than that for moisture per cent (13.33% and 11.76%, respectively) at harvest [2].

Formation of inbreeding tolerant base population: A total of twenty-two crosses showed non-significant ID for PI in the F_2 generation. Conversely, these were having higher level of inbreeding tolerance. As ID is based on the relative performance of both F_1 hybrid

Table 2. Mean performance and inbreeding depression of maize crosses for performance index

Crosses	Mean performance		ID (%)
	F_1 generation	F_2 generation	
P1 × P2	322	238	26.08**
P1 × P3	312	211	32.37**
P1 × P4†	315	296	6.03
P1 × P5	394	244	38.07**
P2 × P3†	348	338	2.87
P2 × P4	376	254	32.44**
P2 × P5†	310	305	1.61
P3 × P4	284	222	21.83**
P3 × P5	346	295	4.73
P4 × P5	403	342	15.13*
P6 × P7	299	256	14.38
P6 × P8	290	246	15.17
P6 × P9	310	294	5.16
P6 × P10†	360	318	11.66
P7 × P8	243	212	12.75
P7 × P9	373	266	29.57**
P7 × P10	203	186	10.14
P8 × P9	300	227	24.33*
P8 × P10†	304	307	–0.99
P9 × P10†	327	322	1.52
P1 × P6#	295	227	23.05*
P1 × P7	311	238	23.47*
P1 × P8	355	290	18.30*
P1 × P9	327	295	9.78
P1 × P10†	388	353	9.02
P2 × P6	490	342	30.20**
P2 × P7	354	231	34.74**
P2 × P8	312	263	15.70
P2 × P9	407	311	23.58**
P2 × P10	409	282	31.05**
P3 × P6	418	263	37.18**
P3 × P7	337	257	23.73**
P3 × P8†	466	288	38.19**
P3 × P9†	261	269	–3.07
P3 × P10	251	214	14.74
P4 × P6	393	268	31.80**
P4 × P7	320	255	20.31*
P4 × P8	356	355	0.28
P4 × P9	364	310	14.83
P4 × P10	314	279	11.14
P5 × P6	245	240	2.04
P5 × P7	384	261	32.03**
P5 × P8	367	277	24.52**
P5 × P9	383	252	34.20**
P5 × P10	258	253	1.93
Mean	337	267	

*,**Significant at P = 0.05 and 0.01, respectively. †Constituents of inbreeding tolerant base population; #P1, ..., P5 were derived from Jogia Local, and P6, ..., P10 were from DH 8644.

*Scale of measurement is completely arbitrary and is not universal.

and the respective F_2 population, a cross having lower mean value could have lower estimate of this parameter and conversely, higher extent of inbreeding tolerance. Thus attention was paid equally for non-significant ID and higher F_2 mean performance while selecting a cross for constituting an inbreeding tolerant base population. Out of the twenty-two crosses a total of nine crosses (20% selection intensity) was selected on the basis of their superior F_2 mean performance and composited to form the base population for PI (Table 2).

Such a population could be used to generate conventional inbred lines as well as non-conventional inbred substitutes for the development of commercially feasible promising single - cross hybrids [3]. Further, this population would attain Hardy - Weinberg equilibrium at individual loci (ignoring linkage) in a single generation of panmixis [4]; hence, no ulterior deterioration would be expected at least theoretically and consequently, such a composite could be exploited for 3-4 generations with seeming impunity.

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