STUDIES ON REDUCTION IN GROWTH VIGOUR IN ADVANCED GENERATIONS OF MAIZE-TEOSINTE HYBRIDS

MANSUR MOHSIN GILANI AND MEDHAT K. HUSSAIN

Experiments were conducted to study reduction in vigour in advanced generations of maize-teosinte hybrids. The investigations showed that maize teosinte F_1 hybrid was superior to the maize parent in characters like dry weight, final height, number of tillers and number of leaves but not in number of tillers and leaves to teosinte.

The maize-teosinte cross was superior to its reciprocal in characters like stem thickness, final height, dry weight and leaf area. The maize-teosinte F_1 was vigorous as compared to F_2 in many vegetative characters and F_2 generation hybrids, though less vigorous than F_2 in stem components, it exhibited a significant increase over the maize parent.

INTRODUCTION

In summer a variety of different fodders like Jowar (*Sorghum vulgare* Pers.), Bajra (*Pennisetum typhoideum* Rich.), and cowpeas (*Vigna catjang* Endl.) are grown yet the green fodder supply throughout the year is not regular. Some years back, the Department of Agriculture introduced teosinte (*Zea mexicana*) to meet the fodder requirements during the months of October and November, which is usually a scarcity period. Teosinte was expected to replace maize because of its nutritive value and drought resistance. The farmers did not, however, pay much attention to this new crop as it had certain drawbacks such as slow growing habit and hairy leaves. The plant tillers profusely; it is more slender and looks like maize until it ripens; the cobs are noticeably smaller than those of maize. The grains are also inferior. On the other hand, maize is much relished by cattle and is grown widely in the country for fodder and grain purposes. It out-balances all other fodder crops in average yield of dry matter and total digestible nutrients.

In view of its profuse tillering and multiple cob bearing, teosinte has been crossed with maize to increase the fodder yielding capacity of the latter. The hybrid gave high yield and matured earlier than teosinte, indicating the possibility of its commercial exploitation. But since hybrid seed involves

*Department of Plant Breeding & Genetics, University of Agri; Lyallpur.

certain practical difficulties, it may be worthwhile to asses the merit of advanced generations for commercial use.

Investigations by Khan (1957), Malik (1958) and Ali (1959) on the growth vigour in F_1, F_2 and F_3 hybrids revealed that maize-teosinte F_2 and F_3 hybrids though less vigorous than F_1, exhibited a significant increase in vegetative characters over maize parent. Malik (1958) also noticed manifestation of hybrid vigour in F_2 and F_3 generations. Josephson (1953) made similar observations on F_1 and F_2 hybrids. This paper reports results of a similar trial on studies of hybrid vigour upto F4 generations.

MATERIALS AND METHODS

The materials utilized in these experiments comprised local yellow maize, annual teosinte, reciprocal F_1 hybrids, F_2, F_3 and F_4 generation hybrids of maize-teosine (open and self pollinated). Thus to determine the extent of hybrid vigour in F_4 generation the parents and hybrids grown were, maize, teosine, maize-teosinte F_1, its reciprocal, maize teosine F_2, F_3 and F_4 self and open-pollinated populations. The material was sown in a complete randomized block design with four replications.

Observations for various characters on selected plants were made as follows :

a) Periodic growth rate of parents and hybrids were measured at a regular interval of seven days and continued till the growth finally ceased.

b) The height of main axis was measured in centimeteres from the ground level to the upper leaf axil.

c) Time of flowering was studied by counting the number of days taken by the plant from germination to anthesis.

d) The period of maturity was determined from the total number of days taken by the plant to mature its seed.

e) Stem thickness was measured in centimeteres by means of a Vernier's caliper.

f) Number of tillers were counted, the number of tillers in maize was considered as zero.

g) The number of leaves per plant was counted, and leaf area of the 4th, 5th and 6th leaves from the tip towards the basal portion of the main axis was measured in square centimeters with Integrator described by Vyvyan and Evans (1932). Mean of the three leaves was recorded as the average leaf area per plant. These data were analysed by the analysis of variance method.

RESULTS AND DISCUSSION

"F" values for the characters studied were statistically significant (Table 1) except for stem thickness.

TABLE 1. *F values for the various Plant Characters.*

Final Height	Time of Flowering	Stem Thickness	Tillering capacity	Number of leaves	Leaf area	Dry weight
4.04++	3.27++	2.05 N.S.	2.96+	4.93++	18.26++	57.4++

++Significant at 1% level.

The performance data for the parental lines and hybrids for different characters are summarized in Table 2, 3 and 4.

Growth Rate: The data presented in Table 2 show that the average relative growth rate was higher in all kinds of populations than the parents, with the exception of teosinte maize F_1. Some hybrids such as maize-teosinte F_2

TABLE 2. *Average relative growth rate per day of the parental and hybrid populations*

Population	Number of days from germination to final height	Final height (cm)	Log CH	Average relative growth rate per day (Log CHN)
Maize	104	168.29	8.188	0.06
Teosinte	118	139.99	7.205	0.06
Maize x teosinte F_1	90	210.74	7.348	0.08
Teosinte x maize F_1	111	177.12	5.358	0.04
Maize x teosinte F_2 (self)	104	160.99	7.141	0.06
Maize x teosinte F_2 (Open)	118	171.74	7.143	0.06
Maize x teosinte F_3 (Self)	118	173.79	7.154	0.06
Maize x teosinte F_3 (open)	90	173.79	7.220	0.08
Maize x teosinte F_4 (self)	111	163.99	7.386	0.06
Maize x teosinte F_4 (open)	90	193.80	7.342	0.08

(open-pollinated) and maize-teosinte F_3 (self-pollinated) showed a growth rate equal to that of teosinte.

Plant Height : The plant height data presented in Table 2 revealed an interesting trend in growth. While the average height of all hybrids populations was greater than the average mean parental height, the early generation hybrids appeared to be more vigorous than the ones in advanced generations. For instance, F_1 was the tallest of all, the F_2 was generally taller than F_3 and F_4 while F_3 had an edge over F_4 generation.

Time of Flowering : A similar performance pattern was evident for the various hybrid generations for time taken to flowring. Mostly early generation hybrids were early in blooming compared to late generation hybrids. But all of them bloomed earlier than teosine. None of them bloomed earlier than maize except the Maize-teosine F_3 self pollinated generation.

Maize-teosinte F_4 self population was late in blooming by 12.75 days as compared to maize but 13.75 days earlier than teosinte. The F_4 and F_3 (Open-pollinated) populations flowered at the same time while F_3 (Self) was earlier in flowering than F_1 by 7.17 days.

The relative length of the photoperiod at which the different populations flowered showed that teosinte flowered mostly in the last two weeks of October ranging over 75-89 days; evidently teosinte exhibited response to short days period. Maize, on the other hand, flowered within a range of 54-64 days. Maize-teosinte F_1 displayed a mid-way tendency.

Stem Thickness : Maize-teosinte F_1 and F_2 selfed hybrids had no difference in thickness. Maize-teosine F_1 stem was a little thicker than that of teosinte. However, teosinte-maize F_1 in the reciprocal cross almost approached the maize parent. The stem was substanially thicker than that of maize, highlighting the presence of cytoplasmic effects.

Number of Leaves : Highly significant differences were obtained for the number of leaves among parents and hybrids. None of the hybrids surpassed teosinte. However, the hybrids showed an appreciable increase over maize. Maize-teosinte F_4 selfed hybrid produced more leaves than F_1, F_2 and F_3 populations.

TABLE 3. *Average performance for different characters of Parents, F_1, F_2 F_3 and F_4 hybrid generations.*

Experimental Material	Final Height (cm)	Number of days taken for flowering	Stem Thickness cm.	Tillering capacity.	Number of leaves	Leaf area (sq. cm)	Dry weight (Ounces)
Maize	148.91	58.18	2.15	O	10.91	439.02	6.50
Teosinte	143.49	84.66	1.92	7.23	130.74	162.91	17.29
Maize x Teosinte F_1	214.75	61.24	2.14	3.16	64.33	380.59	37.45
Teosinte x maize F_1	182.91	63.75	2.03	3.49	66.91	374.05	18.79
Maize x teosinte F_2(s)	156.91	68.41	2.01	2.33	40.99	288.52	23.87
Maize x teosinte F_2(o)	168.87	67.33	2.09	2.49	51.08	373.81	16.70
Maize x teosinte F_3(s)	176.25	57.75	2.39	4.41	55.25	303.71	26.70
Maize x teosinte F_3(o)	175.70	71.16	1.98	3.49	65.75	298.64	21.50
Maize x teosinte F_4(s)	163.97	70.91	2.01	3.83	69.74	338.41	17.70
Maize x teosinte F_4(o)	193.91	68.75	2.09	3.41	69.33	396.43	16.01
Cd1 at 5%	31.06	12.57	0.26	2.43	38.78	52.02	16.97
Cd2 at 1%	41.95	16.98	0.26	3.30	52.37	70.30	22.91

(O) Open pollinated.

(S) Self pollinated.

TABLE 4 : *Extent of hybrid vigour in F_4 generation of maize x teosinte hybrid over both parents.*

Characters	Percentage increase (+) or decrease (—) of F_4 generation of maize x teosinte hybrid over	
	MAIZE	TEOSINTE
1. Dry weight	+ 172.30	+ 2.37
2. Final height	+ 10.53	+ 14.27
3. Stem thickness	— 3.72	+ 7.81
4. Leaf area	— 22.91	+ 107.72
5. Numbe of days taken to flower	+ 21.92	— 16.24
6. Number of days taken to matufe	+ 40.93	— 10.98
7. Number of tillers	+ 300.83	— 47.02

Leaf Area : The hybrid showed some heterotic effect for leaf area compared to teosinte. The F_1 of the reciprocal cross was almost similar in leaf area. F_4 (open pollinated) hybrid populations showed an increase over F_1, F_2 and F_3 (self-pollinated) hybrids. Similarly F_4 (self pollinated) generation was superior to F_2 and F_3 selfed populations. Teosinte-maize F_1 hybrid exhibited an increase of 211.14 sq. cm. over teosinte while maize-teosinte F_1 showed a decrease of 58.43 sq. cm. from maize but 217.68 sq. cm. increase over teosinte.

Dry Weight : Maize-teosinte F_1 out-yielded both teosinte and maize by a good margin (Table 3) Teosinte-maize F_1 hybrid and teosinte gave approximately the same dry weight. The advanced generation hybrids of maize-teosinte selfed populations also outyielded the maize parent.

These investigations have clearly shown that maize-teosinte F_1 hybrid was superior to the maize parent in characters like dry weight, final height, number of tillers and number of leaves, but appeared inferior to

teosinte in number of tillers and leaves. Maize-teosinte F_1 hybrid was more vigorous than its reciprocal in stem thickness, dry weight, leaf area and and final height while its reciprocal, teosinte-maize F_1 hybrid was superior only in number of tillers and leaves. Maize-teosinte F_3 and F_4 hybrids have also shown a significant increase over the maize parent. The hybrid vigour exhibited for different plant characters in F_4 generation is shown in Table 4.

In view, therefore, of the the generally better performance of both early and late generation hybrids than the parents, it may be concluded that both self and cross-pollinated hybrid may be commercially used with advantage.

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