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Short Communication

Performance of single cross maize hybrids during winter season of northern India

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Abstract

Nineteen maize single cross hybrids were evaluated in northern India under severe cold stress in natural conditions during *rabi* 2010-11. Data were recorded on yellowing of leaves, drying of leaves and level of growth at seedling stage at two stages viz. immediately after sever cold and frosting, and after the temperature has slightly increased to observe the recovery in maize plants. Vivek Hybrid 9, Vivek QPM 9 and JH 3459 in early/extra-early maturity, HM 9 in medium maturity and HM10 and Seed Tech 2324 in late maturity group are suitable for sowing in the winter season. Yellowing of leaves caused by cold spell proved to be an important parameter to judge cold tolerance at vegetative stage.

Key words : Maize, single cross hybrid, cold stress

During winter season, maize crop is grown in the month of October and November in north India plains and is exposed to cold temperature or frosting at vegetative stage in the month of January. The optimal temperature for root, shoot and leaf elongation in maize is 30 to 35^{o}C; the minimum temperature at which growth is completely inhibited is between 6 and 8^{o}C [1]. However, deleterious effects such as chlorosis [1] and a reduction of photosynthesis and leaf growth [2] have been observed at temperatures about 15 to 17^{o}C. Low temperature prolongs growth duration, reduces crop growth rate, and thus weakens the seedling; however the duration of the winter crop of maize increases as we move towards northern parts. The chilling-sensitive nature of maize makes early plant establishment in spring difficult under cool environmental conditions [3]. Among the various effects of low temperature on the physiology of maize, that on the photosynthetic apparatus is considered to be especially important [4]. High chilling tolerance during autotrophic growth is accompanied by a high relative growth rate, sustained a high net assimilation rate in spite of a low leaf area ratio. The effects of low growth temperature below (15° C) on the photosynthetic apparatus of maize were studied [5] a total of eight genomic regions which were significantly involved in the expression of target traits.

Nineteen maize Single Cross Hybrids from public and private sector were planted during *rabi* season, 2010-11 at Pusa Campus, New Delhi in two replications. The hybrids were sown on 24th November 2010 following recommended agronomic practices. The experimental unit consists of six rows of five meter length spaced between rows 0.75m and between plants 0.25m. Observations were recorded in field for yellowing of leaves, drying of leaves and growth at seedling stage following 1 to 9 scale at two stages. The first date of recording was immediately after severe cold and minimum temperature (average minimum temperature was below 5^{o}C) (Table 3), while the second date was after the temperature has slightly increased to observe the recovery in maize plants. The data on yellowing and drying of leaves was recorded on scale 1 (no yellowing/ drying) to 9 (high yellowing/drying). Similarly, the plant growth was recorded on scale 1 (poor plant growth) to

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Table 1. Mean performance of maize hybrids for their reaction to cold and days to silk

S.No.	Name of hybrid	Pedigree	Drying of leaves (Scale 1-9)	Yellowing of leaves (Scale 1-9)	Plant* growth (Scale 1-9)	Plant# growth (Scale 1-9)	Days to 50% silk
Extra Early/Early							
1	Vivek QPM-9	VQL-1 X VQL-2	1.5	1	7	6.5	114.5
2	Vivek Hybrid-9	CM 212 X CM 145	1.5	1	5.5	6	119.0
3	Prakash	CM 139 X CM 140	2	2	5.5	6	122.0
4	JH-3459	CM 143 X CM 144	1	1	5.5	6.5	123.0
Medium							
5	HM-4	HKI 1105 X HKI 323	2.5	2	5.5	5.5	127.5
6	Bio-9637	-	2.5	1.5	5	6.5	127.0
7	HM-9	HKI 1105 X HKI 1128	1	1	4	5	128.5
8	Experimental Hybrid 1103	7025 X 7026	3.5	4	5	4.5	132.0
9	DMH-117	BML6 X BML7	4.5	3.5	5.5	5.5	135.0
10	HQPM-7	HKI-193-1 X HKI-161	3	1.5	6	6	126.0
11	HQPM-1	HKI 193-1 X HKI 163	3.5	3.5	5	6	131.0
12	BH-4071356	-	4.5	3.5	5	4.5	126.0
13	Experimental Hybrid 1101	ST X BML-7	3	2	5	5	130.0
14	Experimental Hybrid 1102	ST X BML-6	3.5	2.5	6.5	6.5	128.0
Late							
15	HM-10	HKI193-2 X HKI 1128	1	1.5	5.5	6	123.5
16	PMH-1	LM 12 X LM 14	2	3	5	5	130.5
17	Bio-9681	-	1.5	1.5	6	6	123.5
18	Seed Tech-2324	-	3.5	2	6.5	7	127.0
19	PMH-3	LM17 X LM14	1.5	1	6	6.5	133.0
	Mean		**2.47**	**2.05**	**5.53**	**5.82**	**126.68**
	SD		**1.15**	**1.00**	**0.70**	**0.73**	**5.01**
	SE		**0.264**	**0.229**	**0.161**	**0.167**	**1.149**

*Plant growth was recorded after severe cold (< 5^{o}C); #Plant growth was recorded after rise of temperature from cold

9 (excellent plant growth). Days to 50% silk emergence was also recorded. Correlation coefficients were computed following standard procedure [6].

Performance of 19 single cross hybrids (Table 1) covering all maturity groups were evaluated under cold temperature in natural conditions. There was a differential response of different hybrids to cold which was expressed by yellowing and initiation of drying of leaves in some hybrids during first recording of data (Table 1). Early maturing single cross hybrids viz., 'Vivek hybrid 9', 'Vivek QPM 9' and 'Seed Tech 2324' exhibited lowest score for yellowing and best score for plant growth at both the crop stages. The first recording

Table 2. Correlation among leaf yellowing, plant growth and days to silking

	Plant growth stage 1	Yellowing stage 2	Plant growth stage 2	Days to silking
Yellowing stage 1	0.001	0.801**	-0.287	0.508*
Plant growth stage 1		-0.262	0.692**	-0.419
Yellowing stage 2			-0.557**	0.576**
Plant growth stage 2				-0.366

** P = 0.01; *P≤ 0.01

indicated the expression of cold response of genotypes while the second recording indicated the recovery of these plants. The tolerance of hybrids to cold temperatures (below 5°C) may be attributed to the development of inbred parental lines at an altitude of 900 m above mean sea level at Vivekananda Parvatiya Krishi Anusandhan Sansthan, Almora. The score for yellowness was also low particularly for Vivek hybrid-9 and Vivek QPM 9 and they belongs to the early group comparatively with early flowering even in the winter season. Similarly, HM 9 showed lowest yellowing score and good plant growth and will be promising for growing in winter season of north India. The correlation studies revealed that high yellowing of leaves lead to lesser plant growth at second stage (-0.557**) indicating that yellowing affected the plant growth in maize hybrids (Table 2). Results showed that yellowing during peak cold as well as during recovery of plants delayed silk emergence. This was evident from the significant positive correlation of silking with yellowing of leaves in stage I (0.508*) and stage II (0.576*) (Table 2).

Table 3. Meteorological Data for the month of January-2011

Date	Min. temp. °C	Max. temp. °C	Av. temp. °C
1	8.0	16.0	12.0
2	7.4	15.4	11.4
3	7.9	13.2	10.6
4	1.5	14.0	7.8
5	4.4	13.5	9.0
6	5.0	11.6	8.3
7	3.8	13.0	8.4
8	3.5	15.0	9.3
9	3.2	11.2	7.2
10	4.3	10.0	7.2
11	4.2	13.7	9.0
12	2.0	18.5	10.3
13	3.4	20.0	11.7
14	9.2	23.2	16.2
15	8.8	22.6	15.7
Minimum	**1.5**	**10.0**	**7.2**
Maximum	**9.2**	**23.2**	**16.2**
16	8.7	20.5	14.6
17	7.2	17.0	12.1
18	2.2	19.3	10.8
19	6.0	21.2	13.6
20	4.3	19.5	11.9
21	3.6	20.0	11.8
22	6.2	22.0	14.1
23	7.3	22.5	14.9
24	5.2	22.5	13.9
25	2.8	21.0	11.9
26	9.7	21.1	15.4
27	6.7	21.6	14.2
28	3.3	17.6	10.5
29	3.2	20.6	11.9
30	6.7	21.3	14.0
31	6.0	21.1	13.6
Minimum	**2.2**	**17.0**	**10.4**
Maximum	9.7	22.5	15.4

Changes in temperature, sunshine hours, evaporation rate, rainfall and average wind velocity were recorded throughout the cold spell during the month of January (Table 3). The average minimum temperature (5.1°C) during the first fortnight coupled with low sunshine hours (2.3), low evaporation rate (2.0) and higher wind velocity (5.0) may have cumulative effect on the susceptibility of plants to cold. During first fortnight the range of minimum temperature, average temperature, sunshine hours, evaporation rate and wind velocity, was lower than that in second fortnight (Table 4). As the second fortnight progresses the environmental conditions became slightly warmer and plants showed recovery from the cold symptoms with better growth. During the second fortnight, there was an increase in average minimum temperature (6.6°C) sunshine hours (5.21), evaporation rate (3.43) and decrease in the wind velocity (4.15). The correlation studies during January indicated that minimum temperature is not affected by other agro-meteorological parameters like maximum temperature, sunshine hours, evaporation rate and average wind velocity (Table 4).

Table 4. Correlation of minimum temperature with other agro-meteorological parameters

Days	Maximum temperature	Average temperature	Relative humidity	Sunshine hours	Evaporation rate	Average wind velocity
1-31	0.343*	0.703**	-0.206	0.044	0.055	0.099
1-15	0.437	0.763**	-0.333	-0.031	-0.295	0.102
16-31	0.281	0.867**	0.033	-0.002	0.128	0.138

*P<0.05; **P<0.01

Hence, it was concluded that the single cross hybrids of all the maturity groups *viz*., 'Vivek Hybrid 9', 'Vivek QPM 9' and 'JH 3459' in early/extra-early maturity, 'HM 9' in medium maturity and 'HM10' and 'Seed Tech 2324' in late maturity are suitable for sowing in the winter season. The yellowing of leaves caused by cold spell is an important parameter for cold tolerance at vegetative stage as well as affecting the recovery of the plants and silk emergence in maize.

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