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                                                  149
T. dactyloides              LTQFNSASLNRHLSRAYENNIAGYKNEGFVEVLAAQQSPENPNWFQ

Zea mays       (132)        LTQFNSASLNRHLSRAYGNNIAGYKNEGFVEVLAAQQSPENPNWFQ      (177)

T. dactyloides              QGTADAVRQYMWLFEEH

Zea mays       (177)        QGTADAVRQYMWLFEEH        (193)
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Figure 4. Protein amino acid sequences coded by the *Zea mays Agpsemzm* gene (NP_001105178) and the putative PCR-generated *Agpsem* gene of *Tripsacum*. Amino acid positions are indicated for *Zea mays.*

leads to the replacement of a glycine (maize) with a glutamine acid (*Tripsacum*).

The major differences between the nucleotide sequences of the maize *Agpsemzm* gene and the putative *Tripsacum Agpsem* gene were observed in the intron regions, whereas the coding sequence remains conserved. However, by comparison, the sequence differences found in both introns and exons between the maize *dek1* gene and putative *Tripsacum dek1* gene were not as varied. This fact is both very interesting and points to the need for further research.

PANTNAGAR, INDIA
G. B. Pant University of Agriculture and Technology

Studies on secondary traits of maize inbreds, hybrids and composites across environments
--Devi, P; Singh, NK

Yield stability, as a selection trait in plant breeding programmes as well as in evaluation trials, is constantly gaining importance over yield capacity. This is especially important where environmental conditions vary considerably.

The present study was undertaken during the monsoon season of 2007 in three environments: normal conditions, low nitrogen and irrigated conditions, and low nitrogen and rain (non-irrigated) conditions. Five inbred lines, 10 single crosses and two standard checks, namely Surya (composite) and Nath Samrat 1133 (hybrid), were used as experimental materials with the objective of identifying stable genotypes for the secondary traits, anthesis-silking interval (ASI) and days to 75% ear leaf senescence. The evaluation trials were conducted in each environment in a randomized complete block design with three replications at the Crop Research Centre of the G. B. Pant University of Agriculture and Technology, Pantnagar. The experimental unit was a one row plot 5 m long and 75 cm apart, forming a plot size of 3.75 m^2 and a plant-to-plant distance of 25 cm. The stability of the characters for each genotype was calculated by regressing the mean values of individual genotypes on environmental index and by calculating the deviations of the regression coefficients from unity as suggested by Eberhart and Russell (Crop Sci. 6:36-40, 1966).

The pooled analysis of variance revealed significant differences among genotypes, environments and their interaction for both traits. Inbred lines P_2 and P_3 were found to be the most stable and desirable, whereas single crosses P_1xP_2, P_2xP_3, P_3xP_5 and standard check Surya were identified as ideal in terms of grain yield potential and stability parameters for both the ASI and days to 75% ear leaf senescence (Table).

Table. Stability parameters for anthesis-silking interval (ASI) and days to 75% ear leaf senescence.

Genotypes	Grain yield (kg/ha)	ASI (days)			Days to 75% ear leaf senescence		
	$\overline{X}$ i	$\overline{X}$ i	bi	S^2d_i	$\overline{X}$ i	bi	S^2d_i
Parents							
Pop 31 (P_1)	769.73	4.09	0.877	0.033	80.50	2.539	11.005**
Pop 446 (P_2)	889.29	3.92	0.744	-0.001	78.83	1.735	-0.405
YHP-A (P_3)	1009.72	3.50	0.942	-0.043	80.33	1.312	0.378
Pop 445 (P_4)	737.82	2.67	-0.253**	-0.054	77.00	-0.423*	-0.251
YHP-B (P_5)	858.56	3.17	0.616	2.248**	78.83	-0.375**	-0.546
Crosses							
P_1 x P_2	2184.55	2.50	0.471**	-0.070	80.50	2.253	0.367
P_1 x P_3	1258.50	4.92	1.397	0.140	78.83	3.851	5.318**
P_1 x P_4	1672.48	4.83	1.196**	-0.077	79.83	-0.375**	-0.546
P_1 x P_5	1493.96	4.44	1.341*	-0.040	80.33	0.047*	-0.408
P_2 x P_3	2043.22	4.83	2.429**	0.038	79.94	0.017	0.778
P_2 x P_4	1590.45	3.76	0.418	0.392	79.00	1.126	-0.337
P_2 x P_5	1721.28	2.33	0.725**	-0.074	79.50	3.095*	0.384
P_3 x P_4	1703.05	4.11	1.849**	-0.065	80.17	0.232	0.539
P_3 x P_5	1861.14	5.17	1.921**	-0.077	80.00	-0.142	0.907
P_4 x P_5	1841.12	3.00	0.471**	-0.070	77.33	-2.068*	5.332**
Checks							
Nath Samrat 1133	1530.57	3.17	0.507*	0.018	91.83	2.296	2.341*
Surya	2032.55	4.17	1.341	1.107**	79.33	1.878	0.080
Mean	1482.23	3.798	1.000		80.12	1.000	
SE (±)	219.936	0.373	0.355		1.009	1.430	

Expression of unusual characters in ear shoot and tassel of maize
--Singh, NK; Devi, P; Mishra, P

Maize (*Zea mays* L.) is a monoecious species that produces only unisexual flowers in separate male and female inflorescences. It is one of the most important cereals, with the highest yield potential and diverse uses from staple food and feed to industrial products like starch and biofuels. It is strongly believed that maize is essential for global food security. Maize is largely grown under rainfed conditions where various abiotic and biotic stresses severely affect the genetic yield potential. A global climatic change is now considered to be underway and is expected to result in a long-term trend towards changes in environmental conditions. Congenial environmental seasons support optimal development, however, unfavouable environments influence the genetic architecture of the plant and reduce yield directly by affecting plant growth and development, and indirectly by modifying the normal plant phenotype. Unpredictability of weather conditions has occasionally resulted in many unusual expressions in plant characteristics in general, and ear and tassel characteristics in particular, in maize. Multiple ears on single nodes are one of the environmentally induced oddities widely reported in maize hybrids grown during 2006 in Iowa, Illinois, and Indiana. The expression of multiple ears in inbred lines, populations and experimental hybrids was also recorded in maize grown in the Tarai region of Uttarakhand, India during the monsoon season of 2007. The twin ear expression on single nodes in maize was observed earlier by Hallauer in 1973 in S_2 and S_5 progenies of two populations (Hallauer, MNL 58:21-22, 1984). Multiple ears on single nodes were also recorded in low frequency in different genotypes of maize grown during the monsoon season of 2008. In addition, this season also experienced some other unusual expressions in maize that have an impact directly or indirectly on grain or green cob yield. The unusual expressions include the expression of silks in tassel, part of the tassel converted into an ear, plants with terminal ears without any tassels, sterile bulky anthers and the induction of many ears from different nodes with rare effective silk emergence. In fact, unisexuality in maize occurs through the selective elimination of stamens in ear florets and by elimination of pistils in tassel florets. The two general classes of sex determining mutants have been identified in maize, including those of masculinized ears and feminized tassels. The endogenous gibberellic acid (GA) has been found to have a feminizing role in sex determination in maize (Tanurdzic and Banks, Plant Cell 16:S61-S71, 2004). Moreover, reversal of sexual expression in maize has been shown to be influenced by environment and heredity (Richey and Sprague, Amer. Nat. 66:433-443, 1932; Heslop-Harrison, Biol. Rev. 32:38-90, 2008). The unusual expressions observed in maize experimental plots planted at the Crop Research Centre of G. B. Pant University of Agriculture and Technology, Pantnagar (India) during the monsoon season of 2008 are described in brief on below.

Development of multiple ears on the same ear node. Multiple ears are not unexpected but they typically occur at different nodes, not on the same node. Often one of the double ears is smaller, consisting of a few short husks surrounding a tiny cob with silks. The other ear appears to be full size and not hampered by the double ear. The smaller of the double ears occasionally sets some grain. However, in extreme cases of multiple ears, no seed set will take place and all the ears remain barren (Fig. 1).

Figure 1. Expression of multiple ears on the same node.

Induction of multiple ears on different nodes that lack effective silks. Some plants were found to have many ears on separate nodes. In such cases, ears were generally lacking effective stigmas or silks. As a result, pollination could not take place and ears remained barren or set very few seeds (Fig. 2).

Figure 2. Prolificacy without effective silk development.

Induction of silk in the tassel leading to a lack of anther and pollen development. The tassel is the terminal male organ, consisting of anthers and producing pollen grains for fertilization of the ovule, which is borne in the so-called lateral ear. In some plants, glumes were induced to develop stigmas in the tassel in place of anthers, and therefore, no viable pollen grains were formed.

Figure 3. Tassels with silk development.

Tassels with both anthers and ears. Some plants were found to have both sexual expressions in the tassel. Generally, the tip of the tassel was converted into a small ear that set seed, whereas the remaining lower portions and other branches of the tassel developed anthers with pollen grains of very low viability. (Fig. 4).

Figure 4. Tassel with both anthers and ears.

Induction of terminal ears in place of lateral ears. Maize plants normally consist of terminal tassels as male inflorescences and lateral ears as female inflorescences. In some of the plants, however, the terminal tassels were entirely modified into small single ears in place of tassels. The ears were small with few seeds (Fig. 5).

Figure 5. Terminal ears in place of tassels.

Compact sterile tassels with swollen glumes. Some of the plants showed compact tassels with bulky glumes and few stigmas emerging. Such types of tassels do not have viable pollen grains. Some of the glumes of the tassel also induced silk in place of anthers, and of these, few were able to pollinate and set individual grain (Fig. 6).

Figure 6. Tassels with bulky sterile glumes.

The unusual expressions in ear and tassel are suspected to be due to environmental factors. The monsoon season of 2008 was peculiar in terms of rainfall at regular intervals starting from the 2nd fortnight of June to mid-September 2008. Due to excess soil moisture, it became difficult to perform inter-cultural operations properly. The plants received less sunlight and also experienced low temperatures due to cloudy weather and frequent rainfall during the cropping season. Richey and Sprague (1932) reported the role of environment, i.e., shorter daylight periods and lower temperatures, and heredity in the development of silks in the tassels. Heslop-Harrison (2008) also shared the viewpoint that low temperatures, particularly when experienced through the dark period of the daily photoperiodic cycle, promote female sexual expression and depress male. The frequencies of the unusual expressions described above were extremely low. In case of widespread occurrence of these kinds of characteristics, the quality as well as the quantity of the maize grain or green cob will certainly suffer.

Influence of low nitrogen and excess soil moisture stress on yield of maize inbreds and their hybrids

--Massey, P; Warsi, MZK

Nitrogen fertilization in agriculture has emerged as a serious matter of world concern. Recent statistics on N fertilizer consumption patterns show the average application of N in developed countries is 250 kg ha^{-1}, while in developing countries it is82 kg ha^{-1}, and in sub-Saharan African it is as low as 5.0 kg ha^{-1} (Sasakawa Africa Assoc. Newsl. 18:4-5, 2002). Indian soils are characteristically low in organic matter and N. In India, water logging is also an important constraint for crop production. Out of a total of 6.55 million hectares of maize, about 2.5 million hectares are affected by an excess soil moisture (ESM) problem that causes an average 25-30 percent loss in national maize production every year (Directorate of Maize, Annual Maize Workshop, Kanpur, India, April 5-9, 2001; Bhan, Indian J. Agric. Res. 11:147-150, 1977; Howell and Hiler, Trans. ASAE 17(2):286-288, 1974). Carter et al. (Trans. ASAE 33(4):1203-1207, 1990) reported that yield reductions from 9 days of ESM during the vegetative and tasseling/silking stages can be as high as 77 and 61 percent, respectively. For June plantings, ESM may coincide with flowering, which may interfere with normal pollination behavior and seed setting (Savita et al., J. Plant Biol. 31(1):29-36, 2004). Therefore, it would be desirable to develop maize cultivars with increased resistance to ESM conditions and with improved N-use efficiency. For purposes of this report, a yield reduction of 25 percent or more is categorized as undesirable. Our results indicate we have ESM tolerant genotypes.

The materials consisted of 12 lines, 4 testers and their 48 crosses and were evaluated under low-N, excess soil moisture and normal conditions in Randomized Block Design during the monsoon season of 2007 at the Crop Research Centre of the University. The experimental plot consisted of 5-meter rows, with between row and within row spacing of 75 cm and 25 cm, respectively. For the low-N trials, 40 kg N ha^{-1} was applied. For the ESM trials, water-logging treatment was given at the knee-high growth stage for 6 days, with continuous submergence to about 5 cm. After 6 days of flooding, water was drained out of the plots.

Analysis of variance for yield under normal, low-N and ESM conditions revealed that mean squares for all genotypes studied were highly significant, clearly indicating the existence of genetic variability in the genotypes.

Estimation of yield loss in low-N conditions. The percent yield reduction varied from 0.37 per cent in L_8T_1 to 83.25 per cent in L_7T_1. While most of the hybrids showed relatively more susceptibility to low-N stress than inbred lines, this is likely due to reduced N-requirements associated with the short plant stature and lower yield potential of the inbreds. Among the lines, the highest reduction was recorded in L_{11} (56.36 percent) with the lowest reduction in L_2 (9.31 percent). Among testers, the highest reduction of 16.26 percent was reported in T_1 and the lowest reduction of 4.3 percent was observed in T_3. The crosses with low yield reduction in comparison to normal were L_1T_4 (0.7 percent), L_4T_2 (1 percent), L_6T_3 (3.8 percent) and L_9T_2 (4 percent). Six lines and 5 single cross hybrids showed yield reduction more than 25%, whereas the remaining test materials exhibited less than 25% yield reduction under low N conditions (Table 1).