Only a few of the hybrid plants between maize and *Tripsacum* reached the flowering stage. They had 46 chromosomes. These were large, powerful, bushy plants. Some of them grew some years in greenhouse conditions. They were characterized by full male sterility and partial female fertility.

It has been ascertained also that if the maize has the color genes *A B Pl R*, hybrid kernels and hybrid plants have purple color. Possibly, *Tripsacum* has a gene analogous to the dominant maize gene *A1*. This fact allows the use of genetic markers for discovering apomicts among hybrids of maize and *Tripsacum*.

Megagametophyte investigation of tetraploid maize

--Kolesova, AJ

Tetraploid maize female gametophytes have not been investigated sufficiently. We carried out the analysis of 830 embryo sacs (*ES*) of tetraploid maize form *KrP-1* (population-1 from Krasnodar). *ES* of tetraploids, as a rule, had a structure typical for maize and consisted of a three-celled egg apparatus, the central cell with 2 polar nuclei or one central nucleus and antipodal complex. The characteristic peculiarity of tetraploids in comparison with diploids was the increase of cell, nucleus and, correspondingly, gametophyte sizes. Anomalous *ES* were discovered in 4 of 6 plants examined. The frequency of anomalous *ES* formation in tetraploids varied from 0% to 2.7%. In total, 12 anomalous *ES* were revealed. *ES* with additional polar nuclei (3-4 nuclei) and *ES* with anomalous position of polar nuclei prevailed. *ES* with egg-like synergids, and *ES* with additional nucleoli in the egg and polar nuclei were also discovered. In one ovule, the arrest of *ES* development at a one-celled stage was noted. In tetraploids, in contrast to diploids, the growth of antipodal complex cells was discovered. In one case, cells did not grow so considerably, increasing at a rate of 2-3 times. The structure and morphology of growing cells were similar to the rest of the antipodal cells. In other cases, antipodal complex cells grew considerably more, achieving 2/3 *ES* size. These growing cells were similar to central cells in their morphology. They contained large vacuoles and large nuclei, morphologically similar to polar nuclei. Growing cells always adjoined the antipodal complex. In most cases, growing cells were one-nuclear, and rarely two-nuclear. Cells with 3, 4, 6, 7, 8 and 13 nuclei were also discovered. More often, one cell, rarely two cells grew in the ovule. In one ovule, the growth of three cells was noted. The number of ovules with large growing cells varied from 3.4 to 26.4.

SHALIMAR, INDIA
S.K. University of Agricultural Sciences and Technology of Kashmir

Combining ability analysis for *turcicum* leaf blight (TLB) and other agronomic traits in maize (*Zea mays* L.) in the high altitude, temperate conditions of Kashmir

--Rather, AG; Najeeb, S; Wani, AA; Bhat, MA; Parray, GA

Strategies for developing high-yielding cultivars resistant to *turcicum* leaf blight (TLB, *Exserohilum turcicum*; Northern Leaf blight) is one of the major objectives for our high altitude maize breeding programme. Primary breeding objectives also include: (1) earliness, due to the seasonal limitations of high altitude; (2) good performance under low moisture, critical when the temperature drops abruptly in the latter stages of crop growth; and (3) resistance to lodging, as determined by plant height and ear placement.

Three replications each of forty-five half diallel cross combinations were evaluated along with 10 parents (Table 1) at two locations, Larnoo and Khudwani, representing different altitudes with a temperate ecology. Each entry was sown in two 5 m length rows at a spacing of 60 cm. Plantings for each replication and location included 50 plants for each genotype (83333 per hectare basis). Days to 50 percent pollen shed and silking were determined on a plot basis. Plant height (cm), ear height (cm) and moisture content (%) were measured for five randomly selected plants. Grain yield (kg/plot) was adjusted to 14% moisture. The disease severity was recorded for five randomly selected plants from each plot for crosses and 10 plants for parents using a 1-9 rating scale based on the percent of the leaf area affected of adult plants: 0, 1, 10, 20, 30, 40, 60, 80 and >80 percent, respectively, per Payak and Sharma (In: Proc. Twenty Fourth Workshop of All India Coordinated Maize Improvement Project, IARI, New Delhi, 1981). Inoculations were prepared from infected leaf tissue from a farmer's field and made at the mid-silking stage. The first evaluations were made 15 days later, and thereafter, weekly for 4 weeks. Two leaves were evaluated, the ones immediately above and below the ear leaf, as these have impact on yield (Bowen and Pedersen, Plant Dis. 72:952-956, 1988). The percent disease index was calculated by using the formula suggested by McKinney (J. Agric. Res. 26:195-218, 1923). Combining ability analysis was carried out according to Model I, Method II of Griffing (Australian J. Biol. Sci. 9:463-493, 1956).

Table 1. Estimates of GCA effects for TLB and other agronomic traits in inbred lines in maize.

Parents	Pedigree	Disease severity	Grain yield	Days to 50% pollen shed	Days to 50% silking	Moisture content	Plant height	Ear placement
1	PMI-1	-1.52* (17.24)	0.29*	-1.56*	-1.64*	-0.22*	-0.14	-4.77**
2	PMI-26	-1.76** (17.24)	-0.03	-0.45**	-0.12	-0.76**	4.27**	-6.69**
3	PMI-47	-4.47** (19.89)	-0.04	0.06	0.35**	0.44**	6.04**	5.74**
4	PMI-53	2.32** (42.50)	0.26*	-0.10	-0.56**	0.19*	1.98**	-0.70**
5	PMI-83	0.61 (35.32)	-0.14	-0.21*	1.14**	-0.11	-1.01**	4.97**
6	PMI-135	1.38 (36.47)	-0.02	-1.37**	-0.97**	-0.05	8.56**	2.35**
7	PMI-198	2.56** (18.50)	0.05	1.76**	-1.64**	0.58**	1.62**	-3.98**
8	PMI-199	2.17** (40.77)	0.10	2.14**	1.43**	-0.16*	10.46**	1.66**
9	PMI-224	-1.85** (16.32)	0.25*	-0.02	-0.81**	-0.66**	15.02**	9.64**
10	PMI-401	2.48** (36.22)	0.43**	-4.00**	-2.41**	-1.48**	-34.37**	-9.62**
SE gi		0.43	0.11	0.06	0.05	0.08	0.10	0.10
SE gi-gj		0.58	0.17	0.09	0.08	0.13	0.15	0.15

Parents 1, 2, and 6 are indigenous; 9 is a local line; 3, 4, 5, 7, 8, and 10 are CIMMYT lines.

*, **significant at 5% and 1% level, respectively; parentheses (percentage disease score);

The pooled mean squares for combining ability indicated that both GCA and SCA variances were highly significant for all of the traits, with GCA being greater than SCA. Both GCA and SCA were influenced by environment in the case of all traits, with the exception of SCA for grain yield, plant height and ear placement. Parents P1, P2, P3 and P9 were identified as good sources for *turcicum* resistance based on GCA effect. P10 proved an ideal general combiner for all traits followed by P1 and P9. Cross combinations P7 x P9 and P3 x P9 showed resistance to the disease and good performance for other traits, based on the SCA. In general, crosses having at least one parent with negative GCA effect and a resistant reaction showed resistance; however, crosses of most resistant parents gave intermediate to susceptible reactions.

Studies on genetic variability, genotypic correlation and path coefficient analysis in maize under the high altitude temperate conditions of Kashmir

--Najeeb, S; Rather, AG; Parray, GA; Sheikh, FA; Razvi, SM

A number of studies in maize have been conducted to elucidate the nature of association between yield and its components which identify traits like ear length, ear diameter, kernels/row, ears/plant, 100-seed weight and rows/ear as potential selection criteria in breeding programs aimed at increasing yield (Mohan et al., Natl. J. Plant Improve. 4(1):75-76, 2002; Tollenaar et al., Crop Sci. 44:2086-2094, 2004). Hence, an attempt was made to ascertain the influence of different characters on the improvement of grain yield in 3 local and 7 CIMMYT inbred line crosses of maize under the high altitude temperate conditions of Kashmir (7500 ft asl).

The present half diallel material was generated in Kharif 2006 by crossing the inbred lines in all possible combinations, except reciprocals, at the High Altitude Maize Research Station, Larnoo of Sher-e-Kashmir University of Agricultural Sciences & Technology of Kashmir, J&K (India). The parental lines and all forty-five crosses were evaluated at two diverse locations with temperate conditions, namely Larnoo and Khudwani, representing distinct climatic zones during Kharif 2007. All 55 genotypes were replicated twice at each location in CRBD. Each entry was given a plot size of three rows of 3 m length, with row and plant spacing of 60 and 25 cm, respectively. Recommended practices were followed to ensure a good crop. Maturity parameters (days to 50% pollen shed and silking, 75% husk browning), grain weight and straw weight were recorded on a plot basis. For the other 12 traits under study, data were recorded on five randomly selected competitive plants from each replication. The data were statistically analysed for correlation coefficients and path analysis as per the methods of Al-Jibouri et al. (Agron. J. 50:633-637, 1958) and Dewey and Lu (Agron. J. 51:515-518, 1959), respectively.

The analysis of variability parameters revealed the presence of substantial variability for all traits. Relatively higher estimates of GCV for straw weight, grain weight, plant height, ear placement, kernel rows/ear and number of kernels/row along with high heritability (broad sense) suggest that selection can be effective for these traits. Genetic advance was relatively higher for plant height, ear placement and number of kernels/row. The genotypic correlation coefficients revealed positive and significant association with ear length, ear girth, kernel rows/ear, kernels/row, straw weight, plant height and ear placement. The maturity traits recorded significant negative correlation with yield. The path analysis revealed that the traits with the highest direct effect on grain yield are number of kernels/row, ear length, ear girth and kernel rows/ear. Thus, these traits should be used as target traits for tailoring an ideal plant type for higher yield. Other traits exerted positive indirect effects on yield by affecting ear length, ear girth and ear placement (Table 1).

Table 1. Genotypic path coefficients for grain yield and component traits in maize.

Trait	Days to 50% pollen shed	Days to 50% silking	Husk browning	Plant height (cm)	Ear placement (cm)	Moisture content (%)	Ear length (cm)	Ear girth (cm)	Kernal rows/ear	Kernels/row	Straw weight	Correlation with grain yield/plot
Days to 50% pollen shed	**0.348**	0.163	-0.053	-0.036	-0.22	0.009	0.214	0.126	0.013	-0.212	0.002	-0.342
Days to 50% silking	0.157	**-0.361**	0.052	-0.041	0.280	0.011	-0.072	0.166	0.014	-0.262	0.002	-0.445*
Plant height (cm)	0.196	-0.157	**-0.219**	-0.111	-0.432*	0.013	0.258	0.180	0.025	-0.276	0.035	-0.520*
Ear placement (cm)	0.068	-0.174	-0.074	**-0.086**	0.004	0.002	0.515*	0.338	0.029	-0.555*	0.954	0.886**
Moisture content (%)	0.285	-0.213	-0.076	-0.083	**0.287**	-0.001	0.483	0.314	0.095	-0.520*	0.304	0.875**
Straw weight/plot (kg)	0.042	-0.110	-0.040	-0.004	-0.060	**0.038**	0.195	0.027	0.001	-0.145	0.001	0.008
Days to 75% husk browning	0.056	-0.170	-0.049	-0.070	0.756**	0.011	**0.630****	0.300	0.024	-0.630**	0.004	0.730**
Ear length (cm)	0.052	-0.153	-0.055	-0.074	0.790**	0.002	0.483	**0.392**	0.026	-0.519*	0.003	0.809**
Ear girth (cm)	0.035	-0.079	-0.045	-0.038	0.065	0.000	0.235	0.157	**0.387**	-0.264	0.001	0.384
Kernal rows/ear	0.052	-0.141	-0.049	-0.071	0.767**	0.008	-0.670**	0.304	0.026	**0.593***	0.004	0.69**
Kernels/row	0.056	-0.128	-0.068	-0.058	0.766**	0.010	0.407	0.243	0.107	0.447	**0.006**	0.714**

*, ** Significant at 5% and 1% levels, respectively; R^2 value: 0.841; residual effect: 0.397; diagonal values = direct effect.