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# Stability Analysis in Medium Maturity Maize (*Zea mays*. L) Hybrids for Morphological Traits under Different Ecologies of Kashmir.

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## Abstract

Ten maize hybrids along with two checks were evaluated across three locations spread over different agro-climatic zones of Jammu and Kashmir that differ in soil type, altitude and mean annual rainfall during Kharif 2020. The experiment was laid out in a randomized complete block design with three replications. Stability parameters such as mean (X), regression coefficient (bi) and deviation from regression ($S^2$di), as suggested by Eberhart and Russell (1966) were evaluated in order to assess the stability of these hybrids for various characters under consideration. Analysis of variance revealed that the hybrids possessed highly significant variability for all the traits under study. The mean squares due to G×E (linear) were significant for all the morphological traits viz., days to 50% tasselling, days to 50% silking, plant height, ear height, cob length, cob diameter and test weight. The mean square due to pooled deviation (non-linear) was significant for some traits like days to 50% silking, days to 50% silking, ear height, cob length and cob diameter. The mean square due to environment (E -linear) were significant for all the traits viz., days to 50% tasselling , days to 50% silking, days to maturity, plant height (cm), ear height (cm), cob length (cm), cob diameter (cm) and test weight . Based on the mean performance H05, H32 and H23 were high yielding hybrids across the locations and were average in stability while based on stability parameters the hybrids H11, PMH-10, DHM-117 were poorly

adapted. The genotypes having significant and more than unit $b_i$ values were suited for better environment only for this trait.

**Key words:** Environment, genotype, maize, hybrids, stability, regression.

**INTRODUCTION**

Maize (Zea *mays* subsp. *mays,* also known as corn) is a cereal grain that originated first in southern Mexico about 10,000 years ago and belongs to family Poaceae . Due to its plasticity the suitability of maize to diverse environments is unmatched by any crop as the expansion of maize to new areas and environments still continues. It is grown in such areas where yearly rainfall ranges from 250 to 500 mm and from 580$^o$ N to 400$^o$ S latitude (Dowswell *et al*., 2019).

Globally, the production of maize is 1123.23 million metric tonnes (mMt) on an area of 191.90 million hectare with productivity of 5.85MT/ha (Anonymous 2017). In India it is cultivated on an area of 9.03 mha with production and productivity of 27.72 MT and 3.06 MT/ha respectively. The area under maize cultivation in Jammu and Kashmir is 302516 ha with production and productivity of 5462 quintals and productivity 0.018 q/ha respectively (Anonymous, 2016 a).

Differential yield response of cultivars from one environment to another is called genotype x environment interaction (GEI) and can be studied, described, and interpreted by statistical models (Crossa, 1990). Developing crop cultivars that perform well across a wide range of environmental conditions has long been a major challenge to plant breeders. In practice, genotype × environment interaction complicates the identification of superior genotypes. Genotype × environment interaction is important in the development and evaluation of plant varieties since it reduces the genotypic stability values under diverse environments (Hebert *et al*., 1995). For plant breeders, large genotype × environment interaction impedes progress from selection and has important implications for testing and cultivar release. Genotype × environment interactions are of major importance because they provide information about the effect of different environments on cultivar performance and have a key role for assessment of performance stability of the breeding materials (Moldovan *et al*., 2000). The improvement of cultivars or varieties, which can be adapted to a wide range of diversified environments, is the ultimate goal of plant breeders in crop improvement program. A number of different approaches have been used, for example joint regression analysis and multivariate statistics, to describe the performance of genotype and environments. Consistent performance of a genotype across different sites or years are referred as stability. Environmental stratification to minimize G × E interaction has to be effectively tested.

**Materials and Methods**

The seed material was sown in a Randomized Complete Block Design with three replications at three locations. Row to row spacing was maintained at 75 cm with row length 3m and 2 rows\entry respectively during Kharif-2020 across three locations spreading over different agro-climatic zones of Jammu and Kashmir, viz., Mountain Research Centre for Field Crops, Khudwani (MRCFC), Dry land Agriculture Research Station

(DARS), Rangreth and Faculty of Agriculture (FoA) Wadura. The sowing was completed during the second fortnight of April at all the locations and recommended package of practices were followed to raise the crop. Data was recorded on plot basis for Days to 50% silking, Days to 50% tasselling, ear height (cm), Plant height (cm), No. of cobs plant$^{-1}$, cob length (cm), cob diameter (cm), test weight (g). Seed yield of each hybrid was calculated at 15 per cent moisture content and converted into q/ha. Five plants were tagged randomly for recording observations for each entry for all the quantitative characters. Mean of five plants for each entry in each replication was worked out for each character at each location and used for statistical analysis. Stability parameters for different characters were computed using the regression approach of Eberhart and Russell (1966).

**Table 1: Hybrids under study and their pedigree**

| **Hybrids** | **Pedigree** |
|---|---|
| H02 | KML-225 x BML-6 |
| H04 | BML-6 x LM-13 |
| H05 | BML-6 x LM-14 |
| H10 | CML-451 x BML-6 |
| H11 | CML-451 x LM-13 |
| H18 | IML-187 x BML-6 |
| H23 | BML-6 xCML-425 |
| H24 | KDM-914A x BML -6 |
| H32 | CM212 x CML-451 |
| H25 | QML-16 x DQL-364-1 |
| **CHECKS** | |
| DHM-117 | State released variety |
| PMH-10 | Local check |

## Results and Discussion

Genotype environment interaction which is associated with the differential performance of genetic materials, tested at different locations in different years. Its influence on the selection and recommendation of genotypes has long been recognized in various studies . The evaluation of genotypic performance at a number of locations provides useful information to determine their adaptation and stability (Crossa *et al*., 1990). Analysis of variance for stability in the performance of different hybrids across locations revealed that mean square due to genotypes were highly significant for all the traits indicating the presence of genetic variability in the experimental material under investigation. The mean square due to environment (linear) was also significant for all the traits, indicating that the environments selected were random and were different in agro-climatic conditions. The interaction of genotype with the environment (G × E linear) were observed to be significant for all the traits, indicating differential response of the hybrids to the varying environments. Interaction of genotypes with the environment were significant for all the traits viz., days to 50 % tasselling, days to 50% silking, days to maturity, plant height (cm), number of cobs plant$^{-1}$, ear height (cm), cob length (cm), cob diameter (cm) and test weight (g). The mean square due to pooled deviation (non-linear) was significant for some traits like days to 50 % tasselling, days to 50% silking, cob length (cm), ear height (cm) and cob diameter (cm). Thus the genotypes differed considerably for stability for the traits under investigation over the environment.

Based on Eberhart and Russell's model (1966), a wide adaptable genotype is defined as the one with $b_i$=1 and high stability as one with $s^2di$=0. As per the results obtained during present investigation the genotype demonstrated early maturity were H05 followed by H32 but based on stability parameters the genotypes viz., H05, H32, H23, H11 and H24 were found the most stable across the locations / environments with non-significant linear ($b_i$) and non- linear ($s^2di$) components approaching to 1 and 0 respectively. In case of days to 50% silking, H32, H05, H23 were desirable genotypes across locations because of low mean compared to population mean and regression coefficient bi was nearer to unity and had non-significant deviation from regression. In case of plant height (cm) highest mean performance was found for H18 and H11 and as for stability is considered H05,H23 and H32 were found stable across the locations with regression linear ($b_i$) and regression coefficient equal to unity value i.e., 1 and 0. And some genotypes viz., H18, H24, PMH-10 had $b_i$ value more than unity and non-significant deviation from regression indicating their suitability for all the environments under study with unpredictable performance. For number of cobs plant $^{-1}$, the hybrids H02, H05, H10, H24 were found stable because of high mean and non – significant deviation. For cob length H05, H23, H02, H10, H11 recorded high mean value and with regression coefficient almost equal to unity or less than unity and non- significant deviation from regression indicating good stability across the locations.

For cob diameter, the hybrids possessing high mean were H05, H11, H18, H24, H25 and H32.

**Table 2: Analysis of Variance for stability of different morphological traits in maize over locations**

| | | Mean Sum of Squares | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Source of Variation** | **df** | **50 % Tasselling** | **50 % Silking** | **Days to maturity** | **Plant height (cm)** | **Ear height (cm)** | **Cob length (cm)** | **Cob diameter (cm)** | **Test weight (g)** |
| **Genotypes** | 11 | 7.378 ** | 6.744** | 43.94 *** | 205*** | 36.6 ** | 0.75** | 0.27 *** | 16.1*** |
| **E+(G*E)** | 21 | 6.093 | 6.189 | 94.55 | 1370 | 262.2 | 2.21 | 1.66 | 77.9 |
| **E (Linear)** | 1 | 36.623** | 40.956** | 1299.21*** | 31597** | 4957.8** | 13.02** | 36.8** | 1632** |
| **G*E (Linear)** | 11 | 8.142** | 7.898** | 62.79 *** | 66.1*** | 24.3 * | 3.24*** | 0.12*** | 19.4*** |
| **Pooled deviation (non linear)** | 12 | 1.195** | 1.174** | 2.66 | 47.2 | 6.8*** | 0.37* | 0.14*** | 2.00 |
| **Pooled error** | 72 | 0.341 | 0.374 | 38.38 | 0.671 | 0.1 | 0.19 | 0.01 | 1.53 |

Based on the mean performance H05, H32 and H23 were high yielding hybrids across the locations and were average in stability while based on stability parameters the hybrids H11, PMH-10, DHM-117 were poorly adapted. The genotypes having significant and more than unit $b_i$ values, were suited for better environment only for this trait. Significant mean square have been reported for most of the traits in maize genotypes over environments by Agarwal *et al*. (2000), Dodiya and Joshi (2003), Nadagoud *et al*. (2012), Abera *et al*. (2013) and Puttaramanaik *et al*. (2016). The variance due to genotype x environment (linear), genotype, and environments were found significant for various traits by Nadagoud *et al*. (2012). Significant mean square for pooled deviation (non - linear) regarding various traits have been reported by Arun and Singh (2004), Kaundal and Sharma (2006) and Puttaramanaik *et al.* (2016).

**TABLE 3: Stability parameters for days to maturity, plant height, cob length, cob diameter**

| **HYBRIDS** | **Days to maturity** | | | **Plant height** | | | **Cob length** | | | **Cob diameter** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (X) | $b_i$ | $S^2di$ | (X) | $b_i$ | $S^2di$ | (X) | $b_i$ | $S^2di$ | (X) | $b_i$ | $S^2di$ |
| H02 | 141 | 0.78 | 1.78 | 227.56 | 1.09 | -0.47 | 26.65 | 1.6 | 2.18 | 4.26 | 1.14 | 0.01 |
| H04 | 140.77 | 0.72 | 7.63 | 225.68 | 0.91 | 2.01 | 25.47 | 1.25 | 1.12 | 4.18 | 1.16 | 0.01 |
| H05 | 135.55 | 0.95 | 0.04 | 225.99 | 1.01 | 0.01 | 26.76 | 0.93 | 0.2 | 4.51 | 0.99 | 0.01 |
| H11 | 142 | 0.75 | 1.01 | 218.5 | 0.73 | 0.52 | 26.33 | 0.84 | -0.04 | 4.06 | 0.93 | 0.08 |
| H18 | 141 | 0.68 | 0.26 | 229.23 | 1.05 | -0.41 | 26.45 | -0.17 | 0.54 | 4.41 | 1.44 | 0.12 |
| H23 | 141.55 | 0.71 | 2.5 | 229.8 | 1.12 | -0.49 | 25.59 | 1.67 | 0.16 | 4.41 | 1.06 | 0 |
| H24 | 140 | 0.85 | 0.92 | 224.04 | 1.09 | 0.12 | 26.78 | 0.8 | 0.08 | 4.21 | 0.94 | 0.13 |
| H25 | 140.55 | 0.69 | 0.69 | 226.61 | 1.18 | -0.15 | 25.59 | 1.61 | 1.02 | 4.42 | 0.77 | 0.13 |
| H32 | 140.77 | 0.86 | 0.52 | 222.87 | 0.72 | -0.46 | 25.88 | 1.52 | 1.18 | 4.32 | 0.72 | 0 |
| DHM-117 | 136 | 1.15 | 0.08 | 214.04 | 1.09 | 0.13 | 26.22 | 1.12 | 0.06 | 4.54 | 0.8 | 0 |
| PMH-10 | 141.44 | 2.96 | 6.12 | 217.07 | 0.82 | 0.2 | 23 | 0.76 | 0.42 | 3.97 | 0.91 | -0.03 |
| MEAN | 141.88 | 0.72 | 1.97 | 219.39 | 1.15 | 0.57 | 23.21 | 0.05 | 2.44 | 3.43 | 1.1 | 0.01 |
| SE (m) | 140.21 | - | | **223.4** | **-** | **-** | **25.64** | **-** | - | **4.31** | **-** | |

Based on the findings of the present study, it could be summarized as:

- Hybrids H05, H32 and 23 were identified as most stable hybrids based on stability analysis across locations for yield and other desirable traits, however further both spatially and temporally should be done with increased number of locations to validate the stability. Genotypes selected in the present study were diverse and random. These genotypes possessed significant variation for all the traits.

- Non-linear component of $s^2di$ (representing deviation from the regression slope) was non- significant in most of the cases and thus the prediction of stability was more or less accurate.

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