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Variability and stability evaluation in Indian Maize (*Zea mays* L.) landraces collected from North Eastern Himalayan region

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Abstract

Maize landraces collected from Mizoram state of North Eastern India were evaluated for three years (2017, 2018 and 2019) to assess the amount of variability present among the genotypes, association of traits and stability (parametric and non-parametric). MZM-44 was found to be a superior line with respect to yield and yield related traits. Least difference between GCV and PCV in number of days to silking and tasseling suggested minimal influence of environment in three years which is contrasting as compared to yield per plant. Yield per plant was highly correlated with ear diameter and test weight. From path coefficient analysis it was observed that thousand seed weight has the highest direct effect on the yield predicting the possible influence of these characters on yield increase. The genotypes were grouped into seven distinct clusters. Stable line with respect to yield is MZM-40 according to four stability parameters and MZM-34 by five stability parameters. But there was no significant correlation between the yield and stability parameters noted which proves that no stability parameter can be depicted as superior and all have their own shortfalls in explaining the stable genotype with respect to yield. Presence of diversity in germplasm for yield and yield related traits was observed and few stable genotypes for different characters in three years were identified. This experiment paves the way for future yield and allied traits improvement programmes where the identified genotypes could play a pivotal role.

Abbreviations

βi - Regression coefficient
CD - Critical difference
CH - Cob height
CV - Coefficient of variation
DFS - Days for fifty percent silking
DFT - Days for fifty percent tasseling
ED - Ear diameter
EL - Ear length
GAM - Genetic advance percent mean
GCV - Genotypic coefficient of variability
H^2b - Heritability in broad sense
LW - Leaf width
NORPE - Number of rows per ear
NOSPR - Number of seeds per row
PCA - Principal component analysis
PCV - Phenotypic coefficient of variability
Pi - Superiority index;
PH - Plant height
R^2 - Determination coefficient
SD - Standard deviation
SE - Standard error
$Si^{(1)}$ - Mean absolute rank differences
$Si^{(2)}$ - Variance of rank
SV - Stability variance
TL - Tassel length
TSW - Thousand seed weight
Wi - Wricks ecovalence
YPP - Yield per plant
δij - Variance of deviation from regression coefficient

Introduction

Maize is third most important crop in the world as well as India after Rice and wheat. 125 developing countries grow maize in 100 million hectares (FAOSTAT, 2010) due to its wide adaptability features. In spite of having the highest productivity and production in the world as compared to other cereal crops, by 2050 the demand for maize is believed to be increased further (Rosegrant *et al*., 2009). Maize is the second most important crop after rice in the North Eastern part of India. In spite of the various potential uses of maize, the productivity of maize in NEH regions of India is quite less and is far behind the national average of 2.45 t/ha. In Meghalaya maize is cultivated in 29568 ha land with total production and productivity of 69156 M T and 2339 kg/ha respectively. Largest area and production of maize is in West garo hills and highest productivity is from east Khasi hills with 3405 kg/ha (http://megagriculture.gov.in/PUBLIC/download_CropStatistics.aspx). Mainly maize in North east goes for feed industry and some percentage of maize is also used in consumption. The demand for maize as feed is increasing in the north east as the poultry and piggery industries are booming. To increase the yield, expansion of cultivation area is not a viable solution as it will affect the ecology and natural habitats (Prasanna, 2012). The other option might be utilization of suitable high yielding line.

Maize has enormous diversity spread across the world. Utilisation of this diversity necessitates the need of assessment of variability present in the base germplasm population. The diverse population will help in breeding for abiotic and biotic stress tolerance and increasing the yield of plant. Landraces are diverse, adapted to local farming systems and local conditions and not improved through crop improvement practices (Camacho-Villa *et al*., 2005). In north-eastern part of India abundant landraces are found with extreme variability for kernel characters, cob position, cob numbers and tassel characters (Nass *et al*., 1993; Singode *et al*., 2011; Prasanna 2012). These are cultivated by farmers due to less cost of seeds, direct utilization of seeds for next season and suitability to grow well in the least or nil application of fertilisers. Keeping this in view, a three-year experiment was planned in purview of the need for larger exploration of variability and stability of North Eastern landraces. Many researchers have suggested and justified the importance of screening for variability before starting any breeding programme (Jotshi *et al*., 1988; Alvarez and Lasa, 1994; Lu *et al*., 1994 and Zhang *et al*., 1995). Along with this study, estimating association of character to the yield would prove beneficial as it helps breeders in selection of high yielding genotype based on highly correlated traits. Landraces were also subjected for stability analysis using both parametric and non-parametric methods. The GXE interaction can be studied by various methods. Two different methods parametric method (univariate and multivariate) and non-parametric method are used to screen for stability. In the parametric methods, various assumptions need to be fulfilled before examination such as normality, homogeneity of variance and additivity or linearity of genotype and environmental effects whereas non-parametric methods require no such assumptions (Nassar and Huehn, 1987; Huehn, 1990). Most commonly used parametric methods are Wricks (1962) ecovalence method and Eberhart and Russels (1966) model, apart from it there are some more parametric models such as Shuklas (1972) stability variance (SV) and Francis and Kanenberg's (1978) grouping by coefficient of variation (CV) and Lin and Binn's (1988) cultivar superiority index (Pi). There are many non-parametric methods of stability analysis but the method proposed by Huhn (1990 a and b) was used where two rank of stability measures *i.e.*, $Si^{(1)}$ (mean absolute rank differences) and $Si^{(2)}$ (variance among the ranks over environment) will be calculated. A cultivar that performs equally over years of cultivation is an important parameter to be checked as the stable performance of a cultivar along with good yield is of prime importance for farmer's cultivation. Hence, screening for stable genotypes is necessary for breeders and comparing the different stability models would help in determining the usefulness of different parametric and non-parametric methods.

Material and methods

Germplasm collection and experimental trials

Thirty-nine germplasms collected from Mizoram state of India, as mentioned in supplementary Table S1 were planted in upland farm of ICAR-Research Complex for North Eastern Hill Region, Umiam, Meghalaya, located at the altitude of 956 meters, for three consecutive years (2017, 2018 and 2019) to check the genotypic variability, association between traits and stability in the midhill conditions of Meghalaya. The land was used to cultivate maize followed by lentil in rotations. Each year, the lines were grown in RCBD design in three rows with spacing of 60 X 10 cm and genotypes were carried forward by complete sib mating.

Trait evaluation

Data was recorded for number of days to silking, number of days to tasseling, plant height (cm), location of cob on the plant (cob height) (cm), ear length (cm), leaf width (cm), tassel length (cm), ear diameter (cm), no of rows in the ear, number of seeds per row, 1000 seed weight and yield per plant (g). Standard agronomic and plant protection practices were followed.

Statistical analysis

Components of variability Genotypic and phenotypic variance was analysed using the formula given by Lush (1940). Phenotypic and genotypic coefficient of variability was analysed by applying the method given by Burton and Devane (1953). The heritability (broad sense) of a genotype was estimated as suggested by Johnson *et al.* (1995). Genetic advance over mean was calculated using genetic advance which was explained by Johnson *et al.* (1995) and divided it by mean and converted to percentage.

Clustering of genotypes based on D2 (Mahalanobis, 1936) statistics. The genotypes were grouped into different clusters following Tocher's method as described by Rao (1952).

Correlation coefficients was estimated to know the degree of association among the traits as per the formula given by Al-jibouri *et al.* (1958).

Path co-efficient analysis was carried out using genotypic correlation coefficients to know the direct and indirect effects of the yield components as suggested by Wright (1921) and illustrated by Dewey and Lu (1959).

Principal component analysis (PCA) was performed to analyse the contribution of each trait in explaining the multivariate polymorphism.

Stability analysis

Parametric methods

Francis and Kannenberg's (1978) suggested the use of CV (%) to know the stability of a genotype. Lower the CV(%) more stable is the genotype.

Eberhart and Russel method (1966) The stability will beassessed using the regression coefficient (βi), deviation from regression coefficient of the ith cultivar in jth environment (δij) and determination coefficient (R^2). The line/genotype is deemed stable when $\beta i = 1$, δij = non-significant and R^2 is significant. If $\beta i < 1$ the line/genotype is considered to perform well in unfavourable environment and $\beta i > 1$ the line/genotype will perform well in favourable condition.

Shukla (1972) here the stability of the genotype is estimated by stability variance (SV). Entries with minimum stability variance is considered to be more stable.

Wricke (1962) explained the concept of ecovalence. If the value of ecovalence is lower the genotype/line is considered to be stable.

Lin and Binns (1988) defined the superiority index (Pi) where they explained the cultivar superiority in stability if the Pi value is low.

Non-parametric method

Huhn's stability measures (1990a, b) explained the stability using two parameters $Si^{(1)}$ (mean absolute rank differences) and $Si^{(2)}$ (variance of rank). Maximum stability is noted when $Si^{(1)}=Si^{(2)}=0$.

Results and Discussion

Variability studies

Before starting any breeding programme, assessment of variability of traits in the population, to derive the required results and plan the varietal development programme is a prerequisite. The minimum and maximum performing genotypes with respect to each character are mentioned in the supplementary Table S2. With respect to yield, MZM-44 constantly out yielded all the genotypes for three consecutive years and showed highest test weight, ear length and number of rows per cob during 2018 and 2019. Ear length was minimum in MZM-33 and maximum in MZM-44. Ear diameter was minimum in MZM-14 and maximum in MZM-34. Number of rows in an ear was highest in MZM-25, MZM-10 and MZM-44 in each respective year, whereas number of seeds per row was highest in MZM-26. MZM-32 requires minimum number of days for silking and tasseling. Least anthesis silking interval (ASI) was recorded in MZM-24 in both consecutive years, which is a preferred character as it confers tolerance to the biotic and abiotic stress (Edmeades *et al.*, 1993; Bolanos, 1996). Kumari *et al.*, 2017 collected traditional growing varieties from the Nagaland state of India and evaluated in two locations in two years and confirmed the significant variability among genotypes similar to our experiment. Salami *et al.*, 2007 also found similar results in maize cultivars. There was least significant difference between GCV and PCV in days to silking and tasseling suggesting the least influence of environment (Abdulugu, 2014 and Rahman *et al.*, 2017). Highest difference between GCV (26.67) and PCV (40.15) was recorded for yield per plant predicting the influence of environment over its variability in three years. PCV was also noted on the higher side in number of seeds per row (11.08), number of rows per ear (10.11), Ear length (10.1), leaf width (6.00), Tassel length (5.04), cob height (3.61), ear diameter (2.72), Test weight (2.24) and plant height (1.46), respectively

Table 1 - Estimates of genetic variability of 12 quantitative traits in 39 genotypes of maize evaluated in Meghalaya in three years (2017, 2018 and 2019)

Parameters	DFT	DFS	PH	CH	LW	TL	EL	ED	NORPE	NOSPR	TSW	YPP
Mean	66.93	70.11	219.44	120.10	9.09	37.99	15.45	12.59	12.71	32.21	265.93	117.72
SD	4.54	4.54	32.21	24.15	1.31	5.31	2.91	2.08	1.84	7.07	60.81	47.21
Minimum	59.00	61.00	134.00	71.00	5.90	3.00	9.40	5.80	10.00	14.00	127.00	35.00
Maximum	82.00	84.00	292.00	178.00	12.50	49.50	26.80	17.30	18.00	47.00	407.00	277.00
SE	0.32	0.31	6.61	6.51	0.50	1.93	1.21	0.54	0.83	2.90	12.37	16.66
CD	1.08	1.05	22.57	22.22	1.71	6.57	4.14	1.84	2.83	9.88	42.22	56.84
CV	1.00	0.93	6.39	11.50	11.69	10.75	16.68	9.09	13.82	19.07	9.87	30.02
GCV	6.73	6.43	13.25	16.54	8.40	8.95	8.72	13.84	4.40	10.87	20.68	26.67
PCV	6.80	6.50	14.71	20.15	14.40	13.99	18.82	16.56	14.51	21.95	22.92	40.15
H^2b	97.84	97.94	81.11	67.43	34.05	40.93	21.47	69.87	9.21	24.53	81.46	44.12
GAM	13.71	13.11	24.58	27.99	10.10	11.79	8.32	23.83	2.75	11.09	38.46	36.50

CH-Cob height; CV-Coefficient of variation; CD-Critical difference; DFS-Days for fifty percent silking;DFT-Days for fifty percent tasseling; ED-Ear diameter; EL-Ear length; GAM-Genetic advance percent mean; GCV-Genotypic coefficient of variability; H2b-Heritability in broad sense; LW-Leaf width; NORPE-Number of rows per ear; NOSPR-Number of seeds per row; PCA-Principal component analysis; PCV-Phenotypic coefficient of variability; PH-Plant height; SD-Standard deviation; SE-Standard error; TL-Tassel length; TSW-Thousand seed weight; YPP-Yield per plant.

(Table 1). High heritability with high genetic advance as percentage of mean was observed for thousand seed weight (Bekele and Rao, 2014) followed by ear diameter, plant height (Kinfe and Teshaye, 2015) and cob height. Population can be improved for these traits by practising simple progeny selection.

Correlation

Correlation studies help to analyse the mutual relationship among the characters, whose knowledge would help in selection of a genotype. Yield per plant is a complex trait, which requires knowing its association with other contributing traits to ease the selection process (Fellahi *et al.*, 2013). Yield per plant was highly positively correlated to ear diameter (0.243) and test weight (0.483), this states that increase in diameter of cob may help in increasing the yield (Kinfe and Teshaye, 2015; Rahman, 2017 and Beiragi *et al.*, 2011). It was also positively correlated to plant height (0.119) which was also reported in experiments of Salami *et al.*, 2007 and Rafiq *et al.*, 2010. Yield per plant was negatively but significantly correlated to days to tasseling (-0.176) and silking (-0.201) suggesting increase in days to tasseling and silking may result in decreased yield (Rahman *et al.*, 2017; Raut *et al.*, 2017). Significant positive correlation was also noted between plant height and cob height; leaf width and plant height; plant height and ear length; plant height and thousand seed weight; number of seeds per row and thousand seed weight (Table 2). The selection of genotypes with higher ear diameter, test weight, lower tasseling and silking days would result in substantial increase in yield.

Path analysis

The estimates of path analysis, direct and indirect relations of important maize traits on plant yield are displayed in Supplementary Figure S3. It is an important estimate to know the exact contribution of a character to yield per plant. It partitions the correlation coefficient into direct and indirect effects to depict the influence of a character on the independent character. Studies on path coefficient analysis revealed that thousand seed weight (TSW) had highest positive direct effect on yield (0.46) concurrent with the correlation estimate (0.483), followed by ear diameter (0.15). The positive direct effect of test weight on yield were parallel with the reports from Begum *et al.* (2016), Kumar *et al.* (2015), Kumar *et al.* (2006), Mohammadi (2003) and of ear diameter with Tulu (2014) and Kumar *et al.* (2006). Hence, improvement in the character will eventually show improvement in yield. Cob height revealed highest indirect effect on yield through plant height followed by number of seeds per row through thousand seed weight (0.75 and 0.22). Aman *et al.*, (2020) conducted an experiment in quality protein maize genotype in western Ethiopia and reported the effect of plant height on yield through cob height in support of our findings. The only negative indirect effect on yield was shown by days to fifty percent silking through plant height (-0.21). Days to fifty percent tasseling and leaf width (0.17 and 0.14) showed indirect effect through plant height. Cob height showed positive indirect effect of 0.16 and 0.12 through ear length and thousand seed weight respectively.

Fig. 1 -

Table 2 - Phenotypic correlation among the yield and yield attributing traits in 39 genotypes of maize evaluated in three years (2017, 2018 and 2019)

	DFS	COBHT	PH	LW	TL	EL	ED	NORPE	NOSPR	TSW	YPP
DFT	0.936**	0.001	-0.02	0.068	0.106*	-0.034	-0.053	0.009	-0.018	-0.211**	-0.176**
DFS		0.055	-0.008	0.034	0.116*	-0.027	-0.065	0.012	-0.016	-0.234**	-0.201**
COBHT			0.754**	0.112*	-0.109*	0.158**	0.07	-0.064	0.073	0.141**	-0.039
PH				0.224**	-0.028	0.219**	0.191**	-0.032	0.058	0.236**	0.119*
LW					-0.063	-0.052	0.101	0.074	-0.127*	-0.035	0.017
TL						-0.068	-0.058	-0.009	-0.054	-0.052	-0.019
EL							0.167**	-0.087	-0.007	0.138*	0.194**
ED								0.025	0.013	0.193**	0.243**
NORPE									0.015	-0.005	0.044
NOSPR										0.227**	0.021
TSW											0.483**

**indicate 1% level of significance *indicate 5% level of significance

CH-Cob height; CV-Coefficient of variation; CD-Critical difference; DFS-Days for fifty percent silking; DFT-Days for fifty percent tasseling; ED-Ear diameter; EL-Ear length; LW-Leaf width; NORPE-Number of rows per ear; NOSPR-Number of seeds per row; PH-Plant height; TL-Tassel length; TSW-Thousand seed weight; YPP-Yield per plant.

Cluster analysis

The genotypes were grouped into two main clusters which is further sub divided into seven clusters at the distance of 100 as mentioned in Supplementary Figure S2. Germplasm lines present in each cluster were mentioned in the Table 4 and variation for various characters was represented. Each cluster was compared for superiority or inferiority of characters. The germplasm collected from Mizoram were found phenotypically diverse. Cluster I, II and IV had seven genotypes each divided with respect to lesser dry cob weight, smaller plant and cob height and smaller leaf width. Cluster V and VII had six genotypes, each divided with respect to higher ear diameter, dry cob weight and seeds per row in cluster V and highest cob height in cluster VII. Cluster III was having genotypes with lower leaf width. Cluster VI had two genotypes with highest thousand seed weight and cob length (Table 4). It is noted that, genotypes were clustered mainly on the yield and yield attributing traits followed by plant height and cob height. The grouping of maize genotypes with respect to plant height and cob height is also witnessed in Easter Serbia (Jaric *et al.*, 2010) and Mexico (Mijanos *et al.*, 2007). Similarly, it was also observed by Kumari *et al.*, 2017 in maize genotypes collected from another north eastern state of India *i.e.* Nagaland where it is seen to be diversified with respect to plant height, cob height and yield and yield attributing traits. The diversity in germplasm collected from same place may be due to the selection practised by farmers based on the length and size of cob and its yield (Kumari *et al.*, 2017; Loute and Smale, 2000). There is also possibility of farmers selecting cobs and lines based upon its palatability, which may also lead to the diversification of germplasm at that place. Cluster VI and cluster V genotypes MZM-44, MZM-37, MZM-23, MZM-43, MZM-28, MZM-34, MZM-12 and MZM-24 grouped with respect to good yield and yield related characters, hence these genotypes can be utilised for breeding programme.

Principal component analysis (PCA)

Principal component analysis would further divide the broad genetic diversity present in germplasm into major principal components. The first five principal components (Eigen value >1) expressed 73.62% of total variation indicating major contributions of the characters depicted in these components on phenotype (Table 3). The outliers are MZM-70, MZM-22, MZM-44, MZM-32, MZM-53, MZM-13, MZM-14, MZM-56 and MZM-40 (Supplementary Figure S1). Contribution of variance in PC1 is highest by test weight (0.42) followed by yield per plant (0.41), ear diameter (0.37) plant height (0.36) and cob height (0.28). Days to 50% silking (0.48) and tasseling (0.47) contributed maximum towards PC2. Number of rows per ear (0.51) and Yield per plant (0.35) contributed highest in PC3. PC4 is associated with number of seeds per row (0.54) and anthesis silking interval (0.49). Ear length (0.65) and anthesis silking interval (0.28) contributed maximum in PC5. The presence of high amount of variability and diversity in the germplasm with respect to all the characters was confirmed. The characters associated with yield and size of plants are main contributors towards the variance (Rahman *et al.*, 2017; Hartings *et al.*, 2008). Hence, the germplasm would act as a great source for selection and usage of genotypes to extract the diversified traits. High correlation exist between yield per plant and thousand seed weight (Supplementary Figure S1), therefore the ge-

Table 3 - Principal component analysis of yield and yield related traits in 39 genotypes of maize evaluated in three years (2017, 2018 and 2019)

	PC 1	PC 2	PC 3	PC 4	PC 5
DFT	-0.31	0.47	0.3	0.05	0.11
DFS	-0.31	0.48	0.18	0.21	0.21
ASI	0	0.03	-0.36	0.49	0.28
CH	0.28	0.42	-0.33	0.16	-0.17
PH	0.36	0.42	-0.24	-0.05	-0.17
LW	0.07	0.33	0.08	-0.52	-0.33
TL	-0.14	-0.03	-0.1	-0.12	-0.01
EL	0.26	0.22	0.03	-0.08	0.65
ED	0.37	0.07	0.28	-0.19	0.11
NORPE	-0.11	0.02	0.51	0.12	-0.08
NOSPR	0.13	0.07	0.26	0.54	-0.45
YPP	0.41	-0.13	0.35	0.03	0.23
TSW	0.42	-0.1	0.18	0.21	-0.07
Eigenvalue	3.25	2.14	1.6	1.42	1.17
% Variance	24.98	16.42	12.3	10.89	9.03

CH-Cob height; CV-Coefficient of variation; CD-Critical difference; DFS-Days for fifty percent silking;DFT-Days for fifty percent tasseling; ED-Ear diameter; EL-Ear length;LW-Leaf width; NORPE-Number of rows per ear; NOSPR-Number of seeds per row; PH-Plant height;TL-Tassel length; TSW-Thousand seed weight; YPP-Yield per plant.

notypes found in this vicinity MZM-32, MZM-44, MZM-24, MZM-23, MZM-16 and MZM-26 can be selected as high yielders. Number of seeds per row, ear diameter, ear length, plant height and cob height are grouped together. Number of rows per ear and tassel length falls under the same cluster.

Stability analysis

Most of the researchers conducted Genotype X Environment interaction studies only for yield using both or either parametric and non-parametric methods (Abera *et al.*; 2006; Bujak *et al.*, 2014; Scapim *et al.*, 2000; Changizi *et al.*, 2014). These stability parameters are known to be more of performance evaluating type than explaining the stability of genotype (Purchase, 1997). Both parametric and non-parametric method was inconsistent in explaining stability with all the characters, these kind of inconsistency among stability parameters to judge the stable variety is also found in other studies (Mohamaddi *et al.* ., 2007;2008). But Bujak *et al.*, 2014 in their experiment in maize hybrids reported selection of two hybrids consistently for stability except one stability method. They predicted this might be due to small number of maize genotypes used for evaluation. Since the number of genotypes were high and comparatively low yielding the commercial varieties might explain the inconsistency of results. The stable genotypes with respect each stability parameter is mentioned under each character in paragraphs below.

Yield

MZM-34, MZM-40 and MZM-37 had the lowest CV% of 1.34, 0.41 and 1.48 respectively according to Francis and Kannenberg's (1978). MZM-34 had the second highest yield and MZM-40 and MZM-37 yields were above the mean levels. Hence these three genotypes are considered to be highly stable. MZM-12, MZM-16 and MZM-42 had the highest CV% hence they are the least stable. With respect to Eberhart and Russels model, regression coefficient of 1 was noted only in MZM- 40 which had the δij of -414.89 and R2 0.87. This suggests that it is a stable genotype with good predictability. MZM-16 had the highest βi which is 11.02, δij of -384.392 and 0.92. It had shown its potential to grow well in high yielding congenial environment. MZM-12 had βi of -16.80 but had highest δij of 560.33 and lowest R2 0.468 hence, categorised as highly unstable. Shuklas (1972) and Wricks (1962) results confirmed MZM-40, MZM-34 and MZM-6 had the lowest stability variance of -0.88, 1.09 and 1.35 respectively where in case of Wricks ecovalance MZM-40, MZM-34 and MZM-6 had the least Wi which was 0.44, 4.19 and 4.67, hence these are the most stable genotypes. MZM-16, MZM-47 and MZM-12 had the highest SV of 176.14, 39.00 and 1020.82 respectively and hence are considered to be least stable genotypes with respect to yield. According to Linn and Binn's, MZM-44 had the least Pi (0) followed by MZM-34 (178.76) and MZM-24 (546.83) which were the stable genotypes. MZM-56, MZM-42 and MZM-8 had the highest superiority index and hence less stable. Huhn's model results showed MZM-34, MZM-44 and MZM-8 had $Si^{(1)}$ and $Si^{(2)}$ of zero value, which predicts that these genotypes are highly stable across environments with respect to yield (Table 5). MZM-40 was chosen as stable variety with respect to yield by Francis, Eberhart and Russels, Shukla, Wricks, whereas MZM-34 was noted as stable by all except Eberhart and Russel. Hence MZM-40 and MZM-34 can be labelled as stable line with respect to yield.

Plant height

According to Francis and Kannenberg's equation, MZM-40 had the least coefficient of variability *i.e.*, 0.46 followed by MZM-22 (0.56). MZM-22, MZM-37, MZM-48, MZM-6 and MZM-40 were considered to be most stable genotype with respect to plant height as their CV% was low. MZM-11, MZM-25 and MZM-32 had the highest CV% and hence they are observed to be less stable. If the selection is for low plant height and stable genotype, then MZM-54 and MZM-41 had the lowest plant height with a CV% of 0.88 and 0.94 respectively. Similarly, according to Eberhart and Russels (1966) no genotype was found to have the regression coefficient

Table 4 - Clustering of genotypes based on diversity of 39 genotypes evaluated in Meghalaya

Cluster no	Genotype	No of genotypes	DFT	DFS	PH	CH	LW	TL	EL	ED	NORPE	NOSPR	YPP	TSW	Character
I	MZM-7, MZM-11, MZM-51, MZM-42, MZM-31, MZM-40, MZM-48	7	68.35	71.46	221.84	125.46	9.36	36.9	15.34	12.63	12.73	28.21	93.38	201.6	Less dry cob weight
II	MZM-41, MZM-54, MZM-56, MZM-8, MZM-14, MZM-13, MZM-59	7	68.27	71.54	182.76	96.21	8.93	38.2	14.67	11.15	12.84	29.38	93.1	208.11	Small plant height and cob height
III	MZM-15, MZM-4, MZM-50, MZM-53	4	66.31	69.33	192.5	102.25	8.28	39.78	15.78	12.07	12.53	33.06	112.47	282.58	Low leaf width
IV	MZM-10, MZM-32, MZM-47, MZM-16, MZM-25, MZM-33, MZM-5	7	65.92	69.24	211.76	118.02	8.45	37.41	14.49	12.63	12.92	33.81	114.98	306.3	Low leaf width
V	MZM-23, MZM-43, MZM-28, MZM-34, MZM-12, MZM-24	6	66.41	69.04	218.02	110.74	9.47	38.11	16.01	13.93	12.85	34.22	166.28	292.09	Highest ear diameter, dry cob weight and highest seeds per row
VI	MZM-37, MZM-44	2	66.17	68.94	261.28	140.83	9.77	36	19.57	13.38	12.89	29.67	182.83	377.11	Highest thousand seed weight, highest cob length
VII	MZM-6, MZM-21, MZM-70, MZM-26, MZM-3, MZM-22	6	65.98	69.78	263.02	153.15	9.34	37.76	15.61	12.77	12.22	36.09	120.61	293.59	Highest cob height

CH-Cob height; CV-Coefficient of variation; CD-Critical difference; DFS-Days for fifty percent silking; DFT-Days for fifty percent tasseling; ED-Ear diameter; EL-Ear length; LW-Leaf width; NORPE-Number of rows per ear; NOSPR-Number of seeds per row; PH-Plant height;TL-Tassel length; TSW-Thousand seed weight; YPP-Yield per plant.

Table 5 -Estimates of six stability parameters for yield in 39 maize germplasm evaluated in three years (2017,2018 and 2019) in Meghalaya

Genotype	Mean	CV (%)	βi	δij	R2	SV	Wi	Pi	Si(1)	Si(2)
MZM-3	107.00	2.35	1.82	-412.68	0.79	1.35	4.67	4755.67	0.33	0.50
MZM-4	112.00	2.38	2.02	-413.57	0.88	1.50	4.95	4282.31	0.33	0.50
MZM-5	93.33	3.76	-2.74	-413.48	0.92	22.27	44.36	6161.28	1.00	1.00
MZM-6	148.67	1.69	1.82	-412.68	0.79	1.35	4.67	1568.17	0.33	0.12
MZM-7	128.00	2.23	2.07	-412.12	0.80	2.41	6.69	2933.87	1.33	1.50
MZM-8	55.00	6.39	2.57	-410.81	0.82	5.24	12.05	11174.33	0.00	0.00
MZM-10	131.33	2.67	2.57	-410.81	0.82	5.24	12.05	2688.61	1.67	2.25
MZM-11	84.00	4.18	2.57	-410.81	0.82	5.24	12.05	7264.17	0.33	0.50
MZM-12	164.22	18.44	-16.80	560.34	0.47	1020.82	1939.04	1027.87	8.67	56.50
MZM-13	93.67	4.27	3.04	-411.36	0.88	7.63	16.58	6150.56	1.67	2.50
MZM-14	82.00	4.88	3.04	-411.36	0.88	7.63	16.58	7509.72	0.33	0.12
MZM-15	135.67	2.95	3.04	-411.36	0.88	7.63	16.58	2384.56	0.67	0.50
MZM-16	121.22	11.67	11.02	-384.39	0.92	176.14	336.32	3566.56	2.50	14.62
MZM-21	167.33	2.10	2.57	-410.81	0.82	5.24	12.05	708.61	0.33	0.50
MZM-22	125.00	3.61	3.33	-408.45	0.83	11.24	23.44	3177.00	1.50	2.12
MZM-23	147.67	2.38	2.57	-410.81	0.82	5.24	12.05	1629.67	1.00	1.12
MZM-24	172.00	2.04	2.57	-410.81	0.82	5.24	12.05	546.83	0.67	0.50
MZM-25	122.67	2.86	2.57	-410.81	0.82	5.24	12.05	3358.83	0.67	0.50
MZM-26	103.00	4.85	3.80	-409.13	0.88	14.68	29.96	5167.56	1.00	1.00
MZM-28	168.67	2.96	3.80	-409.13	0.88	14.68	29.96	669.39	1.17	1.62
MZM-31	84.33	4.74	3.04	-411.36	0.88	7.63	16.58	7227.00	0.33	0.50
MZM-32	131.67	2.44	2.61	-415.33	1.00	3.03	7.85	2662.00	0.50	1.12
MZM-33	81.00	6.17	3.80	-409.13	0.88	14.68	29.96	7638.89	0.50	0.25
MZM-34	186.44	1.34	1.87	-413.45	0.85	1.10	4.19	178.76	0.00	0.00
MZM-37	161.33	0.41	-0.51	-415.22	0.88	2.58	7.01	930.76	1.00	1.00
MZM-40	90.33	1.48	1.01	-414.89	0.88	-0.88	0.44	6511.37	0.67	0.50
MZM-41	140.33	3.21	3.33	-408.45	0.83	11.24	23.44	2078.11	0.67	0.50
MZM-42	60.00	7.52	3.33	-408.45	0.83	11.24	23.44	10446.17	0.67	0.50
MZM-43	158.67	3.15	-3.80	-409.13	0.88	39.00	76.12	1042.72	0.50	0.62
MZM-44	204.33	2.45	-3.80	-409.13	0.88	39.00	76.12	0.00	0.00	0.00
MZM-47	123.67	4.04	-3.80	-409.13	0.88	39.00	76.12	3253.56	2.33	10.50
MZM-48	80.33	5.61	3.33	-408.45	0.83	11.24	23.44	7718.11	0.17	0.12
MZM-50	95.89	1.75	-1.32	-415.00	0.94	7.69	16.70	5883.81	0.67	0.50
MZM-51	70.67	3.56	-1.98	-414.59	0.94	13.51	27.75	8935.50	0.33	0.50
MZM-53	106.33	2.37	-1.98	-414.59	0.94	13.51	27.75	4804.11	1.33	2.50
MZM-54	117.00	3.00	-2.74	-413.48	0.92	22.27	44.36	3814.33	1.50	3.62
MZM-56	64.33	2.59	-1.27	-414.64	0.88	7.47	16.29	9803.70	0.67	0.50
MZM-59	99.33	3.54	-2.74	-413.48	0.92	22.27	44.36	5513.28	1.00	1.00
MZM-70	72.67	6.21	3.33	-408.45	0.83	11.24	23.44	8698.17	0.33	0.50

βi-regression coefficient; Pi-superiority index; R^2-determination coefficient; SV-stability variance; $Si^{(1)}$-mean absolute rank differences; $Si^{(2)}$-variance of rank; Wi-Wricks ecovalence; δij- variance of deviation from regression coefficient

equal to 1. MZM-41 and MZM-16 had the lowest regression coefficient of -0.46 and -0.45 and deviation from regression line of -65.20 and -61.06. MZM-11, MZM-44 and MZM-3 had regression coefficient above 1 and δij below 0. All these genotypes had a determination coefficient above 0.90 except MZM-16 which had 0.50. This further indicates that MZM-41 is suitable for harsh environment and has good repeatability as its determination coefficient is good. MZM-11, MZM-44 and MZM-3 was found to be suited to congenial environment. Stability analysis according to Shuklas (1972) and Wricks (1962) results showed MZM-21 had the ne-

Table 6 - Spearman's rank correlations among six stability parameters (parametric and non-parametric) and Yield per plant

	YPP	CV (%)	βi	δij	R^2	SV	Wi	Pi	$Si^{(1)}$	$Si^{(2)}$
YPP	1	-0.521	-0.191	0.103	-0.22	-0.062	-0.062	-1	0.187	0.217
CV(%)		1	0.382	0.638	0.035	0.624	0.624	0.528	0.104	0.111
βi			1	0.459	-0.144	-0.088	-0.088	0.188	-0.051	-0.11
S2di				1	-0.433	0.491	0.491	-0.095	0.112	0.065
R^2					1	0.409	0.409	0.215	0.145	0.208
SV						1	1	0.069	0.373	0.372
Wi							1	0.069	0.373	0.372
Pi								1	-0.184	-0.214
$Si^{(1)}$									1	0.908
$Si^{(2)}$										1

βi-regression coefficient; Pi-superiority index; R^2-determination coefficient; SV-stability variance; $Si^{(1)}$-mean absolute rank differences; $Si^{(2)}$-variance of rank; Wi-Wricks ecovalence; δij- variance of deviation from regression coefficient; Yield per plant

gative stability variance (SV) of -0.79. MZM-70, MZM-3 and MZM-44 had the least stability variance suggesting that these are the most stable genotypes. MZM-32 (219.30) and MZM-25 (232.24) had the highest stability variance and considered as the most unstable genotypes. These results are similar with Wricks ecovalance where MZM- 21 (-0.79), MZM-44 (2.29), MZM- 3(2.29) and MZM-70 (3.44) had least Wi and are the most stable genotypes. MZM-25 and MZM-32 had Wi of 442.81 and 418.26 and hence are the least stable. According to Linn and Binn's (1988), MZM-70, MZM-22 and MZM-3 had the least superiority index of 0, 5.28 and 8.54 respectively indicating the most stable behaviour in each year. Huhn's, 1987 has a different judgement where, MZM-70, MZM-37, MZM-48, MZM-54 and MZM-41 had $Si^{(1)}$ and $Si^{(2)}$ of zero value suggesting these as the most stable genotypes across environments (Supplementary Table S3). Since positive correlation was reported between the yield and plant height, stability of plant height might play a role in yield stability across seasons.

Cob height

According to Francis and Kannenberg's (1978) model, CV% was lowest in MZM-41(0.42), MZM-47(0.65) and MZM-6(0.68). MZM-37 and MZM-14 had a CV% of 1.13 and 1.20 respectively and their cob location was present in the centre of the plant which was quite appropriate to avoid lodging. Hence can be considered stable genotypes and the genotypes of choice. Eberhart and Russels results showed MZM-22 had the regression coefficient equal to 1 and deviation from regression of -63.29 and determination coefficient of 0.99, hence this can be regarded as the most stable genotype according to this stability model. βi was noted to be more than 1 and was highest in MZM-21, MZM-10 and MZM-32 although MZM-32 determination coefficient is more (0.78) but deviation from regression was 21.02 which doubts its stability. Shuklas (1972) model predicted MZM-3 (-0.05), MZM-22 (-0.13) and MZM-53 (-0.05) as the genotypes with the lowest stability variance. Hence, those are regarded as the most stable according to shuklas stability method. Wrickes ecovalance method predicted MZM-3 (0.24), MZM-22 (0.08) and MZM-53 (0.24) as the stable genotypes which is concurrent with the results from Shukla's stability variance. Linn and Binn's superiority index indicated MZM-22, MZM-70 and MZM-3 as the stable genotypes as their values was less in comparison to other genotypes. Huhn's model identified MZM-47, MZM-44, MZM-11, MZM-37, MZM-5, MZM-42, MZM-7 MZM- 22 and MZM-54 as the stable genotypes as their values of $Si^{(1)}$ and $Si^{(2)}$ were Zero (Supplementary Table S4).

Days to flowering

The Lowest CV% for silking was observed in MZM-24, MZM-10 and MZM-4 where mean days of silking was 67.89, 70.44 and 70.44 days respectively which is on par with the average number of days silking by all genotypes. MZM-10, MZM-42 and MZM-4 recorded lowest CV% for tasseling where mean days for tasseling was 66.89, 66.89 and 67.44 which is in line with the average number of days for tasseling by all genotypes. These genotypes can be described as stable genotypes according to the Francis stability analysis. According to Eberhart and Russels (1966) MZM-3 and MZM-56 had the regression coefficient 1 and deviation from regression line was non-significant (-0.004 and -0.005) whereas the determination coefficient was 0.99 and 0.99, by which it can be concluded as the stable variety with respect to tasseling. MZM-13, MZM-21 and MZM-56 had βi one and deviation from regression line was non-significant (-0.001, -0.001 and -0.001) whereas the determination coefficient was 0.99 by which it may be regarded as stable. There are few other genotypes suitable for low performing and high performing environments. Using Shuklas (1972) and Wricks (1962) methods, MZM-13(-0.19 and 0.02), MZM-21(-0.19 and 0.02) and MZM-56 (-0.19 and -0.02) had less shuklas and wricks coefficient, hence these can be regarded as stable genotypes for silking days. MZM-3 (-0.18 and 0.08), MZM-51 (0 and 0.44) and MZM-56 (-0.22 and 0) had less shuklas and wricks coefficient, hence these are also predicted as stable genotypes for tasseling days. Linn and Binn's (1988) prediction concluded that MZM-22 (5.74, 2.62) and MZM-40 (0.67, 0.67) had the least Superiority index both in tasseling and silking hence can be deemed as stable genotypes. Huhn's models results showed MZM-53, MZM-16 and MZM-13 had the least $Si^{(1)}$ (1.17, 1.67 and 1.83) and $Si^{(2)}$ (3.25, 6.12 and 8.75) hence regarded as stable for tasseling. MZM-53, MZM-13 and MZM-21 had the least $Si^{(1)}$ (1, 1.17 and 1.33) and $Si^{(2)}$ (2.62, 4.25 and 1.62) hence these genotypes are stable according to Huhns method (Supplementary Table S5 and Table S6).

Ear diameter

According to Francis method of stability analysis, MZM-34 had the highest diameter of cob with least CV% of 11.55, this defines MZM-34 as the most stable variety with good cob diameter. It was followed by MZM-12 whose mean girth was more than overall average and had the second least CV% (13.82). Highest CV% was noted in MZM-6 (20.52) variety whose mean diameter was less. Hence it can be called as undesirable and unstable with respect to ear diameter. According to Eberhart and Russels (1966) model regression coefficient for almost all the genotypes were equal to unity except MZM-12 (0.92), MZM-16 (0.94) and MZM-32 (0.76). Their deviation from regression coefficient is -0.36, -0.37 and 0.50 and determinant is 0.99, 0.99 and 0.79. This result suggests that MZM-12 and MZM-16 is suitable for unfavourable environment. The δij value was negative for all the genotypes and R2 value was more than 0.90 except MZM-32. Only MZM-6 had the βi 1.50 suggesting its good performance in favourable environment. According to Shuklas (1972) and Wricks (1962), all the genotypes had the stability variance very less except MZM-32 (0.67) and MZM-6 (0.81) suggesting it as the unstable genotype compared to all other genotype. The results from Wricks ecovalance are parallel to shuklas methodology where MZM-6 (1.54) and MZM-32 (1.26) had the highest values suggesting them as unstable. In Linn and Binn's (1988) stability model, MZM-34 superiority index was zero which was the least among all, suggesting it as a stable genotype followed by MZM-43 (0.25), MZM-24 (0.35) and MZM-42 (0.35). As per Huhn's stability model, perfect zero in both $Si^{(1)}$ and $Si^{(2)}$ were obtained in MZM-34, MZM-43, MZM-25, MZM-3, MZM-8, MZM-11, MZM-13, MZM-56 and MZM-14 (Supplementary Table S7).

Ear length

According to Francis and Kannenberg's model, MZM-70 had the mean ear length of 18.64 with the least CV% of 0.45 suggesting good ear length with stable performance across environments. MZM-28 also represented less CV% of 1.45 and good ear length (17.3). No genotype has the regression coefficient equal to unity, suggesting all the genotypes performed well in both unfavourable and favourable environment respectively according to Eberhart and Russels model. MZM-3, MZM-34 and MZM-6 had the least value 0.007 which is in concurrent with wricks methodology of 0.005 rendering them as stable genotypes according to Shuklas (1972) and Wricks (1962) model. Superiority index was zero in line MZM-44 followed by MZM-37 (0.26) and MZM-15 (0.47). Stability was marked accordingly with respect to Linn and Binn's model. MZM-33, MZM-44 and MZM-37 had $Si^{(1)}$ and $Si^{(2)}$ values as zero, these are stable genotypes according to Nassar and Huens method (Supplementary Table S8).

Leaf width

The CV% was low (0.19) and the mean leaf width was high in MZM-43 (9.94) in comparison to all varieties. All varieties except MZM-43 had the low mean leaf width and high CV% rendering it undesirable or explaining its instability according to Francis and Kannenberg's (1978) model. Eberhart and Russels (1966) model predicted there was no genotype whose βi value was equal to one. MZM-7 has the βi value of 12.56, δij of -0.16 with highest R^2 value of 0.84 as compared to all other genotypes making it a suitable variety to be grown in the favourable environment. MZM-14 (-0.002, 0.001), MZM-21 (-0.002, 0.001) and MZM-13 (-0.002, 0.001) had the lowest shuklas and wricks ecovalance values predicting them as the stable varieties with respect to leaf width. Linn and Binn's model predicted that MZM-37 (0.12), MZM-70 (0.12) and MZM-7 (0.13) were the stable varieties. MZM-14 had both the values zero, MZM-4 and MZM-47 had $Si^{(1)}$ value zero and $Si^{(2)}$ value as 0.38 explaining them as stable varieties according to Huhn's, 1987 model (Supplementary Table S9).

Number of rows per ear

Low CV% and high mean number of rows per ear were observed in genotypes MZM-56 (2.79, 13.77), MZM-22(2.83, 13.56) and MZM-43 (2.98, 12.89) suggesting them as the stable and desirable genotypes. MZM-7 recorded the highest CV% (16.36) and low mean number of rows per ear in comparison to the overall average mean making it an unstable genotype according to Francis and Kannenberg's (1978) stability model. Eberhart and Russels (1966) stability results predicted no genotype had the βi as unity but there were only few genotypes whose determination coefficient was above 90% and low deviation from regression point viz., MZM-41, MZM-44, MZM-10, MZM-13, MZM-6, MZM-54, MZM-51, MZM-32, MZM-11, MZM-43 and MZM-50 The regression coefficient values of these lines were 27.25, -27.25, 23.50, 8.69, 8.69, -8.69, 9.88, 9.88, 9.88, 4.93 and -4.93 respectively hence, proving MZM-41, MZM-10, MZM-13, MZM-6, MZM-51, MZM-32, MZM-11 and MZM-43 as suitable for growing in favourable environments and MZM-44, MZM-50 and MZM-54 as varieties for stressful environments. According to both Shukla and wricks varieties MZM-43 (0.0673, 0.20), MZM-56 (0.11, 0.28) and MZM-24 (0.13, 0.33) had less superiority variance and wricks ecovalance values making them stable varieties. Superiority index was minimum for varieties namely, MZM-56 (1.26), MZM-51 (1.40) and MZM-22 (1.63) suggesting them as stable varieties according to Linn and Binn's (1988) stability model. Huhn's model selected MZM-56 (2.17, 8.75), MZM-22 (2.17, 8.62) and MZM-3 (3.83, 25.25) as these genotypes had the least $Si^{(1)}$ and $Si^{(2)}$ values explaining their stable performance in three years (Supplementary Table S10).

Number of seeds per row

MZM-54 (0.56) and MZM-28 (0) had lowest CV values with mean number of seeds per row above the overall average. Hence, these two were stable varieties with good seeds per row as per Francis and Kannenberg's stability model. According to Eberhart and russel model MZM-13 and MZM-7 was the stable line as its βi value was equal to 1 and deviation from regression line was -12.81 with the determination coefficient of 0.97. Regression coefficient of other genotypes were either above one or below one making them favourable to grow in good climatic condition or stressful environment. Both Shuklas stability variance and wricks ecovalance predicted MZM-8, MZM-13 and MZM-7 as the stable varieties, wherein Shuklas values are -0.016, -0.015 and -0.015 and wricks ecovalance values are 0.038, 0.04 and 0.04 respectively. Only MZM-26 had the superiority index as zero which was the lowest making it as the stable genotype according to Linn and Binn's (1988) stability model. MZM-26, MZM-14 and MZM-13 had both the values as zero predicting them as stable varieties for number of seeds per row as of Huhn's stability model (Supplementary Table S11).

Tassel length

MZM-33 was recorded as a stable genotype with the longest tassel length (49.50 cm) and low CV % (1.85). MZM-43 and MZM-31 also recorded good tassel length with comparatively low CV% according to Francis and Kannenberg's stability model. Eberhart and Russels (1966) results indicated genotypes MZM-24, MZM-26, MZM-13, MZM-4, MZM-43, MZM-31, MZM-51, MZM-22, MZM-53, MZM-15, MZM-34, MZM-37, MZM-8, MZM-56, MZM-21, MZM-47, MZM-14, MZM-70, MZM-11, MZM-42, MZM-25, MZM-54, MZM-23, MZM-41, MZM-48, MZM-10, MZM-7, MZM-6, MZM-3, MZM-59, MZM-40, MZM-44 had the βi value almost equal to one and minimal deviation from regression line with good coefficient of determination hence these can be regarded as stable varieties with respect to tassel length. MZM-16 and MZM-28 had regression values above unity suitable for favourable environment conditions. MZM-50 and MZM-33 had regression coefficient below one, hence recommended to grow in stressful conditions. Both in Shukla and Wricks methods, MZM-24 (-0.0201, 0.0281) and MZM-26 (-0.0201, 0.0281) had the lowest value denoting them as stable varieties. MZM-33 had the superiority index value zero which was the lowest indicating it as a stable line according to Linn and Binn's method. Huhn's method selected MZM-33, MZM-43, MZM-22, MZM-53 and MZM-15 as these genotypes had both $Si^{(1)}$ and $Si^{(2)}$ values as zero making them stable lines in comparison to other genotypes (Supplementary Table S12).

Thousand seed weight

In accordance to Francis and Kannenberg's stability model, MZM-37 has high thousand seed weight of 370gm with low CV% of 0.18 followed by MZM-28 which had thousand seed weight of 269.44g with CV% of 0.07. Both the genotypes can be predicted as stable and desirable lines. MZM-41 and MZM-51 had the regression coefficient equal to one and δij value -222.13 and R^2 of 0.98. The two genotypes are predicted stable according to the Eberhart and Russels stability model. MZM-41 (-13.20, 0.12) and MZM-51 (-13.02, 0.12) were the stable varieties according to both shuklas and wricks method. MZM-44 (106.93) and MZM-37 (271.25) both had low superiority index making them stable varieties according to Linn and Bins method. In Huhn's, 1987 stability model, MZM-7, MZM-13, MZM-14 and MZM-56 had both $Si^{(1)}$ and $Si^{(2)}$ value zero hence predicting them as stable variety (Supplementary Table S13).

Spearman rank correlation among stability parameters and yield

Correlation among the mean performance for yield per plant, non-parametric and parametric coefficients were computed (Table 6). The yield per plant and Francis-Kannenberg's coefficient of variance were noted to have the negative correlation but it was non-significant like rest of the stability parameters which is contrary to the results obtained by Bujak *et al.*, 2014 where they could observe significant correlation between regression coefficient and the yield in maize hybrids. Among the stability parameters CV was seen to be highly correlated with δij, SV and Wi but none of these correlates to yield. Shukla's variance and Wricke's ecovalance is highly correlated $(R = 1)$ similar results were obtained by Rea *et al.* (2017) in sugarcane. Either Shukla's stability variance or Wricks ecovalance can be used for stability estimation as both the method ranks genotypes in similar manner. Huhn's stability measures were also correlated with each other but there was no correlation with yield similar to Bujak *et al.*, 2014.

Conclusions

Extensive variability for yield and yield related traits is observed in the germplasm collected from Mizoram state of India which is comparatively less explored and will act to combat the stagnating maize yield across research communities. Association studies have pointed out the use of ear diameter and test weight in increasing the yield of maize germplasm in this region. It was observed that the six stability parameters (parametric and non parametric) have inconsistently reported the stable genotypes with respect to each character except Shuklas and Wricks stability parameter. MZM-40, MZM-34 and MZM-37 was chosen as stable variety with respect to yield by various stability measures. These lines can be utilized in maize breeding programme. Efforts need to be put to develop a germplasm pool of selected lines of maize in order to effectively utilize them for hybrid and composite development in NEH India.

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Table S1 - List of germplasmof maize procured from Mizoram stateused for variability and stability analysis in three years (2017, 2018 and 2019)

Sl.No.	Genotype name
1	MZM-3
2	MZM-4
3	MZM-5
4	MZM-6
5	MZM-7
6	MZM-8
7	MZM-10
8	MZM-11
9	MZM-12
10	MZM-13
11	MZM-14
12	MZM-15
13	MZM-16
14	MZM-21
15	MZM-22
16	MZM-23
17	MZM-24
18	MZM-25
19	MZM-26
20	MZM-28
21	MZM-31
22	MZM-32
23	MZM-33
24	MZM-34
25	MZM-37
26	MZM-40
27	MZM-41
28	MZM-42
29	MZM-43
30	MZM-44
31	MZM-47
32	MZM-48
33	MZM-50
34	MZM-51
35	MZM-53
36	MZM-54
37	MZM-56
38	MZM-59
39	MZM-70
91	phi 101049

Table S2 - List of polymorphic markers, PIC value and heterozygosity value

Year	Range	DFT	DFS	ASI	PH	CH	LW	TL	EL	ED	NORPE	NOSPR	TSW	YPP
2014	Min	MZM-32	MZM-53	MZM-24	MZM-41	MZM-54	MZM-4	MZM-5	MZM-33	MZM-14	MZM-11	MZM-48	MZM-14	MZM-8
	Max	MZM-40	MZM-40	MZM-21	MZM-70	MZM-22	MZM-31	MZM-33	MZM-44	MZM-34	MZM-25	MZM-26	MZM-12	MZM-44
2015	Min	MZM-26	MZM-34	MZM-24	MZM-41	MZM-54	MZM-4	MZM-28	MZM-33	MZM-14	MZM-3	MZM-48	MZM-14	MZM-8
	Max	MZM-56	MZM-56	MZM-11	MZM-70	MZM-22	MZM-7	MZM-33	MZM-44	MZM-34	MZM-10	MZM-26	MZM-44	MZM-44
2016	Min	MZM-21	MZM-32	MZM-34	MZM-41	MZM-54	MZM-47	MZM-5	MZM-33	MZM-14	MZM-3	MZM-53	MZM-14	MZM-8
		MZM-40	MZM-40	MZM-21	MZM-70	MZM-22	MZM-7	MZM-33	MZM-44	MZM-34	MZM-44	MZM-26	MZM-44	MZM-44

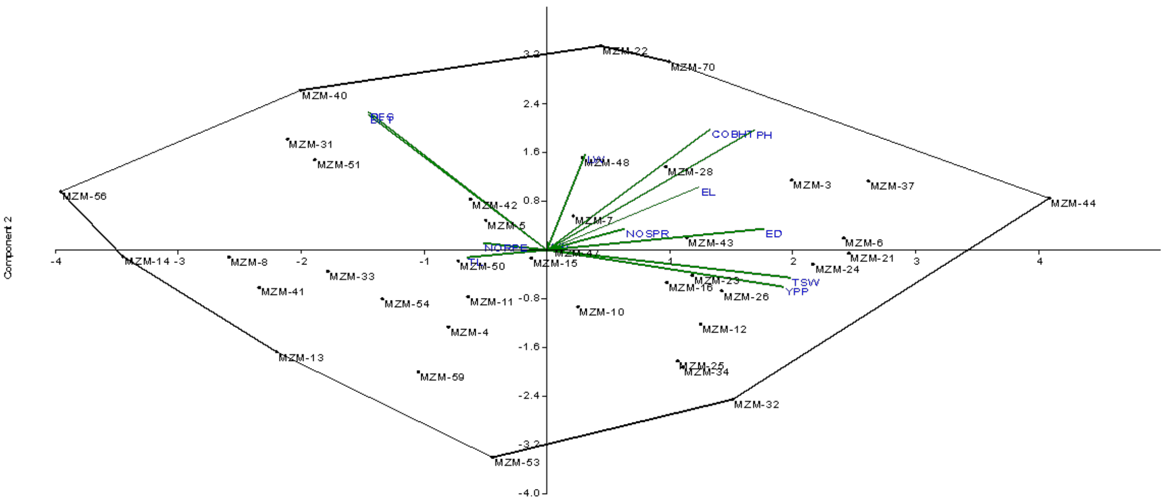

Fig. S 1 - Principal component analysis of yield and yield related traits among 39 genotypes of maize

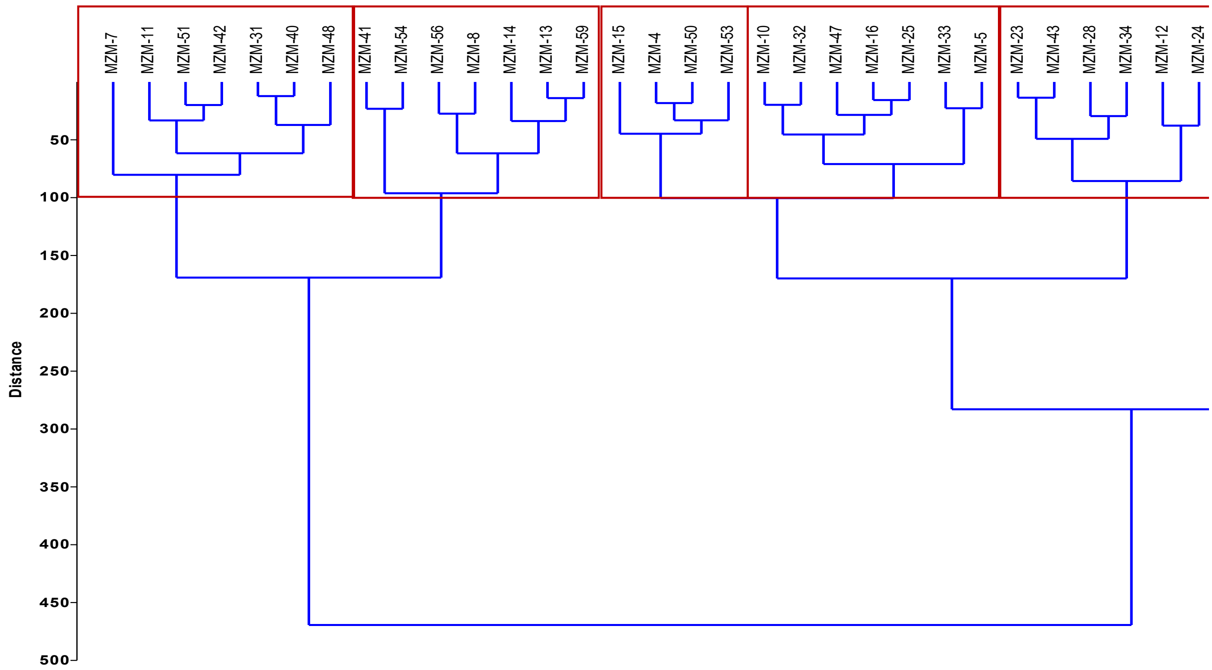

Fig. S 2 - Diagrammatic representation of 39 genotypes in clusters according its relatedness of quantitative traits

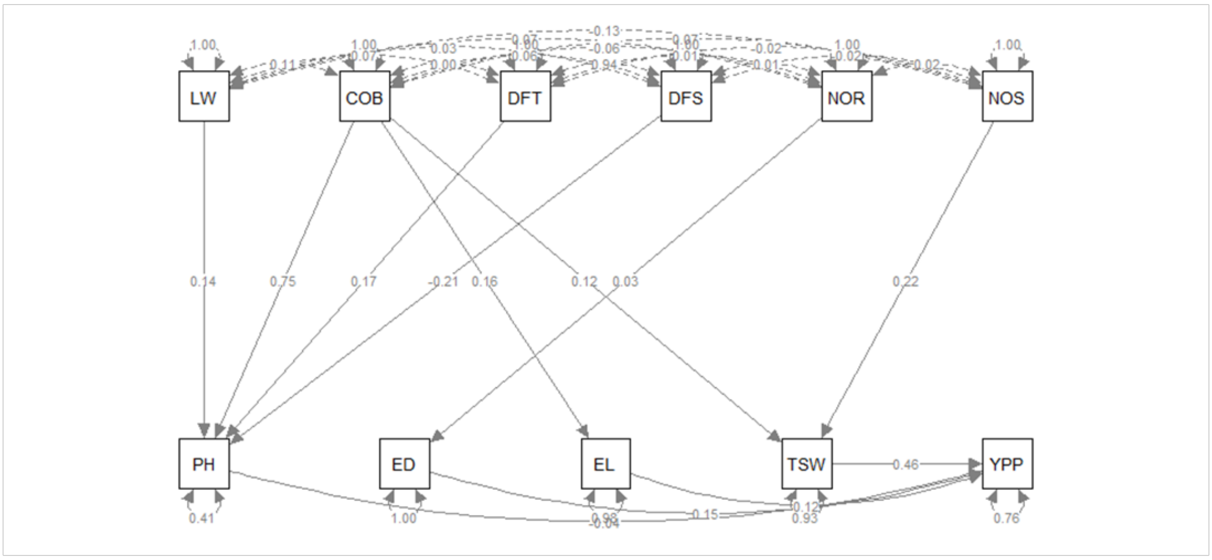

Fig. S 3 - Partitioning of correlation into direct and indirect effects of 11 important traits in 39 maize genotypes

Table S3 - Estimates of plant height stability of maize germplasm evaluated in three years (2017,2018 and 2019) in Meghalaya

Genotype	Mean	CV (%)	βi	δij	R^2	SV	Wi	Pi	$Si^{(1)}$	$Si^{(2)}$
MZM-3	272.89	1.59	1.32	-65.22	1.00	0.07	2.29	8.54	0.33	0.50
MZM-4	189.67	0.81	0.45	-65.15	0.96	2.36	6.63	3774.93	1.33	1.50
MZM-5	204.00	0.75	0.45	-65.15	0.96	2.36	6.63	2632.24	2.00	3.00
MZM-6	258.67	0.59	0.45	-65.15	0.96	2.36	6.63	160.09	0.33	0.50
MZM-7	235.00	0.65	0.45	-65.15	0.96	2.36	6.63	863.52	0.67	1.50
MZM-8	189.33	0.81	0.45	-65.15	0.96	2.36	6.63	3803.94	1.33	1.50
MZM-10	216.67	0.71	0.45	-65.15	0.96	2.36	6.63	1793.43	1.67	2.50
MZM-11	214.33	16.25	10.58	-64.19	1.00	1047.71	1990.11	2295.15	14.00	196.00
MZM-12	191.11	3.56	1.93	-53.67	0.87	14.99	30.59	3659.06	4.00	12.00
MZM-13	185.67	0.82	0.45	-65.15	0.96	2.36	6.63	4130.48	1.33	1.50
MZM-14	194.00	0.79	0.45	-65.15	0.96	2.36	6.63	3407.80	2.00	3.00
MZM-15	196.67	0.78	0.45	-65.15	0.96	2.36	6.63	3191.20	1.33	1.50
MZM-16	224.00	0.93	-0.45	-61.06	0.51	25.12	49.81	1386.02	1.67	8.50
MZM-21	255.67	1.11	0.86	-65.13	0.99	-0.79	0.64	218.41	0.67	0.50
MZM-22	273.33	0.56	0.45	-65.15	0.96	2.36	6.63	5.28	0.33	0.50
MZM-23	229.00	0.67	0.45	-65.15	0.96	2.36	6.63	1130.85	0.67	1.50
MZM-24	235.33	0.65	0.45	-65.15	0.96	2.36	6.63	849.72	0.67	1.50
MZM-25	219.00	8.30	5.52	-64.78	1.00	232.24	442.82	1743.44	5.00	39.00
MZM-26	241.00	0.63	0.45	-65.15	0.96	2.36	6.63	632.19	0.33	0.50
MZM-28	220.67	0.69	0.45	-65.15	0.96	2.36	6.63	1561.87	0.83	0.62
MZM-31	226.67	0.67	0.45	-65.15	0.96	2.36	6.63	1244.54	0.67	1.50
MZM-32	212.00	8.18	4.74	49.70	0.81	219.30	418.26	2165.72	7.50	42.62
MZM-33	209.33	0.73	0.45	-65.15	0.96	2.36	6.63	2259.50	2.00	3.00
MZM-34	202.67	0.75	0.45	-65.15	0.96	2.36	6.63	2729.87	2.00	3.00
MZM-37	266.00	0.57	0.45	-65.15	0.96	2.36	6.63	55.80	0.00	0.00
MZM-40	221.22	0.46	0.30	-65.26	0.96	4.46	10.61	1531.22	1.00	1.75
MZM-41	162.00	0.94	-0.46	-65.20	0.97	23.18	46.12	6565.57	0.00	0.00
MZM-42	219.33	0.70	0.45	-65.15	0.96	2.36	6.63	1637.28	1.33	2.50
MZM-43	229.33	0.67	0.45	-65.15	0.96	2.36	6.63	1115.06	0.67	1.50
MZM-44	256.56	1.69	1.32	-65.22	1.00	0.07	2.29	201.81	1.00	1.00
MZM-47	197.33	0.77	0.45	-65.15	0.96	2.36	6.63	3138.17	1.33	1.50
MZM-48	260.67	0.59	0.45	-65.15	0.96	2.36	6.63	126.31	0.00	0.00
MZM-50	195.67	0.78	0.45	-65.15	0.96	2.36	6.63	3271.59	1.33	1.50
MZM-51	240.33	0.64	0.45	-65.15	0.96	2.36	6.63	656.11	0.33	0.50
MZM-53	188.00	0.81	0.45	-65.15	0.96	2.36	6.63	3921.13	1.33	1.50
MZM-54	174.33	0.88	0.45	-65.15	0.96	2.36	6.63	5224.78	0.00	0.00
MZM-56	185.33	0.82	0.45	-65.15	0.96	2.36	6.63	4160.83	1.33	1.50
MZM-59	188.67	0.81	0.45	-65.15	0.96	2.36	6.63	3862.31	1.33	1.50
MZM-70	276.56	0.73	0.61	-65.25	0.99	0.68	3.44	0.00	0.00	0.00

Table S4 - Estimates of plant height stability of maize germplasm evaluated in three years (2017,2018 and 2019) in Meghalaya

Genotype	Mean	CV (%)	βi	δij	R^2	SV	Wi	Pi	$Si^{(1)}$	$Si^{(2)}$
MZM-3	152.78	0.98	0.81	-63.33	1.00	-0.05	0.24	61.81	0.67	0.50
MZM-4	107.44	1.09	0.63	-63.32	1.00	0.31	0.93	1593.22	0.67	0.50
MZM-5	133.67	1.14	0.82	-63.21	0.97	0.01	0.35	456.78	0.00	0.00
MZM-6	150.22	0.68	0.54	-63.28	0.97	0.60	1.47	93.72	0.67	0.50
MZM-7	125.67	1.22	0.82	-63.21	0.97	0.01	0.35	730.56	0.00	0.00
MZM-8	95.33	1.60	0.82	-63.21	0.97	0.01	0.35	2350.02	0.00	0.00
MZM-10	99.56	6.03	3.25	-63.33	1.00	18.03	34.55	2074.72	3.67	10.50
MZM-11	144.67	1.06	0.82	-63.21	0.97	0.01	0.35	184.83	0.00	0.00
MZM-12	93.22	1.97	-0.43	-57.84	0.18	10.04	19.39	2500.26	1.33	1.50
MZM-13	98.56	0.70	0.36	-63.27	0.94	1.31	2.82	2134.81	1.50	2.12
MZM-14	96.78	1.21	0.63	-63.32	1.00	0.31	0.93	2252.19	0.67	0.50
MZM-15	107.78	1.09	0.63	-63.32	1.00	0.31	0.93	1574.46	0.67	0.50
MZM-16	122.56	2.78	-1.47	-54.97	0.64	26.23	50.12	863.26	2.50	18.75
MZM-21	153.33	4.24	3.52	-63.31	1.00	22.71	43.43	62.46	1.67	2.50
MZM-22	163.89	1.23	1.09	-63.29	1.00	-0.13	0.09	0.00	0.00	0.00
MZM-23	122.00	1.25	0.82	-63.21	0.97	0.01	0.35	877.43	0.33	0.50
MZM-24	117.67	1.30	0.82	-63.21	0.97	0.01	0.35	1068.33	0.33	0.50
MZM-25	118.33	1.29	0.82	-63.21	0.97	0.01	0.35	1037.74	0.33	0.50
MZM-26	143.67	1.06	0.82	-63.21	0.97	0.01	0.35	204.56	0.17	0.12
MZM-28	112.22	0.91	0.54	-63.28	0.97	0.60	1.47	1335.06	0.67	0.50
MZM-31	123.00	1.24	0.82	-63.21	0.97	0.01	0.35	836.04	0.33	0.50
MZM-32	113.22	12.44	6.77	21.03	0.79	163.85	311.24	1334.93	7.00	37.00
MZM-33	110.00	1.39	0.82	-63.21	0.97	0.01	0.35	1452.09	0.67	0.50
MZM-34	97.67	1.56	0.82	-63.21	0.97	0.01	0.35	2192.78	0.50	0.62
MZM-37	134.67	1.13	0.82	-63.21	0.97	0.01	0.35	427.06	0.00	0.00
MZM-40	125.33	1.22	0.82	-63.21	0.97	0.01	0.35	743.35	0.17	0.25
MZM-41	90.89	0.42	-0.18	-63.25	0.73	4.85	9.54	2666.31	0.33	0.50
MZM-42	126.33	1.21	0.82	-63.21	0.97	0.01	0.35	705.30	0.00	0.00
MZM-43	121.67	1.26	0.82	-63.21	0.97	0.01	0.35	891.44	0.33	0.50
MZM-44	147.00	1.04	0.82	-63.21	0.97	0.01	0.35	142.70	0.00	0.00
MZM-47	128.78	0.65	0.45	-63.32	0.99	0.91	2.06	616.85	0.00	0.00
MZM-48	141.33	2.72	2.08	-63.26	1.00	4.04	8.01	255.50	0.17	0.12
MZM-50	104.33	1.46	0.82	-63.21	0.97	0.01	0.35	1773.52	0.67	0.50
MZM-51	124.00	1.23	0.82	-63.21	0.97	0.01	0.35	795.65	0.33	0.50
MZM-53	89.44	1.68	0.81	-63.33	1.00	-0.05	0.24	2771.07	0.33	0.50
MZM-54	73.67	2.07	0.82	-63.21	0.97	0.01	0.35	4070.11	0.00	0.00
MZM-56	115.22	1.17	0.72	-63.28	0.99	0.12	0.57	1184.37	0.67	0.50
MZM-59	103.00	1.48	0.82	-63.21	0.97	0.01	0.35	1853.81	1.00	1.00
MZM-70	155.00	2.27	1.90	-63.26	1.00	2.77	5.59	40.26	0.33	0.50

Table S5 - Estimates of days for silking stability of maize germplasmevaluated in three years (2017,2018 and 2019) in Meghalaya

Genotype	Mean	CV (%)	βi	δij	R^2	SV	Wi	Pi	$Si^{(1)}$	$Si^{(2)}$
MZM-3	69.11	5.33	1.19	0.09	1.00	0.22	0.81	33.15	3.83	21.62
MZM-4	70.44	0.72	0.16	-0.01	0.98	6.83	13.37	30.67	7.83	64.25
MZM-5	72.44	8.97	2.10	0.03	1.00	12.08	23.32	11.33	12.00	114.62
MZM-6	66.44	2.26	0.49	-0.02	1.00	2.44	5.03	62.33	3.33	9.50
MZM-7	69.44	2.16	-0.48	0.03	0.99	21.95	42.05	45.83	16.50	232.12
MZM-8	71.89	12.52	2.91	0.03	1.00	36.67	69.97	17.80	16.33	225.12
MZM-10	70.44	0.72	0.16	-0.01	0.98	6.83	13.37	30.67	7.83	64.25
MZM-11	68.44	3.66	0.81	-0.02	1.00	0.15	0.69	40.67	1.33	2.38
MZM-12	68.44	2.20	0.49	-0.02	1.00	2.44	5.03	43.00	5.33	22.38
MZM-13	68.89	4.36	0.97	-0.01	1.00	-0.20	0.02	35.96	1.17	4.25
MZM-14	72.89	2.76	0.65	0.00	1.00	1.03	2.37	13.07	5.83	48.12
MZM-15	71.44	6.30	1.46	-0.01	1.00	1.90	4.00	16.50	5.00	19.38
MZM-16	68.44	3.66	0.81	-0.02	1.00	0.15	0.69	40.67	1.33	2.38
MZM-21	69.89	4.30	0.97	-0.01	1.00	-0.20	0.02	28.24	1.33	1.62
MZM-22	74.89	6.68	1.62	-0.02	1.00	3.66	7.34	2.63	4.83	18.25
MZM-23	67.78	3.20	-0.70	0.04	0.99	28.86	55.17	63.26	16.50	211.75
MZM-24	67.89	0.28	0.00	0.05	0.00	9.83	19.05	52.69	9.83	72.62
MZM-25	64.44	2.33	0.49	-0.02	1.00	2.44	5.03	85.67	2.67	5.62
MZM-26	65.89	6.08	1.30	-0.02	1.00	0.67	1.68	63.80	2.17	11.25
MZM-28	73.44	4.77	1.13	-0.02	1.00	-0.03	0.35	8.17	2.00	7.38
MZM-31	73.89	5.42	1.30	-0.02	1.00	0.67	1.68	6.02	3.50	10.75
MZM-32	64.00	1.56	0.32	-0.02	1.00	4.39	8.73	92.85	4.00	12.62
MZM-33	72.44	14.49	3.40	0.19	1.00	57.74	109.95	19.33	20.50	333.25
MZM-34	67.22	8.94	1.94	0.76	0.99	9.01	17.51	49.35	8.83	104.12
MZM-37	69.44	9.36	2.10	0.03	1.00	12.08	23.32	29.83	9.67	90.38
MZM-40	76.44	8.50	2.10	0.03	1.00	12.08	23.32	0.67	6.17	28.75
MZM-41	73.44	4.77	1.13	-0.02	1.00	-0.03	0.35	8.17	2.00	7.38
MZM-42	70.44	0.72	0.16	-0.01	0.98	6.83	13.37	30.67	7.83	64.25
MZM-43	69.44	2.16	0.49	-0.02	1.00	2.44	5.03	34.83	4.33	18.25
MZM-44	68.44	3.66	-0.81	0.05	0.99	32.67	62.40	59.00	19.50	299.62
MZM-47	72.44	6.21	1.46	-0.01	1.00	1.90	4.00	11.33	5.50	23.12
MZM-48	69.44	10.80	2.43	0.06	1.00	20.33	38.98	30.83	13.67	182.38
MZM-50	71.56	6.53	1.51	-0.02	1.00	2.43	5.01	15.74	5.50	24.25
MZM-51	72.56	3.68	0.87	-0.01	1.00	-0.02	0.36	13.13	1.67	7.62
MZM-53	63.89	3.14	0.65	0.00	1.00	1.03	2.37	91.57	1.00	2.62
MZM-54	70.89	1.44	0.33	0.02	0.98	4.38	8.71	26.19	5.67	33.12
MZM-56	74.89	4.01	0.97	-0.01	1.00	-0.20	0.02	4.63	2.33	8.25
MZM-59	67.89	5.90	1.30	-0.02	1.00	0.67	1.68	43.35	3.50	30.12
MZM-70	72.44	3.45	0.81	-0.02	1.00	0.15	0.69	14.00	2.17	13.25

Table S6 - Estimates of days for tasseling stability of maize germplasmevaluated in three years (2017,2018 and 2019) in Meghalaya

Genotype	Mean	CV (%)	βi	δij	R^2	SV	Wi	Pi	$Si^{(1)}$	$Si^{(2)}$
MZM-3	65.78	4.82	1.07	0.00	1.00	-0.18	0.09	41.35	2.50	15.62
MZM-4	67.44	0.76	0.17	0.00	0.98	6.18	12.16	35.52	5.33	30.38
MZM-5	68.44	9.50	2.19	0.08	1.00	12.94	24.99	18.91	11.83	119.25
MZM-6	64.44	2.33	0.51	-0.01	1.00	2.04	4.30	58.02	5.50	22.75
MZM-7	66.89	1.52	-0.33	0.11	0.94	16.35	31.46	45.83	14.50	196.75
MZM-8	68.89	13.07	3.03	0.11	1.00	38.15	72.83	19.17	16.83	230.75
MZM-10	66.89	0.29	0.00	0.06	0.00	9.05	17.60	41.50	8.00	68.62
MZM-11	64.44	5.43	1.18	0.00	1.00	0.07	0.58	53.35	3.17	23.62
MZM-12	64.89	3.10	0.68	0.01	1.00	0.76	1.87	52.17	3.50	9.75
MZM-13	65.44	3.82	0.84	-0.01	1.00	0.00	0.44	45.74	1.83	8.75
MZM-14	69.89	2.87	0.68	0.01	1.00	0.76	1.87	16.33	5.50	45.25
MZM-15	68.44	6.58	1.52	0.02	1.00	2.26	4.71	19.57	4.50	15.62
MZM-16	64.44	3.88	0.84	-0.01	1.00	0.00	0.44	55.35	1.67	6.12
MZM-21	61.89	3.25	-0.67	0.16	0.98	25.77	49.32	101.67	11.83	106.62
MZM-22	71.44	6.30	1.52	0.02	1.00	2.26	4.71	5.74	5.33	21.62
MZM-23	64.89	3.10	-0.67	0.16	0.98	25.77	49.32	68.17	14.67	177.38
MZM-24	66.44	2.26	-0.50	0.05	0.99	20.80	39.89	51.80	16.00	222.62
MZM-25	61.89	3.25	0.68	0.01	1.00	0.76	1.87	85.67	2.17	4.25
MZM-26	62.89	6.37	1.35	-0.01	1.00	0.90	2.14	69.50	4.00	24.62
MZM-28	70.44	4.97	1.18	0.00	1.00	0.07	0.58	10.69	2.67	9.38
MZM-31	70.89	5.65	1.35	-0.01	1.00	0.90	2.14	8.17	4.33	15.12
MZM-32	61.44	2.45	0.51	-0.01	1.00	2.04	4.30	92.85	3.67	10.38
MZM-33	68.89	14.52	3.37	0.16	1.00	51.93	98.96	21.50	20.50	337.75
MZM-34	65.89	9.11	2.02	0.01	1.00	9.48	18.42	37.67	7.67	64.38
MZM-37	66.44	9.78	2.19	0.08	1.00	12.94	24.99	33.13	10.00	95.62
MZM-40	73.89	9.48	2.36	0.03	1.00	16.93	32.55	0.67	7.00	37.12
MZM-41	70.44	4.97	1.18	0.00	1.00	0.07	0.58	10.69	2.67	9.38
MZM-42	66.89	0.29	0.00	0.06	0.00	9.05	17.60	41.50	8.00	68.62
MZM-43	65.89	3.05	0.68	0.01	1.00	0.76	1.87	43.00	2.67	7.75
MZM-44	65.89	3.05	-0.67	0.16	0.98	25.77	49.32	59.00	17.83	261.25
MZM-47	69.44	6.48	1.52	0.02	1.00	2.26	4.71	13.96	5.83	25.62
MZM-48	66.44	11.29	2.52	0.13	1.00	21.44	41.12	33.80	14.50	196.75
MZM-50	67.89	7.37	1.69	-0.01	1.00	4.14	8.28	22.67	6.33	31.12
MZM-51	69.44	3.60	0.84	-0.01	1.00	0.00	0.44	17.30	2.50	14.75
MZM-53	61.44	4.07	0.84	-0.01	1.00	0.00	0.44	90.19	1.17	3.25
MZM-54	67.44	0.76	0.17	0.00	0.98	6.18	12.16	35.52	5.33	30.38
MZM-56	71.89	4.18	1.01	-0.01	1.00	-0.22	0.01	6.67	2.00	7.00
MZM-59	63.89	6.27	1.35	-0.01	1.00	0.90	2.14	58.33	3.83	39.25
MZM-70	69.44	3.60	0.84	-0.01	1.00	0.00	0.44	17.30	2.50	14.75

Table S7 - Estimates of ear diameter stability of maize germplasmevaluated in three years (2017,2018 and 2019) in Meghalaya

Genotype	Mean	CV (%)	βi	δij	R^2	SV	Wi	Pi	$Si^{(1)}$	$Si^{(2)}$
MZM-3	12.53	13.82	1.00	-0.44	1.00	0.00	0.00	3.04	0.00	0.00
MZM-4	11.76	14.90	1.01	-0.44	1.00	0.00	0.00	5.26	1.00	1.00
MZM-5	12.37	14.01	1.00	-0.44	1.00	0.00	0.00	3.47	0.33	0.50
MZM-6	12.76	20.52	1.50	-0.44	1.00	0.81	1.54	2.78	7.67	176.50
MZM-7	13.20	13.12	1.00	-0.44	1.00	0.00	0.00	1.62	0.33	0.38
MZM-8	11.40	15.19	1.00	-0.44	1.00	0.00	0.00	6.48	0.00	0.00
MZM-10	13.17	13.15	1.00	-0.44	1.00	0.00	0.00	1.68	0.33	0.38
MZM-11	10.53	16.44	1.00	-0.44	1.00	0.00	0.00	9.98	0.00	0.00
MZM-12	13.82	11.73	0.93	-0.36	0.99	0.06	0.11	0.71	1.33	1.50
MZM-13	10.23	16.93	1.00	-0.44	1.00	0.00	0.00	11.36	0.00	0.00
MZM-14	9.60	18.04	1.00	-0.44	1.00	0.00	0.00	14.58	0.00	0.00
MZM-15	12.70	13.64	1.00	-0.44	1.00	0.00	0.00	2.65	0.00	0.38
MZM-16	12.66	12.99	0.94	-0.37	0.99	0.05	0.09	2.76	2.67	21.50
MZM-21	13.73	12.61	1.00	-0.44	1.00	0.00	0.00	0.80	0.67	0.50
MZM-22	12.13	14.28	1.00	-0.44	1.00	0.00	0.00	4.11	0.33	0.50
MZM-23	12.50	13.86	1.00	-0.44	1.00	0.00	0.00	3.13	0.00	0.38
MZM-24	14.17	12.23	1.00	-0.44	1.00	0.00	0.00	0.35	0.00	0.38
MZM-25	12.57	13.78	1.00	-0.44	1.00	0.00	0.00	2.96	0.00	0.00
MZM-26	12.70	13.64	1.00	-0.44	1.00	0.00	0.00	2.65	0.00	0.38
MZM-28	13.80	12.55	1.00	-0.44	1.00	0.00	0.00	0.72	0.67	0.50
MZM-31	12.50	13.86	1.00	-0.44	1.00	0.00	0.00	3.13	0.00	0.38
MZM-32	12.50	12.01	0.77	0.50	0.79	0.67	1.27	3.34	12.33	114.50
MZM-33	12.00	14.43	1.00	-0.44	1.00	0.00	0.00	4.50	0.33	0.50
MZM-34	15.00	11.55	1.00	-0.44	1.00	0.00	0.00	0.00	0.00	0.00
MZM-37	12.77	13.57	1.00	-0.44	1.00	0.00	0.00	2.49	0.17	0.12
MZM-40	13.00	13.32	1.00	-0.44	1.00	0.00	0.00	2.00	0.33	0.50
MZM-41	11.73	14.76	1.00	-0.44	1.00	0.00	0.00	5.34	0.67	1.00
MZM-42	14.17	12.23	1.00	-0.44	1.00	0.00	0.00	0.35	0.00	0.38
MZM-43	14.30	12.11	1.00	-0.44	1.00	0.00	0.00	0.25	0.00	0.00
MZM-44	14.00	12.37	1.00	-0.44	1.00	0.00	0.00	0.50	0.00	0.38
MZM-47	13.17	13.15	1.00	-0.44	1.00	0.00	0.00	1.68	0.33	0.38
MZM-48	14.00	12.37	1.00	-0.44	1.00	0.00	0.00	0.50	0.00	0.38
MZM-50	11.73	14.76	1.00	-0.44	1.00	0.00	0.00	5.34	0.33	0.50
MZM-51	11.77	14.72	1.00	-0.44	1.00	0.00	0.00	5.23	0.33	0.50
MZM-53	12.10	14.31	1.00	-0.44	1.00	0.00	0.00	4.21	0.33	0.50
MZM-54	13.20	13.12	1.00	-0.44	1.00	0.00	0.00	1.62	0.33	0.38
MZM-56	10.07	17.21	1.00	-0.44	1.00	0.00	0.00	12.17	0.00	0.00
MZM-59	11.80	14.68	1.00	-0.44	1.00	0.00	0.00	5.12	0.33	0.50
MZM-70	12.77	13.57	1.00	-0.44	1.00	0.00	0.00	2.49	0.17	0.12

Table S8 - Estimates of ear length stability of maize germplasmevaluated in three years (2017,2018 and 2019) in Meghalaya

Genotype	Mean	CV (%)	βi	δij	R2	SV	Wi	Pi	Si(1)	Si(2)
MZM-3	15.40	1.63	1.22	-2.24	0.99	-0.01	0.01	10.30	1.50	5.62
MZM-4	15.40	3.25	2.44	-2.24	1.00	0.08	0.17	10.28	2.83	9.12
MZM-5	12.67	3.95	2.44	-2.24	1.00	0.08	0.17	26.40	0.33	0.50
MZM-6	14.00	1.80	1.22	-2.24	0.99	-0.01	0.01	17.62	0.50	0.62
MZM-7	14.73	1.71	-1.22	-2.24	0.99	0.21	0.42	13.71	2.67	17.62
MZM-8	14.56	1.75	-1.22	-2.24	0.96	0.21	0.42	14.65	1.83	5.62
MZM-10	15.07	1.67	-1.22	-2.24	0.99	0.21	0.42	12.03	3.83	29.12
MZM-11	15.07	0.59	-0.41	-2.24	0.89	0.08	0.17	11.96	2.33	15.25
MZM-12	16.41	2.11	-0.42	-2.02	0.06	0.20	0.39	6.35	2.33	4.50
MZM-13	14.90	3.36	2.44	-2.24	1.00	0.08	0.17	12.67	3.33	9.50
MZM-14	15.10	3.31	2.44	-2.24	1.00	0.08	0.17	11.68	3.33	12.50
MZM-15	18.97	2.64	2.44	-2.24	1.00	0.08	0.17	0.47	0.33	0.50
MZM-16	15.89	13.12	9.34	-0.87	0.84	3.79	7.20	9.07	8.67	200.50
MZM-21	16.04	12.36	-9.69	-2.24	1.00	5.04	9.58	9.62	15.00	189.00
MZM-22	17.13	1.86	1.55	-2.24	0.99	0.00	0.03	3.93	0.83	1.12
MZM-23	16.30	8.08	-6.43	-2.24	1.00	2.43	4.63	7.70	10.00	84.00
MZM-24	15.49	3.23	-2.44	-2.24	1.00	0.51	0.99	10.21	6.33	36.50
MZM-25	13.50	1.86	-1.22	-2.24	0.99	0.21	0.42	20.88	1.83	3.12
MZM-26	12.43	2.02	-1.22	-2.24	0.99	0.21	0.42	28.31	1.33	2.50
MZM-28	17.30	1.45	-1.22	-2.24	0.99	0.21	0.42	3.66	1.67	2.50
MZM-31	13.33	3.75	2.44	-2.24	1.00	0.08	0.17	21.78	0.67	0.50
MZM-32	15.98	4.73	2.78	-1.75	0.57	0.39	0.76	7.91	4.50	20.25
MZM-33	10.70	2.35	1.22	-2.24	0.99	-0.01	0.01	42.65	0.00	0.00
MZM-34	14.23	1.77	1.22	-2.24	0.99	-0.01	0.01	16.27	1.17	1.75
MZM-37	19.20	2.60	2.44	-2.24	1.00	0.08	0.17	0.27	0.00	0.00
MZM-40	15.64	3.30	2.52	-2.24	1.00	0.09	0.19	9.20	2.67	9.50
MZM-41	14.33	2.45	1.71	-2.24	0.99	0.01	0.04	15.69	1.83	2.62
MZM-42	15.07	2.68	1.72	-2.16	0.76	0.05	0.12	11.86	3.50	10.12
MZM-43	16.33	3.06	2.44	-2.24	1.00	0.08	0.17	6.48	1.00	2.12
MZM-44	19.93	2.51	2.44	-2.24	1.00	0.08	0.17	0.00	0.00	0.00
MZM-47	17.63	2.84	2.44	-2.24	1.00	0.08	0.17	2.65	1.00	3.00
MZM-48	17.13	2.05	1.71	-2.24	0.99	0.01	0.04	3.93	1.83	4.12
MZM-50	15.60	3.21	2.44	-2.24	1.00	0.08	0.17	9.39	2.00	7.00
MZM-51	15.43	3.24	2.44	-2.24	1.00	0.08	0.17	10.13	2.67	9.50
MZM-53	13.17	3.80	2.44	-2.24	1.00	0.08	0.17	22.89	1.00	1.00
MZM-54	15.37	3.25	2.44	-2.24	1.00	0.08	0.17	10.43	3.00	9.00
MZM-56	12.23	4.09	2.44	-2.24	1.00	0.08	0.17	29.65	0.67	0.50
MZM-59	16.23	3.08	2.44	-2.24	1.00	0.08	0.17	6.85	1.00	1.00
MZM-70	18.64	0.45	0.41	-2.24	0.99	0.01	0.03	0.89	0.33	0.50

Table S9 - Estimates of leaf width stability of maize germplasmevaluated in three years (2017,2018 and 2019) in Meghalaya

Genotype	Mean	CV (%)	βi	δij	R^2	SV	Wi	Pi	$Si^{(1)}$	$Si^{(2)}$
MZM-3	9.43	1.62	1.65	-0.35	0.43	0.01	0.03	0.72	2.67	7.62
MZM-4	7.07	2.16	-0.84	-0.34	0.11	0.03	0.07	6.33	0.00	0.38
MZM-5	9.00	1.70	1.65	-0.35	0.43	0.01	0.03	1.33	2.00	3.00
MZM-6	10.07	1.52	1.65	-0.35	0.43	0.01	0.03	0.18	1.67	4.50
MZM-7	10.32	8.08	12.56	-0.16	0.84	0.63	1.21	0.13	6.17	114.12
MZM-8	9.58	2.70	-1.12	-0.26	0.07	0.08	0.16	0.60	4.67	22.62
MZM-10	7.57	2.89	-1.39	-0.30	0.15	0.06	0.12	4.70	1.33	2.50
MZM-11	7.54	2.01	-0.97	-0.34	0.15	0.03	0.07	4.77	0.33	0.50
MZM-12	10.09	6.41	8.79	-0.12	0.69	0.37	0.71	0.22	6.33	36.50
MZM-13	8.53	0.68	0.82	-0.38	0.76	0.00	0.00	2.19	1.00	1.00
MZM-14	8.73	0.66	0.82	-0.38	0.76	0.00	0.00	1.79	0.00	0.00
MZM-15	7.96	0.48	0.00	-0.38	0.00	0.00	0.01	3.56	0.67	0.50
MZM-16	9.37	8.34	0.90	0.83	0.00	0.64	1.21	1.05	6.33	114.50
MZM-21	7.80	0.74	0.82	-0.38	0.76	0.00	0.00	3.98	0.33	0.50
MZM-22	9.40	2.13	1.66	-0.32	0.26	0.03	0.06	0.77	3.67	19.12
MZM-23	9.13	2.19	-1.66	-0.32	0.26	0.06	0.11	1.16	3.17	12.75
MZM-24	9.60	2.08	-1.66	-0.32	0.26	0.06	0.11	0.58	3.83	11.12
MZM-25	9.37	2.14	-1.66	-0.32	0.26	0.06	0.11	0.84	4.17	18.25
MZM-26	9.13	2.19	-1.66	-0.32	0.26	0.06	0.11	1.16	3.17	12.75
MZM-28	9.63	2.08	1.66	-0.32	0.26	0.03	0.06	0.52	2.00	10.12
MZM-31	10.23	1.95	-1.66	-0.32	0.26	0.06	0.11	0.14	3.67	10.50
MZM-32	8.36	18.46	21.16	1.06	0.70	2.34	4.45	3.14	19.67	292.50
MZM-33	8.43	2.37	1.66	-0.32	0.26	0.03	0.06	2.41	1.00	1.00
MZM-34	8.40	1.82	1.65	-0.35	0.43	0.01	0.03	2.48	0.33	0.50
MZM-37	10.20	1.50	1.65	-0.35	0.43	0.01	0.03	0.12	0.67	1.38
MZM-40	9.57	2.09	-1.66	-0.32	0.26	0.06	0.11	0.61	4.00	12.62
MZM-41	8.63	2.32	-1.66	-0.32	0.26	0.06	0.11	2.02	3.33	9.50
MZM-42	10.17	1.97	-1.66	-0.32	0.26	0.06	0.11	0.16	4.00	12.62
MZM-43	9.94	0.19	0.00	-0.38	0.00	0.00	0.01	0.26	1.83	2.62
MZM-44	9.33	1.99	-1.11	-0.32	0.13	0.05	0.09	0.87	3.33	14.62
MZM-47	7.07	2.16	-0.84	-0.34	0.11	0.03	0.07	6.33	0.00	0.38
MZM-48	9.90	0.67	-0.55	-0.37	0.26	0.01	0.02	0.30	3.17	7.75
MZM-50	9.13	1.09	0.83	-0.37	0.26	0.00	0.02	1.13	1.67	2.50
MZM-51	9.40	1.06	0.83	-0.37	0.26	0.00	0.02	0.77	1.67	6.12
MZM-53	8.97	2.81	-1.67	-0.27	0.16	0.08	0.16	1.42	2.67	9.50
MZM-54	10.10	1.51	-0.84	-0.34	0.11	0.03	0.07	0.18	2.67	5.62
MZM-56	9.63	1.59	-0.84	-0.34	0.11	0.03	0.07	0.53	3.17	8.25
MZM-59	7.33	0.79	-0.01	-0.37	0.00	0.00	0.01	5.41	0.33	0.50
MZM-70	10.20	1.50	1.65	-0.35	0.43	0.01	0.03	0.12	0.67	1.38

Table S10 - Estimates of number of rows per ear stability of maize germplasm evaluated in three years (2017,2018 and 2019) in Meghalaya

Genotype	Mean	CV (%)	βi	δij	R^2	SV	Wi	Pi	$Si^{(1)}$	$Si^{(2)}$
MZM-3	11.11	6.93	-2.38	0.08	0.05	0.62	1.25	9.11	3.83	25.25
MZM-4	12.67	5.26	-2.55	-0.22	0.08	0.47	0.96	3.70	5.33	64.50
MZM-5	13.56	5.68	7.49	-0.48	0.53	0.51	1.03	1.78	5.00	68.62
MZM-6	12.00	5.56	8.69	-0.99	0.95	0.34	0.71	5.70	7.00	39.00
MZM-7	12.44	16.37	-12.60	5.49	0.21	4.49	8.59	5.56	12.00	351.38
MZM-8	12.44	11.15	16.01	-0.04	0.74	1.81	3.51	4.81	16.33	216.12
MZM-10	13.33	13.23	23.50	-0.98	0.99	2.97	5.71	3.04	14.67	173.62
MZM-11	11.11	6.93	9.88	-0.94	0.92	0.48	0.98	9.11	5.33	22.38
MZM-12	13.00	6.78	-10.47	-0.71	0.79	0.91	1.80	2.98	12.33	118.12
MZM-13	12.67	5.26	8.69	-0.99	0.95	0.34	0.71	3.70	7.00	49.00
MZM-14	12.22	11.35	16.18	-0.11	0.76	1.81	3.50	5.48	10.17	145.62
MZM-15	13.11	5.87	-2.38	0.08	0.05	0.62	1.25	2.67	5.00	75.00
MZM-16	11.78	8.65	12.43	-0.69	0.83	0.92	1.81	6.67	8.50	68.62
MZM-21	12.44	11.15	-10.05	1.69	0.29	2.12	4.09	4.81	9.17	211.75
MZM-22	13.56	2.84	-3.75	-0.90	0.53	0.17	0.39	1.63	2.17	8.62
MZM-23	13.33	5.00	-6.13	-0.57	0.47	0.51	1.04	2.15	7.33	56.50
MZM-24	12.22	3.15	-1.19	-0.76	0.05	0.14	0.33	4.89	4.00	24.62
MZM-25	13.33	13.23	-1.02	5.17	0.00	3.26	6.26	3.04	8.67	181.00
MZM-26	12.67	9.12	11.24	0.22	0.53	1.24	2.43	4.00	6.67	127.00
MZM-28	12.44	11.15	-8.52	2.01	0.21	2.10	4.05	4.81	13.33	254.50
MZM-31	13.11	7.77	7.32	0.44	0.29	0.98	1.92	2.81	9.67	134.12
MZM-32	13.11	5.87	9.88	-0.94	0.92	0.48	0.98	2.67	9.00	61.12
MZM-33	13.33	10.00	-5.11	2.23	0.08	1.90	3.68	2.59	8.83	178.12
MZM-34	13.22	8.85	-3.24	1.59	0.04	1.45	2.82	2.69	8.17	155.12
MZM-37	12.22	6.30	2.38	0.08	0.05	0.57	1.14	5.04	5.00	75.00
MZM-40	12.89	10.77	-16.01	-0.04	0.74	2.19	4.22	3.63	18.00	259.00
MZM-41	13.11	15.53	27.25	-1.02	1.00	4.02	7.70	3.85	16.33	236.12
MZM-42	12.67	9.12	-3.58	1.49	0.05	1.42	2.76	4.00	9.00	182.12
MZM-43	12.89	2.99	4.94	-1.01	0.92	0.07	0.20	3.04	4.67	16.50
MZM-44	13.56	15.02	-27.25	-1.02	1.00	4.66	8.92	2.96	22.00	367.00
MZM-47	12.00	11.11	5.11	2.23	0.08	1.78	3.45	6.15	8.17	159.25
MZM-48	13.11	11.74	4.77	3.45	0.05	2.41	4.65	3.26	9.83	261.75
MZM-50	12.44	3.09	-4.94	-1.01	0.92	0.18	0.42	4.22	6.33	30.12
MZM-51	13.78	5.59	9.88	-0.94	0.92	0.48	0.98	1.41	6.33	30.50
MZM-53	11.89	9.01	8.77	0.40	0.37	1.08	2.11	6.31	5.50	74.12
MZM-54	12.67	5.26	-8.69	-0.99	0.95	0.54	1.09	3.70	8.67	68.62
MZM-56	13.78	2.79	1.19	-0.76	0.05	0.11	0.28	1.26	2.17	8.75
MZM-59	13.00	9.25	-14.31	-0.43	0.79	1.66	3.22	3.20	11.50	159.25
MZM-70	11.56	8.81	-12.43	-0.69	0.83	1.21	2.36	7.48	7.33	96.62

Table S11 - Estimates of number of seeds per row stability of maize germplasm evaluated in three years (2017,2018 and 2019) in Meghalaya

Genotype	Mean	CV (%)	βi	δij	R^2	SV	Wi	Pi	$Si^{(1)}$	$Si^{(2)}$
MZM-3	35.44	1.44	0.61	-12.86	0.99	0.08	0.22	24.50	0.67	0.50
MZM-4	35.11	5.23	2.14	-12.51	0.95	1.11	2.18	27.48	3.17	9.12
MZM-5	36.67	0.91	0.38	-12.85	0.92	0.25	0.54	16.70	1.50	2.12
MZM-6	36.00	0.93	-0.09	-12.66	0.06	0.95	1.87	20.93	2.33	6.50
MZM-7	26.11	3.21	0.99	-12.83	0.97	-0.02	0.04	133.43	0.67	0.62
MZM-8	29.56	2.35	0.83	-12.87	1.00	-0.02	0.04	83.07	0.33	0.25
MZM-10	36.89	1.04	0.45	-12.85	0.94	0.19	0.44	15.44	0.67	1.25
MZM-11	32.67	1.02	0.38	-12.85	0.92	0.25	0.54	47.81	2.83	6.12
MZM-12	32.11	7.79	2.92	-12.17	0.94	3.02	5.81	54.76	5.00	19.00
MZM-13	24.78	3.39	0.99	-12.83	0.97	-0.02	0.04	156.09	0.00	0.00
MZM-14	25.44	2.00	0.61	-12.86	0.99	0.08	0.22	144.50	0.00	0.00
MZM-15	36.89	1.04	0.45	-12.85	0.94	0.19	0.44	15.44	0.67	1.25
MZM-16	28.56	15.54	-3.38	10.70	0.40	26.40	50.17	104.17	6.33	120.50
MZM-21	33.00	1.75	0.67	-12.83	0.94	0.06	0.18	44.61	1.50	1.75
MZM-22	36.67	0.91	0.38	-12.85	0.92	0.25	0.54	16.70	1.50	2.12
MZM-23	38.00	2.63	1.15	-12.71	0.92	0.06	0.19	9.96	0.33	0.50
MZM-24	38.67	2.59	1.15	-12.71	0.92	0.06	0.19	7.22	0.33	0.62
MZM-25	36.33	2.75	1.15	-12.71	0.92	0.06	0.19	18.76	2.17	3.62
MZM-26	42.44	1.20	0.61	-12.86	0.99	0.08	0.22	0.00	0.00	0.00
MZM-28	38.33	0.00	0.00	-12.87	NaN	0.69	1.39	8.54	2.00	3.62
MZM-31	35.00	2.86	1.15	-12.71	0.92	0.06	0.19	27.80	0.33	0.25
MZM-32	30.11	15.03	5.32	-11.23	0.96	14.50	27.58	81.50	9.00	61.00
MZM-33	37.67	1.53	0.67	-12.83	0.94	0.06	0.18	11.43	0.50	0.75
MZM-34	28.78	4.07	1.38	-12.76	0.96	0.13	0.31	93.54	0.33	0.62
MZM-37	27.11	5.54	1.76	-12.65	0.95	0.50	1.02	117.89	1.00	2.12
MZM-40	26.67	3.75	1.15	-12.71	0.92	0.06	0.19	124.56	0.33	0.50
MZM-41	32.00	3.13	1.15	-12.71	0.92	0.06	0.19	54.63	0.50	1.12
MZM-42	26.33	2.53	0.77	-12.80	0.92	0.04	0.15	129.80	0.33	0.12
MZM-43	29.44	1.73	0.61	-12.86	0.99	0.08	0.22	84.50	1.00	1.38
MZM-44	32.22	4.18	1.60	-12.80	0.98	0.27	0.57	52.48	1.17	1.75
MZM-47	30.44	3.85	1.38	-12.76	0.96	0.13	0.31	72.15	0.33	0.50
MZM-48	22.33	4.48	1.15	-12.71	0.92	0.06	0.19	202.31	0.17	0.12
MZM-50	37.44	5.79	2.53	-12.33	0.94	1.95	3.78	13.43	4.00	21.38
MZM-51	31.33	1.84	0.67	-12.83	0.94	0.06	0.18	61.74	1.33	1.50
MZM-53	22.78	6.60	1.76	-12.65	0.95	0.50	1.02	193.72	0.17	0.12
MZM-54	34.11	0.56	0.22	-12.86	0.94	0.41	0.84	34.76	1.83	3.12
MZM-56	32.33	2.06	0.77	-12.80	0.92	0.04	0.15	51.13	1.67	2.50
MZM-59	27.44	4.27	1.38	-12.76	0.96	0.13	0.31	112.65	0.33	0.62
MZM-70	33.00	3.03	1.15	-12.71	0.92	0.06	0.19	44.69	1.00	2.50

Table S12 - Estimates of tassel length stability of maize germplasm evaluated in three years (2017,2018 and 2019) in Meghalaya

Genotype	Mean	CV (%)	βi	δij	R^2	SV	Wi	Pi	$Si^{(1)}$	$Si^{(2)}$
MZM-3	33.83	2.96	1.05	-5.64	0.98	-0.01	0.04	62.23	0.33	0.50
MZM-4	36.39	2.76	1.04	-5.57	0.95	0.02	0.11	36.99	1.17	1.62
MZM-5	29.22	6.97	-0.43	2.30	0.04	6.06	11.57	126.25	1.33	1.50
MZM-6	35.00	2.86	1.05	-5.64	0.98	-0.01	0.04	49.90	0.83	0.62
MZM-7	35.17	2.84	1.05	-5.64	0.98	-0.01	0.04	48.25	1.00	1.12
MZM-8	41.00	2.44	1.05	-5.64	0.98	-0.01	0.04	7.97	0.67	0.38
MZM-10	35.50	2.82	1.05	-5.64	0.98	-0.01	0.04	45.03	0.67	0.50
MZM-11	37.67	2.65	1.05	-5.64	0.98	-0.01	0.04	26.82	1.33	1.50
MZM-12	37.56	2.23	-0.24	-4.37	0.07	2.09	4.03	28.27	2.83	6.25
MZM-13	40.72	2.47	1.04	-5.57	0.95	0.02	0.11	9.12	0.67	0.50
MZM-14	39.50	2.53	1.05	-5.64	0.98	-0.01	0.04	15.07	0.83	0.62
MZM-15	42.67	2.34	1.05	-5.64	0.98	-0.01	0.04	2.71	0.00	0.00
MZM-16	38.39	3.94	1.61	-5.68	1.00	0.31	0.65	21.94	1.33	1.50
MZM-21	39.83	2.51	1.05	-5.64	0.98	-0.01	0.04	13.30	0.67	0.50
MZM-22	43.50	2.30	1.05	-5.64	0.98	-0.01	0.04	1.12	0.00	0.00
MZM-23	36.33	2.75	1.05	-5.64	0.98	-0.01	0.04	37.47	0.50	0.62
MZM-24	39.58	2.32	0.97	-5.65	0.98	-0.02	0.03	14.64	0.17	0.25
MZM-25	36.83	2.71	1.05	-5.64	0.98	-0.01	0.04	33.27	1.67	2.50
MZM-26	35.08	2.61	0.97	-5.65	0.98	-0.02	0.03	49.12	0.17	0.25
MZM-28	29.50	18.64	5.80	-4.57	0.98	21.98	41.77	127.21	2.00	7.00
MZM-31	43.83	2.28	1.05	-5.64	0.98	-0.01	0.04	0.68	0.00	0.38
MZM-32	37.30	9.83	-2.75	7.81	0.50	20.20	38.40	35.87	16.67	208.50
MZM-33	44.99	1.85	0.88	-5.66	0.99	-0.01	0.04	0.00	0.00	0.00
MZM-34	41.50	2.41	1.05	-5.64	0.98	-0.01	0.04	6.10	0.67	0.50
MZM-37	41.00	2.44	1.05	-5.64	0.98	-0.01	0.04	7.97	0.67	0.38
MZM-40	32.33	3.09	1.05	-5.64	0.98	-0.01	0.04	80.09	0.33	0.50
MZM-41	36.33	2.75	1.05	-5.64	0.98	-0.01	0.04	37.47	0.50	0.62
MZM-42	37.00	2.70	1.05	-5.64	0.98	-0.01	0.04	31.92	1.67	2.50
MZM-43	44.17	2.26	1.05	-5.64	0.98	-0.01	0.04	0.35	0.00	0.00
MZM-44	31.00	3.23	1.05	-5.64	0.98	-0.01	0.04	97.85	0.33	0.50
MZM-47	39.67	2.52	1.05	-5.64	0.98	-0.01	0.04	14.17	1.00	1.12
MZM-48	36.00	2.78	1.05	-5.64	0.98	-0.01	0.04	40.41	0.67	0.50
MZM-50	37.08	1.57	0.62	-5.67	0.99	0.11	0.27	31.31	0.83	2.12
MZM-51	43.83	2.28	1.05	-5.64	0.98	-0.01	0.04	0.68	0.00	0.38
MZM-53	43.00	2.33	1.05	-5.64	0.98	-0.01	0.04	1.99	0.00	0.00
MZM-54	36.50	2.74	1.05	-5.64	0.98	-0.01	0.04	36.04	0.50	0.62
MZM-56	40.00	2.50	1.05	-5.64	0.98	-0.01	0.04	12.45	0.67	0.50
MZM-59	33.33	3.00	1.05	-5.64	0.98	-0.01	0.04	67.94	0.33	0.50
MZM-70	39.33	2.54	1.05	-5.64	0.98	-0.01	0.04	16.00	1.00	1.12

Table S13 - Estimates of thousand seed weight stability of maize germplasm evaluated in three years (2017,2018 and 2019) in Meghalaya

Genotype	Mean	CV (%)	βi	δij	R^2	SV	Wi	Pi	$Si^{(1)}$	$Si^{(2)}$
MZM-3	308.44	0.54	-0.41	-217.99	0.24	-2.60	20.26	3561.56	1.67	2.50
MZM-4	283.33	0.71	-0.99	-222.13	0.98	3.55	31.92	5985.33	1.00	1.00
MZM-5	308.33	0.97	-1.49	-221.98	0.98	13.01	49.87	3563.50	2.33	6.50
MZM-6	309.44	8.71	-2.00	1198.26	0.02	773.54	1492.92	3632.80	5.33	69.50
MZM-7	215.78	0.47	0.51	-222.25	1.00	-12.24	1.96	15660.89	0.00	0.00
MZM-8	233.44	6.50	7.51	-214.39	0.98	169.94	347.64	12805.13	0.33	0.50
MZM-10	304.78	4.98	7.51	-214.39	0.98	169.94	347.64	3991.50	2.00	7.00
MZM-11	207.78	0.25	-0.25	-222.25	1.00	-6.63	12.61	17102.85	0.50	1.12
MZM-12	332.00	29.65	-39.63	6563.52	0.65	10542.30	20028.51	5001.67	17.00	217.00
MZM-13	215.33	0.46	0.50	-222.22	0.98	-12.18	2.07	15739.00	0.00	0.00
MZM-14	174.33	1.72	1.49	-221.98	0.98	-12.12	2.18	23858.17	0.00	0.00
MZM-15	275.33	1.09	1.49	-221.98	0.98	-12.12	2.18	6907.00	0.33	0.50
MZM-16	303.00	14.94	21.91	23.27	0.94	1965.19	3754.00	4878.54	6.67	127.00
MZM-21	286.56	0.59	-0.84	-222.26	1.00	1.01	27.09	5638.13	1.33	1.50
MZM-22	291.00	1.37	1.98	-221.76	0.98	-8.94	8.23	5196.50	0.67	1.50
MZM-23	274.67	24.15	32.86	-86.01	0.98	4351.03	8280.98	8618.04	14.83	183.12
MZM-24	318.67	3.56	5.61	-218.28	0.98	78.87	174.83	2823.48	1.00	2.50
MZM-25	284.33	6.68	-9.41	-211.08	0.98	451.06	881.05	5950.17	6.33	42.50
MZM-26	285.78	0.88	1.23	-221.93	0.97	-12.87	0.76	5733.52	0.67	1.50
MZM-28	269.44	0.07	0.01	-222.18	0.02	-9.11	7.90	7604.91	0.83	1.62
MZM-31	180.33	1.66	1.49	-221.98	0.98	-12.12	2.18	22566.17	0.67	0.50
MZM-32	326.00	4.89	5.87	10.31	0.54	209.43	422.56	2325.67	1.67	2.50
MZM-33	314.33	4.51	7.00	-213.86	0.98	143.39	297.26	3184.31	1.50	7.12
MZM-34	293.44	0.29	-0.42	-222.26	1.00	-4.76	16.15	4932.69	1.33	1.50
MZM-37	370.00	0.18	0.33	-222.24	0.98	-11.37	3.61	271.26	0.33	0.50
MZM-40	182.33	1.65	1.49	-221.98	0.98	-12.12	2.18	22143.50	0.33	0.50
MZM-41	219.67	0.91	0.99	-222.13	0.98	-13.21	0.12	14983.61	0.33	0.50
MZM-42	208.33	0.28	0.04	-221.60	0.02	-9.00	8.11	17003.72	0.33	0.50
MZM-43	264.33	1.13	-1.49	-221.98	0.98	13.01	49.87	8242.17	0.67	1.00
MZM-44	384.22	5.12	-3.18	469.50	0.10	425.08	831.74	106.96	0.67	1.50
MZM-47	303.33	0.99	-1.49	-221.98	0.98	13.01	49.87	3997.67	2.00	4.00
MZM-48	181.00	0.74	0.66	-222.20	0.98	-12.76	0.98	22417.98	1.00	1.00
MZM-50	302.00	0.69	0.96	-220.91	0.84	-12.55	1.37	4127.67	0.17	0.12
MZM-51	196.33	1.02	0.99	-222.13	0.98	-13.21	0.12	19292.50	0.67	0.50
MZM-53	269.67	0.49	0.66	-222.20	0.98	-12.76	0.98	7581.09	1.17	1.62
MZM-54	212.33	1.41	-1.49	-221.98	0.98	13.01	49.87	16267.50	1.00	3.00
MZM-56	202.33	1.48	-1.49	-221.98	0.98	13.01	49.87	18120.83	0.00	0.00
MZM-59	199.33	1.51	-1.49	-221.98	0.98	13.01	49.87	18696.33	0.67	0.50
MZM-70	280.33	1.43	1.98	-221.76	0.98	-8.94	8.23	6337.83	0.67	0.50