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EFFECTS OF WATERLOGGING ON THE GROWTH OF MAIZE HYBRIDS UNDER FIELD CONDITION

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SUMMARY

The screening for water stress of fifty five CIMMYT maize genotypes was carried out to estimate the genetic variability and correlation at Agriculture Research Farm, Institute of Agriculture Science, BHU, Varanasi. The experiment was conducted in an alpha lattice design with two replication and phenotypic data were analyzed using seven traits. Analysis of variance revealed significant differences among the genotypes for all the parameters studied. The maize hybrids (ZH15506, ZH17506, ZH17229 and ZH17496) showed highest value for grain yield per plant. Yield per plant was increased with germination percentage, plant height at seedling and chlorophyll content. If the selection for a water logging tolerant genotype is made for any of these component traits, the improvement in yield per plant could be achieved.

Key words : Maize, Genetic Variability and Water stress and correlation

Maize (*Zea mays* L.) is the most important cereal crop that ranks third in the world after wheat and rice (Chaudhary *et al*., 2016). Karnataka has the highest area of 1.2 million hectares (m ha) and production of 3.3 million tons (mt), whereas Tamil Nadu has the highest productivity of 6.5 t/ha. Maize ranks second in yield, third in production and area in India (Anonymous, 2016). In India, it is cultivated as a dual-purpose crop, for grain as well as fodder (Arya *et al.,* 2015 & 2020). Maize exhibits greater diversity in phenotypes than any other cereal crop and also in habitat from tropical to temperate regions of the world. Unlike wetland crops such as rice, maize plants do not have a gaseous exchange system between above ground plant parts and inundated roots. Therefore, breeding of waterlogging tolerant maize varieties will likely to boost maize production both at fodder and grain yield beyond the present level. Progress in different disciplines of plant breeding for increased resistance for biotic and abiotic stresses depends predominantly on the extent of genetic variability present in germplasm. This is easily measured as the phenotypic expression reflects non-genetic as well as genetic influences. Correlation is the degree and direction of the association between two or more variables which can be useful in determining yield components and used for genetic improvement of grain and fodder yield. Keeping in view of these aspects, the present study was undertaken to assess effect of the waterlogging situation on growth, earliness and yield parameters in maize.

MATERIAL AND METHOD

Experimental design and sample analysis: The experiment was carried out during crop season Kharif 2017 in alpha lattice design with two replications at the Agriculture Research Farm of Banaras Hindu University, Varanasi, India (Meteorology data Figure 1). The experimental material comprised of 53 maize hybrids along with two checks (900MG from Monsanto and P3502 from Pioneer) which were obtained from CIMMYT (International Maize and W heat Improvement Center, Mexico) germplasm under the project ‘Climate Resilient Maize for Asia (CRMA)’ (Table 1). Each genotype was planted in two rows of three meters each in length with a spacing of 60 x 25 cm with ten plants per row. Waterlogging stress was imposed at approximately 2–3-inch depth for seven days at the V6 -V7 growth stage/ knee height stage of crop growth (35 days after sowing) (Figure 2). Proper bunding was done so that water remains within, and after seven days, water was drained out (Zaidi *et al*., 2016). The crop was raised as per the recommended

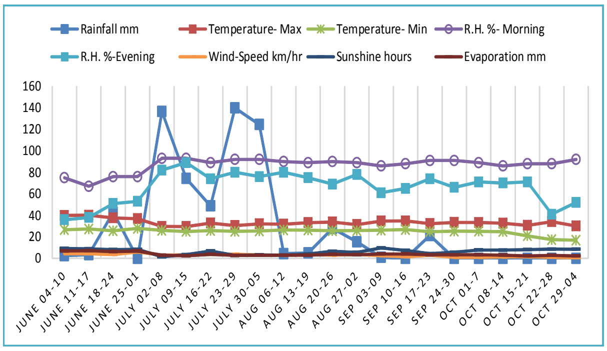

Fig. 1. Mean weekly weather parameters for crop season (Kharif, 2017-18).

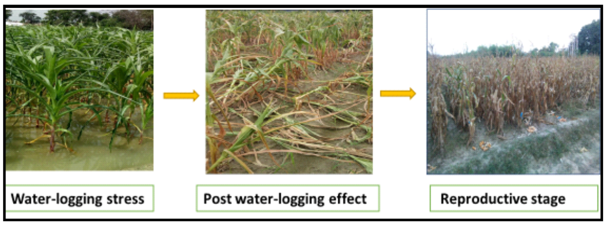

Fig. 2. Effect of water-logging on maize genotypes.

agronomic package of practices. The observations were recorded for seven characters *viz*. Anthesis silking interval (ASI), plant height at seedling (PHS) (cm), Chlorophyll content by spad meter, grain moisture (GM) (%), ear per plant (EPP) and yield per plant (YPP) (g).

Statistical analysis : Statistical analysis of data was carried out according to Paterson and Patterson (1984) for analysis of variance; Al-Jibouri *et al.* (1958) for correlation coefficient.

RESULT AND DISCUSSION

The analysis of variance for the seven characters revealed significant differences among all the experimental genotypes. Thus, the presence of variability among genotype in the present study indicated the ample scope for selection of genotypes for both fodder and grain yield, based on these traits. Similar results for these traits were also reported earlier (Sravanti *et al.*, 2017).

Mean performance of genotypes : The mean performances of the genotypes (53 hybrid progenies and two standard checks) across site are given in Table 2. Anthesis silking interval ranged from 0.50 (ZH17229, ZH17494 and ZH15550) to 7.00 (ZH17502) with general mean 2.23. Most of the crosses showed anthesis silking interval. This shows that it might be because of late crosses in these genotypes. Late maturing hybrids are important in the breeding programs for development of high yielding hybrids in areas that receive sufficient rain fall (Hosana *et al.*, 2015). Further evaluation and recommendation of this group of materials should be based on agro-ecological suitability. Germination percentage were recorded with a class from 34.78 (ZH15564) to 89.56 (ZH138312) with an average mean of 68.49.

The Plant height at seedling stage classified from 37.53 (ZH138260) to 108.47 for (ZH15565) coupled with a general mean of 76.84 among 55 maize genotypes studied. In line with these finding, Hosana *et al.* (2015) reported higher grain yield from taller plants; this could be attributed to high photosynthetic products accumulation during long period for grain filling. Chlorophyll mean value of different genotypes arranged from 42.36 (ZH138260) to 56.56 (ZH17231) with an average mean of 48.08. Grain moisture ranged from 15.08 (ZH15564) to 41.24 (ZH138312) with an average mean of 27.55. Ears per plant ranged from 1.01 (ZH15563) to 2.26 (ZH138305) with an average mean of 1.56. Yield per plant was recorded with a range of 12.00 g (ZH15564) to 100.00 g (ZH15506). Among the tested hybrids, ZH15506 yielded higher than 900MG check (67.3g). The presence of crosses having mean values better than the standard checks indicate the possibility of obtaining good hybrid (s) for future use in breeding program or for commercial use general mean was observed 63.80g.

Character association : Studies on correlation coefficients of different plant traits are useful criteria to identify desirable traits that contribute to improving the dependent variable (yield/plant). The correlations among the traits studied revealed the existence of several statistically significant relationships (Table 4). Yield per plant showed significant and positive correlation with germination percentage, plant height at seedling stage and chlorophyll content. Similar results were also reported by Begum *et al.*, 2016.

Germination percentage showed positive and significant association with plant height at seedling and yield per plant. Plant height at seedling exhibited positive correlation with ear per plant and yield per plant. Grain moisture showed positive significant association with chlorophyll content. Similar results were also observed by Begum *et al.*, 2016 and Ajayi *et al.*, 2014.

CONCLUSION

The maize hybrids (ZH15506, ZH17506,

TABLE 1
Mean value of seven characters of 55 maize genotypes

Treatment	Anthesis silking	Germination %	Plant height at seedling	Chlorophyll content	Grain moisture	Ear/plant	Yield/plant
ZH15546	2.50	79.26	69.88	44.15	24.63	1.50	41.42
ZH15547	4.00	72.79	93.29	48.08	29.35	1.62	52.56
ZH15548	2.00	70.66	72.46	47.57	30.44	1.73	43.24
ZH15549	1.50	85.35	88.34	47.53	29.48	1.77	66.22
ZH15550	0.50	51.82	60.39	51.58	24.89	1.89	79.63
ZH15551	3.50	55.18	69.90	43.64	25.37	1.54	48.72
ZH17494	0.50	71.51	69.93	47.29	25.26	1.69	60.36
ZH17495	1.50	72.38	91.46	50.47	29.80	1.81	69.03
ZH138260	5.00	74.86	82.44	42.36	25.71	1.41	64.44
ZH17496	1.00	82.45	97.66	46.54	24.42	1.70	99.54
ZH15553	1.50	78.84	88.52	45.90	24.51	1.58	72.44
ZH15554	1.50	55.25	85.96	49.17	30.87	1.68	75.56
ZH15555	3.50	62.20	75.34	45.84	23.99	1.38	63.55
ZH15556	2.00	57.50	56.00	47.88	20.29	1.29	77.13
ZH15557	1.00	82.10	62.50	50.02	36.18	1.18	58.78
ZH17497	2.00	69.97	50.57	48.27	25.38	1.13	30.83
ZH17228	1.50	55.17	101.46	46.53	25.19	1.94	71.78
ZH138267	1.00	55.74	93.57	49.89	25.65	1.41	70.58
ZH17229	0.50	80.92	91.91	51.38	25.40	1.33	97.96
ZH15558	6.00	72.23	85.77	44.12	25.14	1.36	52.71
ZH15559	2.00	71.65	77.66	46.87	15.08	1.58	70.32
ZH15560	3.00	69.58	83.44	46.80	30.50	1.62	74.30
ZH15561	1.00	55.10	77.43	50.83	29.79	1.95	63.41
ZH17498	2.00	50.03	77.00	48.22	24.85	2.06	60.25
ZH17499	2.00	71.10	108.19	47.03	19.02	1.69	76.18
ZH138269	1.50	84.95	93.44	46.94	30.40	1.54	90.50
ZH15562	6.50	80.64	62.78	46.78	34.11	1.61	59.80
ZH15563	4.50	63.28	39.89	44.41	34.36	1.01	42.92
ZH15564	2.50	34.78	44.51	47.17	29.85	1.57	12.06
ZH17500	3.00	52.61	58.42	48.79	29.33	1.69	67.62
ZH17501	2.00	63.63	87.41	50.34	36.00	1.75	66.74
ZH138294	1.00	68.41	81.00	48.64	34.80	1.42	84.25
ZH17230	2.00	73.72	87.08	50.15	30.13	1.20	90.46
ZH15565	0.50	76.28	80.48	55.46	41.24	1.52	69.56
ZH15566	1.00	62.24	59.98	43.50	25.02	1.88	52.23
ZH17502	7.00	76.84	72.90	43.60	20.21	1.64	43.66
ZH17503	2.00	76.86	87.83	51.58	19.56	1.48	46.84
ZH138303	2.50	67.81	72.06	49.29	29.83	1.29	46.65
ZH17504	2.50	70.05	75.08	43.85	33.43	1.77	43.17
ZH15567	1.50	79.01	55.08	55.57	34.54	1.45	46.26
ZH17505	0.50	50.53	47.12	45.85	24.55	1.35	46.37
ZH138305	4.00	59.10	80.20	46.10	19.90	2.26	46.96
ZH17506	1.50	55.24	79.40	49.59	25.45	1.83	99.36
ZH17507	1.00	62.71	37.53	49.09	20.51	1.14	36.29
ZH17508	1.50	82.87	62.54	46.12	40.12	1.45	59.87
ZH138312	1.50	89.56	73.21	48.26	19.83	1.35	69.29
ZH17231	1.50	81.40	72.14	56.56	24.30	1.34	81.71
ZH15568	0.50	70.30	80.16	51.76	29.43	1.47	78.70
ZH138278	2.00	60.03	81.76	48.30	25.30	1.67	76.58
ZH17232	3.50	63.31	67.16	45.99	30.48	1.43	60.83
ZH17509	3.50	82.59	103.90	46.76	24.66	1.57	64.69
ZH17510	1.00	69.00	91.07	52.62	24.32	1.44	55.49
VH11128	3.50	70.35	75.31	46.76	31.70	1.43	100.74
900MG	1.00	65.98	97.31	49.54	29.97	1.69	67.23
P3502	3.50	69.02	108.47	47.10	30.64	1.61	61.53
C.D.	0.05	2.25	3.51	2.51	1.29	0.06	4.15
SE(m)	0.02	0.79	1.23	0.88	0.45	0.02	1.46
SE(d)	0.04	1.12	1.74	1.25	0.64	0.03	2.06
Mean	2.23	68.49	76.84	48.08	27.55	1.56	63.80
Minimum	0.50	34.78	37.53	42.36	15.08	1.01	12.06
Maximum	7.00	89.56	108.47	56.56	41.24	2.26	100.74

TABLE 2
Correlation among seven characters of maize

	Anthesis silking interval	Germination %	Plant height at seedling	Chlorophyll content	Grain moisture	Ear/plant	Yield/plant
Anthesis silking interval	1						
Germination %	0.069	1					
Plant height at seedling	-0.031	0.302*	1				
Chlorophyll content	-0.546	0.078	0.063	1			
Grain moisture	-0.052	0.101	-0.092	0.204*	1		
Ear per plant	-0.041	-0.285	0.357*	-0.088	-0.102	1	
Yield per plant	-0.286	0.229*	0.510*	0.254*	0.014	0.093	1

ZH17229 and ZH17496) showed highest value for grain yield per plant. Maize hybrids that performed better than the checks can be used for release as hybrid variety after re-evaluation in multi-location trials. Yield is a complex character that is governed by several major and minor genes. Yield per plant was increased with germination percentage, plant height at seedling and chlorophyll content. Therefore, to obtain high yield per plant, one should consider these characters in maize breeding programme.

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