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Differential Behavior Of Teosinte(Zea *Mays Parviglumis*) Progenitor Of Maize Under Water Logging Condition

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Abstract

***Zea mays* ssp. *parviglumis* is the most probable progenitor of cultivated maize and assume to have tolerance against excess moisture content, that has not been reported so far so there is need of evaluation of *parviglumis* under waterlogged condition, For this teosinte were evaluated in two replication in each condition i.e., normal irrigated condition and water logged condition for thirteen morphological characters including yield contributing traits. Five randomly selected competitive plants for each plot were used for recording observations. The experimental data recorded for various characters were analyzed by using R software. Out of thirteen characters, six were significantly differ between these two condition as p value for plant height was 0.0127 *, for flag leaf length was 0.0127 *, for flag leaf width 0.0448 *, for total number of ears/plant was found 0.0204 *, for days to silk emergence and days to anthesis was 0.0136 *. In the current study it has been found that *parviglumis* show absence of adventitious root formation, lateral branching were absent, tassel with sparse density and thinner stem were produced under water logged condition and there is reduced level of yield related traits were exhibited. Therefore,teosinte was found susceptible to waterlogged condition.**

Keywords: Maize, Teosinte, waterlogging, progenitor

Introduction

Maize (*Zea mays* L., 2n=20) is an important cereal crop belonging to the grass family, *Poaceae*. The centre of origin of maize has been recognized as the Meso- American region and about 9000 years ago domestication was started independently in regions of the South-West USA, including Mexico and in Central parts of America.Racial diversity has always been the basis for productivity enhancement to support continuous increasing demand of maize (Singh *et al*., 2017).Maize requires large amounts of water, but is not tolerant to water logging. When soil moisture reached more than 80% of field capacity, reduction in maize growth and

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development was reported by Chen *et al.* (1988). Therefore, there is an urgent need of potent donor for water logging tolerant for maize improvement and wide cultivation under excess water affected area. Teosinte a wild grass that belongs to Poaceae family is a distantly related species of maize having diverse allele for different biotic and abiotic stresses. It includes the species *Zea maysdiploperennis*, *Z. perennis*, and *Z. luxurians*. *Z. mays* include several subspecies: ssp. *huehuetenangensis*, ssp. *mexicana*, ssp. *parviglumis* and others. Teosintes obtained from the regions that are known to receive frequent rainfall assume to provide a superior genetic resource for the development of flooding-tolerant maize varieties. Roots get injured if the soil remains waterlogged and if water logged condition prevails for longer period then it may leads to death of cell and even death of roots due to poor aeration, hence under water logging condition plant can maintain aerobic condition around the root zone by adventitious root formation . As the result, the adventitious roots of teosinte can obtain oxygen from air,, and due to this peculiar characteristic it may play an important role in its adaptation to flooding conditions.

These teosintes species are reported to be tolerant to water logging condition. Teosintes, viz. *Z. luxurians* and *Z. mays* ssp. *huehuetenangensis* (Mano *et al.,* 2005), *Z. nicaraguensis* (Bird, 2000; Iltis and Benz, 2000), have been observed to exhibit a higher capacity for adventitious root formation than some maize inbreds. Seedlings of *Z. mays* ssp. *huehuetenangensis* were observed to exhibit a high adaptability to flooding by developing adventitious roots above the soil surface (Mano and Omori, 2007). Similarly adult plants of *Z. nicaraguensis* and *Z. luxurians* were reported to develop well formed aerenchyma under water logging condition (Ray *et al.*, 1999) therefore imparting tolerance to flooding conditions. But these species are cross incompatible with maize so can't be utilized in conventional breeding programme.. As per molecular, cytological and enzyme analysis *Zea mays* ssp. *parviglumis* is the most probable progenitor of maize till today and assume to have tolerance against excess moisture content, that has not been reported so far so there is need of evaluation of *parviglumis* under water logging condition as it is easily crossable with maize, no cross incompatibility were reported. Therefore, it can be utilized directly in conventional breeding programme and it is easy to transfer any desirable character from teosinte to maize by conventional breeding method.

Among various abiotic stresses, excessive soil moisture (water logging), caused by flooding, water stagnation or a high water table is one of the most important constraints for maize production and productivity in Asia Pacific region. In South-East Asia alone, about 15% of the total maize growing areas are affected by floods and water logging problem. In India, water logging is a serious problem, where about 8.5 mha of arable land is in the grip of water logging condition. Out of the total 9.86 mha, area is under maize cultivation in India, about 2.5 mha is affected by this problem, which causes on an average 25-30% loss of national maize production, every year (DMR, 2001). Continuous stagnation of water for 10-12 days creates anaerobic rhizospheric environment, which may leads to inhibition of gaseous exchange between

the aerial plant parts and roots. Along with declining oxygen supply in the root, there is accumulation of toxic chemicals, leads to the nutrient imbalance (Zaidi *et al.,* 2007). Keeping in view of ever increasing problem of waterlogging, it is very important to identify sources of tolerance to excess moisture stress. Henceforth, in the present investigation our hypothesis was toevaluate Zea *mays* ssp. *parviglumis*in order to estimate the effect of water logging condition.

Materials and Method

The present investigation was conducted at N. E. Borlaug Crop Research Centre, G. B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand. The planting material was wild progenitor of maize i.e. teosinte (*Z. mays ssp. parviglumis*)were evaluated under normal irrigated and water logging condition during *kharif,* 2017.Teosinte was planted in Completely Randomized block design (RBD) in two replications in each condition *i.e*. normal irrigated and water logged. The *Z. mays ssp.Parviglumis*was grown as 2 m single row with spacing of 75 cm in two environmental conditions and were evaluated for thirteen morphological characters including yield contributing traits i.e. leaf blade width (1^{st} leaf), leaf blade length(1^{st} leaf), plant height, tillers/plant, number of tassel branch, tassel length, flag leaf length, flag leaf width, number of nodes/plant, node bearing first cob, total number of ears/plant,days to silk emergence,days to anthesis and four visual traits i.e. adventitious root, lateral branching, tassel density of spikelet and stem width were recorded in order to estimate effect of water logging on different morphological character including yield contributing traits and visual traits. Five randomly selected competitive plants for each plot were used for recording observations of seventeen traits. The statistical analysis of experimental data recorded for various morphological traits were done with the help of R software.

Results and Discussion

In the present investigation, Analysis of variance (ANOVA) of analyzed data reflected that thirteen morphological characters including yield contributing traits i.e. leaf blade width(1^{st} leaf), leaf blade length(1^{st} leaf), plant height, tillers/plant, number of tassel branch, tassel length, flag leaf length, flag leaf width, number of nodes/plant, node bearing first cob, total number of ears/plant, days to silk emergence, days toanthesis were analyzed by using R software, out of thirteen traits, six traits i.e. plant height, flag leaf length, flag leaf width, total number of ears/plant, days tosilk emergence, days toanthesis were found significant at 5% level(Table 1). The p value for leaf blade width, leaf blade length, tillers/plant, number oftassel branch, tassel length, number of nodes/plant and node bearing first cob are greater than 0.05 shows that a significant difference does not exist for thesecharacter under both growing conditions. For plant height P value is 0.0127* i.e., <0.05 hence sowing conditions have impact on plant height, under normally irrigated condition plants are taller than under water

logging condition. Plant morphology (plant height, ear height, and leaf area index) decreased under water logging condition as reported by Baizhao *et al.*, 2014. Ajaz and Warsi (2009) also reported similar findings i.e. reduction in plant height in almost all maize genotypes due to flooding treatment. Similar results were supported by Ren*et al.,* 2013 conducted experiment and foundreduction in height of maize plants when they were grown under water logging conditions.

For flag leaf length P value was 0.0127* reflecting that the two environments i.e. normal irrigated and water logged have great impact on flag leaf length (Table 1). Under normally irrigated condition flag leaf length is higher than water logged. Results were also close confirmation with the observation of Valerie and Moses, 2016 and they reported that the structural development of maize plant was also affected in response to water stress in maize and decreased leaf area due to water logged condition. Reduction in leaf area corresponds to reduction in length of leaf. 32% reduction in leaf length in response to water logging in maize was reported by Abiko *et al.,* 2012.There is significant difference between normal irrigated and water logged condition for trait flag leaf width. The computed P value was 0.0448 * which showed<0.05 therefore,flag leaf length was found more under normal than water logged condition.Total number of ears per plant significantly differ between water logged (less) and normal condition (more) as P value for total number of ears per plant was 0.0204* which was<0.05. P valve for days to silk emergence and days to anthesis were 0.0136 * whichwas found<0.05, therefore, significant difference were reported for days to silk emergence and days to anthesis between water logged and normal irrigated condition and results were exhibited that for both the traits under normal irrigated condition it was earlier, whereas, delayed silk emergence and anthesis were reported under water logged condition. Such type of finding is similarly responded by earlier worker Shah *et al.,* 2011 reported delayed silking in maize and it was more pronounced when stress was imposed at the tasseling stage.

Results exhibited that in normal irrigated condition adventitious roots formation were observed but it was absent under water logged condition.Roots are injured if the soil remains waterlogged as continued poor aeration causes cell death and even death of roots; hence plant can maintain aerobic condition around the root zone under water logged condition by adventitious root formation. The tips of adventitious roots and root hairs help plants to obtain oxygen dissolved in water (Mahal *et al.*, 2000; Lizaso*et al.,* 2001) and this characteristic may play an important role in its adaptation to flooding conditions. But as adventitious roots are absent under water logging condition in case of *Zea mays* spp. *Parviglumis,* therefore, it was unable to cop up with waterlogged condition hence*Zea mays* spp. *Parviglumis*the most probable progenitor of cultivated maize showed susceptible response in waterlogged situation.Induction in nodal root formation was higher in certain maize genotypes in response to water logging conditions as reported by Shah *et al.,* 2011 indicated that the trait is responsible for providing tolerance against excess moisture conditions. Lateral branching is the regular characteristics of teosinte but it was absent

under waterlogged condition. Stem width and number of primary branches per plant were decreased significantly by waterlogged in winter rape (Zhou *et al.,* 1997). Similarly under normal irrigated condition spikelets are densely present in tassel, whereas, sparsely present under waterlogged condition, showed susceptible behavior of *parviglumis* towards excess moisture stress.

Table1: Analysis of Variance (ANOVA) for morphological traits of teosinte (*Z. mays ssp. parviglumis*) in normal irrigated and water logged condition

S.no.	Characters	MSS	P value
1	Leaf blade width(1^{st} leaf)	1.7689	0.135
2	Leaf blade length(1^{st} leaf)	32.49	0.695
3	Plant height	351.6	0.0127 *
4	Tillers/plant	1.0	0.592
5	Tassel branch	600.3	0.141
6	Tassel length	93.12	0.125
7	Flag leaf length	351.6	0.0127 *
8	Flag leaf width	3.367	0.0448 *
9	Number of nodes/plant	16	0.106
10	Node bearing first cob	12.25	0.192
11	Total number of ears/plant	125316	0.0204 *
12	Days to silk emergence	36.0	0.0136 *
13	Days to anthesis	36.0	0.0136 *

Table 2: Visual observation for morphological traits of teosinte (*Z. mays ssp. parviglumis*) in normal irrigated and water logged condition

S.No.	Characters	Normally irrigated	Water logged
1	Adventitious root	Present	Absent
2	Lateral branching	Present	Absent
3	Tassel density of spikelet	Dense	Sparse
4	Stem width	Thick	Thin

Conclusion

Zea mays parviglumis is the most likely progenitor of cultivated maize. As it is easily crossable with maize, so it is easy to transfer any desirable traits from teosinte to maize by conventional breeding method. In the present investigation based on different morphological character including yield contributing traits *Zea mays parviglumis* were evaluated under normal irrigated and waterlogged condition and in present experiment teosinte was found susceptible to waterlogged condition. Therefore, it can't be utilized as efficient donor for waterlogging tolerance traits.

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