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EFFECT OF WATER STRESSES ON THE GROWTH FEATURES OF DIFFERENT MAIZE (*ZEA MAYS* L.) CULTIVARS

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Abstract

A pot experiment was conducted to study the effect of water stresses on the growth features of maize (*Zea mays* L.) cultivars viz., Amper pop, Bornali, Suvra, Sadaf and Savar II. The treatments were with natural soil moisture (control), constant drought, constant saturated soil moisture and waterlogged conditions of soil. The growth features were plant height, base diameter, leaf number and total life span of the plants. Plant height, base diameter, leaf number and total life span were severely affected by drought and waterlogged conditions in all the test cultivars with significant effect in drought than under waterlogged condition. There were little adverse effect in saturated soil moisture condition. Within the treatment, different cultivars suffered at different magnitude. Amper pop was more resistant to both drought and waterlogged condition as compared to other cultivars.

Introduction

Maize (*Zea mays* L.) is an important food grain crop which has higher potentiality to cultivate throughout the year in Bangladesh (Islam & Kaul, 1986). However, some abiotic causes create problem to cultivate maize, such as in winter and spring (Rabi season) there is shortage of soil water and adequate irrigation facilities, and in summer (Kharif season) there is excess of water beyond the field capacity or heavy rainfall which causes waterlogging condition.

Progressive research on the breeding of maize demands that the morphology, growth, development and anatomy of the plants in relation to water stress be more adequately understood. Investigation on external morphology, growth and development of maize plant in relation to water stress has been carried out by many scientists (Damptey & Aspinall, 1976; Del Rasario *et al.*, 1991; Miller & Duley, 1925; Otegui *et al.*, 1995; Shaw, 1980; Wilson & Allison, 1978; Yang & Hsaing, 1992). However, little information on the growth and development of maize plant in relation to water saturation and waterlogged condition is available (Duthion, 1982; Shaw, 1980; Wang *et al.*, 1992). The present study was, therefore, carried out to investigate the growth features of maize plant at different levels of moisture condition.

Materials and Methods

The experiment was conducted in pots during the Rabi season using maize (*Zea mays* L.) cultivars viz., Amper pop, Bornali, Suvra, Sadaf and Savar II, in the net

houses of Bangladesh Agricultural University, Mymensingh, Bangladesh. The plants were grown under control (natural soil moisture condition), constant drought, constant saturated soil moisture and waterlogged (2 cm standing water) condition of soil. Each treatment was replicated five times. Large plastic pots (35 cm in height) with bottom and the side of the pots were sufficiently perforated for quick drainage of excess water and proper aeration were used. Each pot was filled up with silty loam soil taken from the cultivated land. The soil was thoroughly mixed with rotten cowdung at the ratio of 4:1. Each pot was fertilized @ 4-2-1 g Urea-TSP-MP, respectively. Full TSP and MP, and half of Urea were applied in each pot as basal dose and the rest of Urea was applied as top dressing in two equal instalments at 30 and 60 days after sowing (DAS). For the treatment of constant drought, a level of 3 cm sand was placed at the bottom of the pots, so that the excess water could easily be drained out. For 2 cm standing water, the intact pots (without perforation) were used.

Five soaked seeds were sown in each pot in early December. The soaked seeds were considered as zero-day-old seedling. Two healthy plants having uniform growth were allowed to grow in each pot. After sowing, all the pots were exposed to natural conditions of weather in the net house. Out of 20 pots, 15 pots were allowed to remain in the net house while 5 pots were transferred to water tank. Intercultural operation were done, and effective plant protection measures were taken as and when required.

The tank (360 cm x 200 cm x 90 cm) was provided with outlets to remove excess of stagnant water as and when necessary. The pots having 30 day old plants were kept in the water tank in such a fashion that each plant was exposed to 2 cm constant standing water. This was done by placing the pots on raised platform. The plants were allowed to grow there till they died or decayed. For the treatment of saturated soil moisture condition, sufficient water was applied to each pot two times a day, so that the soil became completely wet with no standing water. The plants were allowed to grow under this condition till maturity.

Artificial drought condition of soil moisture (8-15%) was created in 5 pots. The plants were allowed to grow there till they dried or died. For the control treatment, 5 pots were placed in the net house. Plants of these pots were allowed to grow under normal weather condition.

The following growth parameters were recorded fortnightly:
a) Height of the plant in cm. b) Base diameter of the plant in mm. c) Number of leaves per plant and d) Total life span. Collected data were analysed following ANOVA - technique and means were separated by Duncan's New Multiple Range Test (DMRT) using MSTAT computer package.

Results

Effect of water stresses on the plant height: Plant height showed highly significant differences among the cultivars and also within the treatments (Fig.1). Under natural soil moisture condition, maize cv. Amper pop showed the highest plant height (182.6 cm) and Sadaf the lowest (170.4 cm) at 90 DAS (days after sowing). Other cultivars showed medium plant height. Under drought condition, cv. Amper pop showed the highest plant height (84.2 cm) followed by Savar II (78.3 cm) and Sadaf showed the

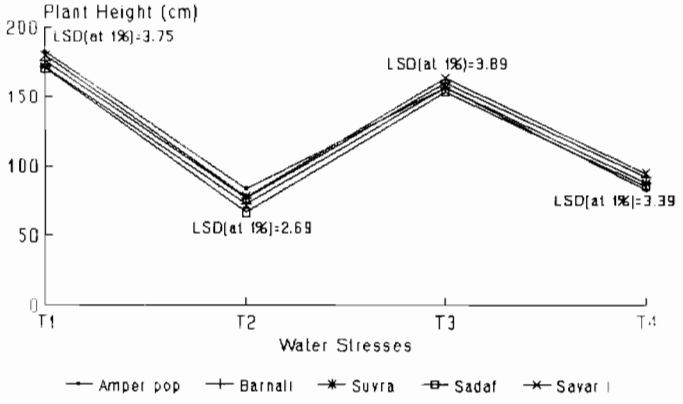

Fig.1. Effect of water stresses on the plant height (90 DAS).

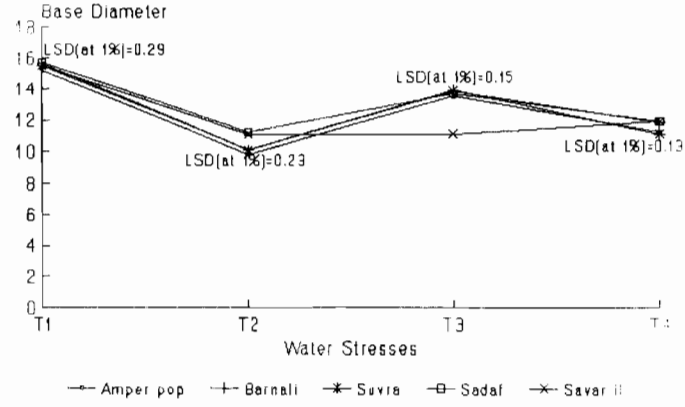

Fig.2. Effect of water stresses on the base diameter (90 DAS).

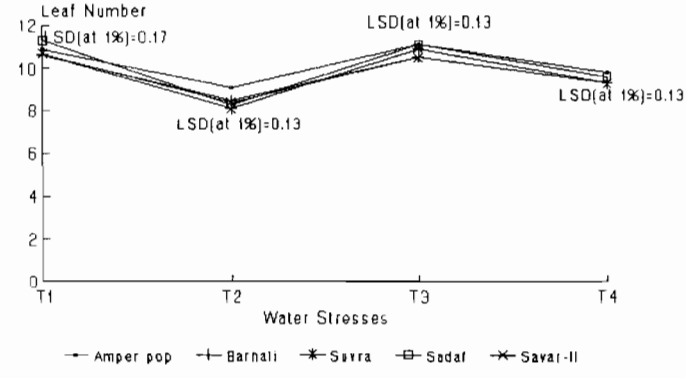

Fig.3. Effect of water stresses on the leaf number (90 DAS).

Table 1. Effect of Water stresses on the total life span of maize.

Cultivar Water stress	Amper pop	Bornali	Suvra	Sadaf	Savar-II
Control	135 a	135 a	135 a	135 a	135 a
Drought	105 c	105 c	90 c	90 c	105 b
Saturated moisture	135 a	135 a	135 a	135 a	135 a
Water logged	120 b	120 b	105 b	120 b	105 b

Column having same letter (s) are not significant at 1% level.

lowest (66.7 cm) at 90 DAS. Under saturated soil moisture condition, Savar II had the highest plant height (163.1 cm) while Sadaf possessed the lowest (153.5 cm) at 90 DAS. Other cultivars were medium in height . Under waterlogged condition, SavarII showed the maximum plant height (95.1 cm) followed by Bornali (92.3 cm), and Amper pop possessed the minimum (83.3 cm) at 90 DAS.

Effect of water stresses on the base diameter: Like the axial growth, the lateral growth in the form of base diameter was affected by water stresses (Fig.2). There were conspicuous differences within the treatments and some differences within the cultivars. Base diameter of different cultivars did not differ significantly. Under natural soil moisture condition, Sadaf possessed the maximum base diameter (15.7 mm) and Amper pop had the minimum (15.2 mm) at 90 DAS . Under drought condition, Sadaf had the maximum base diameter (11.2 mm) followed by Savar II (11.1 mm), and Amper pop possessed the lowest (9.8 mm) at 90 DAS . Under saturated soil moisture condition, Suvra showed the maximum base diameter (13.9 mm) and Amper pop had the minimum (13.5 mm) at 90 DAS . Under waterlogged condition, Sadaf and Savar II had the maximum base diameter (11.9 mm) followed by Bornali (11.8 mm), with Suvra the minimum (11.1 mm) at 90 DAS.

Effect of water stresses on the leaf number: The number of leaves were more or less similar in both drought and waterlogged treatments at different ages of plant. Number of leaves in the drought and waterlogged condition was less than that of the control or saturated soil moisture condition (Fig.3). Under natural soil moisture condition, Sadaf possessed the highest leaf number (11.3) while Bornali had the lowest (10.6) at 90 DAS. Under drought condition, Amper pop showed the maximum leaf number (9.1) while Suvra the minimum (8.1) at 90 DAS . Sadaf and Amper pop showed the maximum leaf number (11.1) and Bornali and Savar II the minimum (10.5) at 90 DAS under saturated soil moisture condition . Under waterlogged condition, the number of leaves was maximum (9.8) in Amper pop , and the minimum (9.3) in cvs. Bornali, Suvra and Savar II at 90 DAS .

Effect of water stresses on the total life span of maize: The test cultivars responded differently in different treatments (Table 1). In both natural and saturated soil moisture condition, the maize plant thrived up to 135 DAS. In drought condition, the cultivars Amper pop, Bornali and Savar II thrived up to 105 DAS while Suvra and Sadaf could

not live beyond 90 DAS. Amper pop, Bornali and Sadaf had been found to withstand waterlogged condition up to 120 DAS while Suvra and Savar II could not withstand the situation beyond 105 DAS.

Discussion

From the results it was evident that values of all the growth parameters increased with the period of growth. However, the rate of increase differed among the cultivars in different fortnight as well as different water stresses. Under drought condition, there was a sharp decline in the values of all the growth parameters. The plant height, base diameter and leaf number of the maize plant decreased up to 60.8, 35.5 and 26.5% respectively compared to their corresponding control plants at 90 DAS. Similar reduction of plant height in corn seedling due to drought was reported by Del Rosario *et al.*, (1991), of leaf number by Eck (1986) and of plant height, maximum leaf area index and shoot biomass by Otegui *et al.*, (1995). The decrease in plant height, base diameter and leaf number might be due to the reduction in the cell division and cell elongation. The rate of cell division will probably be markedly reduced and cell enlargement will virtually cease (Slater, 1967). The total life span was also shortened up to 90 DAS in some maize cultivars. The decrease in life span caused by drought might primarily be due to the dehydration of cells and secondarily the increase in respiration, decrease in photosynthesis and nitrogen metabolism, protein breakdown, enzyme inactivation etc. (Levitt, 1972).

The saturated soil moisture condition had little adverse effect compared to drought and waterlogged condition. The plant height, base diameter and leaf number reduced up to 14.4, 28.4 and 2%, respectively, compared to their corresponding control plants at 90 DAS. Similar reduction of plant height in sugarcane under constant saturated soil moisture condition was reported by Hossain (1995). The reduction might be due to the excessive absorption of water, decrease in enzyme and hormone concentration, enzyme activity etc. However, constant saturated soil moisture condition had no adverse effect in the total life span of maize plant examined.

Under waterlogged condition the plant height, base diameter and leaf number reduced up to 54.4, 28.4 and 15%, respectively, compared to their corresponding control plants at 90 DAS. The decrease in plant height due to waterlogged condition was also reported by Shaw (1980). Del Rosario & Fajardo (1991) also reported that plant height, dry matter yield and leaf area were significantly decreased in mungbean and soybean under waterlogging condition. Total life span of the plant was also reduced. These might be due to reduced absorption of water and mineral intake, formation of callus and adventitious roots, poor soil aeration, reduction in hormone level etc.(Kozlowski, 1976). Rowe & Beardsell (1973) reported that prolonged inundation of soil by standing water was associated with a decrease in soil O_2, increase in soil CO_2, and accumulation of a variety of toxic substances including nitrites, reduced form of iron and manganese, hydrogen sulfide, aliphatic carboxylic acids and ethylene.

The water stresses have a little direct effect on the total number of leaves of a plant like maize which bears persistent leaves. The abscission of a non-succulent persistent

leaf is not influenced by water stress (Levitt, 1972). The water stress may, however, inhibit leaf initiation, suppress node formation and decrease axial growth rate for which the number of leaves becomes less. Though the size (length and breadth) of leaf had not been presented in tabular form for over crowding of data but it was observed that the leaf size was smaller than the corresponding control plant in both drought and waterlogged condition while saturated soil moisture condition had a little effect on the leaf size. Significant reduction in leaf area was reported in corn by Claassen & Shaw (1970) at water deficit condition.

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