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Research Article

Phenology and growth traits response of maize (*Zea mays* L.) genotypes to semi-arid conditions

Abdul Basir[1*], Abdul Aziz[1], Mushtaq Ahmad Khan[1], Iltaf Khan[2], Muhammad Adnan[1], Shah Fahad[1], Abdul Sattar Shah[1], Inayat -Ur-Rehman[1], Muhammad Noor[1] and Abdur Rahman[1]

1. Department of Agriculture, University of Swabi, Anbar Swabi-Pakistan
2. Cereal Section, Agriculture Research Institute, Tarnab, Peshawar-Pakistan
**Corresponding author Email: a.basir@uoswabi.edu.pk*

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Abstract

Erratic rainfall and extreme weather have put the maize crop at risk in semi-arid regions of Khyber Pakhtunkhwa (KP), Pakistan in the recent past. To this extent a field experiment was carried out to identify tolerance of maize genotypes to semi-arid conditions at different growth stages of crop development. Eight maize genotypes (8003-4*66211, Babar, Azam, Iqbal, Jalal, Pahari, Pop-2009, and Sarhad White) were screened in a Randomized Complete Block (RCB) Design with three replications. Significant variations were found for days to 50% silk emergence, days to 50% tasseling, anthesis silking interval (ASI), plant height (cm), tassel length (cm), and number of plants plot^{-1}. The genotype 8003-4*66211 was best for all the studied traits followed by Pop-2009 and Babar. Keeping in view the results of this study, it is concluded that genotype 8003-4*66211 delayed taselling and silking and reduced ASI under water limiting conditions and therefore, is recommended to be grown under semi-arid conditions while fulfilling the required agronomic practices.

Keywords: Maize genotypes; Phenology; Taselling; Silking; Semi-arid conditions

Introduction

Maize (*Zea mays*) being a member of the *Poaceae* family is an important cereal crop of Pakistan after wheat & rice. In Pakistan, it is cultivated on an area of 1,142 thousand hectares with total production of 4,937 thousand tonnes and yield of 4,323 kg ha^{-1}. It contributes 2.2 % to the value added in agriculture and 0.4 % to gross domestic product **[1]**.

Water is one of the main yield reducing factors in agriculture. An adequate quantity of water is essential for crop growth, development, transpiration and also for transport of nutrients to source (leaves) and prepared food materials for consumption in the development of new tissues (sink). Scarcity of water (drought stress) is one of the major contributors which affect crop growth and ultimately reduces yield **[2]**. As

a C4 crop, maize produced maximum dry matter among grain cereal crops [3]. Generally maize requires water in the range of 500-800 mm from sowing till harvesting [4]. In Pakistan, 65 % maize crop is grown under irrigated and 35 % under rain-fed conditions/areas. In the current or existing age of global warming and increasing world population, the drought stress is ultimately becoming a serious issue, therefore, making water a scare reservoir on the biosphere [5]. Maize crop is sensitive to drought stress especially at sensitive growth phases/periods which ultimately reduces crop growth and yield. Scarcity of water or drought stress at sensitive growth phases i.e. at pre and post pollination reduced 40% maize crop yield and thus decreased grain formation [6].

Maize genotypes can be tested for tolerance under water scarce situations to fight against water shortage problem [7]. To improve the yield of maize under drought conditions, drought tolerant maize genotypes might be a good source to obtain high yield mainly in the semi-arid regions of Pakistan [8]. Keeping in view a substantial semi-arid growing area in KP and demands of maize crop, genotypes with desirable characteristics that can sustain its growth in water stress conditions and screening of these genotypes under H_2O scarce situations are required to find out best and suitable genotypes under semi-arid condition.

Materials and methods

An experiment titled "Phenology and growth traits response of maize genotypes to semi-arid conditions" was conducted at Agricultural Research Institute (ARI) Tarnab, Khyber Pakhtunkhwa, Pakistan during summer 2015. The experiment was laid out in randomized complete block (RCB) design with three replications. Eight maize genotypes i.e. 8003-4*66211, Babar, Azam, Iqbal, Jalal, Pahari, Sarhad white and Pop-2009 were sown at uniformed seed rate of 100 kg ha^{-1}. Plot size were consists of 3 *5 m^2. Each plot consisted of four rows each of 5m length. Row to row and plant to plant distance were kept 75 and 25 cm respectively. Recommended dose of NPK fertilizer were applied from their respective sources (Urea, Single Super Phosphate and Sulphate of Potash) at the rate of 150, 125, and 100 kg ha^{-1}. Field was irrigated after 20 days of sowing, at grand growth stage, at pollination and grain filling stage. All other agronomic practices were applied uniformly throughout the growing season.

The collected data were subjected to analysis of variance (ANOVA) [9]. After getting the significant variation among genotypes performance for various parameters, the means for each parameter were further separated and compared by using the least significant difference (LSD) test at 5% level of probability.

Results and discussion

Phenological response of maize genotypes to semi-arid conditions

Maize phenology i.e. days to 50% tasseling, silking, and ASI responded significantly and showed a significantly delayed response for genotype 8003-4*66211 under semi-arid conditions however, ASI were decreased as compare to other genotypes (Table 1). Maximum days to 50% tasseling (64.6) were observed for 8003-4*66211 which was different from rest of genotypes (59.67 to 56.66). Similarly, maximum days to 50% silking (65.3) were observed for 8003-4*66211 followed by Jalal (64.0) and Sarhad white (61.6) while the rest of the genotypes had resulted statistically similar values. However, maximum days to ASI (6.0) were observed for genotype Sarhad white followed by Pop-2009 (5.0) and Azam (4.3) while the rest of the genotypes were statistically similar values for days to ASI. The most prominent effect observed during drought was the variations in plant phenological growth stages. Semi-arid conditions reduced the time for days to 50%

tasseling and silking during growth season. In maize crop drought during flower initiation stage considerably hindered the time for tasseling, silking stage and ultimately increased the time for ASI. Results of the study were similar with the findings of other scientists who reported significant delayed response of maize in tasseling stage, silking stage and ASI under severe drought [10]. The interval between silking and pollen shed can be increased during reproductive stage when crop experienced water stress [11]. One of the reasons in delaying plant phenology and silk emergence is exposure of crop to drought during flower initiation [12]. It had also been reported that drought reduces cob and tassel growth resulting in an increase in ASI [13]. Similar results were also reported in past by some researchers in which drought stress delayed silking and ultimately increased the ASI duration [14].

Table 1. Mean performance of different maize genotypes for days to tasseling, days to silking, anthesis silking interval, plant height (cm), tassel length (cm) and no. of plants plot^{-1} under semi-arid conditions

Genotypes	Days to taselling	Days to silking	ASI	Plant height	Tassel length	Plants plot^{-1}
80003-4*66211	64.67 a	65.3 a	2.66 cd	166.6 a	56.50 a	63.33 ab
Babar	59.67 b	59.3 c	2.33 d	146.3 b	53.53 abc	74.00 a
Azam	56.00 b	60.3 bc	4.33 abc	165.6 a	52.60 bcd	69.66 a
Iqbal	56.00 b	57.3 c	2.66 cd	144.3 b	53.70 abc	63.00 ab
Jalal	58.66 b	64.0 ab	4.00 bcd	147.0 b	55.06 ab	48.00 b
Pahari	57.00 b	61.0 abc	3.33 bcd	144.0 b	51.93 bcd	64.00 ab
Sarhad white	56.33b	61.6 abc	6.00 a	154.3 ab	50.60 cd	81.66 a
Pop-2009	56.66b	60.6 bc	5.00 ab	150.6 b	49.73 d	76.66 a
LSD (0.05)	4.7288	4.3382	1.7512	14.503	3.6740	18.908
CV	4.65	4.05	26.37	5.44	3.96	15.99

Means followed by different latters in each column are significantly different from each other at 5% level of significance

Response of morphological growth traits of maize genotypes to semi-arid conditions

Maize genotypes responded significantly to plant height, tassel length and number of plants plot^{-1} under semi-arid conditions (Table 1). Statistically maximum plant height (166.6 cm) was observed for 8003-4*66211 followed by Azam (165.6 cm) and Sarhad white (154.3 cm) while the rest of the genotypes had statistically similar values. Morphological growth parameters particularly plant height was significantly reduced by drought conditions because the plants have to complete its life cycle quickly and therefore shorten his growth cycle. Results of this study are inconsistent with the findings of other scientists who considered that the reduction in plant height in semi-arid conditions may be due to the unavailability of water to one or more sections of the root system [15].

In case of tassel length statistically maximum tassel length (56.5 cm) was observed for 8003-4*66211 followed by Jalal (55.0 cm) and Iqbal (53.7 cm) while the rest of the genotypes had statistically similar values. However, the remaining genotypes showed average performance for tassel initiation and growth. Due to the

prevailing drought conditions plants had completed its life cycle quickly and shifted from vegetative phase to reproductive phase in short span of time which results in reduce tassel length. These results are similar with other findings **[14]** who reported significant differences for tassel length and declared water stress as a reason for slows tassel growth or anthesis **[16].** No. of plants plot^{-1} had not been significantly affected under semi-arid conditions however, maximum no. of plants (81.6) were observed for Sarhad white followed by Pop-2009 (76.6) and Babar (74.0) while the rest of the genotypes had resulted almost similar values. Initially the conditions for seed emergence were conducive for all genotypes and therefor, similar no. of plants plot^{-1} was emerged in all plots.

Conclusion and recommendation

On the basis of our experimental results, maize genotype 8003-4*66211 due to its stay green and drought resistant characteristics was suggested to be grown under semi-arid conditions.

Author's contributions

Designed the experiment: A Basir & A Aziz, Performed the experiments A Basir & A Aziz, Analyzed the data: A Basir, A Aziz, MA Khan, I Khan, M Adnan & S Fahad, Contributed the materials: AS Shah, IU Rehman, M Noor & A Rahman, Wrote the paper: A Basir, A Aziz & MA Khan.

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