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Phonological and growth traits of spring maize genotypes for silage production in northern Pakistan

Nadar Khan*, **Nazir Ahmad Khan, Nazir Ahmad**

Department of Animal Nutrition, The University of Agriculture, Peshawar, Pakistan

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Abstract

Selection of suitable maize hybrid for quality silage production is one of the major factor that can directly affect the quality and quantity of maize silage. The current study was conducted with the aim to determine the effect of different spring maize genotypes for fresh biomass yield, phonological and growth parameter for maize silage production in northern Pakistan. Six spring maize genotypes named; quality protein maize (QPM) 200, 300, Monsanto, Pioneer-1543, 1429 and Azam local maize cultivar was evaluated in the field of Agronomy, The Agriculture University Peshawar. The seed of each genotype was sown in 12 replicate plots under RCBD design and a total of 72 plots (8 m × 10 m) were blocked in to three replicate fields. Maize seed was sown with hands on March 28, 2017, in ridges with a row to row spacing of 75 cm @ seed rate of plant population of 66000 seeds per hectare for optimal production. The repeated measure analysis of variance using the PROC MIXED procedure of SAS (SAS Inst., Inc., Cary, NC) were used for statistical analysis. The results revealed that there was a large variation ($P<0.05$) for all the measured parameter among spring maize genotypes. The DTF ranged from 57 to 62, DTS 61 to 65. The highest plant hight was observed at Monsanto (245cm) closely followed by QPM300 (237cm) and the lowest at Azam (183cm). The genotype QPM had the maximum number of leaves per plant (17 vs 13) and cobs per plant (1.58 vs 1.07) and. The highest fresh biomass yield (55930 kg/ha) was observed at QPM300 among the spring maize genotypes. It was concluded from the study that maize genotype QPM300 had screen out the best spring maize genotype for silage production in term of biomass yield, growth parameter and phonological characteristics in local environmental condition of northern Pakistan.

* **Corresponding Author:** Nadar Khan ✉ Nadar73vet@aup.edu.pk

Introduction

Maize (*Zea mays* L.) crop is major forage species in the world and is widely grown in most parts of the world for three major purposes as a human food, the raw material for industries and for fodders of Livestock. Whole crop maize is a high yielding potential and suitable ensiling characteristics, but it yields, nutritional characteristics, digestibility is mainly influenced by management practices and maize genotypes. In developed countries, the researcherhas identified special maize genotype for quality silage production and parameter.

In Pakistan, the yield and nutritional quality of maize are very low because of low biomass producing maize genotypes, and traditional agronomic practices. There are several supporting other factors that affect the nutritive value, and yield of maize for silage which include lack of local knowledge on soil fertility. Recently, agriculture agronomists, dairy nutritionists, and producers have placed a high emphasis on the quantification of the factors that caused variation in nutritive value of maize for silage (Hristov *et al.,* 2013).The genotype, season of cultivation and harvest, and agronomic management are the key factors that can mainly modify the yield and composition of maize (Araujo *et al.,* 2012). A survey of the maize silage producers (n = 130) around the country showed that the chemical composition of maize for silage that are produced in Pakistan is extremely variable, and multivariate analysis revealed that most of this variation was created by the differences in maize genotype for silage yield (Khan *et al.*, 2016).

Selection of suitable maize genotype is the most important factor for improving the yield, and nutrient composition of maize (Biro *et al.* 2007; Araujo *et al.* 2012). In Pakistan maize is grown in two seasons, spring and autumn, and selection of suitable maize genotypes for silage production in these seasons warrant detail investigations. There is a huge variation in maize biomass yield from different genotypes (Loucka *et al.,* 2018). It is possible to selected maize genotype with high biomass and grain yield, and as such with high nutritional value for silage production (Masoero *et al.* 2011). Therefore, selection of maize genotypes should be made with special emphasis on high biomass and grain yield, for silage production (Ferraretto *et al.*, 2014; Loucka *et al.*, 2018). In Pakistan there was no systematic study conducted on maize genotype for silage production. Therefore, the current study was conducted with the aim to screen out best maize genotype for silage production in term of biomass yield and growth parameters.

Materials and methods

The field study was carried in the field of Agronomy, The University of Agriculture Peshawar, Pakistan. For this purpose, a total of six spring maize genotypes were selected,(namely; PioneerP1543 and P1429, Monsanto-DK 9108,QPM200, and QPM300 from CIMMYT and Azam a local genotype and evaluated.To obtain higher yields, based on soil nutrient profile all fields were fertilized @10 tons/ha farmyard manures before sowing. The plots were fertilized with 250: 90: 90 kg/ha of N: P: K, respectively using di-ammonium phosphate (DAP), urea, and sulfate of potash (SOP) at their recommended days of application. Seedbeds preparation is important to provide favorable field conditions for higher germination rate and seedlings. For this purpose, all the fields were given three times, ploughed with cultivator followed by rotavator to prepare a fine seedbed before sowing. The seed of each genotype was sown in 12 replicate plots (8 m × 10 m) according to randomized complete block design. Maize seed was sown with hands on twenty-eight March 2017, with a row to row space of 75 cm in ridges and 20 cm from plant to plant for production. Maize is sensitive to drought; therefore, maize crop was timely irrigated on regular basis. For the control of pest attack on maize plant all the plots were used with Furadon powder (pesticide) @20 kg/ha followed by irrigation. All agronomical principals were applied uniformly to each plot and genotype.

The growth of maize crop was monitored from emergence till silking. The appearance of flowering and silks was monitored by counting the number of flowers and silking in total plants of two randomly selected rows of each genotype in each plot on a meter rod. The data for flowering and silking was measure on each third day after silk appearance.

The total crop was considered flowered and silked when 50% of the crop reached at flowering and silking stage. The numbers of dry leaves were counted every week after flowering for the proportion of leaf senesces till harvest of each plot for each genotype. A leaf was considered senescent, when more than 50% of the area changed colour to yellow. Maize plant height was measured with meter rod height of 300cm randomly in each plot of 2 consecutive rows before harvest stage. The number of cobs per plant and was measured by counting the total number of cobs in 1 m^2 area of each plot for each genotype.Weather data (Monthly rainfall (mm), minimum and maximum temperature (^oC)) during the research study of the area from January to December during 2016 is given in Fig. 1.

Statistical analysis

The effects of spring maize genotypes were determined by repeated measure analysis of variance using the PROC MIXED procedure of SAS (SAS Inst., Inc., Cary, NC).

Results

Growth characteristic of spring maize genotypes

Data on phenological and growth parameters of the promising spring maize genotypes are summarized in Table 1. Days to emergence (DTE) differed (P<0.01) among the genotypes. Minimum DTE (9.62) was recorded for genotype Azam whereas maximum DTE (11.2) were observed for genotype P1429. The DTF were found significantly (P < 0.001) different among genotypes, and genotype Azam took minimum DTF (57) after sowing and maximum days (62 DTF) were recorded for genotype P1543. A similar trend was found for DTS in six different spring genotypes and the highest value of DTS (65) was observed for maize genotype P1542 and lowest value (61 DTS) at Azam (Table 1).

Table 1. Growth characteristics of spring maize genotypes evaluated for silage production.

VARIETY	Growth characteristics		
	DTE	DTF	DTS
Poineer-1429	11.2^a	59^{bc}	64^b
Azam cultivar	9.62^d	57^d	61^d
Monsanto-DK9108	10.8^b	59^c	62^c
Quality protein maize QPM200	10.8^b	61^b	64^{ab}
Quality protein maize QPM300	10.5^c	60^{ab}	64^{ab}
Pioneer - P1543	11.0^{ab}	62^a	65^a
SEM	0.31	0.40	0.3
Significance	**	***	***

Mean with different superscription (^{abcd}) within column differ at P < 0.05.

DTE, days to emergence; DTF, days to flowering/ tasseling; DTS, days to silking; SEM; standard error of mean, NS; non-significant, **, P < 0.01; *P < 0.05, ***P < 0.001.

Biomass yield and phonological parameters of spring maize genotypes

There was large variation (P<0.001) in fresh biomass yield among the genotypes and the highest value was found at QPM300 (55930 kg/ha) and the lowest value (38350 kg/ha) at Azam a local cultivar. Height per plant ranged from (183-245 cm) and the maximum height was observed at Monsanto DK9108 (245cm) closely followed by QPM300 (237cm) and the lowest value at Azam (183cm).

The maximum NOL/P (17) was recorded for genotype QPM300 and minimum for genotype Azam (13) summarized in Table 1. The number of cobs per plant (NOC/P) was affected (P<0.001) by maize genotype and the maximum NOC/P was observed at genotype QPM-300 (1.58) and the minimum (1.07) at genotype P1429.The leaf senesces per plant (LS/P) varied (P<0.001) among maize genotypes, and genotype Azam gives the highest value (4.50 LS/P) and QPM-300 has the lowest value (3.30 LS/P) given in Table 2.

Table 2. Fresh biomass yield and phonological characteristics of spring maize genotypes evaluated for silage production.

Variety	(Fresh biomass yield (kg/ha))	Phonological parameters			
		Plant height	NOL/P	LS/P	NOC/P
Poineer-1429	45700^{d}	214^{d}	15^{c}	3.90^{bc}	1.07^{d}
Azam	38350^{e}	183^{e}	13^{d}	4.50^{a}	1.14^{cd}
DK9108	48630^{bc}	245^{a}	16^{b}	3.80^{c}	1.30^{bc}
QPM200	50460^{b}	222^{c}	15^{bc}	3.80^{c}	1.33^{b}
QPM300	55930^{a}	237^{b}	17^{a}	3.30^{d}	1.58^{a}
P1543	47460^{c}	215^{d}	16^{ab}	4.10^{b}	1.25^{c}
SEM	0.30	0.11	0.18	0.18	0.06
Significance	***	***	***	***	***

Mean with different superscription (^{abcd}) within column differ at P < 0.05.

Kg/ha; kilogram per hectare, NOL/P, number of leaves/plant; LS/P, leaf senesces/plant ;NOC/P, number of cobs/plant; SEM; standard error of mean, ***P < 0.001.

Discussion

Growth characteristic of spring maize genotypes

Spring maize silage genotype showed variation for growth and phonological parameter. The genotypes were varied for DTF (57 to 62) and DTS ranged from 61 to 65 days.

The maximum DTF (62) and DTS (65) was at P1543 and minimum value of DTF (57) and DTS (61) was at Azam among the maize genotypes. Current results were in line with the literature reported values ranged (DTF; 57 to 62) and DTS from 54 to 65 days (Inamullah *et al.,* 2011; Zafar *et al.,* 2011; Kamran *et al.,*2014; Pradeep and Patil 2018).

The variation in genotypes may be due to its sowing dates, temperature during the experiment, genetic makeup, early and late germination, nitrogen uptake capacity, adaptation to a certain soil day to germination, and maturity period of these genotypes. Maize fresh biomass yield ranged from (38350 to 55935 kg/ha) and the highest value was observed at QPM300 was in line with the reported value of (Lynch *et al.,*2013;Opsi *et al.,* 2012). *Biomass yield and phonological parameters of spring maize genotypes*

Maize plant height is an important component of maize growth and it can directly help to determine the growth attained during the plant growing period. In the currentstudy, maize genotype got maximum height as compared to local cultivars.

The genotype DK9108 and QPM-300 maize genotypes got the highest height per plant (245cm) and (237cm) as compared to local variety Azam (183cm) with the application of uniform agronomical practices.

The results were inconsistent with the data of published paper ranged from 179 to 249cm (Lopez.*et al.*, 2018; Zamir *et al.*, 2011;Nizam *et al.*, 2010).

This variation is due to its genetic makeup and specific to each genotype. Similarly, NL/P were varied among maize genotypes and plant leaf numbers were closely associated with plant height.

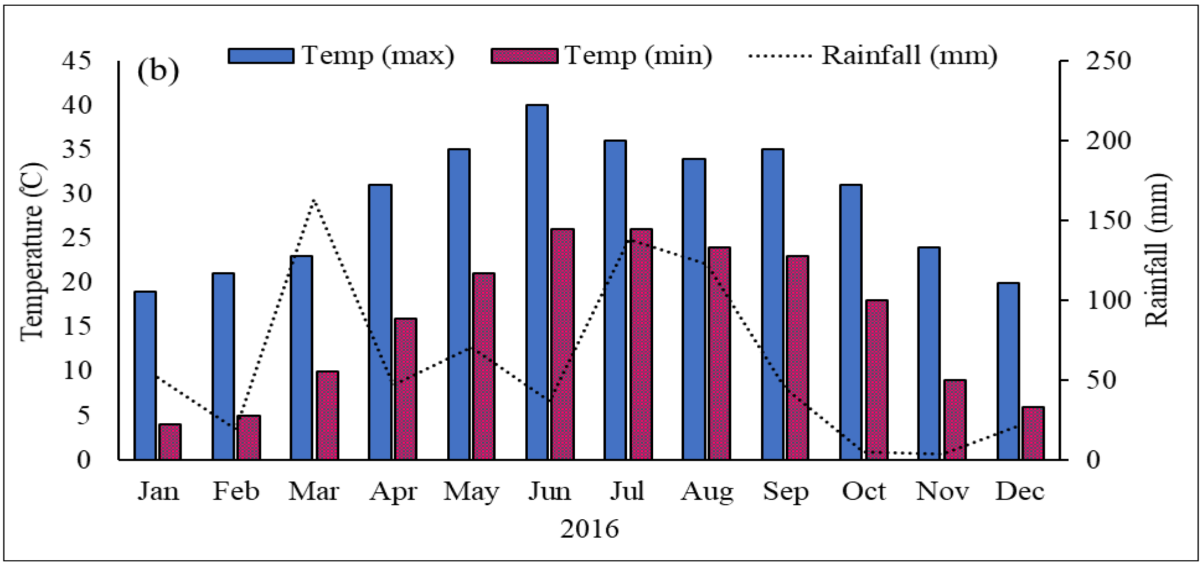

Fig. 1. Monthly rainfall (mm), minimum and maximum temperature (°C) during the research study of the area from January to December during 2016.

The maximum NL/P and NC/P were observed at QPM-300 were (17) and (1.58) as compared to other maize genotypes. The maximum LS/P (4.50) was observed in local cultivar Azam among the genotypes. The result of present experiment was in line with other studies data ranged (14 to 19 NL/P) and (0.90 to 1.51 NC/P) of maize genotypes (Millner *et al.*, 2010; Johnson *et al.*,2002; Moss *et al.*, 2001; Thomas *et al.*, 2001). This variation in plant height, number of leaf and number of cobs per plant is due to the genetic makeup of genotype, as well as maturity stage of these maize genotypes. Maize genotypes that have to reach early maturity produce minimum number of leaves and get less height than those having late maturity stages like QPM-300.

Conclusion

Suitable maize genotype selection for silage production, not only influences the biomass yield but also important for the maize plant growth and yield parameters. Large differences ($P < 0.001$) were observed among the maize genotypes in terms of fresh biomass yield (55930 vs 38350 kg/ha), plant height (237 vs 183), maximum leaf (17 vs 13) and cobs per plant (1.58 vs 1.07). It was concluded that QPM-300 is screen out the most suitable spring maize genotype for biomass yield and excellent growth parameter for silage production under the environmental condition of Northern Pakistan.

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