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EVALUATING THE FORAGE YIELD AND QUALITY POTENTIAL OF DIFFERENT MAIZE CULTIVARS UNDER DIFFERENT HARVESTING TIMES

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Abstract

A pot experiment to evaluate the effect of different harvesting times on forage yield and quality attributes of different maize (*Zea mays* L.) cultivars was conducted at College of Agriculture, Dera Ghazi Khan during summer season, 2011. Seeds of cultivars viz. "Pak-Afgoi", "Neelam", "Cargil", "Goldan" and "Akbar" were sown manually on 20th July and each cultivar was harvested at 30, 45 and 60 days after sowing (DAS). The study was done under completely randomized design with factorial arrangement having three replications. Different cultivars and harvesting times significantly affected the growth, forage and dry weight per plant of maize. The growth and yield per plant of each cultivars significantly increased with the delay in harvesting times. Quality parameters like crude protein, crude fibre and total ash percentage were also significantly influenced by different cultivars and harvesting times. The crude protein contents of all cultivars decreased with the increase in harvesting timings, while the crude fibre and total ash percentage increased with the delay in harvesting times. It is concluded that delaying the harvesting up to 60 DAS, increased the green forage and dry weight per plant but decreased the forage quality.

Keywords: forage maize, cultivars, crude protein, crude fiber, total ash percentage.

Introduction

Livestock industry is an important part of Agriculture in Pakistan. It is considered as back bone of agriculture and it provides essentials dietary requirements like meat and milk to millions of people in the country (Ibrahim, 2010). Good quality fodder is the cheapest source of energy for livestock. Therefore, regular and adequate supply of nutritious fodder is essential to meet the healthy livestock industry in the country, because success of this industry depends on the availability of high quality fodder throughout the year (Ayub *et al.,* 2011). Unfortunately, the animals in Pakistan are usually underfed resulting unsatisfactory production (Ayub *et al.,* 2013).

Many forage crops like maize, sorghum, pearl millet, cluster bean, sesbania and cowpea etc. are grown in kharif season. Maize (*Zea mays* L.) is an important cereal crop, which can be successfully grown under different climatic zones of Pakistan. Being a versatile in nature, maize is used as food for human, feed for poultry and fodder for livestock. Its fodder contains about 8.62 to 10.32% crude protein, 29.92 to 31.38% crude fibre, 1.27 to 1.35% ether extractable fats (EEF), and 8.45 to 9.24% total ash (TA) (Ibrahim *et al.,* 2012). The use of high yielding varieties is helpful to boost up the forage yield (Ayub *et al.,* 2001). Keeping in view the importance of maize as forage, a number of varieties has been developed in the past, but the yield potential and quality traits of cultivars were significantly affected by environmental factors (Roth, 1994). Therefore efforts are needed to select the existing varieties, which are capable of rapid growth and provide higher forage yield in short duration of time.

Harvesting of forage crops at accurate timing is another important factor which can affect the forage yield as well as its quality. Delay in harvesting of maize, sorghum and sorghum-Sudan grass, increased the forage yield whereas the quality contents decreased (Gul *et al.,* 2008). Bukhari (2009) noted a decrease in crude protein and ash contents with delaying the harvest of pearl millet, whereas, crude

fibre and dry matter percentage were increased with advancement in maturity. Ayub *et al.* (2003) harvested forage maize at 40, 50 and 60 DAS and reported that dry matter yield percentage and crude fibre contents were significantly increased with delaying the harvest whereas, crude protein and ash contents were decreased with delay in harvesting.

By knowing the importance of discussed factors, there is a dire need to select the good cultivars of maize for forage which may provide good yield and quality at different harvest timings under agro-ecological conditions of southern Punjab.

Materials and methods

A pot experiment to compare the growth, forage yield and quality of different cultivars of maize at different harvesting times was conducted during summer season 2011 at College of Agriculture, Dera Ghazi Khan. The cultivars viz., "Pak-Afgoi", "Neelam", "Cargal", "Goldan" and "Akbar" were sown on 20th July and harvested at 30, 45 and 60 DAS. The experiment was laid out in completely randomized design with factorial arrangement having three replications. The pots were of equal size about 38 cm lengths, 32 cm top diameter and 23 cm bottom diameter. Seven seeds of each cultivar were planted manually at "Wattar condition" in each pot having 20 kg soil. After germination only five healthy plants were selected for further study after uprooting the weaker ones. Plant nutrition in the form of Nitrogen @ 1.2 g pot^{-1} and phosphorus @ 0.6 g pot^{-1} were applied to all treatments as Urea and DAP, respectively. Furadon was applied to control shoot fly, stem borers. Equal amount of water was applied manually through container having sprinkler at top to each pot when crop was needed. At the end of the each prescribed harvesting duration, all the plants of each cultivar were harvested manually with the help of sickle. Data of each cultivar on growth and yield parameter like, plant height, stem diameter, number of leaves per plant, leaf area per plant, fresh weight per plant, dry weight per plant were recorded at all harvestings. Quality parameters like, crude protein, crude fibre, total ash were determined by procedures suggested by (AOAC, 1990).

The collected data were analyzed statistically by using Fisher's analysis of variance techniques and least significant difference test at 0.01 probability level was applied to compare the significant differences among the treatment means (Steel *et al.,* 1997).

Results and discussions

Plant height: The individual as well as the interactive effects of cultivars and harvesting times on plant height of forage maize were significant (Table 1). The cultivars "Pak-Afgoi", harvested at 60 DAS produced statistically higher (116.07 cm) plants but it was also similar with "Akbar" and "Cargal" harvested at 60 DAS (113.60 cm) and (112.73), respectively. The lowest plant height was observed in cultivar "Neelam" harvested at 30 DAS (51.60cm). It was also statistically at par with "Cargal" and "Golden" harvested at 30 DAS. Variation in the plant height was due to the differences in genetic makeup of the cultivars. Results were quite in line with those of Bukhari *et al.* (2011) reported the taller plants of pearl millet when cultivar "786" was late harvested (75DAS) and shortest plants were observed in cultivar "MB-87" when it was harvested early at 45 DAS. Iptas and Acar (2006) also reported the significant effects of maize hybrids on plant height. But contradictory results were reported by Khan *et al*. (2004), who observed the non-significant differences among different cultivars of pearl millet regarding the plant height. Variation in soil fertility and differences in crops might have been the reasons of these contradictory results. Higher plants of pearl millet at 60 DAS were also reported by Ayub *et al.* (2009).

Stem Diameter: The effects of cultivars, harvesting times and their interactions on stem diameter of forage maize were significant (Table 1). The cultivar "Pak-Afgoi" harvested at 60 DAS produced statistically thickest (1.52 cm) plants keeping at par with "Akbar" (1.31 cm) harvested at 60 DAS and "Cargil" harvested at 60 DAS (1.28 cm). The lowest stem diameter was produced by "Neelam" (0.53 cm) harvested at 30 DAS. It was also statistically similar with "Cargal" (0.58 cm) and "Golden" (0.45 cm). Variability in stem diameter per plant amongst different cultivars may be due to the genetic potential of the individual cultivars. Similar results were also reported by (Awan *et al*., 2001), they observed the thicker stems of maize variety "Sultan", when it was harvested at 60 DAS. Bukhari *et al.* (2011) also reported the thicker plants of cultivar "786" than other cultivars, when the plants of pearl millet were harvested at 75 DAS. **Number of leaves per plant:** Leaves have more nutritive values as compared to the stem of the plant, so, number of leaves per plant is very important parameter for calculating the growth and forage yield of maize. The cultivar "Pak-Afgoi" harvested at 60 DAS produced statistically highest number of leaves (9.00) keeping at par with "Akbar" (8.93), "Cargal" (8.69), "Neelam" (8.40), "Golden" (8.27) each was harvested at 60 DAS, and "Pak-Afgoi" (8.33), "Akbar" (8.17), "Cargal" (8.13)

harvested at 45 DAS (Table 1). Whilst, significantly lowest number of leaves was produced in "Neelam" (4.67) harvested at 30 DAS. It was also statistically similar with "Cargal" (6.00) and "Golden" (5.67) harvested at 30 DAS**.** The reason of variation in leaves may be due to the difference in genetic potential of each cultivar. Significant differences among hybrids of forage maize were also observed by Iptas and Acar (2006) who stated the maximum number of leaves per plant in hybrid "Arifiye" than other hybrids. Kusaksiz (2010) also reported the maximum number of leaves per plant of maize in "C-955" and "DKC-6842", respectively. The reason of having maximum leaves of maize with delay in harvesting may be the increase in nodes due more growth and plant height with time. Significant increase in delaying the harvest of forage sorghum and pearl millet has been also reported by Ayub *et al.* (2002) and Ayub *et al.* (2009), respectively. Bukhari *et al*. (2011) observed the significant differences among cultivars of pearl millet at varying harvesting intervals regarding number of leaves per plant. They reported that cultivar "786" produced more number of leaves per plant when it was harvested at 75 days after harvesting.

Leaf area per plant: The effect of cultivars, harvesting times and their interaction on leaf area per plant of forage maize were significant (Table 1). The cultivar "Pak-Afgoi" produced statistically maximum leaf area (254.60cm) when it was harvested at 60 DAS, while the lowest leaf area was produced by "Goldan" (113.03 cm) and it was statistically similar with "Neelam" (123.90 cm) each was harvested at 30 DAS. The variation in leaf area per plant of maize may be due to the different genetic make-up in each cultivar. Significant differences for leaf area amongst cultivars of forage maize were also reported by (Ayub *et al.,* 1998). Awan *et al.* (2001) also reported the significantly highest leaf area per plant in "Sultan", which finally gave the higher forage yield. Increase in leaf area per plant at 60 DAS may be due to taking the more growing days as compared to other treatments at each delay in harvesting times. Significant increase in leaf area of forage sorghum and pearl millet with delaying the harvest were also reported by Ayub *et al.* (2002) and Ayub *et al.* (2009), respectively. Alias *et al.* (2011) also stated the higher leaf area index of maize at 75 DAS as compared to other harvestings. Bukhari *et al.* (2011) also reported the significant differences in leaf area among different cultivars of pearl millet when were harvested at different dates.

Table 1: Comparison of cultivars regarding growth, forage yield attributes and crude protein of maize at different harvesting times

Treatments	Plant height (cm)	Stem diameter (cm)	Number of leaves per plant	Leaf area per plant (cm^2)	Fresh weight per plant (g)	Dry weight per plant (g)	Crude protein (%)
"PakAfgoi" harvested at 30DAS	65.40g	0.73e	7.00 cd	164.12 g	125.34f	14.58f	9.33cd
"PakAfgoi" harvested at 45DAS	96.00b	1.28b	8.33 ab	235.06cd	241.09d	37.57d	8.81g
"PakAfgoi" harvested at 60DAS	116.07a	1.52a	9.00 a	254.60a	429.12a	84.85a	8.71h
"Neelam" harvested at 30DAS	51.60h	0.53fg	4.67 f	123.90 ij	99.78g	8.20g	9.31d
"Neelam" harvested at 45DAS	76.93ef	1.08d	7.93 bc	207.47ef	211.89e	30.88e	8.62i
"Neelam" harvested at 60DAS	91.27bcd	1.10cd	8.40 ab	234.17cd	341.57c	46.17c	7.73m
"Cargal" harvested at 30DAS	52.42h	0.58fg	6.00 de	139.23hi	116.95fg	11.87fg	9.66a
"Cargal" harvested at 45DAS	81.73de	1.22bcd	8.13 ab	210.95ef	213.70e	30.99e	9.00e
"Cargal" harvested at 60DAS	112.73a	1.28b	8.69 ab	234.07c	375.75b	56.19b	8.07j
"Golden" harvested at 30DAS	56.80gh	0.45g	5.67 ef	113.03j	100.80g	10.13fg	9.36bc
"Golden" harvested at 45DAS	84.07cde	1.12cd	7.93 bc	201.76f	212.38e	29.65e	8.80f
"Golden" harvested at 60DAS	94.73bc	1.14cd	8.27 ab	222.70de	272.21b	73.67b	7.83l
"Akbar" harvested at 30DAS	66.98fg	0.64ef	6.67 de	151.52gh	120.35fg	14.29fg	9.40b
"Akbar" harvested at 45DAS	90.13bcd	1.23bc	8.17 ab	232.63d	238.62d	35.63de	8.91f
"Akbar" harvested at 60DAS	113.60a	1.31b	8.93 ab	251.76b	379.88b	79.85ab	8.00k
LSD @ 0.01	11.29	0.14	1.02	19.47	22.98	6.24	0.038
Mean	**83.37**	**1.01**	**7.59**	**207.80**	**238.63**	**38.97**	**8.78**

Means not sharing a common letter differ significantly at $P \leq 0.01$

Fresh weight per plant: Forage yield dependent on the fresh weight per plant and maximum weight of the plant increased the forage yield. The effects of cultivars, harvesting times and their interaction on fresh weight per plant of forage maize were significant (Table 1). The cultivar "Pak-Afgoi" harvested at 60 DAS produced statistically highest fresh weight per plant (429.12 g) than all other treatments, while the lowest fresh weight per plant of forage maize was produced by "Neelam" (99.78g) harvested at 30 DAS. It was also statistically at par with "Goldan" (100.80 g), "Cargal" (116.95 g) and "Akbar" (120.35 g). The cultivar "Akbar" produced statistically similar fresh weight per plant (379.88 g) with "Cargal" (375.75 g) and "Goldan" (272.21g), when each was harvested at 60 DAS. Production of maximum and minimum fresh weight per plant of maize in "Pak-Afgoi" and "Neelam" respectively was due to the different genetic potential of each cultivar, in addition, higher values of plant height, number of leaves per plant, stem diameter and leaf area per plant of "Pak-Afgoi" also contributed to the fresh weight per plant. Iptas and Acar (2006) reported the maximum fresh weight per plant production in hybrid "Arifiye" over all others hybrids of maize. Variation in fresh weight per plant of maize amongst different cultivars and harvesting times were the conformation of the results of Shakoor *et al*. (1983) and Sartaj *et al*. (1984). Results of Bukhari *et al*. (2011) reported the maximum forage yield in cultivar "786" of pearl millet when it was harvested delayed at 75 DAS.

Dry weight per plant: The individual as well as the interactive effects of cultivars and harvesting times on dry weight per plant of forage maize were significant (Table 1). The cultivar "Pak–Afgoi" harvested at 60 DAS produced statistically highest dry weight per plant (84.85g) keeping at par with "Akbar" (79.85g) which was harvested at 60 DAS. The cultivar "Akbar" was also statistically at par with "Goldan" and "Cargal" each harvested at 60 DAS by producing dry weight (73.67 g) and (56.19 g) per plant, respectively. The lowest dry weight (8.20 g) per plant was observed in the treatment when cultivar "Neelam" was harvested at 30 DAS, either it was statistically similar with "Goldan" (10.13g), "Cargal" (11.87g) and "Akbar" (14.29g) harvested at 30 DAS. In all cultivars, the each delay in harvesting increased dry weight per plant of maize. This increase in dry weight was attributed to the more growth attained due to having maximum photosynthates. Significant interactive effects of cultivars x harvesting intervals of pearl millet grown for forage were also recorded by Bukhari *et al.* (2011). Ahmad *et al.* (2012) also observed the significant variations among different varieties of maize and reported the highest dry weight per plant in variety Pak-Afgoi against the minimum in variety "Neelum". Significant increase in delaying the harvest of forage sorghum has been reported by Ayub *et al.* (2003).

Crude protein: Crude protein is a significant component of forage quality because quality of forage considered better when the level of crude protein contents are high in it. The effect of cultivars, harvesting times and their interactions were significant (Table 1). The cultivar "Cargal" harvested at 30 DAS produced statistically highest crude protein (9.66%), while the cultivar "Akbar" keeping at par with "Goldan" each harvested at 30 DAS produced 9.40% and 9.36% crude protein, respectively. The cultivar "Goldan" was statistically similar with "Pak Afgoi", when it was harvested at 30 DAS. The lowest crude protein was recorded in "Neelam" (7.73%) when it was harvested at 60 DAS. Variation among different varieties of forage maize regarding crude protein contents were also reported by (Ahmad *et al.*, 2012). The reason of having minimum crude protein percentage of maize with delayed harvesting may be due to the dilution factor. Bukhari *et al.* (2011) also recorded the significant effects of cultivars x harvesting times on crude protein of pearl millet grown for forage. They reported the statistically lowest crude protein of pearl millet in cultivar "786" harvested at 75 DAS (late harvesting) than all other treatments. The results of Tariq *et al.* (2011) were in contradiction, because they recorded the non-significant interactive effects, when different varieties of pearl millet were harvested at different intervals. Variation in results may be due to the differences in crops, climatic conditions, and soil fertility status at both sites.

Crude fibre: Crude fibre is an important parameter of quality for estimating the forage diet. The forage quality considered best having optimum amount of crude fiber, but quality decreased with the increase its contents beyond the normal level. The effects of cultivars, harvesting times were significant, but their interactive effects were non-significant (Table 2). Higher crude fiber (39.71%) was observed in cultivar "Neelam" against the minimum (37.74%) in "Goldan". Variation amongst the cultivars regarding crude fibre contents attributed to the genetic material of each cultivar. Statistically significant results amongst different varieties of forage maize were also reported by (Ahmad *et al.*, 2012). Maximum value of crude fiber (38.78 %) of maize was observed, when plants were harvested at 60 DAS. The lowest percentage of crude fibre (38.65%) was produced at

30 DAS. The reason of having maximum crude fibre percentage of maize with delayed harvesting may be due to the maturity of stem and dilution factor. Results were similar with those of Bukhari *et al.* (2011), who reported the increase in crude fibre of pearl millet with delayed harvesting at 75 DAS.

Total ash: Total ash percentage was significantly affected by different cultivars, harvesting times and their interactions were non-significant (Table 2). The cultivar "Pak-Afgoi" gave significantly maximum total ash (9.80) percentage, while the lowest values of total ash were attained by cultivars "Neelam" (8.17%) and "Golden" (8.35%). The reason in variable ash contents may be due to the different genetic potential of cultivars. Bukhari *et al.* (2011) and Amodu *et al*. (2007) also stated the significant variations among the varieties.

The plants harvested at 60 DAS gave higher total ash (8.93 %) against the lowest ash contents (8.83%), where plants were harvesting at 30 DAS. The reason of having maximum total ash with delayed harvesting might be due to more uptakes of minerals for longer period of time in the field. Significant increase in ash percentage with delay in the harvesting of forages was observed by Zahid and Bhati (1994) and Tariq *et al*. (2011) for sorghum and pearl millet, respectively.

Table 2: Comparison of cultivars regarding quality attributes of maize at different harvesting times

Treatments	Crude fibre (%)	Total ash (%)
Cultivars		
Pak-Afgoi	38.78c	9.80a
Neelam	39.71a	8.17e
Cargal	38.15d	8.86c
Golden	37.74e	8.35d
Akbar	39.15b	9.24b
LSD @ 0.01	0.019	0.017
Harvesting Times		
30 Days after sowing	38.65c	8.83c
45 Days after sowing	38.71b	8.88b
60 Days after sowing	38.78a	8.93a
Interaction	NS	NS
LSD @ 0.01	0.014	0.013
Mean	**38.72**	**8.88**

Means not sharing a common letter differ significantly at $P \leq 0.01$
NS = Non Significant

Conclusion:

It is concluded that the cultivar "Pak-Afgoi" proved to be the superior one over all other cultivars. The delay in harvest upto 60 DAS gave the higher fresh and dry weight per plant but it decreased the quality attributes. It is recommended to the farming community of southern Punjab that growing of "Pak-Afgoi" and harvested at 60 DAS is the best option for getting higher forage yield with adequate quality of maize.

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