

## Quality response of maize fodder cultivars to harvest time

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### Abstract

The study was conducted to investigate the fodder quality of four maize cultivars; DK919, 30R50, 31R88 and 6621 as influenced by harvest time at Agronomic Research Area of University of Sargodha. Maize cultivars were harvested at three different times viz. 80, 90 and 100 days after sowing (DAS). Significant differences were recorded among the cultivars for plant height, acid and neutral detergent fiber contents, lignin and crude protein. Maximum acid detergent fiber content, neutral detergent fiber content and lignin were observed at 100 DAS while crude protein was maximum at 80 DAS. However, plant height was remained unaffected with respect to harvest times. Moreover, maize cultivars had distinct differences in plant height and fodder quality parameters. Maximum plant height and crude protein were recorded in cultivar 31R88. The cultivar DK919 showed maximum values of acid detergent fiber content and neutral detergent fiber while lignin content was higher in V6621. Fodder quality parameters of cultivars 31R88, DK919 and V6621 were superior than 31R88 under the present climatic conditions of Sargodha.

**Keywords:** Harvest Time, Cultivars, Fodder Yield, Maize, Fodder Quality

### Introduction

Maize (*Zea mays* L.) is a dual-purpose crop universally grown for grain and forage. It produces ample quantity of green herbage with high nutritional and appetizing value (Akdeniz et al., 2004; Erdal et al., 2009). It has a distinct position in the national economic system of Pakistan and have 6.4% share in the total grain production. Moreover, it is a quality source of food, feed and fodder (Abdullah et al., 2007). In Pakistan, at least two crops of maize can be harvested in a year i.e., in spring and autumn seasons. According to the Economic Survey of Pakistan, the maize cultivation during the year (2014-15) was 1.13 million hectares with grain production of 4.69 million tons with average production was 4155 kg ha<sup>-1</sup> (GOP, 2014-15). Maize production in Pakistan is still low compared to other countries in spite of favourable

environmental conditions and high yielding varieties. There are various limiting factors like water shortage, unpredictable rainfall, unavailability and high cost of fertilizers, less significance of fodder production and human population pressure adversely affecting fodder production (Rashid et al., 2007).

Quality of grain and fodder is considered as most important in maize production. Environment, planting time, stage at harvest, type of hybrids, agronomic management, hygienic quality, digestibility and consumption by animal are the most important grain, fodder and silage quality determining and limiting factors (Bal et al., 2000; Widdicombe and Thelen, 2002; Geren, 2000; Yilmaz et al., 2003). Maize fodder and feed products provides all forms of elementary nutrients and source of energetic nutrients with relatively low content of crude protein (Mlynár et al., 2004). Fodder harvesting at appropriate time is a main



aspect for a successful forage production. Fodder cutting at maturity resulted in higher lignin content while lower concentration of fodder quality traits like plant protein, neutral detergent fiber (NDF), acid detergent fiber (ADF) and leaf proportion (Atis et al., 2012). Forage quality is directly influenced by the stage of maturity, which decreases as plant advances towards maturity and results in lower forage digestibility and consumption by animals (Ball et al., 2001). The neutral detergent fiber and acid detergent fiber are the most important fodder quality constituent, which are used as standard forage testing techniques. Moreover, these quality parameters are used to calculate fodder digestibility and intake potential (Ball et al., 2001).

Fodder quality characters may vary among different maize cultivars. Similarly, the time of fodder harvesting is affecting the fodder quality of each cultivar. The present study, therefore, was undertaken to evaluate the quality of four maize cultivars harvested at three different harvest time of autumn sown maize under semi-arid condition of Pakistan.

## Materials and Methods

### Study site

The current study referred to know the fodder quality response of four autumn maize cultivars to three harvest times was conducted at the research area of University College of Agriculture, University of Sargodha, Sargodha during the year 2012. Sargodha lies at 32.08° N and 72.67° E. General elevation of land from sea level is 193 m.

### Soil collection and analysis

The soil on which experiment was conducted was clay loam. Before starting the experiment, the samples of soil were collected to a depth of 30 cm and were analyzed for various physical and chemical properties (Jackson, 1962; Moodie et al., 1959; Watanable and Olsen, 1965). Soil characteristic recorded are presented in Table-1.

### Experimental design and crop husbandry

Experiment was conducted applying randomized complete block design in a split plot arrangement having three replications with net plot size assigned to single treatment of 4 m x 6 m. Three harvest times 80, 90 and 100 days were allocated to main plots while four cultivars (DK919, 30R50, 31R88 and 6621) were assigned to subplots.

**Table – 1: Pre-sowing analysis of experimental soil during 2012**

Characteristic	Unit	Values	
		0-15 cm	15-30 cm
<b>Chemical analysis</b>			
Saturation	%	37	36
pH	----	7.8	7.9
EC	dS m <sup>-1</sup>	1.64	1.65
Organic matter	%	0.96	0.84
Total nitrogen	%	0.047	0.043
Available phosphorous	Ppm	12.5	8.5
<b>Mechanical analysis</b>			
Sand	%	29	25
Silt	%	47	46
Clay	%	22	33
Soil texture	----	Silt loam	Loam

Field was prepared by using tractor mounted cultivator, cultivating thrice which resulted in well pulverized. There were 36 plots prepared and each plot had 5 ridges in East-West direction. Sowing was done manually on July 26, 2012. Maize hybrids seed was used at the rate of 10 kg acre<sup>-1</sup>. Nitrogen fertilizer was applied in three splits in the form of Urea i.e. 1/3<sup>rd</sup> at the time of sowing, 1/3<sup>rd</sup> when crop was at knee height and 1/3<sup>rd</sup> at tasseling stage. Whole of the phosphorus and potash fertilizers, in the form of Di-ammonium phosphate and murate of potash were applied as basal dose. On the basis of need of the crop, seven irrigations were applied in addition to rainfall during the whole growth period. First irrigation was applied after 05 days of sowing and later irrigations were applied as when needed. To maintain inter plant spacing thinning was done when crop reached at the height of 15 cm. Plant protection measures like application of weedicide and insecticide etc. were kept normal for all treatments. Harvesting of different samples was done 80, 90 and 100 days after sowing respectively.

### Fodder quality parameters of maize

Ten plants were selected at random from each plot to record individual plant observation like plant height (cm) by using standard procedure. On each harvest date one plot of each genotype was harvested. Dried samples were ground using a hammer mill to pass a 1 mm screen. Whole plants samples were analyzed for NDF, ADF and CP content. A 0.5 g sample was used



for sequential detergent analysis to determine NDF and ADF contents (Soest et al., 1991). Total N was determined by the Kjeldahl procedure and CP content was calculated by multiplying total N by 6.25. All compositional data were calculated on a dry matter basis. The concentration of lignin was measured by using the simplified method adopted by Goering and Van Soest, (1970).

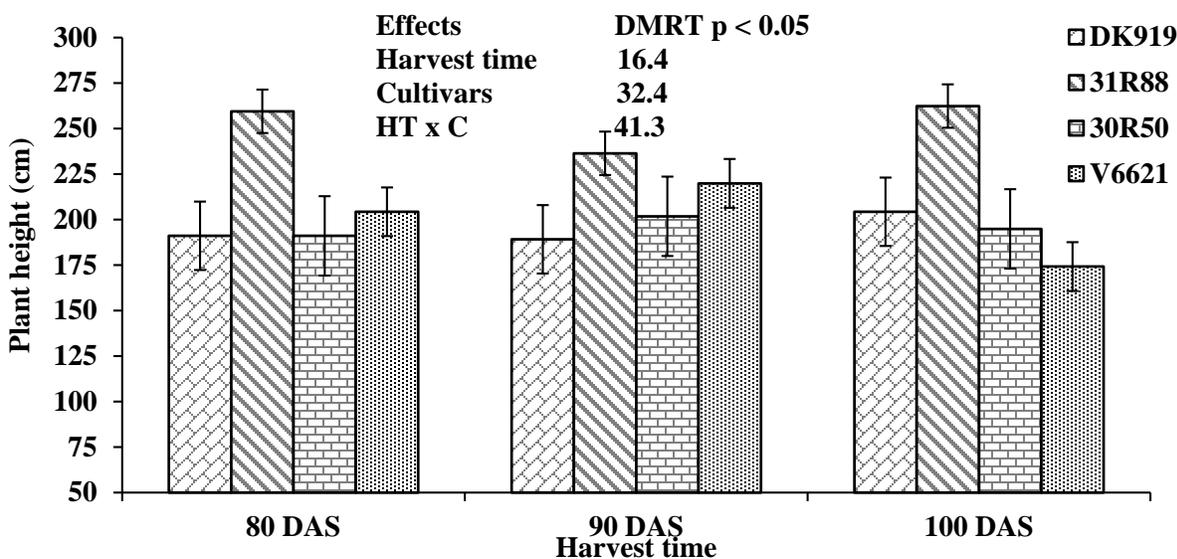
**Statistical analysis**

Data were analyzed statistically using SAS (SAS Institute, 2008). The effects of harvest time and cultivars and their interaction were evaluated by the Duncan’s Multiple Range test (DMRT) at  $p \leq 0.05$  unless otherwise mentioned. The computer package MS-Excel was used to prepare the graphs.

**Results**

Different maize cultivars were affected by harvest time, cultivars and their interactive effect were significantly different ( $p > 0.05$ ) on plant height (cm), acid and neutral detergent fiber (%), lignin (%) and crude protein (%). Plant height is an important yield-contributing as well as fodder production factor. It is apparent from Figure-1 that there is significant difference in plant height of maize cultivars when harvested at various times. Statistically taller (212 cm) plant height was noted at 100 DAS. Cultivars 31R88

cultivars. The interaction between harvest time and cultivars showed that cultivar 31R88 recorded (262.4 cm and 259.5 cm) taller plants ( $p > 0.05$ ) at harvest time of 100 and 80 DAS, respectively. However, shorter (174.2 cm) plant height was recorded in V6621 at 100 DAS compared than other treatments. An overview of the acid detergent fiber data (Figure-2) revealed that maximum (32.7 and 32.3 %) ADF was attained in V6621 and DK919 at 100 DAS respectively. Neutral detergent fiber is the percent of cell wall material of the forage cellulose hemicelluloses and unavailable protein. It is the evident from the results (Figure 3) that harvest time and varieties significantly affected the neutral detergent fiber. Moreover, significantly maximum (50.7, 48.3 and 48.3 %) neutral detergent fiber was recorded in DK919, 31R88 and V6621 at 100 DAS respectively. Lignin is an indigestible plant structural constituent which binds the other plant molecules and makes them indigestible. Statistically maximum lignin contents (3.6 and 3.4 %) were attained in variety V6621 and DK919 at 100 DAS while statistically minimum lignin (2.4 %) was observed in 31R88 at 80 DAS (Figure 4). Crude protein affects the nutritional value and palatability of the forage crop. It is apparent from Figure 5 that harvest time and cultivars had a significant effect on crude protein of maize. The interaction between harvest time and cultivars showed maximum crude protein (8.8, 8.7, 8.3 and 8.1 %) in 31R88, V6621, 30R50 and DK919 at 80 DAS



showed taller (252.8 cm) plant height among other respectively.

**Figure – 1: Effect of harvest time and cultivars on plant height (cm) of autumn maize.**



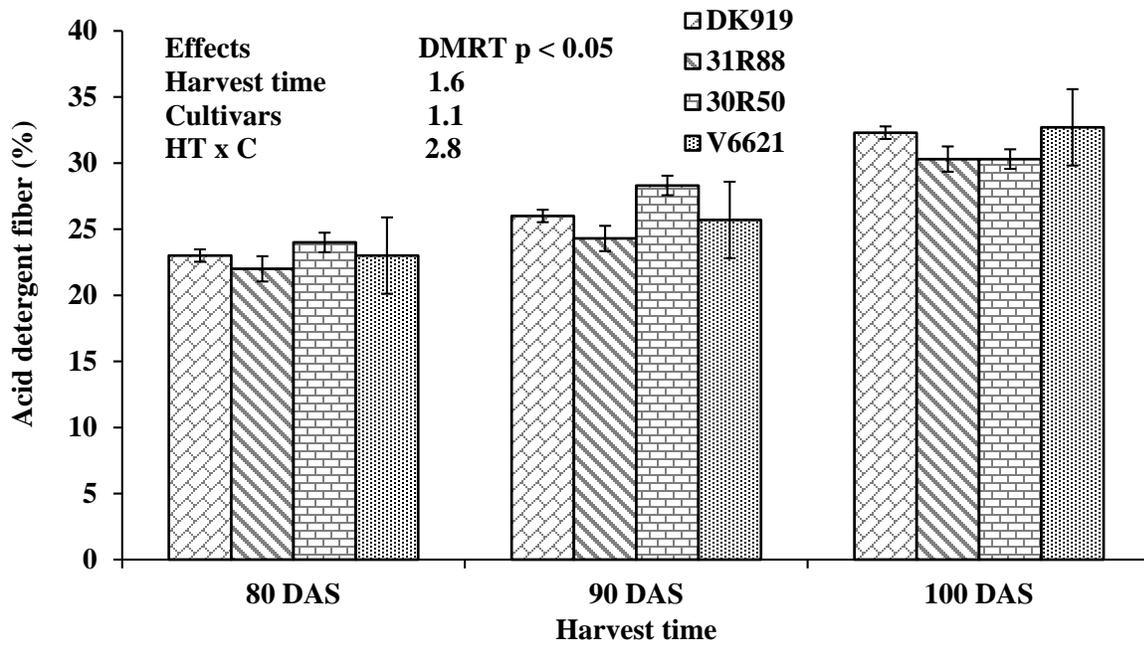


Figure - 2: Effect of harvest time and cultivars on acid detergent fiber (%) of autumn maize.

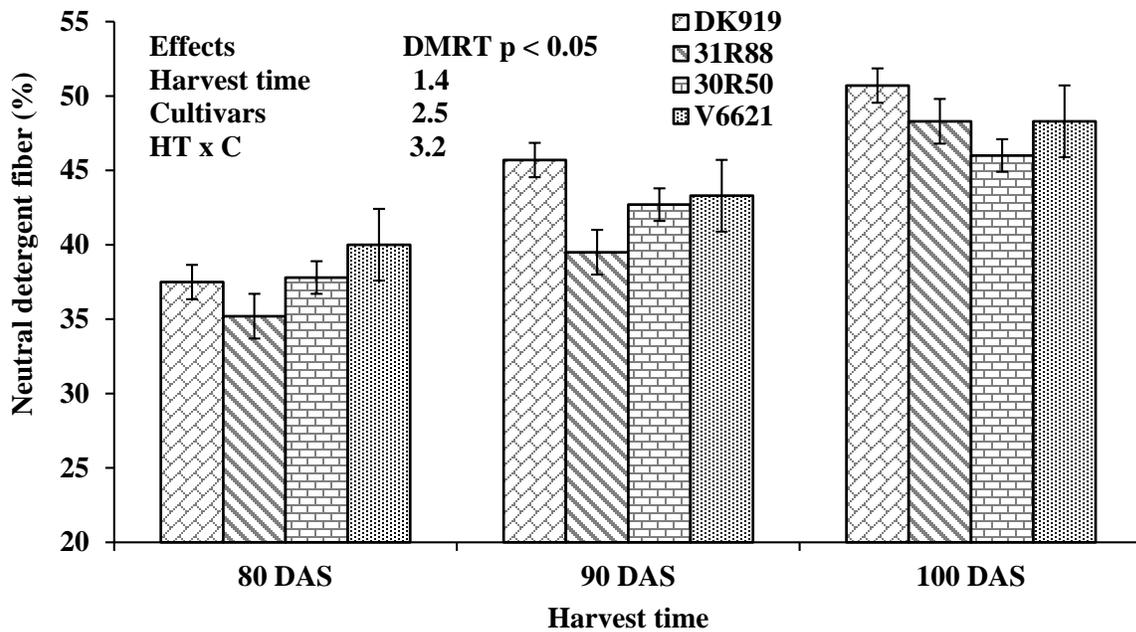


Figure - 3: Effect of harvest time and varieties on neutral detergent fiber (%) of autumn maize.

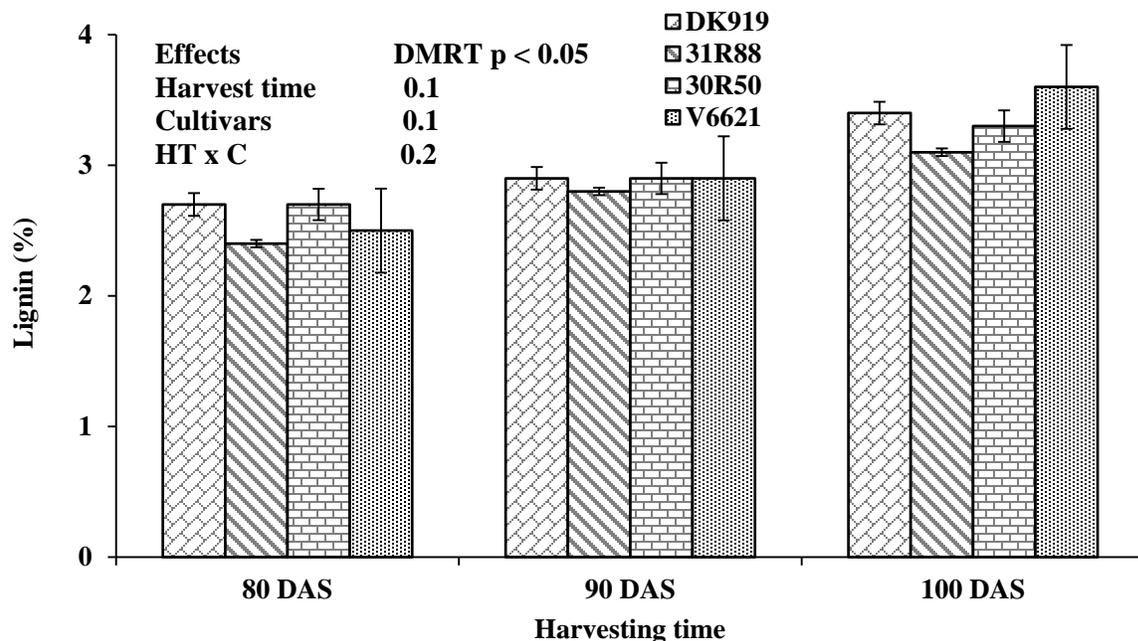


Figure - 4: Effect of harvest time and cultivars on lignin (%) of autumn maize.

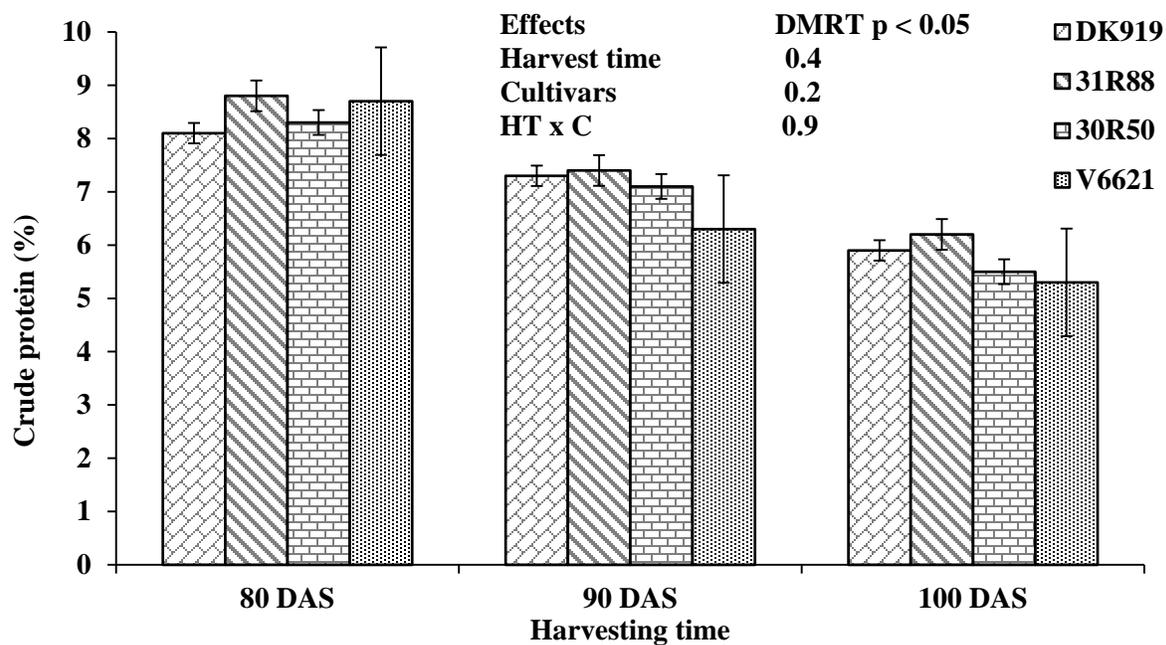


Figure - 5: Effect of harvest time and cultivars on crude protein (%) of autumn maize.

## Discussion

Maize forage yield and quality were influenced by harvest time and cultivars. During plant maturity the trend in plant height was increased from early to late harvest due to prolonged exist in field (Ayub et al., 2002; Xie et al., 2012). On the contrary, Carmi et al. (2006) testified that plant height at early harvest was not changed from late harvest. The inconsistent findings might be due to genetic variation in plants traits while in the current study shorter plant height was recorded. The variation among cultivars might be due to environment, soil fertility, harvesting stage and cultivars genome. Moreover, under similar agronomic and climatic conditions genetic character dominated and showed significant variation in cultivars tallness among various maize cultivars (Hussain et al., 2010; Awan et al., 2001). Forage quality and yield must be optimized to determine the best time for harvest. If forage is harvested too early, excessive loss of nutrients, from soil run off, occurs due to poor starch development in the kernel and low energy concentration. Fodder harvested too late above 100 DAS has decreased nutritive value due to poor starch and fiber digestion of silages (Neylon and Kung, 2003). The effect of harvest time and cultivars were significant for quality parameters. Fraction of leaves was constantly reduced as improvement in maturity (Carmi et al., 2005 and 2006). Harvest time significantly influenced the fodder quality parameters like acid detergent fiber, neutral detergent fiber and lignin which were maximum at late harvest stage (Butler and Muir, 2003; Carmi et al., 2005). Lignin accumulation and synthesis occur at the stage of secondary cell wall development (Carmi et al., 2006). The reason might be that at early harvest, the moisture contents in the plant were high and the concentration of dry matter was less as the plant matures dry matter accumulation increased in the plant, which resulted in maximum content of ADF, NDF and lignin (Carmi et al., 2006). However, the crude protein content was minimum observed in our study due to late harvest stage. Our results supported the findings of Huang et al. (2012) they reported that delayed harvest stage produced lower crude protein concentration which might be due to the higher dry matter yield per land area. Differences in crude protein content among genotypes were also reported by Carmi et al. (2005); Miron et al. (2005); Miron et al. (2006); Yosef et al. (2009). They reported that crude protein concentration was maximum at the first harvest stage and declined

with maturity of plant due to increase in concentration of acid and neutral detergent fiber and lignin. They have a reverse trend and reached at maturity. Additionally, cultivars may affect rates of nutrient translocation (nutrients moving from the stalk and leaves to the ear) and rates of maturation (Lewis et al., 2004; Owens, 2005).

## Conclusion

The results of the research showed that investigated fodder quality parameters of cultivars were influenced by harvest time. Fodder growers who are interested in increased concentration of ADF, NDF and lignin content than maize fodder was harvested late. Keeping in view the yield and silage quality the cultivars 30R50 and 31R88 should be preferred respectively over other cultivars under the present climatic conditions of Sargodha.

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