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ORIGINAL ARTICLE

Effect of different nitrogen sources on growth, yield and quality of fodder maize (*Zea mays* L.)

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Forage quality

Abstract A field experiment was conducted for two consecutive seasons in 2004/2005 and 2005/2006 at the demonstration farm of the Faculty of Agriculture, Omdurman Islamic University, Sudan, to investigate the effect of different nitrogen sources on growth, yield and quality of fodder maize (*Zea mays* L.). The nitrogen sources are urea, nitrophoska (NPK), ammonium sulphate nitrate (ASN) and ammonium sulphate (AS). The design used was completely randomized block design with four replicates.

The growth attributes measured, were plant height, stem diameter, number of leaves, leaf area, leaf area index. Number of days to 50% tasseling, forage yield, crude protein and crude fiber were also investigated in this study.

The results revealed that nitrogen sources significantly affected growth parameters at all sampling occasions during the two seasons. Remarkable results noticed at nitrogen sources ASN flowed by NPK and the AS, as compared with urea.

The results showed that, the number of the days for 50% tasseling, fresh forage yield and dry forage yield were significantly affected by nitrogen sources during two seasons. Moreover, dry and fresh forage yield, increased progressively by ASN and NPK as compared with other nitrogen sources.

The present data revealed that, the crude protein and crude fiber were significantly affected by nitrogen sources in both seasons. The urea gave the lowest crude protein compared with the other nitrogen sources. On the other hand, the lowest crude fiber content was recorded when plant was treated with (ASN) fertilizer, while the highest crude fiber content was recorded only under the control.

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1. Introduction

Maize (*Zea mays* L.) is a member of the family Poaceae. It was originated in Mexico where its oldest known ears could be traced back to about 7000 years ago (Mangeisdorf et al., 1964). In world production, maize is ranked as the third major cereal crop after wheat and rice. The crop has a wider range of uses. These include the following: human food, industrial processed food production of starch and used as forage to feed animals. Maize with its large number of cultivars and different maturity periods has wider range of tolerance to different environmental conditions (Purseglove, 1972).

In Sudan, natural rangelands constitute about 45% of the total area of the country. This area supported about 80% of livestock (Ipperisiel et al., 1989). The major cultivated grass forage crops include Abu Sabein (*Sorghum bicolor*), Sudan grass (*Sorghum sudanence*), Tongna bean (*Lablab purpureus*), Alfalfa America (*Medicago sativa*), the hybrid Pioneer (*S. bicolor* × *S. sudanence*), and recently maize (*Z. mays* L.).

In Sudan, maize can be grown to produce forage in winter seasons to solve problems of livestock feed shortage during this period. Maize proved to be most suitable forage as it is characterized by its high energy content and considerable protein content, compared to other cereal forage crops (Ipperisiel et al., 1989). The reason behind planting maize for green forage production is to obtain succulent vegetative part in a comparatively short time (Toosey, 1972).

Maize plant as a whole is an important forage for many dairy and beef animals. The crop is palatable, quick growing with a high dry matter production and relatively high nutritive value. Dry matter yield of maize is a function of numerous interacting environmental and genetic factors. Temperature and available soil water are major environmental factors, with subsequent influence on leaf area development and subsequent dry matter yield (Dwyer and Stewart, 1986).

The leaf area and canopy structures are important growth parameters for forage production. The optimum leaf area index for grain production is considerably less than that for maximum dry matter production. Goldsworthy et al. (1974) demonstrated that when leaf area index was larger than five the additional dry matter produced accumulated mainly on the stem and therefore, leaf production can be increased by increasing leaf area per plant. All growth attributes that directly or indirectly affected forage yield and quality are affected by cultural practices as well as agricultural inputs.

Maize is commonly fed to livestock as fodder stover or silage (Christopher et al., 1966). The feeding of corn fodder is popular in the semi-arid as well as in areas where corn often fails to reach the stage of mature grain. The stalks of the crop at this stage are more palatable and higher in protein than other stages (John and Warren, 1967).

Forge yield in maize increases and quality decreases rapidly as plant matures (Jung and Barkjer, 1973), indicating that harvesting at early heading stage is generally the right time to produce high forage yield with high quality. When maize is grown for silage it is harvested 2–3 weeks earlier than maize harvested for grain. Pain (1978) reported that when maize is the most suitable crop to be grown for silage in temperate countries, forage maize become one of the most important feed stuff for ruminants specially cattle (Rouanet, 1987).

Forage maize compared to other grasses has a relatively high content of non-structural carbohydrates. In case of silage maize, sugars within the cell and the water soluble carbohydrates are more important in the preservation of the silage material (Pain, 1978). Other carbohydrate sugars are often added to the crop for silage making.

In some performance studies, the introduced variety 8742, recorded the highest relative growth rate, leaf area and dry weight as compared to Mugtama 45 and Tlatizapan 8743 (Mohamed, 1997). Therefore, the selection of cultivars for forage production may be an important management practice, because it influences the nutritive value (Graybill et al., 1991).

Nitrogen element is the nutrient that most frequently limits yield and plays an important role in quality of forage crops. It is almost deficient in most soils of Africa and most of the tropics (Jules, 1974).

Positive response of nitrogen fertilizers has been reported by Koul (1997), Omer (1998), Gasim (2001) and Sawi (1993). Sharma (1973) observed that addition of nitrogen fertilizer increased plant height. Increase in plant height resulted in an increase in leaf number per plant as reported by Akintoye (1996).

Gasim (2001) indicated that the increase in plant height with nitrogen fertilizer is due to the fact that nitrogen promotes plant growth, increases the number of internodes and length of the internodes which results in progressive increase in plant height. Chandler (1969), Turkhede and Rajendra (1978) and Koul (1997) reported similar results.

Nitrogen fertilization increased number of leaves per plant and leaf area (El Noeman et al., 1990; Gasim, 2001). John and Warren (1967) noted that the addition of nitrogen increased stem diameter. Koul (1997) recorded that nitrogen application resulted in greater values of plant height, leaf area, number of leaves and stem diameter of fodder maize, fresh and dry forage yield were also increased due to addition of nitrogen. Leaf to stem ratio was found also to be increased by nitrogen (Duncan, 1980). These findings are in full agreement with that of Gasim (2001) who reported that the increase in leaf to stem ratio with nitrogen application is probably due to the increase in number of leaves and leaf area under nitrogen treatments, producing more and heavy leaves.

The uptake of nitrogen by maize is low during early development and increased at tasseling. Although only relatively small amounts of fertilizers are required during the very early stages of plant growth, high concentration of nutrients in the roots zone at that time are beneficial in promoting early growth (Ritchie et al., 1993). Gasim (2001) has observed that nitrogen fertilization accelerated the time to reach 50% tasseling, promoted the fresh and dry forage weight. Salem and Ali (1979) found that nitrogen application increased the number of ears per plant, ear height, number of days to mid-silking and protein content, and decreased the number of barren stalks.

Grain protein content was increased by nitrogen (Warren et al., 1975; Gangwar and Kalra, 1988). Increased protein content in maize straw was obtained with increased dose of nitrogen (Rai, 1965). Tripathi et al. (1979) found that application of nitrogen gave a significant additional increase in crude protein contents of forage oats.

Kalifa et al. (1981) studied the effect of nitrogen on an open-pollinated variety of corn which was given as ammonium nitrate applied as nitrogen source. His results indicated that ammonium nitrate fertilizer increased the number of days to mid- tasseling, mid-silking and shelling percentage. Singh et al. (1986) found that the biological yield, content and uptake of nitrogen in grain and stover of maize were highest with nitrogen as urea applied in two split dressings. Sawi (1993) and Omara (1989) observed that nitrogen had significant effects on chemical composition of leaves, plant height, leaves, internodes number per plant at early stages. Shoat and root dry weight and cob number per plant. Nitrogen also significantly affected final seed yield and some yield components such as number and weight of cobs/m^2 and weight of seeds per cob, also significantly affected straw yield. In addition