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**Effect of Nitrogen and Phosphorus Fertilizers on  
Growth and Yield of Some  
Graminaceous Forages\***

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**Abstract :** An experiment was conducted for two consecutive seasons (1987/88 and 1988/89) at the Demonstration Farm of the University of Khartoum in Shambat to test the response of some graminaceous forages to nitrogen and phosphorus fertilizers and to examine the residual effects of these fertilizers on ratoon yield. The tested crops were Abu Sabein (*Sorghum bicolor* (L.) Moench), sudangrass (*Sorghum sudanense*), Pioneer 988 (*Sorghum bicolor* x *Sorghum sudanense*), and napiergrass (*Pennisetum purpureum*). Four levels of fertilizer combinations of urea and superphosphate, namely 0N0P (control), 0N2P, 2N0P and 2N2P were used and arranged in a randomized complete block design with three replicates. Nitrogen fertilizer significantly improved growth and productivity of the graminaceous forages, whereas phosphorus had no effect on growth attributes but it significantly improved the productivity in the second season. Among the graminaceous forages, napiergrass outyielded the others due to its high tillering capacity.

### INTRODUCTION

The Sudan is endowed with a large livestock population estimated at about 23 million animal units. This population comprises about 65 million heads of camels, cattle, sheep and goats. This large livestock population is important for subsistence, and contributes positively to the

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national economy and foreign exchange earnings. Most livestock is raised under open grazing of natural rangelands. These lands have been adversely affected by the occurrence of recurrent droughts of the 1980s and by an increasing livestock population. Consequently, their production have declined both in quantity and quality.

To cope with this large livestock population and to satisfy both the local and foreign market demands for animal proteins, irrigated forages are highly needed to bridge the gap in animal feeds and to improve the quality of animals reared under natural rangelands. More areas are needed for forage production, and much research is needed to study forage productivity, nutritional requirements and improved cultural practices.

It is a well established fact, from research carried out in Sudan (Osman and El Saeed 1968; Bebawi and Mazloun 1986) and elsewhere (Thomas *et. al.* 1980; Bhati and Mather 1984), that nitrogenous fertilizers have a positive effect on yield and quality of graminaceous forages. But little research was carried and sometimes contradicting results were reported on the effect of phosphorus fertilizers on graminaceous forages under Sudan conditions (Ali and Salih 1972; Sokrab 1983) and in other parts of the world (Walmsley and Sergeant 1978).

The objective of this study was to evaluate the productivity and quality of four graminaceous forages (*Sorghum bicolor* variety Abu Sabein, Pioneer 988, sudangrass and napiergrass) in response to the application of nitrogen and phosphorus fertilizers, both for the first and ratoon crops.

## MATERIALS AND METHODS

An experiment was conducted during 1987/88 and 1988/89 seasons at the Demonstration Farm of the Faculty of Agriculture, University of Khartoum in Shambat (latitude 15°, 40' N; longitude 32°, 32' E). The soil of the experimental site is classified as Fine Mixed Isohyper-thermic entice Chromustert clay i.e. : Montmorillonitic clay (Gaafar 1983).

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Four forage grasses viz : Abu Sabein (*Sorghum bicolor*), Pioneer 988 (*Sorghum bicolor* x *Sorghum sudanense*), sudangrass (*Sorghum sudanense*) and napiergrass (*Pennisetum purpureum*) were used as test crops. Four levels of nitrogen and phosphorus fertilizers were applied namely, zero phosphorus - zero nitrogen (0N0P), zero nitrogen + 200 kg P<sub>2</sub>O<sub>5</sub>/ha (0N2P), 86.47 kg N/ha + zero phosphorus (2N0P) and 86.47 kg N/ha+200 kg P<sub>2</sub>O<sub>5</sub>/ha (2N2P). A factorial combination (4 cultivars x 4 levels of fertilizers) with three replications was used. Nitrogen was used in a form of urea (46% N) and phosphorus in a form of granulated triple superphosphate (46% P), and both fertilizers were applied at the time of sowing.

The experimental site was ploughed, harrowed and then ridged up. The seeding rates used were 18.5 kg/ha for Abu Sabein, 16.2 kg/ha for Pioneer 988, 9.2 kg/ha for sudangrass and 854 kg of cuts/ha for napiergrass. Sowing was done in August 1987 for the first season and in April 1988 for the second season. Watering was at 7 day intervals during 1987 and at 9 day intervals during 1988.

The parameters measured, during each growing season, at the time of harvest (milk stage) were : plant height, number of green leaves/plant, plant density and productivity in terms of fresh and dry weights. In addition, proximate analysis was performed on dry weight basis to determine the forage nutritive value.

## RESULTS AND DISCUSSION

### Growth Parameters

Nitrogen fertilization significantly ( $P = 0.01$ ) affected the growth attributes, e.g. plant height, number of green leaves and plant density during both seasons (Figs. 1, 2 and 3). Napiergrass and sudangrass significantly outgrew the other three forages in plant height and plant density, whereas Pioneer 988 outnumbered the others in green

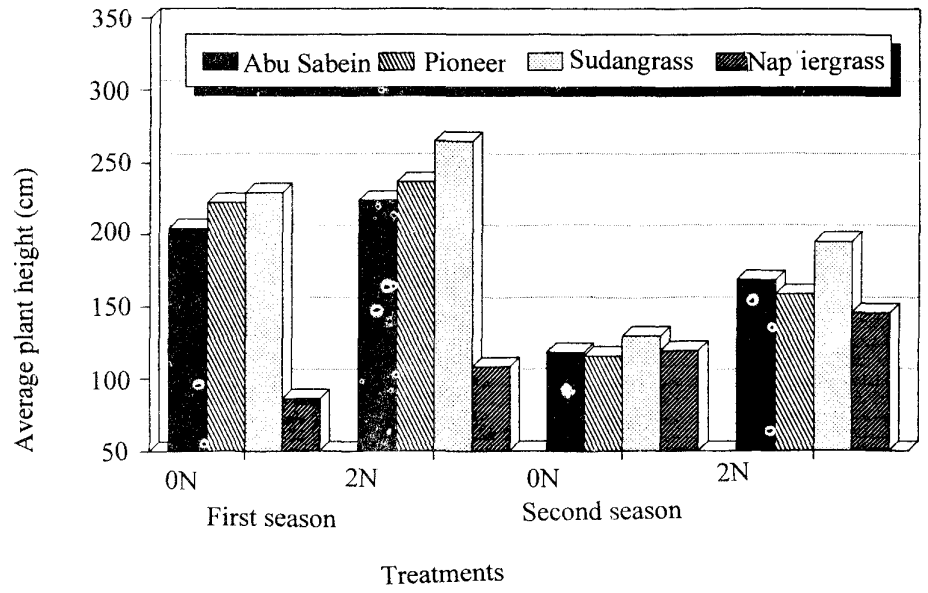


Fig. 1. Effect of nitrogen fertilizer on plant height (cm).

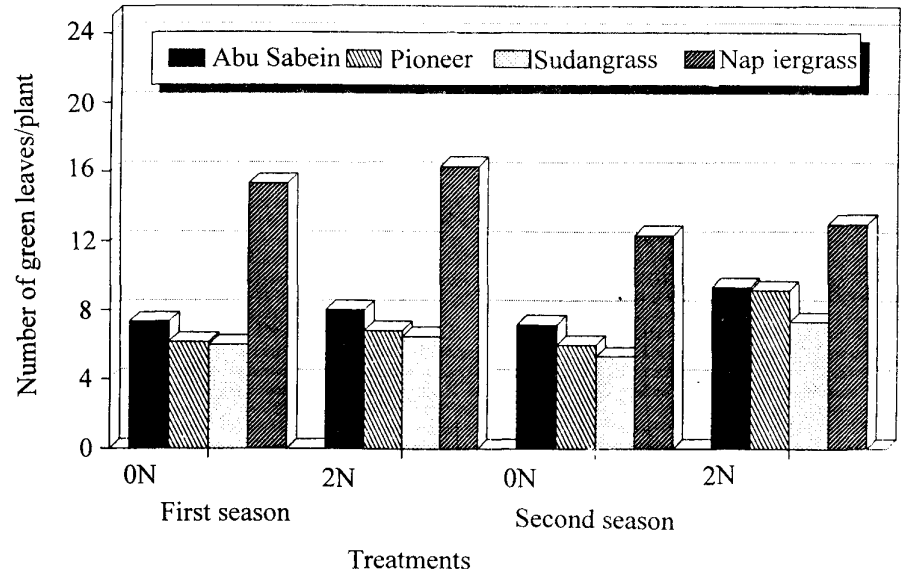


Fig. 2. Effect of nitrogen fertilizer on number of green leaves/plant.

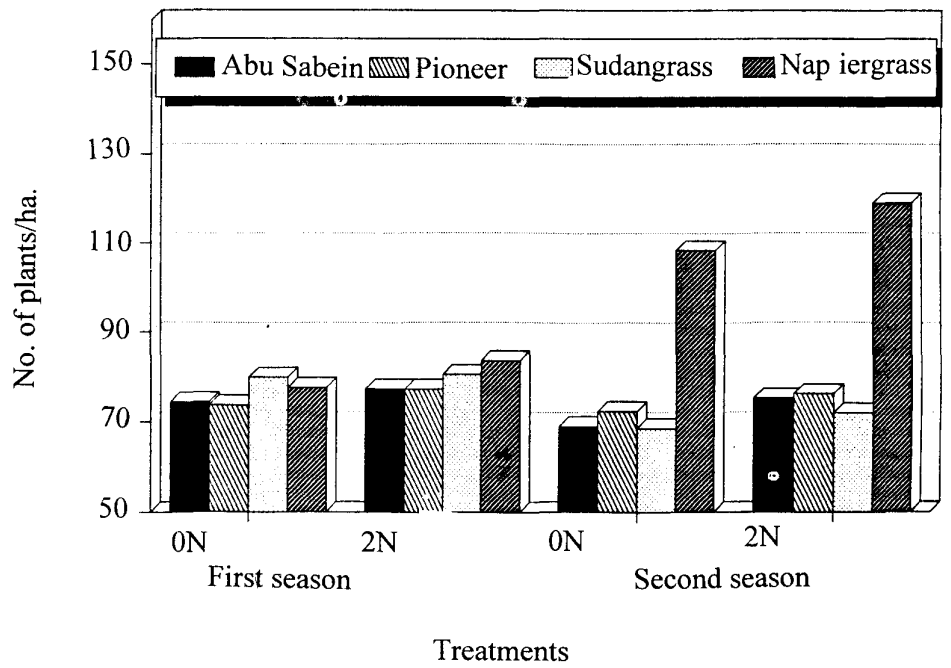


Fig. 3. Effect of nitrogen fertilizer on plant density.

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leaves/plant. On the other hand, phosphorus fertilization had no significant effect on growth attributes. It was expected that nitrogen application would improve the growth attributes of grasses as they are known to be more responsive to nitrogen than phosphorus fertilizers. Elamin (1980) and Mustafa and Abdelmagid (1982), among others, reported a positive response of Abu Sabein and other cereal forages to urea. Walmsley and Sergeant (1978) reported a negative response of grasses to phosphorus fertilizers.

### **Forage Productivity**

Nitrogen fertilization significantly increased forage fresh and dry yields of the first crop as well as the ratoon crop during both seasons. It increased forage fresh yield of napiergrass, Pioneer 988, Abu Sabein, and sudangrass by 97.5, 43.8, 30.7 and 27.9% for the first season, and by 131, 95.7, 93.5, and 21.5% for the second season, respectively (Fig. 4).

The residual effect of nitrogen fertilizer on ratoon fresh and dry yields was significant ( $P=0.01$ ). It increased ratoon fresh yield of napiergrass by 52.75%, Pioneer 988 by 32.4%, Abu Sabein by 17.5% and sudangrass by 12.8% in the first season and by 77.8% for napiergrass, 69.2% for sudangrass, 14.2% for Pioneer 988 and 2.1% for Abu Sabein in the second season (Fig. 5). Similarly, nitrogen fertilizer significantly increased the dry weight of the first crop as well as that of the ratoon crop. It increased the first crop dry weight of napiergrass by 86.4%, Pioneer 988 by 24.6%, Abu Sabein by 21.7%, and sudangrass by 15.8% in the first season and by 116.1% for napiergrass, 98.5% for Abu Sabein, 96.3% for sudangrass and 16.7% for Pioneer 988 in the second season (Fig. 6).

The increments in dry weight of the ratoon crop as a result of the carried over nitrogen were 49.1%, for napiergrass, 35.9%, for Pioneer 988, 16.6%, for Abu Sabein and 14.1% for sudangrass during the first season and they were 78.7, 69, 14.5, and 0.8% in the second season for napiergrass, sudangrass, Pioneer 988 and Abu Sabein, respectively (Fig.7).

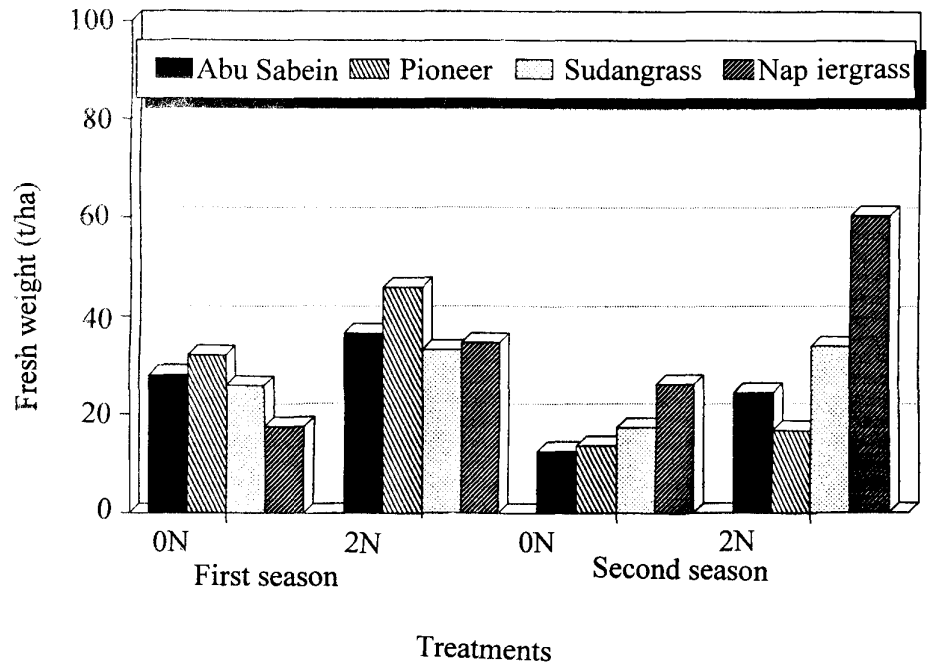


Fig. 4. Effect of nitrogen fertilizer on forage fresh weight (t/ha)



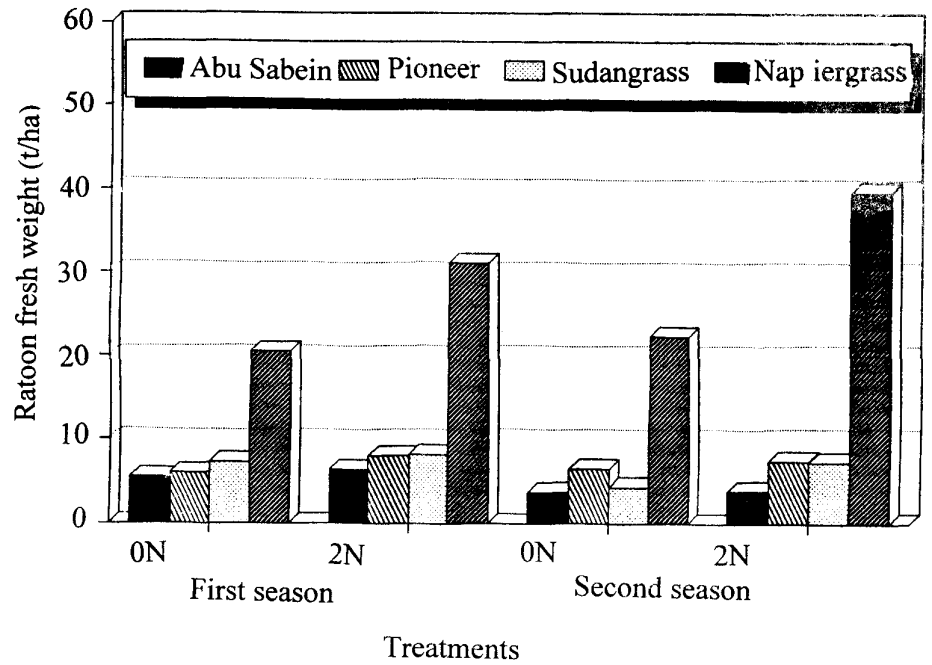


Fig. 5. Effect of residual nitrogen fertilizer on ratoon fresh yield (t/ha)

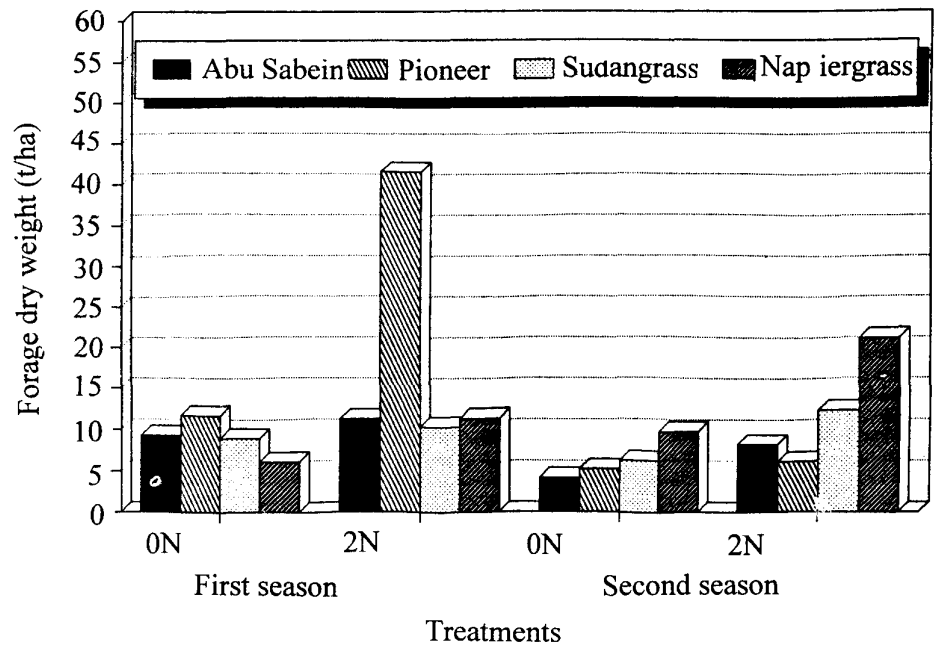


Fig. 6. Effect of nitrogen fertilizer on forage dry weight (t/ha)

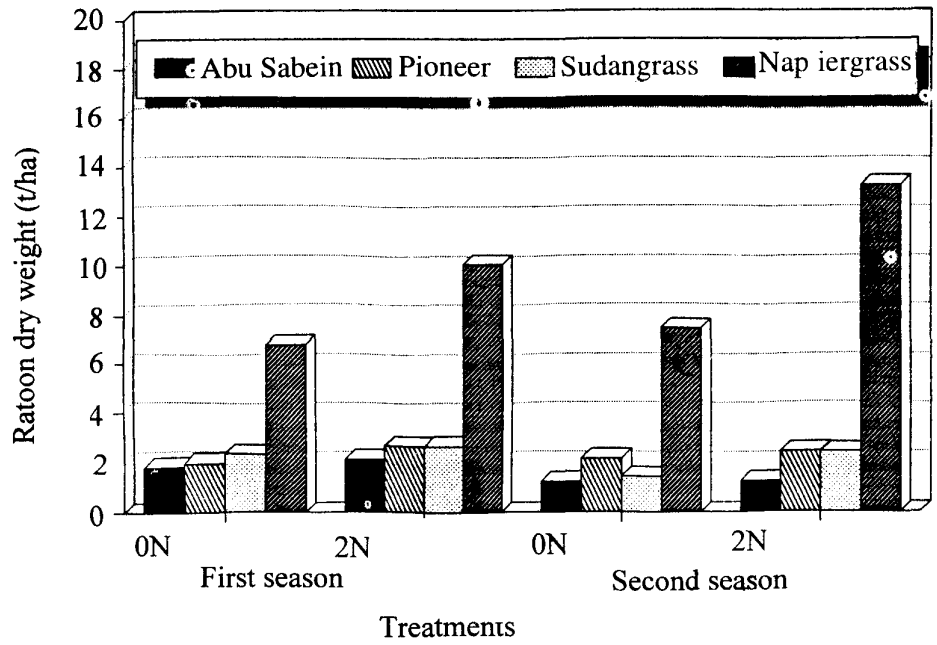


Fig. 7. Effect of nitrogen fertilizer on ratoon dry weight (t/ha)

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It is clear from these results that nitrogen application increased both fresh and dry yields of the first crop and the ratoon crop. This finding is in agreement with those reported by Thomas *et al.* (1980), Prasad and Prasad (1982), Bhati and Mather (1984), Bebawi and Mazloun (1986) and Nambiar *et al.* (1986).

The effect of phosphorus on forage productivity, on the other hand, was positive. It increased forage fresh yield of Abu Sabein by 26.4%, napiergrass by 19.2%, Pioneer 988 by 4.8% in the first season and by 33.5% for sudangrass, 24.7% for Abu Sabein, 8.3% for Pioneer 988 and 2.8% for napiergrass in the second season (Fig. 8). A similar trend was observed in the dry matter production of the first crop during both seasons (Fig. 9) and in the ratoon fresh and dry matter during the second season only (Fig. 10). It is worth mentioning that phosphorus had a negative effect on ratoon dry yield of Abu Sabein in both seasons.

Phosphorus is known to improve leguminous forages but some researchers reported its positive effect on grasses as well (Costas and Chandler 1961; Govil and Prasad 1971; Sokrab 1983), while Ali and Salih (1972) and Walmsley and Sergeant (1978) reported that phosphorus fertilizer did not affect the yield of cereal forages. These contradictory results could be due to the difference in the amount of available phosphorus in the soil. An unpublished data obtained from Soba Research Station, Sudan, showed a lack of response of some cereals to phosphorus fertilization. Soba area is known for its high salinity, and probably this was the main reason for the lack of response to phosphorus since the availability of phosphorus is affected by soil pH.

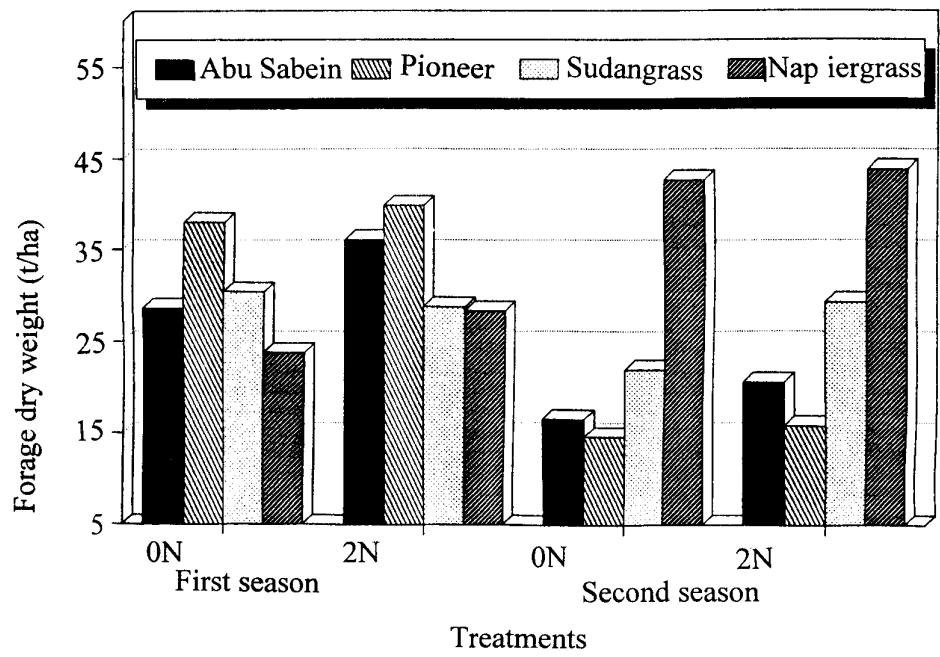


Fig. 8. Effect of phosphorus fertilizer on forage fresh weight (t/ha)

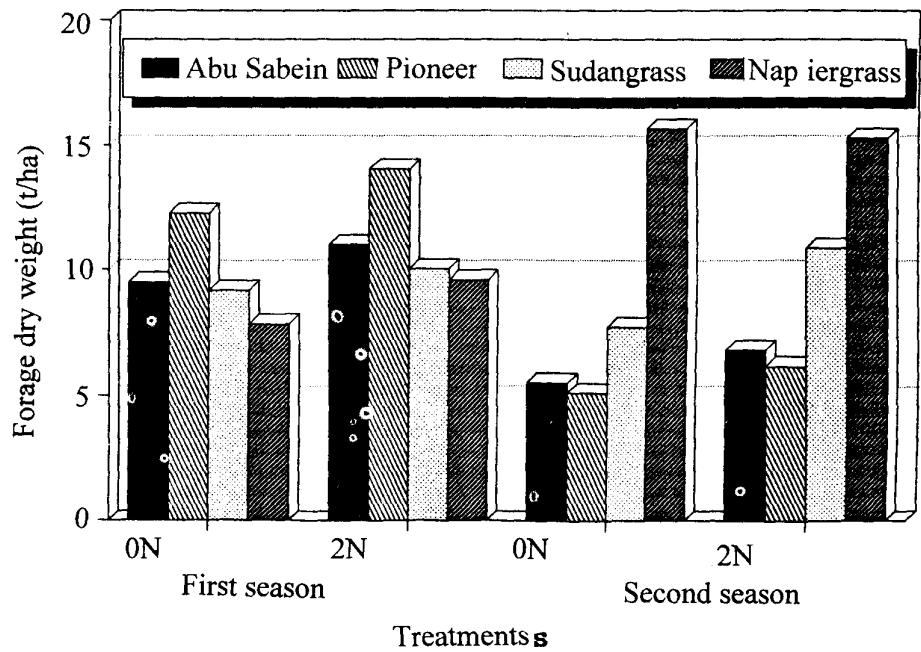


Fig. 9. Effect of phosphorus fertilizer on forage dry weight (t/ha).

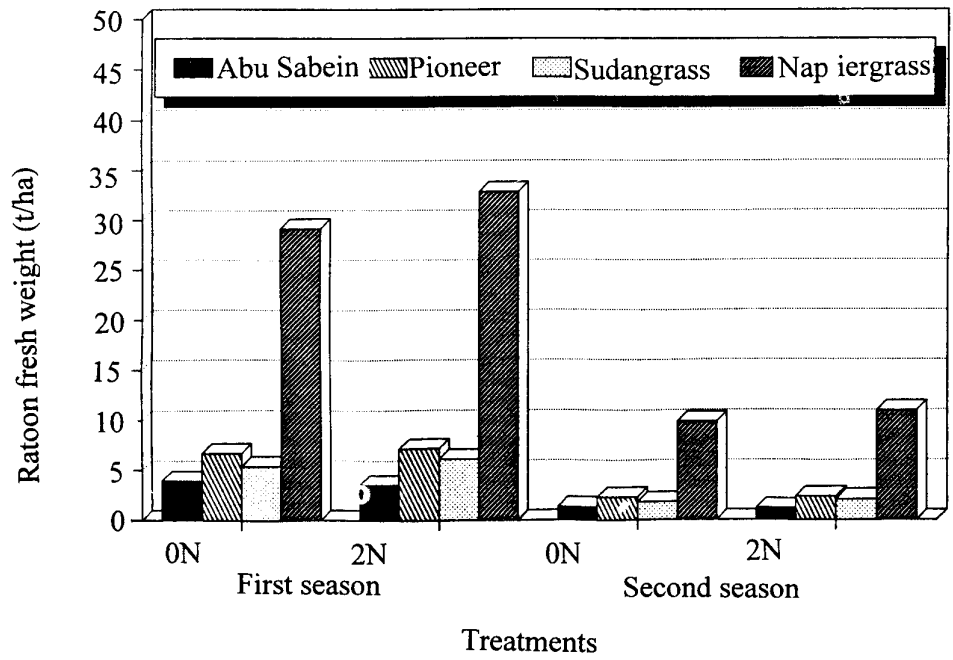


Fig.10. Effect of residual phosphorus fertilizer on ratoon fresh weight (t/ha)

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## أثر التسميد النيتروجيني والفوسفوري على نمو وإنتاجية بعض الأعلاف النجيلية

عوض عثمان أبوسوار وجبير جودات محمد

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موجز البحث : أجريت تجربة في مزرعة جامعة الخرطوم التجريبية (شمبات) خلال موسمي 1988/87 و 1989/88 ، وذلك لتقييم استجابة بعض محاصيل الأعلاف النجيلية لجرعات مختلفة من السماد النيتروجيني والفوسفوري وكذلك الأثر المتبقى لهذه الأسمدة على إنتاجية الخلف .

شملت الدراسة أربعة محاصيل علف نجيلية هي أبوسبعين وحشيشة الفيل وحشيشة السودان وبايونير 688 ، واستخدم تصميم القطاعات العشوائية الكاملة بثلاث مكررات ، حيث استخدمت أربع جرعات مركبة من اليوريا والسوبر فوسفات على النحو التالي :-

صفر نيتروجين مع صفر سوبرفوسفات (كشاهد) ، صفر نيتروجين مع وحدتين من السوبرفوسفات ، وحدتين نيتروجين مع صفر سوبرفوسفات ، وحدتين من النيتروجين مع وحدتين من السوبرفوسفات (وحدة النيتروجين = 40 كجم يوريا/هكتار ، وحدة الفوسفور = 50 كجم سوبرفوسفات/هكتار) .

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أدت اضافة السماد النيتروجينى إلى زيادة معنوية فى الإنتاجية فى الموسمين أما بالنسبة للفوسفور فلم تكن الزيادة معنوية إلا فى الموسم الثانى .

أوضحت الدراسة أيضاً أن إنتاجية حشيشة الفيل من العلف أعلى من إنتاجية المحاصيل الثلاثة الأخرى نتيجة لمقدرتها على إنتاج الكثير من الأشطاء .