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EFFECT OF NITROGENOUS AND PHOSPHATIC FERTILIZERS ON PERFORMANCE OF RAINFED PEARL MILLET (*PENNISETUM GLAUCUM* L.) GROWN ON CLAY LOAM SOIL

[12]

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ABSTRACT

An experiment was conducted for two summer seasons (2000 and 2001) to study the effect of nitrogenous and phosphatic fertilizers on performance of rainfed pearl millet (*Pennisetum glaucum* L.) grown on clay loam soil at University of Zalingei site, Western Darfour states, Sudan. The experimental design used was spilt-plot design with five replications. Four nitrogen treatments (0, 30, 60 and 80 kg N/ha) and four phosphorus treatments (0, 15, 30 and 60 kg P/ha) were used. Nitrogen treatments were assigned to the main plots and phosphorus levels were allotted to the sub-plots. Urea (46% N) and triple superphosphate (48% P_2O_5) were used as sources of nitrogen and phosphorus, respectively. Phosphorus treatments were applied at sowing, whereas nitrogen fertilizer was split into two equal doses, one was added four days after emergence and the second was three weeks after sowing. Results of the experiments showed that application of nitrogen increased the plant height over the control. The increments were in range of 5.7% - 16.1%. Leaf area index (LAI), grain and stover yields were significantly affected by nitrogen application. The increments over control were in the range of 39% - 92.3%, 10.1% - 112.7% and 34.1% - 126.9% for LAI, grain yield and stover yield, respectively. Regarding phosphorus, the results revealed that phosphorus addition had a significant effect on plant height, LAI, grain and stover yields. The increments over control ranged from 2.4% - 11.3%, 6.3% - 17.9%, 6.7% - 24.6% and 6.8% - 35.4% for plant height, LAI, grain and stover yields, respectively. The interaction between nitrogen and phosphorus had a significant effect only on LAI and plant height at the sixth week measurement in the first and second seasons, respectively. The tallest plants were obtained from 3N × 3P treatment whereas the greatest LAI was obtained by 3N × 2P treatment.

Keywords: Phosphatic fertilizers, Pearl millet, Plant height, Leaf area index, Grain yield

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INTRODUCTION

Soils, particularly in the arid and semiarid regions, rarely contain adequate amounts of essential plant nutrients to sustain high yields of most crops. This is particularly true for nitrogen and mostly for phosphorus. Use of chemical fertilizers has been practiced for a long time in modern agriculture to compensate these deficiencies in nitrogen and phosphorus.

In Sudan, pearl millet is an important cereal crop, next to sorghum. It constitutes the stable food of the majority of Western Sudan (Darfur and Kordofan) where it occupies an area of 1.2 – 2.9 million hectares. Most of the area is cultivated and harvested under traditional rainfed agriculture **(Abuelgasim and Jain, 1987; FAO, 1999)**. It is also cultivated on alluvial soil along wadis. Recently, some farmers in the mechanized clay plain of central Sudan started to grow pearl millet instead of sorghum which is susceptible to *Striga hermonthica* **(Elmahi, *et al* 1995).** Very little research work was conducted in this sector compared with irrigated agriculture. In particular, pearl millet did not receive the appropriate attention. Therefore, the present study was conducted to investigate the effect of nitrogen and phosphorus fertilization on performance and yield of pearl millet grown on clay loam soil under Western Sudan conditions.

MATERIAL AND METHODS

An experiment was carried out for two summer seasons (2000 and 2001) to investigate the effect of nitrogen and phosphorus fertilizers on growth and yield of rainfed pearl millet (*Pennisetum glaucum*). The study site was at the University of Zalingei, Western Darfur state (latitude 12º 45´ N and longitude 23º 29´ E with an attitude of 900m above mean sea level).

The soil of the site is clay loam (41% clay), pH range from 6.4 to 7.0 with low available soil phosphorus (0.83 – 0.9 ppm). According to **Black *et al* (1969)** standards, the soil organic carbon is low (0.25 – 0.32%) and, hence, low soil nitrogen content (0.029– 0.035%). The experimental design used was spilt-plot design replicated five times with nitrogen in the main plots and phosphorus in the subplots. The area of main plots and subplots was $108m^2$ and $27m^2$, respectively. A local pearl millet cultivar (Darmasa) was sown on the 12^{th} and 15^{th} of July in the first and second seasons, respectively. Traditional hand sowing was used by using local implement. Nitrogen treatments consisted of four N levels: 0, 30, 60 and 80 kg N/ha designated as 0N, 1N, 2N and 3N, respectively, phosphorus treatments consisted of four P levels: 0, 15, 30 and 60 kg P/ha designed as 0P, 1P, 2P and 3P, respectively. Urea (46% N) and triplesuperphosphate (48% P_2O_5) were used as sources of nitrogen and phosphorus, respectively. Triplesuperphosphate was applied at sowing in bands of 5cm depth and at a distance of 5cm from the seeds. Urea was split into equal doses, one dose added four days after germination and the other was three weeks after sowing by hand placement method. Thinning was done when the plant were four weeks old to end up with three plants per hole. Growth parameters, plant height and leaf area index (LAI) were measured at an interval of two weeks starting a month after sowing until harvest. The crop was harvested at 120 and 112 days from sowing in the first and

second seasons, respectively. Grain and stover yields were determined in an area of 6.25m^2 in the centre of the middle three rows in each plot.

RESULTS AND DISCUSSION

Nitrogen application had a significant effect ($P \leq 0.05$) on plant height (Table, 1). The plant height was significantly increased over the control by nitrogen treatment. The increases in plant height produced by 1N, 2N and 3N treatments over the control at 12th week after sowing were 7.1%, 10.5%, 9.3% and 5.7%, 11.0% and 16.1% for the first and second seasons, respectively. These findings were in conformity with results obtained by **Ibrahim, (1996).**

Nitrogen application had a significant effect on LAI in both seasons (Table, 2) where LAI index increased with increasing nitrogen rate up to the 8th week of the sowing but this disappeared as the season proceeded. The increments in LAI over the control due to nitrogen application at the rate of 1N, 2N and 3N at the 8th week measurement were 39.0%, 52.4% and 60.0%, respectively, in the first season and 39.6%, 78.6% and 92.3%, respectively, in the second season. **Mourad *et al* (1986)** found that LAI values were significantly increased with increasing nitrogen rate up to 90 kg N/ha, which was almost equivalent to the rate used in this study.

Phosphorus application had a significant effect on plant height (Table, 3). The increments in plant height produced by P treatments ranged, on average, between 2.4% - 10.0% over the control. Similar findings were reported by **Okalebo (1984).** The added phosphorus increased LAI significantly over the control (Table, 4) for the first three measurements but later this disappeared. These results were in line with those obtained by **Elmedani, (1997)** who quoted similar results.

Grain and stover yields were significantly affected by nitrogen and phosphorus application (Table, 5). The increments due to nitrogen fertilization were in the range of 10.1 % - 112.7% and 34.1% - 126.9% of grain and stover yields, respectively, whereas, the respective increments in grains and stover yields due to phosphorus application ranged between 6.7% - 24.6% and 6.8% - 35.8%.

These results were in line with those obtained by many research workers **(Mason, 1989 and Singh & Sharma, 1995).**

The yield of the first season was higher than that of the second season. This was mainly due to the fluctuating rainfall which is a critical factor that determines yield in rainfed agriculture. The rainfall in the first season was favorable for crop growth in terms of total amount (777.8 mm) and distribution throughout the growth period whereas in the second season the rainfall was low (421 mm), less than the twenty years mean (488.4 mm). These results were similar to those reported by **Bationo *et al* (1989)** who reported that low rainfall can adversely affect crop productivity.

However, the interaction of N × P had exerted a non significant effect on most measured parameters. Exception of this, LAI at the 6th week after sowing in the first season was significantly affected by treatment interaction (Table, 6). Similarly, plant height recorded at the 6th week measurement in the second season was significantly affected by N × P interaction (Table, 7).

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

Nitrogen level	Time (weeks after sowing)				
	4	6	8	10	12
First season					
0 N	43.56 b	96.97 c	159.48 c	198.15 b	199.98 b
1 N	48.45 ab	123.70 bc	189.72 b	212.78 a	214.22 a
2 N	53.38 a	141.24 a	203.67 a	220.03 a	220.89 a
3 N	51.61 a	133.09 b	200.70 ab	218.33 a	218.51 a
Second season					
0 N	40.80 c	73.87 d	110.28 c	159.89 c	161.11 c
1 N	45.91 b	97.06 c	133.58 b	169.84 bc	170.23 bc
2 N	50.72 a	105.71 b	144.58 b	178.57 ab	178.80 ab
3 N	52.39 a	116.30 a	156.23 a	187.73 a	187.73 a

Means within the same column followed by the same letter are not significantly different at $P \leq 0.05$ according to Duncan's Multiple Range Test (DMRT).

0N = 0 kg N/ha 1N = 30 kg N/ha 2N = 60 kg N/ha 3N = 80 kg N/ha

Table 2. Effect of nitrogen fertilizer on leaf area index (LAI)

Nitrogen level	Time (weeks after sowing)			
	4	6	8	10
First season				
0 N	0.76 b	2.49 c	3.13 c	2.55 a
1 N	1.19 a	3.41 b	4.35 b	2.65 a
2 N	1.35 a	3.93 a	4.77 ab	2.72 a
3 N	1.26 a	3.81 ab	5.01 a	2.83 a
Second season				
0 N	0.65 c	1.09 c	1.54 c	1.10 a
1 N	0.91 b	1.67 b	2.15 b	1.12 a
2 N	1.17 a	2.14 a	2.75 a	1.43 a
3 N	1.27 a	2.29 a	2.97 a	1.50 a

Means within the same column followed by the same letter are not significantly different at $P \leq 0.05$ according to Duncan's Multiple Range Test (DMRT).
Symbols as shown in Table 1

Table 3. Effect of phosphorus fertilizer on plant height (cm)

Phosphorus level	Time (weeks after sowing)				
	4	6	8	10	12
First season					
0 P	44.68 b	111.04 c	125.90 c	205.79 c	207.31 c
1 P	50.06 a	124.24 b	188.00 bc	211.34 b	212.35 bc
2 P	51.34 a	125.59 b	197.44 a	218.70 ab	219.03 a
3 P	50.91 a	134.13 a	192.25 ab	213.46 a	214.93 ab
Second season					
0 P	43.01 c	83.35 c	120.28 c	162.58 c	163.00 c
1 P	47.40 b	99.77 b	136.67 b	173.97 b	174.08 b
2 P	49.34 a	103.63 ab	142.29 a	178.55 ab	179.36 ab
3 P	50.07 a	106.19 a	145.43 a	180.94 a	181.43 a

Means within the same column followed by the same letter are not significantly different at $P \leq 0.05$ according to Duncan's Multiple Range Test (DMRT).

0P = 0 kg P/ha 1P = 15 kg P/ha 2P = 30 kg P/ha 3P = 60 kg P/ha

Table 4. Effect of phosphorus fertilizer on leaf area index (LAI)

Phosphorus level	Time (weeks after sowing)			
	4	6	8	10
First season				
0 P	0.84 b	2.99 b	4.11 a	2.61 a
1 P	1.25 a	3.53 a	4.37 a	2.67 a
2 P	1.23 a	3.58 a	4.37 a	2.76 a
3 P	1.23 a	3.53 a	4.41 a	2.71 a
Second season				
0 P	0.74 b	1.54 b	2.13 b	1.28 a
1 P	1.03 a	1.82 a	2.35 a	1.28 a
2 P	1.11 a	1.91 a	2.47 a	1.31 a
3 P	1.12 a	1.93 a	2.45 a	1.28 a

Means within the same column followed by the same letter are not significantly different at $P \leq 0.05$ according to Duncan's Multiple Range Test (DMRT).

Table 5. Effect of nitrogen and phosphorus fertilizers on grain and stover yields

Treatments	Yield (ton/ha)	
	Grain	Stover
	First season	
0 N	1.652 b	5.16 c
1 N	1.819 b	6.92 b
2 N	2.152 a	7.97 a
3 N	2.184 a	8.07 a
	Second season	
0 N	0.512 c	1.6 c
1 N	0.653 c	2.49 b
2 N	0.909 b	3.08 ab
3 N	1.089 a	3.63 a
	First season	
0 P	1.781 c	6.46 b
1 P	1.900 bc	6.90 ab
2 P	2.018 ab	7.39 a
3 P	2.109 a	7.38 a
	Second season	
0 P	0.668 b	2.29 c
1 P	0.799 a	2.59 bc
2 P	0.819 a	2.82 ab
3 P	0.857 a	3.10 a

Means within the same column followed by the same letter are not significantly different at $P \leq 0.05$ according to Duncan's Multiple Range Test (DMRT).

Table 6. Effect of treatment interaction on LAI at the six week after sowing (1st season)

Phosphorus level	Nitrogen level			
	0N	1N	2N	3N
0 P	1.81 h	3.08efg	3.68abcde	3.38de
1 P	3.11 ef	3.63abcde	3.83abcd	3.55bcde
2 P	2.57fg	3.40de	4.13ab	4.22a
3 P	2.48g	3.51cde	4.07abc	4.07abc

Mean within same column followed by the same letters are not significantly different at $P < 0.05$ according to Duncan's Multiple Range Test (DMRT)

Table 7. Effect of treatment interaction on plant height (cm) at the six week after sowing (2nd season)

Phosphorus level	Nitrogen level			
	0N	1N	2N	3N
0 P	66.07h	79.70g	88.00f	99.63e
1 P	69.53h	98.70e	110.63cd	120.20ab
2 P	79.20g	105.67cd	108.23cd	121.43ab
3 P	80.67fg	104.17cd	115.97bc	123.93a

Mean within same column followed by the same letters are not significantly different at $P < 0.05$ according to Duncan's Multiple Range Test (DMRT)

The highest value of LAI was obtained from 3N × 3P treatment which the tallest plants were recorded from 3N × 3P treatment.

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أثر إضافة أسمدة النتروجين والفسفور علي نمو وإنتاجية الدخن المطري في التربة الطينية الطميية

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أجريت تجربة حقلية لموسمين متتاليين (٢٠٠٠ و ٢٠٠١) بموقع جامعة زالنجي بولاية غرب دارفور بالسودان ، لدراسة تأثير إضافة سمادي النتروجين والفسفور علي نمو وإنتاجية الدخن المزروع في التربة الطينية الطمييية. تم زراعة صنف محلي من الدخن (درمسا)، وأستخدم أربعة معاملات من النتروجين هي: صفر و٣٠ و ٦٠ و٨٠ كجم نتروجين للهكتار ، وأربعة معاملات من الفسفور هي: صفر و١٥ و٣٠ و٦٠ كجم فسفور للهكتار. أُستعمل اليوريا كمصدر للنتروجين (٤٦% N) والسيوبر فوسفات

الثلاثي كمصدر للفسفور (P_2O_5 ٤٨%). وأُتبع في تنفيذ التجربة تصميم القطع المنشقة في خمس مكررات وكانت معاملات النتروجين في القطع الرئيسية ومعاملات الفسفور في القطع الفرعية. السماد الفسفوري أضيف مع الزراعة اما النتروجين فقد أضيف علي جرعتين الأولي بعد أربعة أيام من الإنبات والثانية بعد ثلاثة أسابيع من الزراعة.

أوضحت النتائج أن إضافة النتروجين أدت إلي زيادة معنوية في طول النبات ، حيث تراوحت الزيادة بين ٥,٧%-١٦,١% مقارنة بالشاهد . كما أدت إضافة النتروجين إلي تأثير معنوي علي دليل مساحة الورقة، وكل من إنتاجية الحبوب والقصب حيث تراوحت الزيادة بين ٣٩% - ٩٢,٣% لدليل مساحة سطح الورقة و١٠,١% - ١١٢,٧% بالنسبة للحبوب ، بينما تراوحت نسبة الزيادة بين ٣٤,١% - ١٢٦,٩% بالنسبة للقصب.

أما الفسفور فقد كان له تأثير معنوي علي طول النبات ودليل مساحة سطح الورقة وإنتاجية الحبوب والقصب ، وقد تراوحت نسبة الزيادة مقارنة بالشاهد بين ٢,٤% - ١١,٣% و٦,٣% - ١٧,٩% لمساحة سطح الورقة و٦,٧%-٢٤,٦% للحبوب و٦,٨% - ٣٥,٤% للقصب. وكانت العلاقة بين الفسفور والنتروجين ايجابية علي طول النبات فقط في الاسبوع السادس في الموسم الأول وعلي مساحة سطح الورقة في الاسبوع السادس من الموسم الثاني ، وقد تحصل على أكثر النباتات طولا من المعاملة $N_3 \times P_3$ وسجلت أكبر مساحة لسطح الورقة من المعاملة $N_3 \times P_2$.

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