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Effect of Nitrogen, Phosphorous Fertilizers on Yield and Yield Components of Three Cultivars of Maize (*Zea Mays*)

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Abstract Field experiments were conducted in the demonstration farm of People's Arms Defense Camp at El-Getaina (White Nile) for the two consecutive seasons (summer and winter) 2001/02 to study the effect of nitrogen and phosphorous fertilizers on yield and yield components of three cultivars of maize (*Zea mays* L.) under irrigation.The treatments used consisted of three levels of nitrogen control (N_0), 43 kg N/ha, (N_1), 86 kg N/ha (N_2), two levels of phosphorous control (P_0), 43 kg P_2O_5/ha, (P_1) and three cultivars, Geza-2 (V_1), Mugtama-45 (V_2) and Pannar-6480 (V_3).The 18 factorial treatments were executed in randomized complete block design, with 5 replications.The results obtained showed that the nitrogen fertilizer had a significant effect on growth of maize cultivars, particularly plant height and leaves number, leaf area and dry weight of plant. Nitrogen fertilizer also significantly affected final grains yield and some yield components, cob yield and number of grains per cob. When phosphorous fertilizer has no significant effect on grain yield.The studies obtained showed negligible differences between the two seasons (summer and winter) in grain yield.This suggest that the maize crop can be grown successfully in both seasons, but since there is few winter crops, it would be possible to treat maize as a winter crop in the area to intensively and diversify the rotations.

Keywords Cultivar, Irrigation, Nitrogen, Phosphorous, Yield

1. Introduction

Maize or corn as a world crop is grown in various countries. The crop is widely used as a food crop in many parts of the world especially in the tropical and subtropical countries. Maize is rich in starch (carbohydrates) with an average of about 70%, but low in protein (about 9.5%). The oil is concentrated mainly in the germ with an average of 4% of the kernel weight. The compositions of the other components of the kernel are 1.4% sugars, 2.3 crude fiber and 1.4% ash.

Maize grain enters also in livestock feeds, and in other industrial purposes as in the case of glucose and starch and edible oil industries.

In Africa, the Portuguese brought maize from the West Indies to the Island of St. Thome, and from there it was taken to the Gold Coast. Apparently, it reached South Africa shortly after the arrival of the first Dutch Colonists, where it now occupies 65% of the land under crops, and it is the main staple food of the majority of the people. Another possibility is that the crop may have entered Africa through Egypt, where maize cultivation was established in the latter half of the eighteenth century with cultivars imported from Syria and India Tothill [1].

In Sudan, maize until recently, its utilization as a human food for making bread was limited, where most of the produce is consumed as roasted kernels or in mixing with wheat to make bread.

The environmental conditions in the Sudan are generally favourable for maize production.

Lower yields and low market prices, where among the factors, which gave low priority for maize in agricultural development plants in the Sudan FAO[2].

2. Materials and Methods

The Experimental Site and Soil Properties

The experiment was conducted for two consecutive seasons (winter and summer) of 2000/2001 and 2001/2002.

The objectives of this experiment was to investigate the effect of nitrogen and phosphorous on yield and yield components of three maize (*Zea mays*) cultivars under irrigation.

Source of Grains

The grains were obtained from the Grain Propagation Administration (Sennar Station) Mugtama-45, Giza-2 (open pollinated) and hybrid cultivar (Pannar-6480) obtained from

Gezira Research Station, were used in the experiment.

Experimental Design and Treatments

The experimental design was a factorial in a randomized complete block design, with five replications. Treatment consisted of the three cultivars of maize (V1 = Giza-2, V2 = Mugtama-45 and V3 = Pannar-6480).

Three levels of nitrogen: N0 (control) with no nitrogen, N1 (43 kg N/ha) and N2 (86 kg N/ha). Two levels of phosphorous: P0 (control) with no phosphorous, P_1 (48 kg P_2O_5/ha).

The treatment combinations are shown below:-

1-	$V_1N_0P_0$	10-	$V_2N_1P_1$
2-	$V_1N_0P_1$	11-	$V_2N_2P_0$
3-	$V_1N_1P_0$	12-	$V_2N_2P_1$
4-	$V_1N_1P_1$	13-	$V_3N_0P_0$
5-	$V_1N_2P_0$	14-	$V_3N_0P_1$
6-	$V_1N_2P_1$	15-	$V_3N_1P_0$
7-	$V_2N_0P_0$	16-	$V_3N_1P_1$
8-	$V_2N_0P_1$	17-	$V_3N_2P_0$
9-	$V_2N_1P_0$	18-	$V_3N_2P_1$

Fertilizer, Sowing and Sowing Date

Before sowing the fertilizer was applied where nitrogen was broadcast on top of the ridges and superphosphate was banded on the side of the ridge at a depth of 7 cm.

Sowing was done by hand where 2-3 grains per hole were sown on top of the ridge in hole 20 cm within the ridge, then the seedling were thinned to one plant per hole.

The experiment was sown on the 12^{th} of July in the first season (2001/2002) and on the 1^{st} of December in the second season (2001/2002).

Measurements of Growth Attributes

Measurements of growth attributes were taken approximately every two weeks, starting 30 days from sowing.

From each plot, nine plants were selected at random from the two inner ridges and after leaving one meter at each end of the plot. The selected plants were tagged and the observations were made on them.

Plant Height

The plants were measured at 30, 45, 60 and 75 days from sowing in each subplot. Measurements were made from the base of the youngest leave to the top of the plant. Then the means plant height were recorded for each plot.

Leaf Number per Plant

The nine plants used for the measurement of plant height where also used for the count of number of leaves per plant where the average number of leaves were recorded.

Leaf Area

Leaf area for three leaves per plant of each of the nine plants per plot was measured.

For each leaf, the highest length and the maximum width were reported and multiplied by 0.75 to obtain the leaf area. Average leaf areas per plant were used.

Number of Cobs per Plant

The number of cobs per plant was taken at 60 and 75 days from sowing, for each of the nine plants per plot.

Dry Weight

The nine plants of each plot were cut at 120 days old from sowing and dried then weighed and the average dry weights per plant were recorded.

Harvesting

When signs of maturity were clear on the plants (complete yellowing of leaves and cobs and partial shedding of leaves), harvesting was made for the remaining plants for the plot to estimate the final yield.

Length of Cob/Cm

The cobs of nine plants in each plot were measured and the average cob length was recorded for each plot.

Number of Rows/Cob

Similarly, the numbers of rows per cob were made for the cobs of the nine plants and the average was recorded.

Number and Weight of Grains/Cob

The average number of grains per cob and the average weight per cob were also made.

100-Grains

100 grains were counted randomly and weighed for each plot.

Final Grain Yield (Kg/Ha)

The cobs from each plot of the harvested plants were weighed then threshed and the grain yields for each plot were recorded.

3. Results

Vegetative Growth of the First Season

The results of summer season of 2000/2001 on yield and yield components and other plant characteristics were as follows:-

Plant Height (Cm) at 30 Days

From the analysis of variance it was clear that there were significant (P=0.01) difference in plant height per plant between the levels of nitrogen. The application of 43 kg N/ha gave 16% significantly higher plant height over control, whereas the application of 86 kg N/ha increased plant height over control by 35%. On the other hand, there were no significant differences in plant heights between the levels of nitrogen.

There were significant (P=0.01) different between cultivars, whereas cultivar Pannar-6480 gave significantly higher plants than the cultivars Mugtama-45 and Giza-2. Which were significantly different from each other.

The effect of phosphorous on plant height was not significant. Also, all other interactions were not significant.

Plant Height (Cm) at 45 Days

From the analysis of variance, it was clear that, there were significant (P=0.01) difference in plant height per plant between the levels of nitrogen. The application of 43 kg N/ha gave 14% significantly higher plant over control, whereas the application of 86 kg N/ha increased the plant height over the control by 24%. On the other hand, there were no significant differences in the plant height between the application of 43 and 86 kg N/ha.

The differences between the two levels of phosphorous were not significantly. All other interactions were not significant.

Plant Height (Cm) at 60 Days

Similar results as the plant height at 60 days were obtained, were from the analysis of variance there were significant (P=0.01) differences in plant height between the levels of nitrogen. The application of 43 kg N/ha gave 9% significantly higher plants over control, whereas the application of 86 kg N/ha increased the plant height over the control by 12%. On the other hand, there were significant differences in the plant height between the application of 43 and 86 kg N/ha. There were significant (P=0.01) difference between cultivars, where cultivar Pannar-6480 gave significantly higher plant height per plant than the cultivars Giza-2 and Mugtama-45, which were not significantly different from each other. The differences between the two levels of phosphorous were significant. All other interactions were not significant except for the interaction of cultivars x nitrogen.

Plant Height (Cm) at 75 Days

The analysis of variance showed similar results as those of previous dates. From the analysis of variance, it was clear that there were significant (P=0.01) difference in plant height between the levels of nitrogen. The application of 43 kg N/ha gave 10% significantly higher plants over control, whereas the application of 86 kg N/ha increased the plant height over the control by 14%. On the other hand, there were no significant differences in the plant height between the application of 43 and 86 kg N/ha. There were significant differences between cultivars, where cultivar Pannar-6480 gave significantly higher plants height than the cultivars Giza-2 and Mugtama-45, which were not significantly different from each other. The differences between the two levels of phosphorous were not significant. All other interactions were not significant, except for the interaction of cultivars x nitrogen.

Number of Leaves at 30 Days

From the analysis of variance, it was clear that there were significant (P=0.01) difference in number of leaves per plant between the levels of nitrogen and also between the two levels of phosphorus the differences between the cultivars and all interactions were not significant.

Number of Leaves at 45 Days

From the analysis of variance, it was clear that there were significant (P=0.01) difference in leaf number per plant between the different levels of nitrogen. The application of 43 kg N/ha gave 23% significantly higher leaf number over control, whereas the application of 86 kg N/ha increased the number of leaves over the control by 38%, on the other hand, there were no significant differences in the leaf number between the application of 43 and 86 kg N/ha.

Also, there were significant differences between cultivars, where cultivars Giza-2 and Pannar-6480 gave significantly higher leaf number per plant than the cultivar Mugtama-45, which were not significantly different from each other. The difference between the two levels of phosphorous was significant.

Number of Leaves at 60 Days

The application of 43 kg N/ha gave 30% significantly higher leaf number over control, whereas the application of 86 kg N/ha increased the number of leaves over the control by 53%. On the other hand, there were significant differences in the leaf number per plant between the application of 43 and 86 kg N/ha. There were no significant differences between cultivars, levels of phosphorous and interaction.

Leaf Area (Cm) at 30 Days from Sowing

From the analysis of variance it was clear that, there were significant (P=0.01) differences in leaf area between the levels of nitrogen. The application of 45 kg N/ha gave 6% more leaf area than the control, whereas the application of 86 kg N/ha increased the leaf area over the control by 20%. Also, there were significant differences in the leaf area between the application of 43 and 86 kg N/ha.

There were significant difference between cultivars, where cultivar Giza-2 gave significantly higher leaf area than the cultivars Mugtama-45 and Pannar-6480, which were not significantly different from each other. Also the difference between the two levels of phosphorous was significant.

Leaf Area at 45 Days from Sowing

The application of 43 kg N/ha gave 37% significantly higher leaf area over control, whereas the application of 86 kg N/ha increased the leaf area by 43%. Also, there were significant differences between cultivars, where cultivar Giza-2 gave significantly higher leaf area than the cultivars Mugtama-45 and Pannar-6480, which were significant different from each other. The difference between the two levels of phosphorous was significant.

Leaf Area at 60 Days

From the analysis of variance, it was clear that there were significant (P=0.01) differences in leaf area between the levels of nitrogen. The application of 43 kg N/ha gave 12% significantly higher leaf area over control, whereas the application of 86 kg N/ha increased the leaf area over control by 17%. On the other hand, there were significant differences in the leaf area between the application of 43 and 86 kg N/ha. Also, there were significant differences between cultivars, where cultivar Giza-2 gave significantly more leaf area than the two cultivars Mugtama-45 and Pannar-6480, which were significantly different from each other. The difference between the two levels of phosphorous was significant and whereas all other interactions were not significant.

Yield and Yield Components

Dry Weight (G) of Plant

From the analysis of variance, it was clear that there were significant (P=0.01) differences in dry weight between the levels of nitrogen. The application of 43 kg N/ha gave 64% significantly higher dry weight over control, whereas the application of 86 kg N/ha increased the dry weight of the plants over the control by 84%. Also, there were significant (P=0.01) differences between cultivars, where cultivar Pannar-6480 gave significantly higher dry weight of the plants than the cultivars Mugtama-45 and Giza-2, which were significantly different from each other. The differences between the two levels of phosphorous and the interactions were not significant.

Number of Rows per Cob

The application of 43 kg N/ha gave 9% significant higher number of rows per cob over the control, whereas the application of 86 kg N/ha increased the number of rows per cob over the control by 27%. On the other hand, there were no significant difference in the number of rows per cob between the application of 43 and 86 kg N/ha. Also, there were no significant (P=0.01) differences between the three cultivars in the number of rows per cob. The differences between the two levels of phosphorous and the interaction were not significant. All other interactions were not significant.

Weight of 100-Grains

From the analysis of variance it was clear that there were significant (P=0.01) difference in weight of 100-grains between the levels of nitrogen. The application of 43 kg N/ha gave 20% significantly higher weight of 100-grains over the control, whereas the application of 86 kg N/ha increased the weight of grains of the plant over the control by 50%.

There were significant (P=0.01) differences between cultivars, where cultivar Mugtama-45 gave significantly higher weight of 100-grain than the cultivars Giza-2 and Pannar-6480, which were not significantly different from each other. The differences between the two levels of phosphorous and interaction were not significant.

Length of Cob (Cm)

The application of 43 kg N/ha gave 27% significantly higher longer cobs than the control, whereas the application of 86 kg N/ha increased the length of cobs over the control by 39%. On the other hand, there were no significant differences in the length of cobs between the application of 43 and 86 kg N/ha.

Weight of Cobs (Kg/Ha)

From the analysis of variance, it was clear that there were significant (P=0.01) difference in weight of cob per plant between the levels of nitrogen. The application of 43 kg N/ha gave 10% significantly heavier weight of cobs over the control, whereas the application of 86 kg N/ha increased the weight of cob over the control by 23%. On the other hand, there were significant differences in the weight of cobs between the application of 43 and 86 kg N/ha.

Also, there were significant (P=0.01) difference between cultivars, where cultivar Pannar-6480 gave significantly higher weight of cobs than the cultivars Giza-2 and Mugtama-45, which were not significantly different from each other. The difference between the two levels of phosphorous was significant.

Weight of Grains (Kg/Ha)

From the analysis of variance it was clear that there were significant (P=0.01) differences in weight of grains per plant between the levels of nitrogen. The application of 45 kg N/ha gave 20% significantly higher weight of grains per plant over the control, whereas the application of 86 kg N/ha increased the weight of grains per plant over the control by 44%. (Table 1).

There were significant (P=0.01) differences between cultivars, where cultivar Pannar-6480 gave significantly higher weight of grains per plant than the cultivars Mugtama-45 and Giza-2, which were not significantly different from each other. The difference between the two levels of phosphorous was not significant, whereas, all other interactions were significant (Table 1).

Table 1. Effect of nitrogen and phosphorous on weight of grains kg/ha of three cultivars of maize

Treatment (SE±=1.45)	Nitrogen and cultivars (SE± = 0.59)						Mean
	V1		V2		V3		
	P-level (SE± = 0.48)						
	P0	P1	P0	P1	P0	P1	
N0	2520	2400	2100	2340	2880	3000	2540
N1	2940	3120	2700	2460	3600	3480	3060
N2	3780	3360	3540	3300	3900	4020	3650
	3020		2740		3480		
P0							3120
P1							3053

Number of Grains per Cob

From the analysis of variance it was clear that there were significant (P=0.01) differences in grains number per plant between the levels of nitrogen. The application of 43 kg N/ha gave 56% significantly higher number of grains over the control, whereas the application of 86 kg N/ha increased the number of grains per plant over the control by 88%. On the other hand, there were no significant difference in the number of grains per plant between the application of 43 and 86 kg N/ha. Also, there was significant (P=0.01) difference between cultivars, where cultivar Pannar-6480 gave significantly higher number of grains per plant than the cultivars Mugtama-45 and Giza-2. The differences between the two levels of phosphorous and all interactions were not significant.

Vegetative Growth of the Second Season

The results on yield and yield components and other plant characteristics for the winter season 2001/2002 were as follows:-

Plant Height at 30 Days from Sowing

From the analysis of variance, it was clear that, there were significant (P=0.01) difference in plant height between the various levels of nitrogen. The application of 43 kg N/ha increased the plant height of plants over the control by 21% where was the application of 86 kg N/ha increased plant height over the control by 41%. On the other hand, there were no significant differences in plant height due to the application of 43 kg and 86 kg N/ha.

Also, there were no significant differences between cultivars and between the two levels of phosphorous.

Plant Height at 45 Days from Sowing

From the analysis of variance, it was clear that, there were significant (P=0.01) difference in plant height between the levels of nitrogen. The application of 43 kg N/ha gave 28% significantly higher plant height over control where the application of 86 kg N/ha increased the plant height over the control by 49%.There were significant (P=0.01) differences between cultivars, where cultivar Giza-2 gave significantly higher plant height than the cultivars. Mugtama-45 and Pannar-6480, which were not significantly different from each other. The differences between the two levels of phosphorous were significant. All other interactions were not significant with the exception of the interaction of cultivar x nitrogen which was no significant at (P=0.01).

Plant Height at 60 Days from Sowing

From the analysis of variance, it was clear that, there were significant (P=0.01) differences in plant height between the levels of nitrogen, cultivars, phosphorous and the interaction of nitrogen x cultivar.

The application of 43 kg N/ha gave 22% significantly higher plant height over control, whereas the application of 86 kg N/ha increased the plant height over the control by 43%. On the other hand, there were significant differences in the plant height of plants between the applications of 43 kg N/ha and 86 kg N/ha.

The cultivar Giza-2 gave significantly higher plant height than the cultivars Mugatama-45 and Pannar-6480, which were not significantly different from each other. The differences between the two levels of phosphorous were also significant, where the application of 42 kg P_2O_5/ha increase the plant height over the control by about 5%.

Plant Height at 75 Days from Sowing

From the analysis of variance, it was clear that there were significant (P=0.01) difference in plant height between levels of nitrogen.

The application of 43 kg N/ha gave 39% significantly higher plant height over control, where as the application of 86 kg N/ha increased the plant height over the control by 47%. On the other hand, there were significant differences in the plant height between the applications of 43 and 86 kg N/ha.

There were significant (P=0.01) differences between cultivars, where cultivar Giza-2 gave significantly higher than the cultivars Mugtana-45 and Panar-6480.

The differences between the two levels of phosphorous were significant whereas all other interactions were not significant.

Number of Leaves per Plant at 30 Days from Sowing

From the analysis of variance, it was clear that there were significant (P=0.01) differences in number of leaves per plant between the levels of nitrogen. The application of 43 kg N/ha gave 22% significantly higher number of leaves over control, whereas the application of 86 kg N/ha increased the number of leaves per plant over control by 44%. On the other hand, there were no significant differences in the number of leaves per plant between the applications of 43 and 86 kg N/ha.

There were no significant in the number of leaves per plant between the two levels of phosphorous, the three cultivars and all other interactions with the exception of the interaction of cultivars x nitrogen.

Number of Leaves per Plant at 45 Days from Sowing

From the analysis of variance, it was clear that there were significant (P=0.01) differences in number of leaves per plant between the different levels of nitrogen. The application of 43 kg N/ha gave 25% significantly higher number of leaves over the control, whereas the application of 86 kg N/ha increased the number of leaves per plant over control by 41%. On the other hand, also there were significant (P=0.01) differences between cultivars, where cultivars Giza-2 and Mugtama-45 gave significantly higher number of leaves per plant than cultivar Pannar-6480. The differences between the two levels of phosphorous were not significant and other interactions were also not significant.

Number of Leaves per Plant at 60 Days from Sowing

From the analysis of variance it was clear that there were significant (P=0.01) differences in number of leaves per plant between the levels of nitrogen. The application of 43 kg N/ha gave 21% significantly higher number of leaves over the control, whereas the application of 86 kg N/ha increased the number of leaves per plant of the plants over the control by 42%. On the other hand, there were no significant differences in the number of leaves per plant between the application of 43 and 86 kg N/ha.

There were significant (P=0.01) differences between cultivars, where cultivar Mugatama-45 gave relatively greater number of leaves than the other cultivars and all other interactions were not significantly.

Leaf Area at 30 Days from Sowing

From the analysis of variance, it was clear that there were significant (P=0.01) difference in leaf area between the levels of nitrogen. The application of 43 kg N/ha gave 24% significantly higher leaf area than the control, whereas the application of 86 kg N/ha increased the leaf area than the control by 95%. On the other hand, there were significant differences in the leaf area between the applications of 43 and 86 kg N/ha. There was significant (P=0.01) difference between cultivars, whereas cultivar Giza-2 gave significantly higher leaf area of leaves than the cultivars Mugtama-45 and Pannar-6480. The differences between the two levels of phosphorous and the other interaction were not significant.

Leaf Area at 45 Days from Sowing

From analysis of variance, it was clear that there were significant (P=0.01) differences in leaf area of leaves between the different levels of nitrogen. The application of 43 kg N/ha gave 65% significantly higher leaf area over control, whereas the application of 86 kg N/ha increased the leaf area over control by 88%. On the other hand, there were significant differences in the leaf area between the application of 43 and 86 kg N/ha. Also other were significant (P=0.01) differences between cultivars, where cultivar Giza-2 gave significantly higher leaf area than cultivars Mugtama-45 and Pannar-6480, which were significantly different from each other. The differences between the two levels of phosphorous were significant, where the application of 43 kg P_2O_5/ha increased leaf by 9%. All other interactions were significant with the exception of the interaction of nitrogen x cultivar.

Leaf Area at 60 Days from Sowing

From the analysis of variance, it was clear that there were significant (P=0.01) differences in leaf area between the levels of nitrogen. The application of 43 kg N/ha gave 33% significantly higher leaf area over control, whereas the application of 86 kg N/ha increased the leaf area of the plant over control by 95%. On the other hand, there were significant differences in leaf area between the application of 43 and 86 kg N/ha.

There were significant (P=0.01) differences between cultivars, whereas cultivar Giza-2 gave significantly higher leaf area per plant than the cultivars Mugtama-45 and Pannar-6480, which were significantly different from each other. The differences between the two levels of phosphorous were significant. Also the all interactions were significant.

Yield and Yield Components

Dry Weight of Plant

From the analysis of variance, it was clear that there were significant (P=0.01) differences in dry weight of plants between the levels of nitrogen. The application of 43 kg N/ha gave 40% significantly higher dry weight over the control, whereas the application of 86 kg N/ha increased the dry weight of the plant over the control by 76%. On the other hand, there were highly significant differences in the dry weight of plants between the application of 43 and 86 kg N/ha. There were significant (P=0.01) differences between cultivars, whereas cultivar Pannar-6480 gave significantly higher dry weight than the cultivars Mugtama-45 and Giza-2, which were not significantly different from each other. The differences between the two levels of phosphorous and all other interactions were not significant.

Number of Rows per Cob

From the analysis of variance, it was clear that there were significant (P=0.01) differences in number of row per cob between the levels of nitrogen. The application of 43 kg N/ha gave 27% significantly higher number of rows over control, whereas the application of 86 kg N/ha increased the number of rows per cob over the control by 36%. On the other hand, there were no significant differences in the number of rows per cob between the application of 43 and 86 kg N/ha. There were significant (P=0.01) differences between cultivars, whereas cultivar Mugtama-45 gave significantly higher number of rows per cob than the cultivars Giza-2 and Pannar-6480, which were not significantly different from each other. The differences between the two levels of phosphorous and all other interactions were not significant.

Weight of 100-Grains

The analysis of variance showed that there were significant difference in the 100-grain weight (g) due to the effects of nitrogen, cultivars, phosphorous, and the interaction of cultivar x nitrogen and cultivar x phosphorous.

Length of cob (cm)

From the analysis of variance, it was clear that there were significant (P=0.01) difference in the length of cob between the levels of nitrogen. The application of 43 kg N/ha gave 17% significantly higher length of cob over the control, whereas the application of 86 kg N/ha increased the length of cob over the control by 25%.

On the other hand, there were no significant differences in the length of cob between the application of 43 and 86 kg N/ha.

There were no significant (P=0.01) differences between cultivars, which were not significantly different from each other. The differences between the two levels of phosphorous were not significant. All other interactions were not significant.

Weight of Cobs Kg/Ha

From the analysis of variance, it was clear that, there were significant (P=0.01) difference in weight of cob between the levels of nitrogen. The application of 43 kg N/ha gave 9% significantly higher weight of cob per plant over control, whereas the application of 86 kg N/ha increased the weight of cobs per plant over the control by 15%. On the other hand, there were no significant differences in the weight of cobs. There were significant (P=0.05) differences between the cultivars, where cultivar Pannar-6480 gave significantly higher weight of cobs than the cultivar Giza-2 and Mugtama-45, which were not significantly different from each other. The differences between the two levels of phosphorous and all interactions were not significant.

Weight of Grains per Cob (G)

From the analysis of variance, it was clear that there were significant (P=0.01) differences in weight of grains per plant between the levels of nitrogen. The application of 43 kg N/ha gave 7% significantly higher weight of grains per plant over the control, whereas the application of 86 kg N/ha increased the weight of grains per plant over the control by 40%. On the other hand, there were no significant differences in the weight of grains per plant between the application of 43 and 86 kg N/ha (Table 33). Also, there were significant (P=0.01) differences between cultivars, whereas cultivar Pannar-6480 gave significantly higher weight of grains per plant than the cultivars Giza-2 and Migtama-45, which were significantly different from each other.

The differences between the two levels of phosphorous were not significant. All other interactions were also significant.

Number of Grains per Cob

From the analysis of variance, it was clear that there were significant (P=0.01) differences in number of grains per plant between the levels of nitrogen.

The application of 43 kg N/ha gave 6% significantly higher number of grains per plant over the control, whereas the application of 86 kg N/ha increased the number of grains per plant over the control by 23%. On the other hand, there were no significant differences in the number of grains per plant between the cultivars, phosphorous levels and all interactions.

Weight of Grains (Kg/Ha)

From the analysis of variance, it was clear that there were significant (P=0.01) differences in weight of grains between the levels of nitrogen.

The application of 43 kg N/ha gave 27% significantly higher grains yield over the control, whereas the application of 86 kg N/ha increased the grains yield over control by 51%. On the other hand, there were significant differences in the grain yield between the application of 43 and 86 kg N/ha.

Also, there were significant (P=0.01) differences between cultivars, whereas cultivar Pannar-6480 gave significantly higher grain yield than cultivars Giza-2 and Mugtama-45, which were significantly different from each other. The differences between the two levels of phosphorous were significant. All the other interactions were also significant except the interaction between cultivars and phosphorus (Table 2).

Table2. Effect of nitrogen and phosphorous on grain yield (kg/ha) of three cultivars of maize

Treatment (SE±=0.80)	Nitrogen and cultivars (SE± = 0.0.32)						Mean
	V1		V2		V3		
	P-level (SE± = 0.20)						
	P0	P1	P0	P1	P0	P1	
N0	2586	2682	2280	2566	2473	2539	2521
N1	3199	3259	2888	3717	3184	3896	3190
N2	3424	3870	3737	3820	4151	3867	3813
	3170		3085		3269		
P0							3103
P1							3246

4. Discussion

Vegetative Growth

From the results obtained for both seasons for plant height, number of leaves per plant, it was clear that all the vegetative growth parameters increased with increasing levels of nitrogen. Also cultivar Geza-2 gave taller plants in both seasons, greater number of leaves per plant. In this connection, El Hattab *et al*[3]. reported similar results on the effects of nitrogen on plant height, where they attributed the result to the facts that nitrogen promote plant growth. With regards to the number of leaves per plant, El Moemani, [4] found similar results. Also it was reported by Yanusa *et al*[5]. that taller cultivars gave greater leaf area index (L.A.I) than the dwarf cultivar, which agree with our results where Geza-2 gave taller plants and greater leaf area.

The results of phosphorous that increasing the levels of phosphorous resulted in significantly taller plants in both seasons, similar results were obtained by Kamaraswamy [6]. reported that phosphorous gave taller plants when applied at sowing.

The effect of nitrogen and phosphorous was reported by Rai [7] who found that both elements increased plant growth up to the 100 days from sowing, the application of both nitrogen and phosphorous significantly increased the dry weight of the plants, and this result was in agreement with the results obtained by Okajima *et al*[8]. who found that the application of 150 kg P_2O_5/ha and 200 kg N/ha gave the highest dry matter yield of maize.

Yield and Yield Components

Weight of Cobs (Kg/Ha)

From the results it is evident that nitrogen, phosphorous and their interaction had significant effect on cob yield in both seasons. Sharma[9] found that nitrogen significantly affected cob weight per plant.

Weight of Grains (Kg/Ha)

The effects of nitrogen, phosphorous and their interaction on grain yield were significant. Also cultivar Pannar-6480 gave significantly grater cob and grain yields than the other two cultivars. These results are in agreement with the results of Magboul *et al*. [10] studied the effects of different dosage of fertilizer on yield and yield components of maize, where it was clear that increasing the levels of phosphorous alone did not affect the grain yield. On the other hand, increasing nitrogen, irrespective of phosphorous, gave a continuous increase in grain. Similar results were obtained from both Rahad and Hudeiba locations. The best combinations that gave the maximum yields were from 43 P_2O_5/ha with 86 kg N/ha, 129 kg Nlha and 172 kg N/ha. In this connection, Nour and Lazin [11]working at the Gezira station, found that there was significant effects of nitrogen and phosphorous and their combinations on grain yield, days to flowering and plant population. Also, Ali [12] from a trial on the effects of NPK reported significant responses of rainfed maize to nitrogen, where there were no significant responses to the application of phosphorous and potassium. The best grain yields were obtained with the application of 2N2P (86 kg pure N and 86 kg P_2O_5/ha). In the irrigated area, Ali [13] from an NP trial on maize found that the crop responded only to the application of 86 kg pure N/ha. Although there was no response to the application of phosphorous and the interaction of nitrogen and phosphorous, the maximum grain yield was obtained with the application of 86 kg pure N and 43 kg P_2O_5/ha. He also found no significant effects of nitrogen and phosphorous on 100 grain yield. Adeyefa *et al*. [14] found significant increases in grain yield with increasing levels of nitrogen and phosphorous but the increase in grain yield above the levels of 80-100 kg N/ha was low and not significant. On the other hand, Abdel Malik *et al*.[15]; found that grain yield increased significant with the application of nitrogen and phosphorous.

In the two seasons, our study nitrogen gave a consistent, significant increase in yield and yield components. Nitrogen also significantly increased grain weight per cob.

In this connection, Ebaisory [16] obtained the highest yield of grain when 168 kg N/ha were applied to no-tillage treatment of maize. Also Plenet *et al*.[17] reported responses to nitrogen up to the levels of 240 kg N/ha. Gardner *et al*.[18] reported that various maize cultivars responded to the application of nitrogen up to 240 Kg N/ha. The responses to these highly levels of nitrogen might be due to the poor soil conditions of the experimental site or due to high response of the cultivars used, also Singh and Dubey [19] studied the effects of different levels of nitrogen and phosphorous and they found that the maximum yield of grain was obtained with the application of 120 kg N/ha + 60 kg P_2O_5/ha. Nelson *et al*.[20] found in similar results.

Number of Grains per Cob

The significant effects of nitrogen on number of grains per cob, where phosphorous and the interaction of nitrogen and phosphorous were not significant in the second season. In this connection, Sharma [9]; found significant effects of nitrogen on number of grains per cob. Pending and Broadbent [20]; found that maize yield and yield components were significantly increased by the application of nitrogen.

100 grains weight (g)

The results obtained in both seasons showed significant effect of nitrogen on 100 grains weight, with no significant effect of phosphorous. As mentioned earlier, Ali [13] found no significant effects of nitrogen and phosphorous on 100 grain weight. Also these results were similar to that to those obtained by Ologunde and Ogunlela [21].

From the results obtained in our study in both seasons, it was clear that the significant increase in grain yield and yield components were mainly due to the application of nitrogen. Also the increase in grain yield can be attributed to the increase in cob yield and number of grains per cob.

From the comparison of the grains yield in the summer and winter seasons, it was clear that there were very little differences between seasons, where in the summer season grain yield varied between 2540 to 3650 kg/ha with an average of 3083 kg/ha and in the winter season yield varied between 2521 to 3813 kg/ha with an average of 3175 kg/ha. Although these results are not the results of a proper sowing date trial it suggest that this crop can successfully be cultivated in both seasons.

5. Conclusion

Since the yield and yield components were similarly affected by the fertilizer treatments in both seasons, this suggests as mentioned earlier that the maize crop in this area (The While Nile) can successfully be grown in the winter and summer seasons.

This finding as very important since it provide a new winter crop to the area.

Since there are mainly possible summer crop, which can be grown in the area (sorghum, cotton, groundnuts, …, etc), which might compete with the maize crop, the suggestion of growing the maize crop as a winter crop will help in the intensification and diversification of the rotations of the agricultural schemes in the area.

It is worth mentioning that there are many new developmental scheme in the White Nile area (Robi, sugarcane factory, Kenana sugarcane company, …, etc) Ali[22], where the maize crop was suggested to be grown as a winter crop to divers by the sugarcane rotation.

Also the results obtained from one study confirmed that the fertilizer need for maize in this area is only 86 kg N/ha. These are in agreement with the recommendation of the cultural practices for maize production, which was used on the feasibility studies of most of the new schemes in the area.

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