Effect Of NPK Micro Doses Fertilizer On Leaf Area, Leaf Area Index And Pods And Hay Yield Of Six Genotypes Of Groundnut –North Kordofan State-Sudan

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Abstract: This experiment was conducted at two locations, in North Kordofan under rain fed conditions for two consecutive seasons (2011/012 and 2012/013), to study the effect of NPK micro doses on leaf area, leaf area index, pod yield and hay yield of six groundnut genotypes. The tested genotypes were arranged in a Randomized Complete Block Design with four replications. Leaf area increased rapidly up to 90 days from planting. Thereafter, it started increase but at slower rate in all treatments. Non significant differences were observed among genotypes and treatments in leaf area at 30 days after planting. At this stage the highest leaf area of about 278.4 cm2 was recorded by ICGV89171 without NPK treatment and the lowest of 149.5 cm2 by ICGV93255 with NPK treatment. At sixty days after planting the significant differences in leaf area were observed, the highest recorded by genotypes ICGV89171 (1278.8 cm2) with NPK treatment while the lowest by line ICGV93255 (743.8 cm2) without treatment. At 90 days after planting the leaf area showed high significant differences among genotypes, the maximum leaf area 1570.1 cm2 recorded by line ICGV92121 with NPK treatment. The Significant differences were record at 60 and 90 days after planting for leaf area index, NPK treatment increase the value 0.30 at all stages of genotypes. Significant varietal differences were observed for pod yield, hay yield, hundred seed weight, and number of pods per plant, while non significant differences were recorded in seeds per pod, shelling percentage and harvest index were not significant. The high significant correlation between leaf area and pod and hay yield were observed, with pod yield was 0.278 and with hay yield was 0.242 respectively.

Keywords: Arashis hypogaea L, leaf area, Gubiesh, Faris village

1 Introduction

Groundnuts, or peanut (Arashis hypogaea L.), is a very important oilseed crop. Groundnut is grown in more than 100 countries over 22 million hectares in the tropical and sub-tropical parts of the world. The total annual world production of unshelled nuts amount to about 28 million tons. India, China and U.S.A produce almost 65% of the world production. Other major groundnut producing countries include Nigeria, Senegal, Sudan, Zaire and Indonesia (Osman, 2003). In Sudan, groundnut is important oil, cash export crop. Area planted in groundnut is about 0.8 million hectares with an estimated production of 0.4 million ton (Osman, 2003). The crop is grown under irrigation in the central clay plains and in the rain fed areas in the sandy soils of western Sudan. The major production regions are south Darfur, North Kordofan, Gezira and Managil. These regions account for about 75% of the total production. It's grown both under intensive, high technology, irrigated agriculture and traditional methods in rain fed condition. Rain fed production account for about 84% of the total crop area and 62% of production (Mohammed, 1980).

Under rain fed condition, mostly, in the western region, the crop is grown on sandy soils of low fertility. Inadequate rainfall and declining soil fertility is most limiting factor for groundnut production in these regions (Ishag, 1986). Most of the cultivated area in North Kordofan is located in poor sandy soil under low amount and bad distribution of rain fall, added to the use of low yield genotypes (Ishag, 1980). Meager studies were carried out on relationships among yield determinant factors aforementioned. Several genotypes and lines are tested and evaluated by Agricultural Research Corporation in western Sudan (Abdalla, 1999). The productivity in western Sudan about 600 k \ ha in contrast to that in irrigated schemes more than 1200 k\ha and the lack of application of any type of fertilizers in the area (Osman, 2003). The objectives of this study are: To improve pods and hay yield of groundnuts 2- To detect relationship between NPK micro dose and leaf area, yields and its components and hay yield. 3- To determine their response to different combination of NPK fertilization in term of leaf area, leaf area index, yields and its components and hay yield.

2 MATERIALS AND METHODS

This experiment was conducted under rain fed conditions for two seasons (2011\12-2012\13), at two locations in North Kordofan State. The first location is at Elobeid Research Station farm (13-12\N and 3-14\E), while the second location is at Faris village, latitude 12.7 and longitude 30.1. General characteristics of the soil at the study locations showed in table (1). The field experiment was laid out in Randomized Complete Block Design with 12 treatment combinations consisting of six groundnut genotypes (Sodiri, Gubiesh, ICGV89171, ICGV93296, ICGV86744 and ICGV92121), the treatment from 1 to 6 without NPK application. Any genotype treated and without treated by NPK. The plot size is five meter long by 60 cm between rows and 20 cm between holes. To record the growth observations during the growing period samples were taken at 30 days interval until harvest. 10 plants

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were selected randomly from net plot area of each treatment and tagged. Leaf area and leaf area index were recorded at 30, 60, 90 days after plant.

Table 1*: General characteristics of the soil at the study locations*

Property	Elobeid	Faris
Sand (%)	97	94
Clay (%)	2.0	3.6
Silt (%)	1.0	2.4
PH (H2O)	7.11	7.16
N (ppm)	0.025	0.036
P (ppm)	0.07	0.21
K (ppm)	0.41	0.37
Organic matter (ml/lit)	0.55	0.35
Organic carbon (ml/lit)	0.32	0.21
C.E.C	6	8.5

Source: *Elobeid Research Station (soil lab 2011)*

2.1 Application of fertilizers

Nitrogen (N), phosphorus (P) and potassium (K) fertilizers (NPK 15:15:15) were applied at the sowing with doses (0.9 gm per holes) main plot treatment and covered with soil.

2.2 Data collected:

Leaf area plant-1(cm²)

Leaf area was calculated using area meter (Model AM 101.001). Leaves from one plant were collected and their area was measured by the leaf area meter. Then, these leaves were dried and weighed. The leaves of the sampled plants were dried and weighed. Using area: weight ratio the total leaf area could be calculated as follows (Vivckanadan et al, 1972):

$$LA\ (cm2) = \frac{\text{Leaves weight of all the sampled plants}}{\text{Leaves weight of the plant measured by area meter}} \times$$

Leaves area of the plant measured by leaf area meter

After that take mean of 10 plant leaf area.

Leaf area index (LAI): $\frac{LA}{\text{Ground area}}$

Yield and its components

a- Number of pods per plant.
b- Number of seeds per pod.
C- 100-seed weight.
d- Maturity (%): after 90 days from planting using the formula:

$$\frac{\text{Mature pods/plant} \times 100}{\text{Number of pods/plant}}$$

e- Shelling (%): $\frac{\text{Seeds weight /plot} \times 100}{\text{Pods weight /plot}}$

f- Pods yield/hectare (kg/ha):

$$\frac{\text{Weight of pods (kg/plot)} \times 10000}{\text{Harvest plot area (m2)}}$$

g- For hay yield: the formula used the follows:

$$\frac{\text{Weight of hay (kg)} \times 10000}{\text{Harvest plot area (m2)}}$$

h- Harvest index (%):

$$\frac{\text{Pod yield} \times 100}{\text{(Hay yield+ pod yield)}}$$

2.3 Statistical analysis and interpretation

The data collected from the experiment at different growth stages were subjected to statistical analysis as described by Gomez and Gomez (1989). The level of significance used in F and t test was p=0.05. Critical difference values were calculated where the F test was significant. combined analyses of variance were carried out using MSTAT- C computer program.

3 RESULTS AND DISCUSSION

3.1 Leaf area

The seasonal pattern of leaf area development, leaf area index and yield and yield component is presented in Table (2 to 4) and figure (1 and 2). Leaf area increased rapidly up to 90 days from planting. Thereafter, it started increase but at slower rate in all treatments. Non significant differences were observed among genotypes and treatments in leaf area at early stage of development (30 days after planting). At this stage the highest leaf area of about 278.4 cm2 was attained by ICRISAT line ICGV89171 without NPK treatment and the lowest of 149.5 cm2 by ICGV93255 with NPK treatment. At sixty days after planting the leaf area was significant, the highest recorded by genotypes ICGV89171 with NPK treatment while the lowest by line ICGV93255 without treatment. At the end of season i.e. Ninety days after planting the leaf area was high significant differences among genotypes, the maximum leaf area recorded by line ICGV92121 with NPK treatment, the widely grown genotypes and known in the area i.e. Sodiri and Gibiesh recorded a leaf area between 1006.7 to 1040.4 cm2 without treatment and 1240.8 t0 1352.0 cm2 with NPK treatment. In all genotypes and treatments maximum leaf area was attained at 90 days after planting. Similar results were reported by Maeda, (1971). He observed that the value of leaf area in Spanish types was 500 to1500 cm2. In this study mean leaf area was from 206 to 1050.8cm2 per plant with treatment and 224 to 1247.5 cm2 with NPK treatment by the end of the growing period. The leaf area effected with NPK treatment for all genotypes and these effected on yield.

Table (2): *Leaf area (cm2) per plant at 30, 60 and 90 days after planting*

	Treatments	30 days	60 day	90 days
Without NPK treatment	1-ICGV92121	172.67	868.2	1365.5
	2-ICGV86744	192.6	931.5	811.3
	3-ICGV93255	248.7	743.8	983.5
	4-ICGV89171	278.4	878.0	1097.2
	5-Soderi	155.1	766.8	1040.4
	6-Gibiesh	188.3	838.6	1006.7
	Mean	188.3	838.6	1006.7
With NPK treatment	7-ICGV92121	265.6	995.1	1570.1
	8-ICGV86744	275.7	1120.9	1190.8
	9-ICGV93255	149.5	914.8	983.0
	10-ICGV89171	224.9	1278.8	1148.3
	11-Soderi	213.3	1000.7	1352.0
	12-Gibiesh	215.0	1231.5	1240.8
	Mean	224.06	1090.3	1247.5
	SE ±	22.5^{ns}	56.8*	50.5**
	C.V	41.7	23.6	17.6

3.2 Leaf area index

Across the season, significant differences were observed among genotypes and treatments for LAI at 60 and 90 days after planting. the maximum LAI was attained around 90 days after planting. Leaf area index mean increase with NPK treatment about 0.30 at all stage of growth. Singh (2007) reported increase in LAI with an increase in N level up to 80 kg N ha-1 (1.28) but there was significant decrease in LAI with an increase in N level to 120 kg N ha-1(1.22). Higher leaf area index in groundnut with application of 40 kg N ha-1 as compared to lower doses (20 kg ha-1) and control was also reported by Reddy et al. (1982). Lalitha and Gopala (2004) reported that application of 120 kg N ha-1 in groundnut resulted in significantly higher LAI (0.99) which was superior over control (0.28), 40 kg N ha-1 (0.53) and 80 kg N ha-1 (0.81). Dash et al. (2005) reported that the LAI of soybean under control, 50 per cent recommended dose of fertilizer (10:30;20 kg N, P2O5, K2O ha-1) and 100 per cent recommended dose of fertilizer (20:60:40 kg N, P2O5, K2O ha-1) were 2.46, 2.79 and 2.93 respectively.

Table (3): *Leaf area index per plant at 30, 60 and 90 days after plant*

	Genotypes	30 days	60 days	90 days
Without NPK treatment	1-ICGV92121	0.288	1.44	2.28
	2-ICGV86744	0.321	1.55	1.35
	3-ICGV93255	0.415	1.24	1.64
	4-ICGV89171	0.465	1.46	1.83
	5-Soderi	0.259	1.28	1.78
	6-Gibiesh	0.314	1.39	1.68
	Mean	0.344	1.39	1.76
With NPK treatment	7-ICGV92121	0.443	1.66	2.62
	8-ICGV86744	0.460	1.87	2.05
	9-ICGV93255	0.249	1.53	1.64
	10-ICGV89171	0.374	2.13	1.91
	11-Soderi	0.355	1.68	2.25
	12-Gibiesh	0.359	2.05	2.07
	Mean	0.373	1.82	2.07
	SE ±	0.037ns	0.09*	0.08**
	C.V	41.7	23.7	17.5

3.3 Effect of NPK micro dose on leaf area, pod yield and hay yield

Effect of NPK micro doses on leaf area, pod yield and hay yield of genotypes showed in figure 1 and 2. Mean of leaf area for NPK treatment across the seasons and location was 200 cm2 while 180 cm2 without treatment at 30 day after planting. At mid of season 60 days after planting NPK treatment was 1080 cm2 and without treatment was 800 cm2. At the end of season 90 days after planting the mean of genotypes treated by NPK was 1200 cm2 while without treatment was 100 cm2. At all stages of crop the NPK treatment increase the leaf area 20%, pod and hay yield 10%. Anil Kumar Das et al. (2008), Ranjit, 2005, Kamara E.G,. et al 2011 and Kausale S.P*. et al* 2007 also reported increased haulm production with addition of Phosphorous Singh and Ahuja 1985 reported that applied phosphorous increased the leaf area and increased accumulation of dry matter. Nasr-Alla et al. (1998) reported that increasing the rate of NP individually or in combination increased the crop growth and yield characters. Bala et al. (2011) reported that pod yield was positively influenced by a combination of NPK rates because of the benefit of a large growth period and a longer vegetative phase. The positive response of groundnut pod and seed yields to P application had been reported by Naab et al. (2009). However, the findings of this study are in contrary to those of Hossain et al. (2007) and Bala et al. (2011) who found insignificant influence of N and P fertilizers on seed yield in groundnut.

3.4 Effect of NPK treatment on relationship between leaf area, leaf area index and hay and pod yield

Effect of NPK treatment on Correlations between leaf area, leaf area index and hay and pod yield at the end of season is presented in Table (4 and 5). The high significant correlation between leaf area and pod and hay yield were observed, with pod yield was 0.278 and with hay yield was 0.242 respectively, that is may be due to effect of NPK micro doses on genotypes. At all treatment, NPK micro doses application or control the correlation was same, high significant correlation was observed between LA and LAI. The significant differences were found between pod yield and hay yield but the correlation between pod and hay yield increased by NPK micro doses application. Edna Antony et.al. (2000) revealed that LAD, LAI increased with an increase in nitrogen dose in all genotypes studied and concluded that 25 kg N ha-1 was necessary for optimal yield. Yield of peanut tended to decrease with higher dose of N beyond 25 kg ha-1. Williams (1975) found a poor correlation between LAI and yield.

Table (4): *Correlations between leaf area, leaf area index and hay and pod yield without NPK treatment:*

	LA	LAI	Pod yield
LA			
LAI	1.00**		
Pod yield	0.092^{ns}	0.034^{ns}	
Hay yield	0.163^{ns}	0.162^{ns}	0.484**

Table (5): *Correlations between leaf area, leaf area index and hay and pod yield with NPK treatment**:***

	LA	LAI	Pod yield
LA			
LAI	0.988**		
Pod yield	-0.02^{ns}	-0.062^{ns}	
Hay yield	-0.18^{ns}	-0.265^{ns}	0.579**

3.5 Yield and its components

Yield and yield components of the tested genotypes and NPK treatment are shown in Table (6) and figure (2). Significant ($p \leq 0.05$) varietal differences were observed for pod yield, hay yield, number of pods per plant, hundred seed weight and maturity, while differences in seeds per pod, shelling percentage and harvest index were not significant. Pod yield, hay yield, hundreds seed weight, number of pod per plant and maturity were significant. The highest pod yield of 526, 498 and 478 kg/ ha were recorded by ICGV86744 without treatment, ICGV86744 with treatment and Sodiri with treatment respectively. The lowest yield of 376 kg/ ha was recorded by ICRISAT line ICGV93296. Sodiri cultivar with NPK treatment recorded the best hay yield followed by the ICRISAT lines. Sodiri and Gubiesh without treatment, the released cultivars recorded a high hay yield of more than 700 kg/ ha. Hundred seed weight of all genotypes, except ICGV92121, ranged between 31.5 and 37.5g. ICGV92121 recorded a 100 seed weight of 41g. The widely grown cultivars i.e. Sodiri and Gubiesh recorded almost similar 100 seed weight by treatments and without. High significant differences in number of pods per plant, the highest number were recorded by Gubiesh 28 with NPK micro doses application. Differences in shelling out-turn were slight. Maturity among genotypes ranged from 81 to 85%. The highest maturity was recorded by ICGV86744 by treatment, while the lowest was recorded by

ICRISAT line ICGV92121without treatment. Differences in harvest index were slight and not significant. Harvest index of all genotypes ranged between 38 and 41 %. The highest by ICGV92121 without treatment and lowest harvest index were reported by Sodiri. Studies carried out by Abdalla (1999), showed that the mean pod yield of ICRISAT lines was 500 kg/ha and 570 kg/ha for the released varieties, shelling percentage was 65 % in ICRISAT lines and 68 % for the released varieties, hay yield was 2000 kg/ha for ICRISAT lines and 1950 kg/ha for the released varieties, hundred seed weight ranged from 32 to 37 % in ICRISAT lines and 32 for the released cultivars. Significant increase in pod yield of groundnut was observed at a fertilizer level of 30:60:30 kg NPK ha-1 and increase in yield was 30 per cent higher than lower level of fertilizer doses (Vijaya Kumar, 1997). Subrahmaniyan et al. (2000) reported that application of NPK levels up to 100 per cent of the recommended doses of fertilizer (17:34:54 kg NPK ha-1) gave significantly better effect on the growth and yield parameters and pod yield of 1848 kg ha-1. Barik et al., (1994) who recommended the “20N+60P+40K” kg/ha as best fertilizer-combination for high peanut yield.

4 Conclusion

The leaf area and leaf area index effected with NPK treatment for all genotypes and this may be due to effected on hay and pod yield. The high significant correlation between leaf area and pod and hay yield were observed. Pod and hay yield increased with NPK treatment.

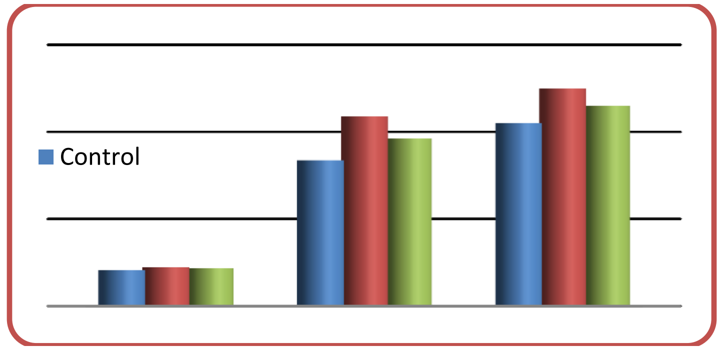

Figure (1): *Leaf area (cm2/plant) during growth period at 30, 60 and 90 days after planting for Genotypes mean (treatment and control).*

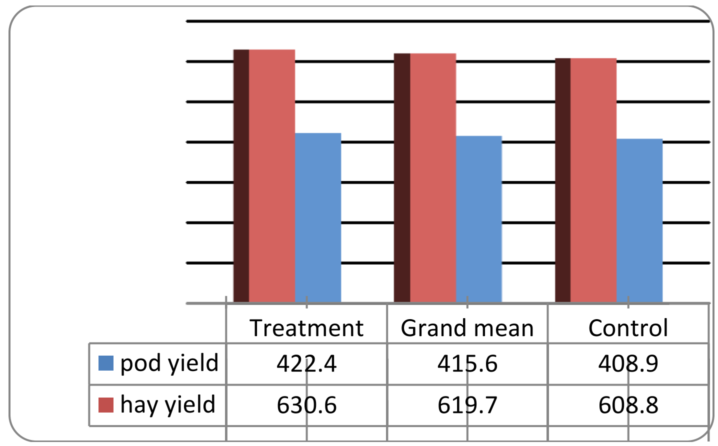

Figure (2): *Yield and yield components of the six groundnut genotypes and its treatment*

Table (6): *Yield and yield components of the six groundnut genotypes and its treatment*

	Genotypes	Shelling %	Harvest index %	100/w	Maturity%	Pods/plant	Hay yield	Pod yield
Without NPK treatment	1-ICGV92121	58.3	40.7	41.4	81.0	22.6	567.6	396.2
	2-ICGV86744	58.3	38.8	33.9	83.0	19.9	786.7	526.0
	3-ICGV93255	54.1	41.0	34.0	82.0	19.0	623.1	430.0
	4-ICGV89171	55.3	39.8	36.6	83.6	20.5	525.3	361.4
	5-Soderi	57.8	40.5	32.4	83.8	20.7	419.5	272.6
	6-Gibiesh	56.3	39.4	33.3	83.2	21.8	730.5	467.0
	Mean	56.7	40.0	35.3	82.8	20.8	608.8	408.9
With NPK treatment	7-ICGV92121	57.8	39.9	42.8	81.3	26.6	554.3	379.6
	8-ICGV86744	58.9	39.5	34.3	85.1	23.3	678.1	498.7
	9-ICGV93255	60.3	40.7	34.4	84.7	21.4	703.4	461.8
	10-ICGV89171	58.2	38.6	37.5	84.1	27.7	593.0	398.8
	11-Soderi	58.2	37.9	32.4	84.9	27.8	500.4	322.7
	12-Gibiesh	59.6	38.9	31.5	85.0	28.5	754.3	472.7
	Mean	58.8	39.3	35.5	84.2	25.9	630.9	422.4
	SE ±	1.01^{ns}	1.04^{ns}	0.28**	0.41**	0.93**	31.8**	22.6**
	C.V	7.0	10.5	3.2	2.0	16.0	20.5	21.8

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