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Effect of nitrogen and phosphorus on growth and yield of irrigated sunflower (Helianthus annuus L.)*

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ABSTRACT

Experiments were conducted in winter (2000 2001) and summer (2001) seasons at Elrahad Research Station to investigate the influence of four levels of nitrogen and two levels of phosphorus on growth characters and seed yield of two sunflower cultivars, viz Rodio and Hysun 33. Experiments were arranged in a randomized complete block design with four replications. Rodio and Hysun 33 varied in their growth characters. Differences between the two cultivars. Were highly significant for plant height, leaf area index, days to 50% flowering, days to maturity, head diameter, number of seeds per head, 1000-seed weight and empty seeds percentage. The two cultivars were siY1ificantly different in their seed yield. Nitrogen application significantly increased all growth characters and seed yield of the two cultivars, in both seasons, however, it decreased days to 50% flowering and days to maturity. Nitrogen fertilizer had no significant effect on empty seeds percentage. Phosphorus application significantly increased leaf area index, head diameter, number of seeds per head and 1000-seed weight. However, plant height, days to maturity and percentage of empty seeds were not affected. Application of phosphorus had no significant effect on seed yield.

INTRODUCTION

Sunflower (Helianthus annuus L.) ranked second after soybean as a source of vegetable oil. The oil content of the seed is about 45-55%South Africa is by far the main producing African country and Sudan

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is among the first producing Arab countries. There is an increasing interest in sunflower over the world due to its wide adaptability. Environmental conditions and soil properties of the Sudan are suitable for commercial production of this crop. The crop water use, soil and temperature requirements indicate that the central clay plain is a suitable area for growing sunflower. It can be grown under rainfall as well as under irrigation (Skoric, 1983).

Khalifa (1981) found siY1ificant differences in grain yield among open - pollinated cultivars. A research conducted by AAAID (1986) at Agadi farm, Damazin, Sudan, revealed that open—pollinated cultivars gave very low yield and had a high percentage of empty seeds compared to hybrids. Data collected for the last ten years concerning the area and yield of sunflower in the Sudan showed that they were fluctuating. However, a sharp drop in sunflower production was noticed in the mid nineties, which could be attributed to many factors including marketing, funding, cultural practices and N deficient soils.

Almost all studies carried out under irrigation and rainfed sectors deal with sowing date, population density, row and intra-row spacing (Nur, 1978; Khalifa, 1981, 1984). Data on nitrogen and phosphorus fertilization of sunflower are limited and variable results were reported (Ali, 1990; Babiker, 1990; Osman, 1995). The present work was carried out to study the effect of nitrogen and phosphorus fertilizers on growth characters, yield and yield components of irrigated sunflower.

MATERIALS AND METHODS

Field experiments were conducted for two consecutive seasons (2000/2001 and 2001) winter and summer, later referred to as first and second seasons, respectively, to investigate the response of two sunflower cultivars, open pollinated and hybrid, namely Rodio and Hysun 33, to the application of nitrogen and phosphorus fertilizers and their interactions. The experiment was carried out at the experimental farm of Elrahad Research Station at ELFau (latitude 140 25' and longitude 330 31). The field has a cracking clay soil.

The experimental area was disc harrowed and ridged at 80 cm apart and 30 cm between holes and divided into plots each plot with 5 ridges (6 x 0.8 m). The experiment comprised of 16 treatments in factorial combinations and arranged in a randomized complete block.

design (RCBD) with 4 replications. Two cultivars Rodio (open-pollinated cultivar) and Hysun 33 (hybrid), 4 levels of nitrogen (0, 43, 86 and 129 kg N/ha) and two levels of phosphorus (0,43 kg P205/ha) were used. Phosphorus was applied before sowing in the form of triple super phosphate and incorporated in the soil and N was applied 30 days after sowing as a side dress in the form of urea (46%N).

Seeds of sunflower were sown on 14th of November and 30th of July for the first and second seasons, respectively. Sowing was carried manually at a rate of 3 seeds/ hole, thinned to one plant/hole, 3 weeks after sowing.

Samples were collected from the 3 middle rows at random Observations included plant height, leaf area index (LAI), days to 50% flowering and days to maturity. Yield components included head diameter, number of seeds per head, weight of 1000-seeds, empty seed percentage and seed yield. Minimum and maximum temperature during winter and summer seasons were (16.0-34.600) and (22.0-36.700), respectively. The standard statistical analysis of variance procedures were used to analyze the data.

RESULTS AND DISCUSSION

Highly significant (P=O.OI) differences were detected between Rodio and Hysun 33 for plant height, leaf area index, days to 50% flowering and days to maturity in both seasons. Rodio had taller plants and higher LAI than Hysun 33. However, Hysun 33 flowered earlier and matured quicker than Rodio (Tables 1 and 2). The shorter plant and the smaller leaf area index of Hysun 33 in the second season could be explained by the high temperature during that season which indicates that the hybrid might be less tolerant to the environmental changes than the open-pollinated cultivar.

Nitrogen application had significant (P= 0.01) effects on plant height, leaf area index, days to 50% flowering and days to maturity. The tallest plants (150.58, 149.61 cm) were obtained by the application of 43 and 86 kg N/ha, respectively, in the first season. Plant height was increased in the second season by all levels of applied nitrogen compared to the control. Similar results were reported by Massey (1971) but with nitrogen level up to 56 kg N/ha.

Application of 86 and 129 kg N/ha resulted in higher leaf area index. This was in line with the results reported by Tenebe et al.

(1996) who found that LAI increased significantly with increasing the rate of nitrogen from 0 to 100 kg N/ha. Days to 50% flowering and days to maturity were shortened (2 —3 days) by the application of nitrogen, in both seasons (Tables 1 and 2).

Table 1. Main effects of nitrogen, phosphorus and cultivar on growth of sunflower (winter 2000/2001).

Treatment	Plant height (cm)	Leaf area index	Days to 50% flowering	Days to maturity
Nitrogen (kg/ha)				
Control	142.50 c	2.60 c	70.63 a	100.00 a
43	150.58 a	3.40 b	69.69 b	98.63 ab
86	149.61 a	3.71 ab	69.00 b	97.69 b
129	146.20 b	3.93 a	67.44 c	97.88 b
Phosphorus (kgP_2O_5/ha)				
Control	145.92	3.21	67.44	98.13
43	147.89	3.61	68.94	98.97
Cultivar				
Rodio	152.67	3.55	70.06	99.84
Hysun 33	141.15	3.27	68.31	97.25

Means followed by the same letter(s) within columns are not significantly different at 0.05 probability level according to Duncan's Multiple Range Test (DMRT).

Table 2. Main effects of nitrogen, phosphorus and cultivar on growth of sunflower (summer 2001).

Treatment	Plant height (cm)	Leaf area index	Days to 50% flowering	Days to maturity
Nitrogen (kg/ha)				
Control	140.13 b	2.66 c	61.69 a	88.94 a
43	148.41 a	3.87b	61.13 ab	87.50 b
86	150.70 a	4.30 a	60.06 bc	86.88 b
129	148.38 a	4.34 a	59.19 c	86.13 b
Phosphorus (kgP_2O_5/ha)				
Control	146.39	3.69	60.00	87.19
43	147.41	3.89	61.03	87.53
Cultivar				
Rodio	161.87	4.12	64.84	91.34
Hysun 33	131.94	3.46	56.19	83.38

Means followed by the same letter(s) within columns are not significantly different at 0.05 probability level according to Duncan's Multiple Range Test (DMRT).

The results were in agreement with AAAID (1986) and Bhan (1977) who reported that nitrogen application hastened sunflower maturity. Phosphorus application slightly increased plant height. Similar results were obtained by Sami (1998) who indicated that phosphorus application had no significant effect on this pararneter. However, leaf area index was significantly increased by phosphorus application in both seasons. The positive effect could be due to the rapid expanding cells resulting from nutrient supply. However, it had little effect on days to 50% flowering and days to maturity. This in agreement with Read et al. (1977) who found that plant utilization of phosphorus fertilizer in the year of application was less than 30%.

Yield and yield components

Head diameter of Hysun 33 was significantly (P = 0.05) bigger (15.56 cm) than Rodio (14.95 cm). Head diameter significantly increased by the application of nitrogen and phosphorus fertilizers, m both seasons (Tables 3 and 4). These results were in agreement with Hussein et al. (1981) who reported that head diameter increased progressively by increasing N level from 0 to 108 kg N/ha. The interaction effects of phosphorus and nitrogen and phosphorus, nitrogen and cultivars were significant in the first season only (data not shown).

Rodio produced higher number of seeds/head than Hysun 33. However, no significant differences were detected between cultivars in the first season. Nitrogen application at the rate of 86 and 129 kg N/ha significantly produced higher number of seeds in the first and second seasons, respectively. Similar results were observed by Petrova and Kolev (1976) and Karami (1980) who obtained significant increase in the number of seeds per head up to 200 kg N/ha. On the other hand, application of phosphorus at the rate of 43 kg P205 significantly increased the total number of seeds per head by 4.08% and 2.83% in the first and second seasons, respectively. Phosphorus and nitrogen interaction was siY1ificant in the first season only, where the application of 86 kg N/ha with 43 kg P205 produced the highest number of seeds (data not reported).

One thousand seed weight was significantly (P=O.OI) different between the two cultivars, in both seasons. While the heavier seeds with overall mean of 72.02 and 77.63g was produced by Hysun 33, Rodio on the other hand, had only 68.36 and 70.29g in the first and

second seasons, respectively (Tables 3 and 4). The difference in the overall mean of seed weight between the two seasons could be attributed to the different responses of the two cultivars to nitrogen fertilizer. Similar findings were reported by Ample (1980) who found significant variation in seed weight with the hybrid being superior in some characteristics.

Nitrogen application at the rate of 86 kg N/ha significantly (P = 0.05) produced higher seed weight of 73.46 and 76.77 g in the first and second seasons, respectively. The interaction be6veen nitrogen and cultivars was significant in the second season only. Application of 43 kg P205 increased seed weight by 7.9% over the control (Tables 3 and 4).

Hysun 33 produced significantly lower empty seeds percentage than Rodio. While nitrogen application had no ,significant effects on this parameter, phosphorus fertilizer, however, had significant effect on empty seed percentage in the first season only (Tables 3 and 4).

Seed yield of Hysun 33 was significantly (P 0.01) higher than Rodio which might be due to the fact that the hybrid had siY1ificantly higher head diameter, heavier seed weight and lower empty seed percentage (Tables 3 and 4). This result agrees with the findings reported by AAAID (1986) and disagrees with Adam and Osman (1990) who reported that there was no increase in seed yield when some hybrids were compared with some of the open—pollinated varieties

Seed yield was significantly increased by nitrogen fertilizer where the application of 86 kg N/ha gave the highest seed yield of (3.42 t/ha). This increase could be attributed to the positive response of the yield components (head diameter, number of seeds and seed weight) to the nitrogen application. Similar results were stated by Massey (1971) and Zubriski and Zimmerman (1974). Final seed yield was significantly increased by the application of phosphorus (43 kg P205/ha) in the first season only. Similarly, Daualy and Singh (1980) found that high yield of sunflower was obtained when the crop received 30 --- 60 kg P205/ha.

In conclusion, fertilization by applying nitrogen (urea) to ensure high yield of irrigated sunflower is vital. Application of 86 kg N/ha with 43 kg P205 should be practiced by sunflower growers at Elrahad scheme to maximize seed yield.

Table 3. Main effects of nitrogen, phosphorus and cultivar on seed yield and yield components of sunflower (winter 2000/2001).

Treatment	Head Diameter (cm)	Number of seeds per head	1000-seeds weight (g)	Empty seeds percentage	Seeds yield (t/ha)
Nitrogen (kg/ha)					
Control	14.08 b	1426.50 d	66.96 c	10.97 a	2.58 c
43	14.78 b	1662.69 c	69.24 bc	11.38 a	2.81 c
86	15.83 a	1807.25 a	73.46 a	10.07 a	3.42 a
129	16.35 a	1746.19b	71.10 ab	9.74 b	3.14b
Phosphorus (kg P20s/ha)					
Control	14.78	1262.00	67.32	12.20	2.84
43	15.73	1695.31	73.07	8.87	3.14
Cultivar					
Rodio	14.95	1658.53	68.36	12.37	2.76
Hysun 33	15.56	1662.78	72.02	8.70	3.22

Means followed by the same letter(s) within columns are not significantly different at 0.05 probability level according to Duncan's Multiple Range Test (DMRT).

Table 4. Main effects of nitrogen, phosphorus and cultivar on seed yield and yield components of sunflower (summer 2001).

Treatment	Head Diameter (cm)	Number of seeds per head	1000-seeds weight (g)	Empty seeds percentage	Seeds yield (t/ha)
Nitrogen (kg/ha)					
Control	13.74 c	1456.89 d	69.45 c	9.35	2.77 c
43	14.96 b	1753.50 c	74.02 b	10.14	3.12b
86	15.98 a	1800.19b	76.77 a	10.67	3.30 b
129	16.14 a	1930.06 a	75.98 ab	11.83	3.42 a
Phosphorus (kg P20s/ha)					
Control	14.93	1710.22	73.26	10.60	3.08
43	15.48	1760.00	74.86	10.94	3.23
Cultivar					
Rodio	15.27	1824.59	70.29	11.69	3.12
Hysun 33	15.14	1645.63	77.83	9.31	3.18

Means followed by the same letter(s) within columns are not significantly different at 0.05 probability level according to Duncan's Multiple Range Test (DMRT).

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