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Performance of Sunflower (*Helianthus annuus* [L.]) as Affected by NPK Rates and Sowing Dates in Sudan Savanna Region of Borno State, Nigeria

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Abstract: *Field experiment was conducted to study the performance of sunflower (*Helianthus annus*.) as affected by NPK rates and sowing dates in Maiduguri, Sudan savannah region of Borno state. The trial was conducted during the wet seasons of 2021 at the Teaching and Research Farm of Department of Agricultural Technology, Ramat Polytechnic Maiduguri (11 59' N, 13 16' E). The experiment consisted of four sowing dates: 29th June, 9th July, 19th and 29th July of 2018 and 2019 and six rates of NPK: 0:0:0 KgNPK/ha, 25:12.5:7.5 KgNPK/ha, 50:25:15 KgNPK/ha, 75:37.5:22.5 KgNPK/ha, 100:50:30 KgNPK/ha and 125:62.5:37.5 KgNPK/ha. The treatments were laid out in a split plot design and replicated three times. Sowing dates were allocated to the main plots and NPK rates to the sub plots. Growth, yield and yield components: plant height, leave area, number of leaves, days to first flowering, days to 50% flowering number of heads/plant, head diameter, dry weight/head, number of grains/head, 1000 grain weight, yield (kg/ha); as well as oil quality parameters: % oleic, % linoleic, % palmitic, % stearic and % myristic were measured. The results indicated that first sowing date of 29th June gave significantly the highest plant height, leave area and number of leaves/plant as well as yield and yield parameters except for days to: first flowering and 50% flowering. The last sowing of 29th July favoured early flowering and days to 50% flowering. The sowing of 29th June (first planting) was also best for oil quality parameters. The NPK rate of 100:50:30 KgNPK/ha was found to be optimum for all the growth, yield and yield parameters measured except for days to: first flowering and 50% flowering. The supply of 0:0:0 KgNPK/ha favoured early flowering and days to 50% of plants with flowers. Also the supply of 100:50:30 KgNPK/ha was optimum for oil quality parameters. The combination of 29th July planting with 100:50:30 KgNPK/ha was optimum for yield and yield components. Thus from the results of the present study farmers could be encouraged to plant sunflower around 29th July and supplied with 100:50:30 KgNPK/ha to get optimum yield and oil quality is recommended.*

Keywords: *Sunflower, NPK, Sowing, Borno, Rates*

INTRODUCTION

Sunflower (*Helianthus annuus* [L].) belongs to the family *Compositae* and it's of temperate origin though it is now grown under different climatic conditions. The place of origin of sunflower is still under contention but it was first domesticated in Central United States of America (Summons, 1976). It was introduced into Europe from America in the 16th century and to Russia in the 18th century. Hurt (1946) further reported that sunflower grains were found to exist in archeological sites of American Indians as food stuff, dated 300 years before the cultivation of corn and it is now grown in the tropics and subtropical countries from

latitude 55°N (Purseglove, 1968). It is mainly cultivated in the Sudan, guinea and derived savanna regions of Nigeria with monomodal rainfall pattern (Olowe *et al.,* 2005). However, due to its high potentials, its cultivation is now rapidly expanding in other agro-ecological zones of Nigeria. Sunflower grows best on well drained, loam and sandy loam soil with high organic matter content. It is essential that the rain should be evenly distributed during its early growing period although its efficient tap root system enables it to grow in areas where soils are relatively dry for many crops to perform. Sunflower grows well within a temperature range of 20-25 ^{o} C but under controlled condition, reports indicated 27-28 ^{o} C as optimum. Tolerance of 8-34 ^{o} C by sunflower indicated its adaptation to the regions with warm days and cold nights. Prolonged high temperature reduces the time of maturity and high temperature is known to affect the seed oil content, seed and oil characteristics. In general, temperature above 25 ^{o} C at flowering reduces seed yield and its oil content. Low temperatures below 16 ^{o} C can also reduce seed set and oil content (Prasad *et al.*, 2001). Sunflower was developed first as important commercial oil seed crop in the former Soviet Union (FSU). The oil has gained wide spread acceptance as a high quality, edible oil throughout the world. In 1981-1982 USSR was ranked first with 4.69 million metric tones annually followed by Eastern Europe with 2.25 million metric tones. USA was third with 2.04 million annual metric tones followed by Argentina, China, France, Spain and others with total annual world production figure of 14.82 million metric. In 1986-1987, USSR was ranked first with 5.26 million metric tones followed by Eastern Europe with 2.56 million metric tones, Argentina with 2.50, France with 1.90 million metric tone, China with 1.54, USA with 1.26 million metric tones, followed by Spain and other countries; and the total world production was 19.25 million metric tones. In 1991-1992, USSR was ranked fist with average production figure of 5.65 million metric tones, followed by, Argentina with 3.30 million metric tones, France with 2.56 million metric tones, Eastern Europe with 2.19 million metric tones, USA with 1.64 million metric tones, China and Spain with 1.10 and 0.90 million metric tones, respectively and the total world production was 20.67 million metric tones (Zhera 2011). In 2013, world production of Sunflower was 44.5 million metric tones. Ukraine was ranked first with 11.0 million metric tones followed by Russia with 10.6 million metric tones. Argentina was third with 3.1 million metric tones followed by China and Romania with 2.4 and 2.1 million tones respectively (FAOSTAT, 2013). In Africa, Tanzania is the leading producer with annual grain production of 20,000 tones, and this is followed by Kenya and Zimbabwe (Zhera 2011). However, Adebayo *et al.,* (2012) mention that there was a clear upward trend in sunflower cultivation in Nigeria, there is no statistical data on its production tonnage up to present time in the country. Sunflower is an important oil crop in the world particularly because of its very low oil cholesterol. It is a new crop in the semi arid environment of Nigeria and suitable agronomic practices for its production, most importantly the nutrient requirements, in this environment is yet to be fully established. Farmers in this zone depend mostly on inorganic fertilizers to produce crops. The inorganic fertilizers are expensive, yet the little that is acquired is not used appropriately. Thus the present study will attempt to establish the most optimum (NPK) rate and suitable sowing date for the crop in order to step up its productivity in the semi arid environment.

MATERIALS AND METHODS

Description of the Experimental Site

The experiments were conducted during the wet seasons of 2018 and 2019 at the Teaching and Research Farm, Department of Agricultural Technology, Ramat Polytechnic Maiduguri (Longitude 13^{o} 12' 36.02" E and Latitude 11^{o} 48' 2.32" N and on an altitude of 354 m above sea level). Maiduguri is located in the Sudan savannah region of Borno state, under a semi arid environment characterized by sparse vegetation with an average annual rainfall of 650 mm, spanning 4 – 5 months (May - September). The average temperature is 28.5^{o}C with relatively low humidity during the dry season and high humidity during the wet season.

Experimental Material

Source of NPK

The fertilizers were purchased from Borno State Agricultural Development Program (BOSADP).

Source of sunflower seeds

The sun flower seeds were purchased from Sasakawa Global 2000, Kano, Kano State

Treatments and experimental design

The experiment consist of six rates of NPK; 0:0:0 kgNPK/ha, 25:12.5:7.5 kgNPK/ha, 50:25:15 kgNPK/ha, 75:37.5:22.5 kgNPK/ha, 100:50:30 kg NPK/ha and 125:62.5:37.5 kgNPK/ha and four sowing dates; 29th June, 9th July, 19th July and 29th July. The treatments were laid out in split plot design replicated three times. Sowing dates was allocated to the main plot and NPK rates to the sub plots. The experiment covered a total land area of 840 m^2 (56 m x 15 m). The sub plots sizes were 9 m^2 (3 m x 3 m), the main plots sizes were 168m^2 (56m x 3m), and the alleys between main plots and sub plots were 1m apart. The inter and intra row spacing was 75 cm x 25 cm, respectively and data were not collected on plant at outmost rows in the sub plots. Thus the net plot was 5.62m^2

Cultural Practices

Land preparation

The experimental site was cleared and harrowed. The land was then properly leveled and the beds marked out according to specification in 3.4.3 above. The edge of each of the bed was raised to prevent fertility drift.

Sowing and fertilizer application

The different NPK treatments as presented in 3.4.3 were obtained through the use of fertilizers presented in 3.4.1. Full dose of P and K were applied at time of planting and half dose of N was applied at time of planting and the remaining half at bud initiation stage.

Weed, pest and disease control

Weeding was done three times to control the weeds, these was manually done using hoe. Pest and diseases were monitored and controlled appropriately.

Collection of Data
Data for growth yield and quality parameters were measured and recorded as follows:

Plant height (cm)
Five plants were randomly selected from the net plots and tagged. The tagged plants were measured using meter rule from the ground level up to the apex at 4, 6, 8 and 10 WAS; Average plant height for each plot was recorded.

Number of leaves per plant
This was also taken from the five tagged plants in 3.6.2 above. Only green and photosynthetically active leaves were counted and this was done at 4 WAS and continued at 6, 8 and 10 WAS. The average for each plot was recorded.

Leave area per plant (cm^2)
Leave area was taken at 4, 6, 8 and 10 WAS from each plot (tagged plants). It was measured using grid method by taking ten leaves at random from the net plots and leaves were placed on a graph paper and traced using pencil. The number of full and half squares covered by each leave was counted and their average was evaluated as leaf area per plant (Pal and Murari, 1985).

Days to flowering
This was determined by regular field inspection and recording number of days taken from sowing to the attainment of first flowering in each plot.

Days to 50% flowering
This was obtained by daily field inspection and recording the total number of days taken for 50% plant population to attainment of flowering from the date of sowing.

1000-grain weight (g)
This was obtained at harvest by random selection of 1000 grains which was obtained from net plots and weighed on an electronic balance.

Grain yield per hectare (g)
The heads of all plants from net plots was collected, threshed and weighed after winnowing to obtain grain yield per net plot area and the value was converted to yield per hectare for each plot as follows:

$$\text{Grain yield ha}^{-1} = \frac{\text{Grain weight (t ha}^{-1})}{\text{Net plot area (m}^2)} \times 10{,}000\ \text{m}^2$$

Analysis for oil fatty acid contents (%)

The various fatty acid profiles (oleic, linoleic, palmetic and steric acids) of the oil will be analysed using oil and fats extraction by trans-esterification method as determined by Hamilton and Rosselle (1986).

Data Analysis

All data recorded was subjected to analysis of variance (ANOVA) using statistical package, "statistix" 8.0, and the difference between treatment means was identified using Duncan's multiple range test (DMRT) at 5% level of probability. (Duncan,1955)

Results and Discussions

Table 1: Effect of Sowing Dates and NPK Rates on Plant Height (cm) of Sunflower.

Sowing Dates (A)	4WAS	6WAS	8WAS	10WAS
29th June	15.15[a]	39.32[a]	110.18[a]	160.79[a]
9th July	14.66[a]	36.57[b]	98.62[b]	146.66[b]
19th July	13.71[b]	30.50[c]	88.54[c]	138.57[c]
29th July	13.56[b]	30.96[c]	88.72[c]	127.31[d]
SE ±	0.36	0.40	0.97	1.82
NPK Rate (B)				
0:0:0	9.26[e]	19.46[e]	47.40[c]	85.53[c]
25:12.5:7.5	11.80[d]	27.80[d]	67.74[d]	110.12[d]
75:37.5:22.5	15.08[b]	37.02[b]	110.30[b]	150.75[b]
100:50:30	17.59[a]	45.93[a]	132.04[a]	192.79[a]
125:62.5:37.5	18.15[a]	46.88[a]	134.04[a]	196.25a
SE ±	0.33	0.55	1.75	3.77
Interaction				
A x B	**	**	**	**

Means followed by the same letter(s) within a column are not significantly different at 5% level of probability (p≤ 5%) according to Duncan Multiple Range Test

Table 2: Interaction Effect of Sowing Dates and NPK Rates on Plant Height (cm) of Sunflower.

Sowing Dates (A)		NPK Rates	4WAS	6WAS	8WAS	10WAS
29th June	X	0:0:0	11.17[jl]	29.97[g]	67.73[i]	121.00[el]
29th June	X	25:12.5:7.5	13.33[ht]	36.10[a]	93.20[fg]	143.83[ed]
29th June	X	50:25:15	15.07[fg]	38.60[c]	104.00[e]	130.43[e]
29th June	X	75:37.5:22.5	16.50[be]	44.40[b]	123.43[d]	179.03[b]
29th June	X	100:50:30	19.37[a]	54.30[a]	152.90[a]	244.80[a]
29th June	X	125:62.5:37.5	20.77[a]	56.03[a]	154.5[a]	248.07[a]
9th July	X	0:0:0	7.90[m]	11.20[i]	22.97[i]	25.27[k]
9th July	X	25:12.5:7.5	9.00[i]	14.97[o]	34.87[k]	41.24[jo]
9th July	X	50:25:15	15.50[eg]	38.90[c]	107.07[e]	132.00[c]
9th July	X	75:37.5.22:5	16.10[ef]	44.90[b]	124.50[d]	174.30[b]
9th July	X	100:50.30:	17.63[b]	45.73[b]	147.20[b]	237.50[a]
9th July	X	125:62.5;37.5	19.30[a]	43.167[b]	149.43[ab]	233.33[a]
19th July	X	0:0:0	8.17[a]	15.67[hi]	33.37[k]	75.93[i]
19th July	X	25:12.5:7.5	10.73[ki]	24.47[g]	54.90[i]	113.60[fg]
19th July	X	50:25:15	11.77[k]	17.67[h]	55.33[i]	65.60[i]
19th July	X	75:35.5:22.5	13.20[hi]	24.23[g]	86.97[gh]	96.67[h]

19th July	X	100:50:30	7.33^{bd}	35.17^{c}	135.53^{c}	186.57^{b}
19th July	X	25:62.5:37.5	17.53^{bc}	44.97^{d}	137.37^{c}	188.63^{b}
29th June	X	0:0:0	9.83^{i}	25.03^{g}	65.53^{i}	119.93^{eg}
29th June	X	25:12.5:7.5	13.33^{hi}	35.67^{d}	88.20^{fgh}	141.80^{ed}
29th June	X	50:25:15	12.63^{ij}	28.60^{f}	83.67^{h}	131.93^{de}
29th June	X	75:38/5:22.5	14.53^{gh}	34.57^{d}	106.30^{e}	153.00^{c}
29th June	X	100:50:30	15.16^{eg}	30.60^{ef}	93.20^{fg}	105.57^{gh}
29th June	X	125:62.5:37.5	15.90^{df}	31.30^{e}	94.37^{f}	11.63^{fg}
SE ±			0.66	1.11	3.40	7.50

Means followed by the same letter(s) within a column are not significantly different at 5% level of probability (p≤ 5%) according to Duncan Multiple Range Test

Table 3: Effect of Sowing Dates and NPK Rates on Leaves Area of Sunflower.

Sowing Dates (A)	4WAS	6WAS	8WAS	10WAS
29th June	34.24^{a}	70.51^{a}	143.12^{a}	366.41^{a}
9th July	30.26^{b}	67.16^{b}	135.75^{a}	345.08^{b}
19th July	27.13^{c}	51.66^{c}	110.28^{c}	279.42^{c}
29th July	16.95^{d}	44.72^{d}	97.68^{d}	194.82^{d}
SE ±	4.30	0.69	0.50	4.45
NPK Rate (B)				
0:0:0	8.72^{c}	23.56^{c}	73.43^{c}	149.00^{c}
25:12.5:7.5	12.05^{c}	34.62^{d}	88.06^{d}	196.34^{d}
50:25:15	16.90^{c}	56.30^{c}	111.06^{c}	253.42^{c}
75:37.5:22.5	33.30^{b}	68.60^{b}	123.22^{b}	337.47^{b}
100:50:30	45.85^{a}	85.60^{a}	169.98^{a}	418.95^{a}
125:62.5:37.5	55.05^{a}	86.39^{a}	170.48^{a}	423.42^{a}
SE ±	4.89	1.21	1.39	4.88
Interaction				
A x B	**	**	**	**

Means followed by the same letter(s) within a column are not significantly different at 5% level of probability (p≤ 5%) according to Duncan Multiple Range Test

Table 4: Interaction Effect of Sowing Dats and NPK Rates on Leaves Area of Sunflower.

Sowing Dates (A)	NPK Rates	4WAS	6WAS	8WAS	10WAS
29th June X	0:0:0	12.07^{gf}	33.03^{g}	117.33^{j}	250.97^{f}
29th June X	25:12.5:7.5	15.47^{fg}	48.20^{h}	138.63^{h}	314.57^{gh}
29th June X	50:25:15	21.63^{fg}	78.43^{f}	136.30^{g}	370.07^{f}
29th June X	75:37.5:22.5	45.80^{bd}	90.40^{c}	171.27^{e}	512.50^{d}
29th June X	100:50:30	63.47^{ab}	102.80^{ab}	231.97^{ab}	671.50^{a}
29th June X	125:62.5:37.5	97.77^{a}	111.23^{a}	237.03^{a}	661.13^{a}
9th July X	0:0:0	7.47^{g}	11.07^{i}	14.80^{r}	14.27^{a}
9th July X	25:12.5:7.5	6.57^{g}	13.77^{i}	17.73^{r}	19.57^{n}

9th July X	50:25:15	22.33^{fg}	80.00^{ef}	164.67^{f}	400.13^{e}
9th July X	75:37.5.22:5	46.43^{bd}	92.20^{c}	178.43^{d}	539.37^{c}
9th July X	100:50.30:	62.60^{be}	100.97^{b}	211.57^{c}	605.50^{b}
9th July X	125:62.5;37.5	63.07^{bc}	105.00^{b}	227.30^{b}	619.13^{a}
19th July X	0:0:0	7.47^{g}	18.73^{k}	54.47^{o}	109.60^{i}
19th July X	25:12.5:7.5	11.57^{fg}	30.10^{j}	70.40^{n}	156.57^{k}
19th July X	50:25:15	7.67^{g}	18.73^{k}	28.53^{q}	32.73^{mn}
19th July X	75:35.5:22.5	42.33^{ce}	28.40^{j}	37.27^{f}	45.00^{m}
19th July X	100:50:30	43.53^{be}	100.97^{b}	136.37^{h}	304.40^{gh}
19th July X	25:62.5:37.5	11.67^{fg}	105.00^{b}	138.63^{h}	317.97^{g}
29th June X	0:0:0	10.90^{fg}	31.43^{g}	107.13^{k}	221.17^{j}
29th June X	25:12.5:7.5	14.60^{fg}	46.43^{h}	125.47^{i}	294.67^{h}
29th June X	50:25:15	16.00^{fg}	48.07^{B}	94.53^{i}	210.73^{h}
29th June X	75:38.5:22.5	29.33^{df}	63.40^{g}	103.93^{k}	253.00^{i}
29th June X	100:50:30	15.00^{fg}	38.00^{ii}	76.03^{m}	94.40^{i}
29th June X	125:62.5:37.5	15.87^{fg}	41.00^{i}	78.99^{m}	94.97^{i}
SE ±		9.7	2.42	2.78	9.76

Means followed by the same letter(s) within a column are not significantly different at 5% level of probability (p≤ 5%) according to Duncan Multiple Range Tes

Table 5: Effect of Sowing Dates and NPK Rates on Number of Leaves of Sunflower.

Sowing Dates (A)	4WAS	6WAS	8WAS	10WAS
29th June	5.85^{a}	8.90^{a}	15.55^{a}	21.95^{a}
9th July	5.42^{b}	8.51^{b}	14.32^{b}	20.49^{b}
19th July	5.37^{b}	8.42^{b}	14.68^{b}	19.19^{c}
29th July	5.17^{b}	8.09^{c}	13.97^{c}	18.96^{d}
SE ±	0.11	0.12	0.14	0.29
NPK Rate (B)				
0:0:0	2.91^{c}	5.12^{c}	9.30^{c}	13.98^{c}
25:12.5:7.5	3.77d^{c}	6.36^{d}	11.38^{d}	16.10^{d}
50:25:15	4.95^{c}	7.41^{c}	12.73^{c}	18.60^{c}
75:37.5:22.5	6.10^{b}	9.42^{b}	15.85^{b}	20.96^{b}
100:50:30	7.40^{a}	11.27^{a}	19.97^{a}	26.60^{a}
125:62.5:37.5	7.44^{a}	11.29^{a}	20.03^{a}	25.65^{a}
SE ±	0.14	0.19	0.21	0.27
Interaction				
A x B	**	**	**	**

Means followed by the same letter(s) within a column are not significantly different at 5% level of probability (p≤ 5%) according to Duncan Multiple Range Test

Table 6: Interaction Effect of Sowing Dates and NPK Rates on Number of Leaves of Sunflower.

Sowing Dates (A)		NPK Rates	4WAS	6WAS	8WAS	10WAS
29th June	X	0:0:0	3.47^{i}	6.07^{a}	10.00^{ij}	16.73^{hb}
29th June	X	25:12.5:7.5	40.40^{b}	6.97^{gh}	12.27^{g}	18.70^{h}
29th June	X	50:25:15	5.07^{fg}	7.87^{ef}	13.37^{cf}	21.00^{ag}
29th June	X	75:37.5:22.5	6.50^{a}	9.87^{cd}	17.37^{ef}	23.57^{d}
29th June	X	100:50:30	7.80^{a}	11.73^{a}	21.73^{a}	28.83^{a}
29th June	X	125:62.5:37.5	7.60^{a}	11.47^{d}	21.17^{d}	28.17^{ab}
9th July	X	0:0:0	2.40^{k}	4.23^{i}	8.23^{b}	9.67^{a}
9th July	X	25:12.5:7.5	3.17^{ij}	5.47^{k}	10.20^{a}	11.70^{ab}
9th July	X	50:25:15	5.20^{af}	7.93^{af}	14.73^{d}	22.00^{c}
9th July	X	75:37.5.22:5	6.70^{cd}	10.10^{c}	18.03^{c}	24.10^{d}
9th July	X	100:50.30:	7.63^{a}	11.63^{a}	21.43^{d}	26.07^{c}
9th July	X	125:62.5;37.5	7.47^{ab}	11.20^{ab}	19.57^{b}	27.33^{b}
19th July	X	0:0:0	2.60^{jk}	4.33^{i}	9.20^{i}	13.33^{i}
19th July	X	25:12.5:7.5	3.37^{i}	6.27^{jk}	11.20^{h}	13.37^{k}
19th July	X	50:25:15	4.53^{gh}	6.50^{hj}	11.16^{h}	13.03^{i}
19th July	X	75:35.5:22.5	5.47^{ef}	8.43^{e}	13.13^{g}	14.93^{k}
19th July	X	100:50:30	7.47^{ab}	11.17^{ab}	19.57^{b}	25.63^{c}
19th July	X	25:62.5:37.5	7.30^{ac}	11.30^{ab}	21.50^{c}	28.27^{ab}
29th June	X	0:0:0	3.20^{ij}	5.87^{k}	9.80^{ij}	16.20^{ij}
29th June	X	25:12.5:7.5	4.17^{h}	6.77^{gh}	11.87^{gh}	18.63^{h}
29th June	X	50:25:15	5.03^{fg}	7.37^{gh}	12.17	18.37^{h}
29th June	X	75:38/5:22.5	5.73^{e}	9.30^{d}	14.73^{d}	21.27^{ef}
29th June	X	100:50:30	6.87^{bd}	10.63^{dc}	17.37^{c}	19.97^{g}
29th June	X	125:62.5:37.5	7.27^{bc}	11.13^{ab}	17.30^{c}	20.73^{fg}
SE +			0.28	0.39	0.43	0.55

Means followed by the same letter(s) within a column are not significantly different at 5% level of probability (p≤ 5%) according to Duncan Multiple Range Test

Results from this experiment revealed the effects of sowing dates and NPK rates on plant height, leave area and number of leaves of sunflower in Maiduguri. Planting on 29th June which represents earliest planting, gave significantly tallest plants, largest leave area and most number of leaves in Maiduguri. The least plant height, leave area and number of leaves was obtained from 29th July late planting (last planting) at the end of sampling period [10 weeks after sowing (WAS)]. The 100:50:30 and 125:62.5:37.5 KgNPK/ha produced the tallest plants, leave area and number of leaves than other NPK treatment rates and are not statistically different from each other in both years and combined mean at all stages of sampling. Thus the 100:50:30 KgNPK/ha. The least plant height, leave area and number of leaves was obtained at NPK rate of 0:0:0 KgNPK/ha by the end measurement period (10WAS). There was significant interaction between planting dates and NPK rates on plant height of sunflower. The earliest planting (29th June) in combination with 100:50:30 or 125:62.5:37.5 KgNPK/ha gave significantly taller plants, larger leave area and most number

of leaves at all stages of sampling than the other treatment combinations. Baghdadi *et al*., (2014) and Ahmed *et al*., (2015), reported that vegetative parameters of sunflower increased with first sowings and higher ammonium nitrates and decreased when there was a delay in sowing date and decrease in inorganic fertilizer rates. Lawal *et al*., (2011) and Soleymani *et al*., (2013) also reported that maximum plant height, number of leaves per plant and leave area was obtained at early sowing supplied with higher inorganic nutrients supplied.

Table 7: Effect of Sowing Dates and Different in NPK Rates on Days to First Flowering and Days to 50% Flowering of Sunflower.

	Days to First Flowering	Days to 50% Flowering
Sowing Dates (A)		
29th June	51.61[a]	58.48[a]
9th July	48.33[b]	54.59[b]
19th July	45.88[b]	50.33[c]
29th July	45.11[d]	50.33[c]
SE ±	0.27	0.24
KgNPK HA (B)		
0:0:0	45.58[E]	48.50[c]
25:12.5:7.5	42.25[d]	51.08[d]
50:25:15	46.83[c]	53.00[c]
75:37.5:22.5	48.41[d]	54.41[b]
100:50:30	51.08[a]	56.66[a]
125:62.5:37.5	51.25[a]	57.58[a]
SE ±	0.21	0.27
Interaction		
A x B	**	**

Means followed by the same letter(s) within a column are not significantly different at 5% level of probability (p≤ 5%) according to Duncan Multiple Range Test

Table 8: Interaction Effect of Sowing Dates and NPK Rates on Days to First Flowering and Days to 50% Flowering of Sunflower.

			Days to First Flowering	Day to 50% Flowering
Sowing Dates (A)		NPK Rates		
29th June	X	0:0:0	49.66[f]	57.66[fg]
29th June	X	25:12.5:7.5	50.56[h]	60.66[e]
29th June	X	50:25:15	51.66[g]	61.33[e]
29th June	X	75:37.5:22.5	51.56[fg]	63.33[d]
29th June	X	100:50:30	57.00[a]	65.00[b]
29th June	X	125:62.5:37.5	57.00[a]	66.33[a]
9th July	X	0:0:0	42.66[i]	48.33[k]
9th July	X	25:12.5:7.5	45.33[k]	58.33[f]
9th July	X	50:25:15	53.33[d]	60.00[e]
9th July	X	75:37.5.22:5	55.00[be]	63.00[d]
9th July	X	100:50.30:	56.00[ab]	63.6[cd]
9th July	X	125:62.5;37.5	56.00[b]	64.56[bc]
19th July	X	0:0:0	36.00[o]	34.66[a]
19th July	X	25:12.5:7.5	37.33[n]	34.33[m]
19th July	X	50:25:15	45.00[k]	46.00[b]
19th July	X	75:35.5:22.5	46.00[k]	47.33[k]
19th July	X	100:50:30	52.00[de]	56.66[g]

19th July	X	25:62.5:37.5	54.00[d]	56.66[g]
29th June	X	0:0:0	33.56[e]	35.00[p]
29th June	X	25:12.5:7.5	35.33[o]	37.00[o]
29th June	X	50:25:15	47.33[j]	48.00[i]
29th June	X	75:38.5:22.5	48.33[i]	50.66[g]
29th June	X	100:50:30	49.66[gh]	58.33[i]
29th June	X	125:62.5:37.5	49.66[gh]	57.55[i]

Means followed by the same letter(s) within a column are not significantly different at 5% level of probability (p≤ 5%) according to Duncan Multiple Range Test

Table 9: Effect of Sowing Dates and Different in NPK Rates on 1000 Grain Weight (g) and Yield (kg/ha) of Sunflower.

	1000 grain weight(g)	Yield (kg/ha)	
Sowing Dates (A)			
29th June	64.73[a]	400.16[a]	
9th July	59.39[a]	386.55[b]	
19th July	53.83[c]	301.53[c]	
29th July	36.68[d]	231.24[d]	
SE ±	0.64	3.94	
KgNPK HA (B)			
0:0:0	21,51[e]	168.09[c]	
25:12.5:7.5	3187[d]	251.00[d]	
50:25:15	39.85[c]	291.61[b]	
75:37.5:22.5	62.19[b]	361.45[b]	
100:50:30	85.69[a]	456.94[a]	
125:62.5:37.5	86.84[a]	464.13[a]	
SE ±	0.71	6.53	
Interaction			
A x B	**	**	**

Means followed by the same letter(s) within a column are not significantly different at 5% level of probability (p≤ 5%) according to Duncan Multiple Range Test

The effects of sowing dates and NPK rates on days to first flowering and days to 50% flowering of sunflower shows that planting on 29th July, which is the last planting gave significantly earliest days to first flowering and days to 50% flowering. The longest days to first flowering and days to 50% flowering was obtained from 29th June early planting (first planting). The earliest days to first flowering and days to 50% flowering was obtained at NPK rate of 0:0:0 KgNPK/ha. The 100:50:30 and 125:62.5:37.5 KgNPK/ha took longer days to first flowering and days to 50% flowering than the other NPK treatment rates and are not statistically significant from each other. There was significant interaction between planting dates and NPK rates on days to first flowering and days to 50% flowering of sunflower. The last planting (29th July) in combination with 0:0:0 KgNPK/ha gave significantly shortest days to first flowering and days to first flowering.

Table 10: Interaction Effect of Sowing Dates and Different NPK Rates on 1000 Grain Weight and Yield of Sunflower

		1000 grain weight (g)	Yield ($KgHa^{1}$)
Sowing Dates (A)	NPK Rates		

29th June	X	0:0:0	25.27^{ho}	68.60^{no}
29th June	X	25:12.5:7.5	28.90^{m}	85.27^{n}
29th June	X	50:25:15	29.53^{m}	211.53^{i}
29th June	X	75:37.5:22.5	37.60^{k}	268.6^{k}
29th June	X	100:50:30	123.27^{a}	676.4^{a}
29th June	X	125:62.5:37.5	123.35^{a}	686.6^{a}
9th July	X	0:0:0	10.70^{g}	116.5^{n}
9th July	X	25:12.5:7.5	14.53^{g}	120.5^{m}
9th July	X	50:25:15	57.97^{i}	431.7^{f}
9th July	X	75:37.5.22:5	85.20^{f}	549.0^{d}
9th July	X	100:50.30:	104.4^{c}	603.9^{c}
9th July	X	125:62.5;37.5	107.5^{b}	624.5^{b}
19th July	X	0:0:0	35.07^{i}	277.7^{k}
19th July	X	25:12.5:7.5	47.83^{j}	385.7^{h}
19th July	X	50:25:15	48.00^{j}	397.5^{gh}
19th July	X	75:35.5:22.5	75.10^{g}	496.2^{c}
19th July	X	100:50:30	90.23^{e}	416.5^{g}
19th July	X	25:62.5:37.5	92.20^{d}	427.2^{f}
29th June	X	0:0:0	15.03^{q}	41.57^{p}
29th June	X	25:12.5:7.5	27.53^{mn}	56.6^{op}
29th June	X	50:25:15	18.90^{p}	141.5^{m}
29th June	X	75:38.5:22.5	84.23^{o}	206.6^{i}
29th June	X	100:50:30	34.57^{i}	315.2^{j}
29th June	X	125:62.5:37.5	64.23^{a}	355.0^{i}
SE ±			1.43	13.0

Means followed by the same letter(s) within a column are not significantly different at 5% level of probability (p≤ 5%) according to Duncan Multiple Range Test

Table 11: Effect of Sowing Dates and Different NPK Rates on Fatty Acids of Sunflower.

Sowing Dates (A)	Oleic (%)	Linoleic(%)	Palmitic (%)	Stearic (%)	Myristic(%)
29th June	0.058	0.63	8.87	7.32	0.07
9th July	0.061	0.62	8.02	6.68	0.06
19th July	0.038	0.59	6.46	5.03	0.04
29th July	0.025	0.44	5.95	4.80	0.03
SE ±					
KgNPK HA (B)					
0:0:0	0.023	0.40	5.54	4.81	0.03
25:12.5:7.5	0.027	0.47	5.93	4.09	0.04
50:25:15	0.039	0.51	6.22	5.22	0.05
75:37.5:22.5	0.048	0.56	7.60	5.97	0.05
100:50:30	0.061	0.64	8.81	6.99	0.07
125:62.5:37.5	0.060	0.62	8.78	7.01	0.06
SE ±	0.001	0.03	0.35	0.14	0.003
Interaction					
A x B	NS	NS	NS	NS	NS

Means followed by the same letter(s) within a column are not significantly different at 5% level of probability (p≤ 5%) according to Duncan Multiple Range Test

The effects of sowing dates and NPK rates on 1000 grain weight, yield and oil quality of sunflower indicates that early planting on 29th June (first planting date) gave significantly the heaviest 1000 grain weight, highest yield and best oil quality than the other planting dates.

The least 1000 grain weight, yield and oil quality was obtained from 29th July late planting (last planting). The 100:50:30 and 125:62.5:37.5 KgNPK/ha significantly produced the greater 1000 grain weight, yield and oil quality than the other NPK rates and are not statistically different from each other. There was significant interaction between planting dates and NPK rates on 1000 grain weight, yield and oil quality of sunflower had no interaction because it was non significant statistically. The earliest planting (29th June) in combination with 100:50:30 or 125:62.5:37.5 KgNPK/ha gave significantly greater 1000 grain weight, yield and oil quality in both years and combined mean. The application of fertilizers consisting of nutrients like nitrogen, phosphorus and potassium can increase sunflower growth and yield (Sandras, 2006; Prasad, *et al,* 2002 and Kho, 2000); and N, P and K ratio in soil is an important indices in crop production, and balanced application of fertilizer therefore is important for optimum performance of sunflower. Quality characters like oil yield, protein, fatty acids and carbohydrate contents of sunflower grain are all influenced by NPK; inorganic fertilizer application (Abou-Bakr and Omar, 1996). Total protein, nitrogen and oil contents of sunflower grain have significantly increased with increased nitrogen and phosphorus interaction and farm yard manure (Singh *et al.,* 1996), Muhammad (2006) found higher percentage protein and oleic acid of sunflower grain with combined application of 50-75 kg N, P_2O_5/ha, respectively and 50 kg K_2O ha $^{-1}$.

Conclusion

Based on the results obtained in this study, it can be concluded that early planting of 29th June with supply of 100:50:30 KgNPK/ha is best for sunflower production in the study area.

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