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Full Length Research Paper

Effect of planting time on sunflower (*Helianthus annuus* L.) productivity in Ibadan, Nigeria

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Planting at appropriate time leads to good crop yield; hence the need for detailed investigation on optimum planting dates of sunflower (a vital oil seed crop). Experiments were therefore conducted to determine the appropriate planting time of two cultivars of sunflower in Ibadan. Two cultivars of sunflowers, "Funtua and Isanka", as main plot were subjected to five weekly planting dates (WPD) as subplot between August 13 and September 10 in 2004 and seven WPD between July 21 and September 1 in 2005 arranged in split plot layout in randomised complete block design with three replications at the Teaching and Research Farms, University of Ibadan. Nitrogen, phosphorus and potassium were applied as basal treatment based on soil test results. Vegetative, reproductive and yield parameters were collected to assess the influence of the treatment combinations on productivity of sunflower. Data collected were analysed using ANOVA and means were separated with $LSD_{(0.05)}$. Planting date significantly affected all the growth and yield parameters including oil yield. As planting was delayed, seed and oil yields declined (2,513 kg/ha and 1,077 L/ha, respectively when planted on August 13 as against 1,234 kg/ha and 528 L/ha, seed and oil yields respectively, at September 10 planting) in 2004. Similar trend was observed in 2005; but there was a significant reduction in yield (815 kg/ha and 349 L/ha, respectively when planted on July 21 as against 216 kg/ha and 92 L/ha seed and oil yields, respectively, at September 1 planting) due to change in rainfall distribution (climate) during growth period. The luxuriant growth of those planted late did not translate to seed yield because there was not enough water during the seed filling stage of growth. The two cultivars had similar agronomic qualities and consequently no significant influence on all the yield parameters. Late July till mid August is the best planting time for optimum sunflower seed and oil yields in Ibadan. However, for successful planting, farmers must rely heavily on meteorological weather forecast most especially that the world is experiencing climatic change phenomenon.

Key words: Sunflower, cultivar, planting date, oil yield, rainfall.

INTRODUCTION

Sunflower, a temperate crop which has been found to fit well into Nigeria farming systems (Ogunremi, 1979a) was introduced to Nigeria as an alternative oil crop to existing oil crops. Robinson et al. (1975) reported that one of the world most important annual crops grown for edible oil is sunflower (*Helianthus annuus* L) together with soyabeans, peanut and rapeseed. Sunflower, an oil seed with good quality (drying oil and low cholesterol) and high oil content (38%), matures within 90 to 120 days (Ogunremi, 1988). Grown as a fodder crop for livestock feeding, the cake of the seed after oil extraction is rich in protein and could supply 50% of protein requirement of laying chicken without significantly reducing egg production (Smith, 1965). The excellent pale yellow oil from the seed can also be used in the manufacture of soap, vanishes and as lighting oil in addition to its major use for cooking. Sachan and Singh (1977) have found the oil to have a potential value as fuel in diesel motor. Robertson and Morrison (1977) observed that the oil remains liquid at lower temperature, an advantage over olive oil and the best for margarine production.

Sunflower has a deep tap root and very large lateral spread of surface roots (Purseglove, 1968). The roots

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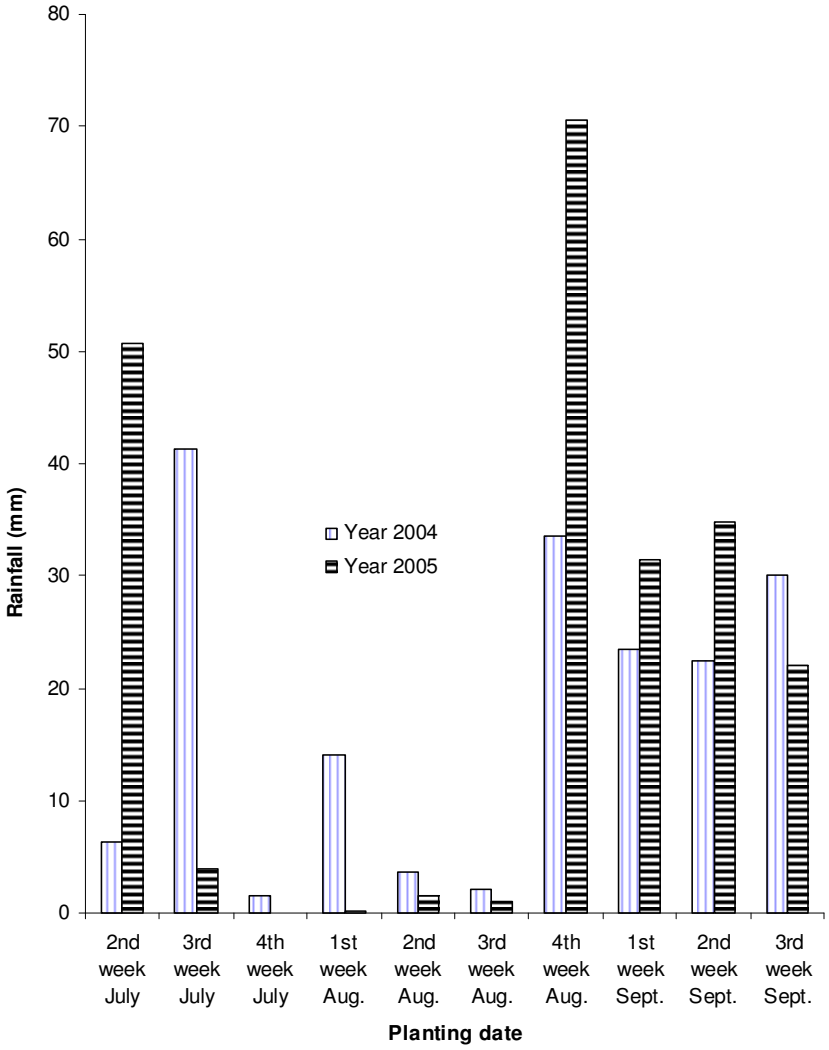

Figure 1. Weekly rainfall distribution during the planting period (IITA, 2004, 2005).

absorb water and nutrients from depth not reached by maize and form better canopy than maize (Shivaramu and Shivashamka, 1994). It takes up large amount of nutrients over a short period and the uptake is affected by many ecological factors namely soil water relationship, weather, nutrient supply and other soil factors (Chapman et al., 1993). Sunflower replenishes soil nutrients quickly, grows better on alluvial and black soil than on lateritic soil and prefers pH range of 6.8 to 8.0 and did poorly on acidic soils. Ogunremi (1979b) observed that each cultivar of sunflower has different best sowing dates in southern Nigeria, referred to as cultivar and sowing dates interaction. For instances, he reported that as a late season, crop "Peredovik" produced its best yield when sown in early July whereas "Russians Giant" yielded most when sown during the first week of August. He also noted that high humidity during seed filling should be avoided. Planting date exerted significant influence on vegetative traits along with yield and its component (Allam et al., 2003). Esechie (1994) observed that late planting delayed emergence, flowering and maturity in Islero and *Upsol veraflor* hybrid of sunflower. In Florida, lateness in planting have been observed to reduce yield of sunflower achene and even the distribution of oleic and linoleic acid content in the oil (Robertson and Green, 1981). This contribution reports the effect of climatic change on sunflower productivity and the best planting date for the two varieties cultivated in Nigeria.

MATERIALS AND METHODS

Two cultivars of sunflower, "Isanka and Funtua" were planted in the late seasons of year 2004 and 2005 at the Teaching and Research Farm, University of Ibadan, Ibadan. The Isanka cultivar seed is brown with white stripes while the seed of Funtua cultivar is dark in colour. The rainfall distribution data during planting period for the two years were collected and presented in Figure 1. On the same site, in the first year, five different planting dates at weekly intervals were tried, namely August 13, 20, 27 and September 3 and 10.

Table 1. Physico-chemical properties of soil from the experimental sites at Ibadan.

Property	Year	
	2004	2005
pH (H_2O, 1:1)	6.7	6.7
Organic C (g/kg)	16.1	12.3
Total N (g/kg)	1.2	1.0
Available P (mg/kg)	9.9	8.5
Exchange cation (cmol/kg)		
Ca^{2+}	0.5	0.5
Mg^{2+}	0.9	1.2
K^{+}	0.5	0.2
Na^{+}	0.3	0.5
Exchange acidity (cmol/kg)	0.6	0.8
ECEC (cmol/kg)	2.7	3.2
Sand (g/kg)	830.0	826.0
Silt (g/kg)	74.0	76.0
Clay (g/kg)	96.0	98.0
Textural class	Loamy sand	Loamy sand

ECEC, Effective cation exchange capacity.

Based on the results of the first year, seven planting dates; July 21, 28, August 4, 11, 18, 25, and September 1 were chosen in the second year. These translated to 10 treatments (2 cultivars by 5 planting dates) in the first year and 14 treatments (2 cultivars by 7 planting dates) in the second year. Planting in the late season was picked in reference to earlier works by Ogunremi (1988) and Fagbayide (1995). It is worth noting that in year 2005, the normal rain break between the bimodal rainfall patterns extended towards August ending. Commencement of rainfall in the last week of August led to adding September 1 planting date, because it was originally designed to terminate at August 25 as the last planting date.

The plots were disc ploughed, harrowed, and laid out in split plot designed in randomized complete block design (RCBD) with planting date as sub-plot and cultivar as main-plot. Surface soil (0-15 cm) samples collected from the plots were air-dried and sieved with 2 mm sieve and analysed for physico-chemical properties (Table 1). Two to three seeds per hole were planted at 30 by 60 cm plant spacing on 2.7 by 3 m treatment plot size, giving 60 plant stands per treatment plot. Based on the results of soil analysis, visual observation on the field during the first year and as guided by Ogunremi (1986, 1988) and Fagbayide (1995), fertilizer treatments of 90 kgN/ha, 40 kg P/ha and 72 kg K/ha were applied during the two years. Agronomic data collected were plant height, stem girth, number of leaves, days to flowering, number of flowers, head diameter, head weight, seed yield, percentages oil content and oil yield. The oil was extracted using soxylet extractor while oil yield was obtained as a product of seed yield and percentage oil content. Data collected were subjected to analysis of variance and means obtained were compared using the least significant difference at 5%.

RESULTS AND DISCUSSION

The laboratory analysis of results of soil sampled from the field revealed that 0.12 and 0.10% nitrogen and 9.88 and 8.48 ppm phosphorus in both years respectively, were below the critical values recommended by Uponi and Adeoye (2000). Hence, the application of nitrogen at 100 kg N/ha (Ogunremi, 1986) using urea and phosphorus at 40 kg P/ha, (Fagbayide, 1995) using SSP. From the results, potassium appeared to be adequate but scorching on the leaves (suspected to be potassium deficiency symptom) necessitated application of potassium at 72 kg K/ha (Fagbayide, 1995), which restored the green colour of the leaves.

Rainfall distribution during the planting period in 2004 was relatively even compared with 2005. In 2004, poor seed yield from the two planting dates in September led to shifting of the planting dates to span between third week in July (July 21) and first week in September (September 1) in 2005. Indeed, September planting date would not have been added but prolonged rain break, which ended during last week in August 2005, necessitated adding September planting date; probably the yield might differ from what was obtained in 2004. The severity of rain break in 2005 was so pronounced that those planted in fourth week in July (July 28) and first week in August (August 4) did not germinate until third and second week after sowing respectively. The mean temperature during the planting periods (July-September) ranged between 24-25°C and rose to about 27°C during maturity (November-December) in both years (Table 2). Harvesting was a bit delayed in 2005 on account of the higher relative humidity compared with that of the earlier year 2004, so as to take the advantage of dry season in both years which eliminated cost of manual sun drying as recommended by Fagbayide (1995).

Plant height, number of leaves and stem girth

Table 2. Monthly rainfall, mean temperature and mean relative humidity for the period of the experiments, 2004-2005.

Month	Rainfall (mm)		Mean temperature (°C)		Mean relative humidity (%)	
	2004	2005	2004	2005	2004	2005
January	35.3	0.0	26.7	26.3	61.4	47.3
February	16.3	38.1	28.0	29.3	60.5	60.2
March	11.1	89.9	29.2	28.4	58.1	67.5
April	209.2	185.2	27.4	28.6	75.1	69.5
May	143.6	176.6	26.8	27.0	78.7	77.0
June	172.1	256.8	25.1	25.2	79.8	83.2
July	191.3	168.6	24.5	24.6	84.7	85.9
August	53.4	69.1	24.1	23.8	85.0	88.8
September	87.8	246.8	25.2	25.4	78.7	83.9
October	191.8	120.1	26.1	25.9	77.9	79.5
November	8.1	3.8	27.3	27.4	69.0	73.9
December	0.0	45.7	27.1	27.9	61.0	72.9
Annual total	1,119.6	1,400.5	-	-	-	-
Annual mean	93.3	116.7	26.5	26.7	72.5	74.1

Source: IITA weather station.

(vegetative parameters) of those planted late were significantly higher than those planted early in both years. The significant difference in the aforementioned vegetative parameters could be explained by availability of adequate moisture, which enabled roots to absorb enough nutrients for plant growth. This observation is in line with the report of Pandey et al. (1984a) and Hussain et al. (1992). According to them, adequate moisture aids nutrient absorption to result in good growth response. Explaining the observation further, those planted late had access to adequate moisture from emergence through their vegetative stage and were able to develop good root system (Pandey et al., 1984); because during their growth, there was no rain break as the second rain peak period of the year (Lawson and Sivakumar, 1991) had commenced. This luxuriant growth of those planted late did not translate to seed production as rain has stopped during their seed filling stage of growth (9-11 WAP). That is, those planted early had their seed filling stage with adequate moisture compared with those planted late; as a result, they had good seed settings. This confirmed the essentiality of adequate water supply for good seed production of sunflower as reported by Hussain et al. (1992) and Malik and Ahmad (1993).

Planting date exerted significant influence ($P \leq 0.01$) on all the yield parameters except oil content while cultivar did not during both planting years; with a gross reduction in the second year compared with first year (Tables 3 and 4). Heads of those planted late were smaller with tiny seeds. In addition, looking at the heads harvested from those planted late critically, majority of the achenes, towards the centre of the head were hollow, therefore wasted away during winnowing. This explains why the ratio of seed weight to head weight (shelling percent) obtained was relatively constant, about 50% for those planted in July and August in both years. However, it was about 40% in 2004 and 30% in 2005 for those planted in September. The yield parameters, head diameter, head weight, seed yield, oil content and oil yield, obtained from the two cultivars were alike in both years. Also with regards to cultivar effect, the shelling percentage obtained was about 50% for both in the two years. Also, the reduction in seed and oil yields was about 60% for the two cultivars when the yields obtained in 2005 were compared with 2004. This observation could be explained by the effect of rainfall distribution mentioned earlier. Funtua cultivars produced mean seed yield of 1587.30 kg/ha in the first year but declined to 641 kg/ha in the second year. However, Isanka cultivar with higher seed yield, which was not significantly different from Funtua, produced 1798.94 kg/ha in first year and 645.00 kg/ha in the second year. Apparently, similar trend in reduction of oil yield during the second year was observed. The percentage reduction in seed yield corresponded with the reduction in oil yield when that of year 2005 was compared with 2004, basically, because the oil content in both years was relatively constant (36%). By implication, water stress only affected seed and oil yields but not oil content. In line with this, planting date was reported not to influence oil content percentage of Islero and *U. veraflor* hybrid of sunflower (Esechie, 1994). However on the contrary, Allam et al. (2003) reported that planting date influenced oil content of Vidoc and Euroflora hybrid of sunflower. The reduction was about 65% in both seed and oil yields for those planted in late August, while it was about 80% for those in September, comparing 2005

Table 3. Influence of planting date on yield parameters of sunflower during years 2004 and 2005.

Planting date	Parameter				
	Head diameter (cm)	Head weight (kg/ha)	Seed yield (kg/ha)	% Oil content	Oil Yield (kg/ha)
2004					
August 13	13.38	4272.49	2513.23	36.55	920.67
August 20	12.44	3796.30	1895.94	36.66	694.51
August 27	10.97	2777.78	1366.84	36.57	499.53
September 3	11.28	3359.79	1455.03	36.35	530.63
September 10	8.25	2023.04	1234.57	36.53	451.55
Mean	11.26	3245.88	1693.12	36.53	619.38
LSD $_{(0.05)}$	1.09	767.15	397.61	ns	154.54
2005					
July 21	9.25	1547.62	815.70	36.20	295.39
July 28	10.60	1679.90	837.74	36.28	302.91
August 4	8.52	1190.48	630.51	36.05	227.18
August 11	9.00	1362.44	679.01	35.94	243.96
August 18	8.27	1322.75	692.24	36.11	250.45
August 25	8.40	1322.75	630.51	35.89	226.42
September 1	4.92	701.06	216.05	35.75	77.24
Mean	8.42	1303.21	643.11	36.03	231.94
LSD $_{(0.05)}$	1.80	317.46	136.40	ns	49.26

Table 4. Influence of cultivar on yield parameters of sunflower during years 2004 and 2005.

Cultivar	Parameter				
	Head diameter (cm)	Head weight (kg/ha)	Seed yield (kg/ha)	% Oil content	Oil yield (kg/ha)
2004					
Funtua	10.90	2804.23	1587.30	36.66	583.55
Isanka	11.63	3687.25	1798.94	36.40	655.21
Mean	11.27	3245.74	1693.12	36.53	619.38
LSD $_{(0.05)}$	ns	ns	ns	ns	ns
2005					
Funtua	8.20	1283.67	641.22	35.98	230.67
Isanka	8.64	1322.75	645.00	36.09	233.20
Mean	8.42	1303.21	643.11	36.04	231.94
LSD $_{(0.05)}$	ns	ns	ns	ns	ns

yields with that obtained in 2004.

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