# Growth Response and Flower yield of Sunflower to Phosphorus Fertilization in Ibadan, Southwestern Nigeria

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**Abstract**: Sunflower is a crop with high cut flower potential that needs to be developed in Nigeria for its socio-economic values. Field studies were conducted in 2007 and 2008 cropping season at the experimental field of the Floriculture Programme, National Horticultural Research Institute, Ibadan, derived savanna ecology of Nigeria, to evaluate the effect of phosphorus (P) fertilizer application on flower yield of sunflower. Results indicated that growth and flower yield of sunflower was significantly influenced by P application. Highest plant heights (157 cm), stem girth (3.42 cm) were obtained with the application of 90 kg P $ha^{-1}$. Leaf area of 100.48 $cm^2$ was obtained with 60kgha-1application, while the highest number of leaves of 33.5 was recorded with 60 kg P $ha^{-1}$ application in 2007 and 35.11 with 30 kg P $ha^{-1}$ in 2008 respectively. However, flower diameter was highest with 60 kg P $ha^{-1}$, seed weight (406 g) and 100 seed weight (6.3 g) per plant were obtained with 30 kg $ha^{-1}$. [Report and Opinion 2010;2(4):29-33]. (ISSN:1553-9873).

**Keywords**: Sunflower, growth, flower yield, phosphorus fertilization

## 1. Introduction

Over the last decade, the popularity of sunflower as a cut flower has increased. This growing importance has extended its potential as a cut flower with the aim of diversifying its productive advantage. Sunflower (*Helianthus annus* L.) belongs to the family Asteraceae and is characterized by considerable decor ability, as production of heads varying in the different cultivars by size and color of the flower, from cream to yellow.

Sunflower is an agronomic crop that is cultivated widely throughout the world (Groove *et al* 2005). FAO, (2004) reported that the current world area under sunflower cultivation is 22.3 ml hectares, while seed production and average yield stands at 27.7 ml tons and 1.2 t $ha^{-1}$ respectively. Although statistical data on production level and hectarage in Nigeria are not available, grain yield above 1 t $ha^{-1}$ has been reported depending on cultivars planted (Olowe *et al* 2005). It is tolerant to abiotic stress such as temperature and high humidity and will grow well in any light textured, well drained sandy loam soil (Aduayi *et al* 2002, Tonev 2006).

It is mainly cultivated in the Sudan, guinea and derived savanna regions of the tropics with monomodal rainfall pattern (Olowe *et al* 2005). However, due to its potential; its cultivation is now rapidly expanding in other agro-ecological zones of Nigeria. There is a need to encourage the production of this crop in other parts of the country especially in the rain forest zone where it can be grown twice a year because of its bimodal rainfall pattern. Despite the potential of this crop, few studies on its fertility requirement have been published (Groove *et al* 2005).

The common constraint to realizing good yield in agricultural production in Nigeria as iterated by Asadu *et al* (2004), are related to low inherent fertility of soil, which is attributed to the dominance of kaolinite and montmorilonite clay, low organic matter content, high rate of nutrient loss through erosion, leaching, inappropriate cultural practices and crop removal. Fertilizer application either organic or inorganic therefore becomes a major condition towards yield increase. Phosphorus (P) is a major requirement for the growth of sunflower, its deficiency results in stunted growth, purplish discoloration of leaves. It also affects flowering, fruit formation and seed production (Aduayi *et al* 2002). Flower size is reduced to half its normal size and fruit head is decreased to one- third. Uptake of major nutrients elements by sunflower has also been reported to be facilitated when P was applied at the rate of 40-60 kg $ha^{-1}$ in the forest zone (Fagbayide and Adeoye, 1999).

The need for cut flower development in Nigeria will necessitate meaningful research into nutrient requirement of crops with potentials for cut flower production such as sunflower. This study was carried out to investigate the growth and flower yield response of sunflower to different rates of P in the southwestern part of Nigeria.

## 1. Materials and Method

Field experiments were conducted in 2007 and 2008 growing season at the experimental field of National Horticultural Research Institute, Ibadan (NIHORT) ($7^0$25”N and $3^0$52”E). The soil of the site is mainly sandy-loam. Meteorological data for the two seasons are presented in Table 1. Seeds of

sunflower (African giant) sown in June 2007 and April 2008 were transplanted at 4 weeks after sowing (WAS) on a $4m^2$ plot with spacing of 50 cm x 50 cm to give a plant population of 62500plants per hectare. N.P.K 20:10:10.was split applied at two and four weeks after transplanting to give Nitrogen (N) 60 kg N $ha^{-1}$ (9.6g/plant), Phosphorus (P) 30 kg P $ha^{-1}$ (4.8g/plant) and Potassium (P) 30 kg K $ha^{-1}$ (4.8g/plant) to the whole plots except 0 kg $ha^{-1}$ treatment. This was to supply N and K requirement of the soil. P was further supplemented by single super phosphate (SSP) (18% $P_20_5$ to give 60 kg P $ha^{-1}$ (2.67 g $plant^{-1}$) treatment and 90 kg P $ha^{-1}$ (5.33g/plant) treatment. The summations of the P rates were 0, 30, 60, 90 kg P \$ha^{-1}$ as treatments; these were laid out in a randomized complete block design (RCBD) and replicated three times.

Random samples of four plants per plot were selected and tagged for data collection. Data on growth parameters were taken at two weeks interval on the tagged plants from 3 weeks after transplanting (WAT) until anthesis. Plant height was measured using a meter rule from ground level to the terminal apex, stem girth was taken using vernier caliper from the point above ground level, leaf area was calculated using Karanja (1990) model, number of leaves and branches were counted on the plants. At maturity yield data such as head weight and 100 seed weight both on dry weight basis, number of flowers and flower diameter were also recorded.

Data collected were subjected to analysis of variance (ANOVA). Means were separated with Duncan's multiple range test ($P<0.05$ confidence level) SAS Institute 2000).

## 2. Results

### 3. 1 Soil analysis

The results of the physical and chemical analysis of the experimental site before planting are presented in Table 2. The soil was mostly sandy loam in texture with pH of 6.4 and 6.2 in 2007 and 2008, respectively. Total nitrogen of 1.2 mg $g^{-1}$ and 1.3 mg $g^{-1}$ for both years and available P of 1.10 mg $kg^{-1}$ and 1.95 mg $kg^{-1}$ are inadequate. The exchangeable acidity ($H^+$) of 0.08 and 0.06 c mol $kg^{-1}$, and organic carbon of 9.8 mg $g^{-1}$ and 11.1 mg $g^{-1}$ are very low(Aduayi 2002).

### 3. 2 Growth attributes

Growth parameter values were generally higher in 2007 than 2008 (Table 3). Results indicated that phosphorus (P) application resulted in increase in sunflower plant height, stem girth and number of leaves. Gradual increase in growth parameters was observed throughout the growing period of sunflower in all the P levels over control. Number of leaves (35.11) was highest in 2008 with 30 kg $ha^{-1}$ while leaf area (100.48$cm^2$), reached its peak with 60 kg $ha^{-1}$. Stem girth of sunflower was significantly affected by P levels, in both years of study; maximum value of 3.42cm was obtained for this parameter with 90 kg $ha^{-1}$ application. Phosphorus application was not significant on sunflower height in 2007, but was significant ($P<0.05$) in 2008. In both years of study 90kgha-1 had the highest plant height.

### 3.3 Yield and yield components

Flower diameter was significantly ($P<0.05$) affected by P levels, its value increased with increasing P levels up to 60 kg P $ha^{-1}$ in both years of study. Head weight values for both years increased significantly from 0 kg P $ha^{-1}$ (control) to 30 kg P $ha^{-1}$ application, Generally, flower diameter, head weight and 100seed weight increased significantly with P application compared to the control (Table 4). 30 kg P $ha^{-1}$ recorded the highest head weight (296.7 g) and 100 seed weight (6.07 g) for 2008.

Table 1: Weather data of experimental site for 2007 and 2008

| Months | Total rainfall (mm) | | Evaporation | | Max Temp $^oC$ | | Air Temp $^oC$ | | R humidity (%) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2007 | 2008 | 2007 | 2008 | 2007 | 2008 | 2007 | 2008 | 2007 | 2008 |
| Jan | 0.0 | 0 | 5.6 | 5.6 | 36 | 33 | 25 | 25 | 71 | 77 |
| Feb | 0.0 | 20 | 6.0 | 6.7 | 37 | 37 | 29 | 27 | 88 | 81 |
| Mar | 17 | 89 | 6.3 | 5.7 | 40 | 34 | 29 | 28 | 86 | 68 |
| Apr | 69 | 182 | 6.1 | 5.7 | 35 | 33 | 29 | 28 | 89 | 89 |
| May | 237 | 234 | 5.2 | 5.3 | 33 | 31 | 28 | 29 | 90 | 89 |
| Jun | 223 | 373 | 5.3 | 4.8 | 31 | 30 | 26 | 27 | 91 | 89 |
| Jul | 255 | 250 | 4 | 4.6 | 30 | 28 | 25 | 26 | 91 | 90 |
| Aug | 139 | 221 | 4 | 3.9 | 29 | 28 | 25 | 25 | 92 | 90 |
| Sep | 286 | 402 | 4.3 | 5.9 | 31 | 29 | 26 | 26 | 91 | 90 |
| Oct | 245 | 275 | 5.0 | 5.2 | 32 | 32 | 27 | 27 | 91 | 88 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Nov | 132 | 27 | 4.1 | 4.9 | 33 | 34 | 27 | 27 | 91 | 88 |
| Dec | 3 | 27 | 4.7 | 4.4 | 34 | 33 | 27 | 27 | 87 | 87 |

Table 2: Pre-cropping physical and chemical properties of the soils used for the study

| Soil property | 2007 | 2008 |
|---|---|---|
| pH | 6.4 | 6.2 |
| Sand mg $g^{-1}$ | 810 | 770 |
| Clay mg $g^{-1}$ | 36 | 56 |
| Silt mg $g^{-1}$ | 154 | 174 |
| Ca cmol $kg^{-1}$ | 2.95 | 1.80 |
| Mg cmol $kg^{-1}$ | 0.89 | 0.74 |
| Na cmol $kg^{-1}$ | 0.46 | 0.35 |
| K cmol $kg^{-1}$ | 0.35 | 0.21 |
| Exch. Acidity | 0.08 | 0.06 |
| CEC me/100g | 4.73 | 3.16 |
| % Base Sat | 98.31 | 98.10 |
| C mg $g^{-1}$ | 9.8 | 11.1 |
| N mg $g^{-1}$ | 1.2 | 1.3 |
| Av. P mg $kg^{-1}$ | 1.10 | 1.95 |
| Cu mg $kg^{-1}$ | 0.39 | 0.34 |
| Zn mg $kg^{-1}$ | 1.31 | 1.18 |
| Fe mg $kg^{-1}$ | 7.55 | 6.15 |
| Mn mg $kg^{-1}$ | 39.90 | 45.45 |

Table 3: Effects of phosphorus (P) on vegetatitive growth of sunflower grown in Ibadan, southwestern Nigeria.

| Treatment (kg N $ha^{-1}$) | MEAN Plant height (cm) | Stem girth (cm) | Number of leaves | Leaf area ($cm^2$) |
|---|---|---|---|---|
| 2007 | | | | |
| 0 | 130.8a | 2.10b | 29.0b | 73.28b |
| 30 | 154.4a | 2.69ab | 32.5a | 93.94ab |
| 60 | 143.2a | 2.72a | 33.5a | 100.48a |
| 90 | 157.1a | 3.42a | 30.0b | 84.01b |
| 2008 | | | | |
| 0 | 60.6b | 1.53b | 32.83a | 71.08b |
| 30 | 66.5b | 1.99a | 35.11a | 91.74ab |
| 60 | 71.6b | 1.91a | 31.67a | 98.28a |
| 90 | 88.1a | 2.12a | 29.5a | 81.81a |

Means represented by same letter along same column are not significantly different

**Table 4: Effect of phosphorus (P) on yield parameters of sunflower grown in Ibadan, southwestern, Nigeria**

| Treatment (Kg N $ha^{-1}$) | Flower diameter (cm) | | Head weight (g) | | 100 seed weight (g) | |
|---|---|---|---|---|---|---|
| | 2007 | 2008 | 2007 | 2008 | 2007 | 2008 |
| 0 | 13.45c | 11.36c | 228.7c | 188.3b | 4.02b | 4.00c |
| 30 | 19.14a | 17.10a | 406.4a | 296.7a | 4.79b | 6.07a |
| 60 | 20.24a | 18.89a | 295.1b | 276.7a | 4.58b | 5.43b |
| 90 | 16.55b | 14.40b | 289.2b | 251.7a | 6.34a | 5.73b |

Means represented by same letter along same column are not significantly different

4. **Discussion**

The native fertility status of the soil used for the study is very low in major nutrient elements particularly phosphorus as revealed by the pre plant soil test (Aduayi *et al* 2002). The conditions of soil used for the study are similar to those used by poor resource farmers that grows oil crop such as sunflower in the tropics (Weiss, 1983). Therefore there is a probability of getting economic response with addition of fertilizer.

The importance of supplemental P fertilizer in enhancing sunflower yield has been well documented (Muralidharudu *et al*., 2003). Because further increases in yield (flower diameter) diminish with further increases in the amount of fertilizer P beyond 60kg$ha^{-1}$, the efficiency of nutrient utilization declines as yield increases (Muralidharudu *et al*., 2003).

In this study, the increase in growth parameters values as P increased up to 60kg$ha^{-1}$ agrees with the findings of Muralidharudu *et al* (2003) in sunflower, Adebayo *et al* (2008) in marigold, Haggai (1996) and Anwulu *et al.,* (2006) in sesame who reported that application of P significantly affected growth characters of these plants and further suggested that this might be attributed to the P stimulating effect on root growth and expansion. The decrease in growth parameters beyond this rate also confirm the report of Anwulu *et al* (2006) and Desmukh (1990) working on sesame flower, and Adebayo *et al* (2008) on marigold who observed same trend when applying P beyond 75 kg P $ha^{-1}$ and 60 kg P $ha^{-1}$ respectively

The higher head yield observed in 2007 could probably be as a result of better plant establishment, lower rainfall and effective utilization of applied nutrient during the period of study in 2007. This trend was also observed in marigold (Adebayo *et al* 2008) and tomato (Alasiri and Odeleye 2001). The response of sunflower fertilized with phosphorus at a lower rate, suggest that P could increase yield of sunflower especially when the P level in the soil is sub optimal.

However, further research is required to determine whether addition of lower or higher amounts of P will consistently support yield. This would discourage excessive mineral fertilizer application which may not necessarily lead to income reduction for farmers. This result agrees with Olowe (2005) and also similar to Fagbayide and Adeoye, (1999) who reported 40 kg P $ha^{-1}$ to be adequate for grain yield production in sunflower in the forest zone of Nigeria. Although the increase in yield up to 60 kg P $ha^{-1}$ are similar to earlier studies, it could be concluded that for cut flower production where flower diameter is the main yield and target, 60 kg P $ha^{-1}$ which recorded the highest value (20.24cm) is considered optimum for cut flower production of Sunflower in Southwestern Nigeria.

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