ISSN 2278 – 0211 (Online)

Effect of Environmental Factor on the Seed Yield and Oil Content of Sunflower (*Helianthus Annuus L*)

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Abstract:

A field experiment was conducted on a Farm in Ekiti South-West Nigeria (Lat.7°37'23 N and log 5°13'15E with 1440 ft. above sea level) to evaluate the performance of two Sunflower genotypic varieties (SAMSUN 1 and SAMSUN 2) as affected by the geographical location and abiotic factors. Soil analysis result showed pH of 5. During the vegetative stage, 61cm was recorded as the highest plant height for SAMSUN 1 and 46cm was recorded as the highest plant height for SAMSUN 2. The number of leaves of SAMSUN 1 was 28 and 24 for SAMSUN 2 after 84days of planting. 1.8cm was recorded as the final stem diameter for SAMSUN 1 and 1.6cm for SAMSUN 2. Harvesting of seeds was carried after 124days of planting; the seed yield for SAMSUN 1 was 3.74kg and 2.96kg for SAMSUN 2. Proximate analysis on the seeds showed that SAMSUN 1 contained 5.88% moisture, 1.58% ash, 7.10% crude protein, 3.35% fat and 3.35% crude fiber while SAMSUN 2 contain 4.37% moisture, 2.05% ash, 6.45% crude protein, 4.16% fat and 4.16% crude fiber. Oil extraction was carried out on the seeds of the Sunflower using a Soxhlet apparatus and n- hexane as the extraction solvent. 400ml and 460ml of sunflower oil were recorded for the two varieties respectively. The oil composition analysis showed that SAMSUN 1 contained 5.37% moisture, 0.74% ash and 11.91% crude protein and SAMSUN 2 contained 7.12% moisture, 0.72% ash and 13.93% crude protein. The result of the experiment was compared with that from the northern region of Nigeria where it is predominately cultivated. It can be concluded after the whole experiment that sunflower will give more yield and oil in the northern region of Nigeria.

Keywords: Sunflower, abiotic factor, ph, proximate analysis, protein, fat, crude fiber

1. Introduction

Sunflower is an annual plant of the family *Asteraceae* with America as its origin (Hamed et al., 2012). Sunflower (*Helianthus annuus L.*) occupies the fourth position among vegetable oilseeds after soybean, oil palm and canola in the world (Rodriguez et al., 2002; Ahmad et al., 2011). Per 100 g, the seed enclose protein up to 20.78 g, total lipid (fat) up to 51.46 g, ash up to 3.02 g, and fiber up to 8.6 g with total energy of 2445 kJ. The oil accounts for 80% of the value of the Sunflower crop, as contrasted with Soybean which derives most of its value from the meal (Hamed et al., 2012). The major goal of growing Sunflower is for its seed (achene) that contains oil (36–52%) and protein (28–32%) as reported by Rosa et al., (2009). There are two types of Sunflower seeds produced: oilseed and confectionary. Sunflower seeds can be sun dried or roasted and used as a medicine in South America. Mainly, there are three types of Sunflower oil available, namely Mid-Oleic, Linoleic and High Oleic Sunflower oil. They all have different oleic levels, making the uses for Sunflower oil vast. (Schild et al., 1991) The crop has been receiving steady attention by various scientists from diverse disciplines in recent past because Sunflower oil is a premium oil and is widely used in the diets of patients with cardiovascular diseases as it contains very low cholesterol and high (90%) unsaturated fatty acid concentration (Flagella et al., 2002; Qahar et al., 2010). Lately, there has been a steady increase in its demand globally because of the health risks posed by conventional method of production (Yiridoe et al., 2005). Compared to other edible oils, Sunflower oil has not been in wild circulation except in foreign countries. Sunflower is under-utilized in Nigeria because fewer farmers cultivate it, some farmers doubt that Sunflower will grow and the seeds are not even available (presently in Nigeria Sunflower seeds can only be gotten from Institute for Agricultural Research A.B.U Zaria) and only cultivated in the northern region of Nigeria (Showemimo et al., 2010). The above established importance of Sunflower justifies and rekindles the interest of National Institute with the genetic mandate of Sunflower improvement, Institute for Agricultural Research (IAR) of Ahmadu Bello University (ABU),

Zaria to intensify Sunflower improvement, adaptation, registration and release to Nigerian farmers so as to compliment the short fall in vegetable oil production (Showemimo et al., 2010) this study was carried out to ascertain the effects of the environment on the growth of *Helianthus annuus* (Sunflower) and to determine the suitability of the two Sunflower genotypes for breeding work.

2. Materials and Methods

2.1. Experimental Site

The experiment was carried out on a farm in Ado-Ekiti, Ekiti State, a rainforest region of Nigeria with coordinate Lat 7°37'23 N and log 5°13'15E with 144m above sea level.

2.2. Seeds and Seed Origin

The seeds used for the experiment were SAMSUN 1 and SAMSUN 2. SAMSUN 1 which was a Sunflower variety with an old name of Vniimk 8883 (SSL 803) and it originated from Romania while SAMSUN 2 was a Sunflower variety which originated from Canada, it was formally called Chernanka 66 (SSL 806). The seeds were gotten from the Institute for Agricultural Research (IAR), Ahmadu Bello University (A.B.U), Zaria Nigeria with coordinate Lat. 11°5'7.9476" N and Log 7°43'11.8020" E and elevation of 2,103 ft. above sea level.

2.3. Type of Soil

The soil used for the experiment was a Sandy Loam soil. Soil analysis test was done to elucidate the soil composition

2.4. Replication and Harvesting

Three (3) replications of 50 stands each were planted for each Sunflower variety. The seed were planted at the depth of 2cm with inter and intra-row spacing of 70cm by 30cm. The seeds were harvested 124 days after planting. Harvesting was done manually. Manual harvesting is practiced by cutting the umbel containing the seeds of the plant with a knife. The cleaning process followed immediately after harvesting. This involves hand picking of stones and dirt accumulated during the harvesting process.

2.5. Data Collection and Analysis

Data were collected every two weeks on the plant height, stem diameter and the number of leaves. The agronomic data from the two plant varieties were analyzed mathematically USING IBM SPSS 21 (Paired Samples Test)

2.6. Oil Extraction and Determination of Vitamins

Oil was extracted from the grounded samples of the seed using extraction solvent (n-hexane) in a Soxhlet apparatus. After the extraction process, SAMSUN 1 gave 400ml of oil and SAMSUN 2 gave 460ml of oil.

2.6.1. Determination of Vitamin A

A weighed sample of the oil containing not more than 1g fat and at least 240 units of vitamin A was mixed with 30ml absolute ethanol and 3ml of 5% potassium hydroxide. The mixture was boiled gently under reflux for 30 minutes in a steam of oxygen free nitrogen. It was allowed to cool down and 30ml of water was added after which it was transferred to a separator. It was then washed with three (3) times 50ml ether and the vitamin A was extracted by shaking it for 1 minute, after complete separation, the lower layer was discarded and the extract was washed with 50ml water. The extract was washed and evaporated to 5ml and the remaining ether was removed in a steam of nitrogen at room temperature. The residue was dissolved in sufficient isopropyl alcohol to give a solution. The extinction was measured at 300, 310, 325 and 334nm and the wavelength of maximum absorption (Pearson, 1975).

2.6.2. Determination of Vitamin E

1g of the sample was weighed into a 100ml flask fitted with a reflux condenser, to which 10ml of absolute ethanol was added with 20ml of 1M alcoholic Sulphuric acid. It was then refluxed for 45minutes and allowed to cool down. 50ml of water was added and then transferred to a separating funnel of low actinic glass with additional 50ml of water. The unsaponifiable matter present was extracted with five (5) times 30ml diethyl ether, and the extract was evaporated at low temperature. While protecting from sunlight, the residue was dissolved in 10ml absolute alcohol, then the standard and the sample were transferred to a 20ml volumetric flask and 5ml of absolute alcohol was added followed by 1ml concentrated Nitric acid. The flask was placed in water bath at 900°C for 3minutes. The flask was cooled under running water and the volume was made up to 20ml with absolute alcohol. The absorbance was measure at 470nm. (Pearson, 1975)

2.6.3. Determination of Vitamin C

The vitamin C content was determined using the ascorbic acid as the reference compound. 200µl of the extract was pipetted and mixed with 300 µl of 13.3% Trichloroacetic acid (TCA) and 75µl 2,4-dinitrophenylhydrazine (DNPH). The mixture was incubated at 370 °C for 3hrs and 500 µl 65% H₂SO₄ was added and the absorbance was read at 520nm. (Benderitter et al., 1998).

2.6.4. Determination of Vitamin K

The procedure for color development as adopted from Menotti's procedure. The solution in which the concentration of vitamin K was being determined was placed in a flask and sodium pentacyanoamineferroate reagent was added. The solution was stirred and then allowed to stand for fifteen minutes to allow maximum color development. When the blue color has developed, the absorption of the solution was measured by means of a spectrophotometer at 650nm

2.7. Proximate Analysis

2.7.1. Moisture

The moisture content of the sample was determined using air oven (AOAC, 2000). The petri dishes were washed and dried in air oven. The dishes were then transferred into the desiccator which allowed cooling. The weights of the petri dishes were measured. 3g of sample was weighed into a dry petri dish and the contents were transferred into an oven maintaining a temperature of 105°C. The content was allowed to dry at this temperature for 6hrs. The petri dish with its content was removed from the oven and placed in the desiccator. After cooling, the weight was measured, after drying to constant weight. The percentage moisture was calculated using the following equation:

$$\text{Moisture \%} = \frac{\text{Initial sample weight (g)} - \text{dry sample weight (g)} \times 100}{\text{Total weight}}$$

2.7.2. Ash

Clean crucibles were ignited at 350°C for about 15mins, cooled in a desiccator and weighed. 1g of each sample was transferred into each of the appropriately labelled crucibles and then reweighed. Then, the crucibles with their contents were transferred into the muffle furnace at 550°C for about 5hours. After complete ashing, the crucibles were allowed to cool in a desiccator and then reweighed. The percentage of ash was then calculated using the formula,

$$\text{Ash content (\%)} = \frac{\text{Weight of crucible with ash (g)} - \text{Weight of empty crucible (g)} \times 100}{\text{Weight of sample (g)}}$$

2.7.3. Crude Protein

Crude protein of the samples was estimated using Kjeldahl procedure. A sample of 0.5 g and a blank was estimated in the digestion tube. For digestion at high temperature, 10 ml of concentrated H₂SO₄ and 1.1 g digestion mixture were added in the tube. The digestion tubes were then set in digestion chamber fixed at 420°C for 45 minutes ensuring water supply, easier gas outlets etc. After digestion the tubes were allowed to cool and 5ml of Sodium thio-sulphate (Na₂S₂O₃, 33%) and 30 ml Sodium hydroxide (NaOH) solution were added in each tube. Then the distilled extraction was collected with 25ml of Boric acid (4%) and titrated with standard HCl (0.2N). The Nitrogen values obtained was converted into percentage of crude protein by multiplying with a factor of 6.25 assuming that protein contains 16% nitrogen.

$$\% \text{ Nitrogen} = \frac{\text{Milliequivalent of nitrogen (0.014)} \times \text{Titrant value (ml)} \times \text{Strength of HCL} \times 100}{\text{Sample weight (g)}}$$

$$\% \text{ Crude protein} = \% \text{ Nitrogen} \times 6.25$$

2.7.4. Crude Lipid

Crude lipid was determined by extracting a weighed quantity (3g) of samples with analytical grade acetone in ground joint Soxhlet apparatus. Extraction was allowed to continue by heating in the electric heater at the temperature 70°C until clear acetone (without oil) was seen in siphon, which took about 3 hours. Then the round bottom flask of the apparatus was separated and the extract was transferred to a pre-weighed beaker and left for evaporation of acetone. After the evaporation of acetone, only the lipid was left in the beaker and the crude lipid was calculated in percentage thus,

$$\% \text{ Crude lipid} = \frac{\text{Weight of beaker with lipid} - \text{Weight of empty beaker} \times 100}{\text{Weight of sample (g)}}$$

2.7.5. Crude Fiber

A small amount of finely grinded sample (2g) was taken into a filter crucible and was inserted into the hot extraction unit (Hot Extractor, Model-1017). Pre-heated 0.128M of H₂SO₄ was added into the reagent heating system and few drops of alcohol (C₈H₁₈O) were added through the valves. The mixture was digested for 30 minutes. Acid was then removed from it by filtering and washing with boiling water. The residue in the flask was boiled with 0.223M of potassium hydroxide (KOH) for 30 minutes and then filtered with subsequent washing in boiling water and acetone. The residual content was then dried in an oven at 105°C for a few hours and then ignited in muffle furnace at 550°C for 3 hours. The loss of weight represented the crude fiber. Then percent crude fiber was calculated by the following formula,

$$\text{Crude fibre (\%)} = \frac{\text{Oven dried weight of sample (g)} - \text{Ash weight of sample (g)} \times 100}{\text{Weight of sample (g)}}$$

2.7.6. Minerals

The minerals were analyzed from the solution obtained by the first seed dry ashing. 1g of each sample was placed in a crucible and placed in a muffle furnace at 550°C for 5 hours to ash and then transferred into desiccators to cool. The cooled ash was dissolved in 10% HCl, filtered into a clean graduated sample bottles and the solution was made up to 50ml with distilled water. The solution was aspirated into the atomic absorption spectrophotometer to obtain the mineral concentration.

3. Result and Discussion

3.1. Seed Description

After harvesting, the seeds of the Sunflower were measured in kilogram using a measuring scale. Weight per 100 seeds of SAMSUN 1 (803) was 6g while Weight per 100 seeds of SAMSUN 2 (803) was 6g. The total weight of harvested SAMSUN 1 and SAMSUN 2 seeds was 3.74 kg and 2.96 kg respectively.

3.2. Agronomic Performance

An overall agronomic performance that was observed on the two different Sunflower varieties SAMSUN 1 and SAMSUN 2 between December 2017 and April 2018 presented in table 1 below and figure 1 to 6 shows that there was a significant variation between the two varieties of sunflower. At the end of the experiment, the overall results show that the height of SAMSUN 1 and SAMSUN 2 were statistically significant as the probability level of 0.001 was lower than the critical value of 0.05. Likewise the number of leaves on both plants was significantly different with p-value of 0.004 lower than the critical value of 0.05. The same conclusion goes for the size of the stem as the p-value of 0.044 was less than the critical value of 0.05.

Paired Samples Test									
		Paired Differences					T-test	Degree of Freedom	Sig. (2-tailed)
			Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Mean				
Pair 1	Height of S1 and Height of S2	9.37222	9.21698	2.17246	4.78873	13.95572	4.314	17	0.001
Pair 2	Leaf on S1 and Leaf on S2	-0.77778	1.51679	0.35751	-1.53206	-0.0235	-2.176	17	0.044
Pair 3	Stem of S1 and Stem of S2	0.07778	0.15168	0.03575	0.00235	0.15321	2.176	17	0.044

Table 1: Paired Samples Test

Figure 1: 14 Days after Planting

Figure 2: 14 Days after Planting

Figure 3: 42 Days after Planting

Figure 4: 56 days after planting

Figure 5: 70 Days after Planting

Figure 6: 84 Days after Planting

SAMSUN 1 performed better during the vegetative stage when compared to SAMSUN 2 as shown in figure 7 below but when compared with the data from similar research conducted in Zaria, it was observed that environmental difference played a significant role. The average plant height recorded by Showemimo *et al.*,

(2010) showed that when planted in Zaria, the plant height was 120cm and 125cm respectively. However, when compared with the Sunflower planted in Ekiti State, the average height recorded was 61cm and 46cm respectively.

Figure 7: A Plot Showing Variation in Plant Height of SAMSUN 1 And 2

A steady increase in the number of leaves on both plants which began to decrease between the tenth and twelfth week of growth was observed as shown in figure 8 below. The average number of leaves recorded according to Showemimo *et al.*, (2010) was 20 and 24 for SAMSUN 1 and 2 while that of Ekiti State was 28 and 24 for SAMSUN 1 and 2.

Figure 8: A Plot Showing Variation in the Number of Leaves Produced by SAMSUN 1 and 2 over a Period of Time

A steady growth was also observed in the stem diameter of both SAMSUN 1 and 2.

Figure 9: A Plot Showing Slight Variation in Stem Diameters of SAMSUN 1 and 2 over a Period of Time

3.3. Vitamins

The vitamin contents of the extracted oils from SAMSUN 1 and 2 were analyzed and the result presented in table 2 below.

	VIT. A mg/g		VIT. E mg/g		VIT. C mg/g		VIT. K mg/g	
SAMSUN 1	1488.03	1484.99	2.736184	2.757264	1.632515	1.745102	0.042106	0.041915
SAMSUN 2	1809.74	1811.35	3.882936	3.904016	4.784958	4.559784	0.057967	0.058413

Table 2: Vitamin Contents of Sunflower Seed

The oil richly contains vitamin E, which prevents dangerous free radicals from oxidizing the body cholesterol; this is in line with Flagella *et al.*, 2002 and Qahar *et al.*, 2010. It also contains vitamins A, D, C which keeps the skin supple and functions as excellent face moisturizer with its antioxidant activity. This oil helps in the regeneration of skin cells and in the prevention of various body aches, (Flagella *et al.*, 2002; Qahar *et al.*, 2010).

3.4. Proximate Composition

The shafts of the two varieties SAMSUN 1 and 2 contain 7.10% and 6.45% crude protein respectively with 3.35% and 4.16% crude fat respectively, thus they can be used as animal feeds in line with the report from BIO, (2005). Due to difference in the geographical areas, the Sunflower seeds had a high moisture content of 5.88% and 4.29% for SAMSUN 1 and 2 respectively (Table 3) while that of Zaria was reported to contain 2.01% and 1.68% respectively; this is suggestive of higher rainfall in the rainforest zone of Nigeria. A decrease was also observed in the ash content and the crude fiber level of the sunflower planted in the southwest region of Nigeria in comparison with the high ash and fiber content of the sunflower planted in the northern part of Nigeria. In the nutritional composition of the oil, the crude protein recorded by Showemimo *et al.*, (2010) was 17.2% and 19.72 % for SAMSUN 1 and 2 respectively but the ecological and environmental factor in the rainforest region of Nigeria played a role by reducing the protein content of the two oils giving 11.91% and 13.92% respectively as shown in table 3 below.

Sample	Moisture content	Ash content	Crude protein
SAMSUN 1	5.88%	0.74%	11.91%
SAMSUN 2	4.29%	0.73%	13.92%

Table 3: Oil Composition

3.5. Mineral Composition

The mineral component of the seeds of SAMSUN 1 and 2 was analyzed and the result showed that SAMSUN 1 contains (in ppm) 13.600 Na, 42.200 K, 3.693 Mg, 0.625 Fe, and 1.310 Zn while SAMSUN 2 contains 15.100 Na, 37.800 K, 1.965 Mg, 0.371 Fe and 0.960 Zn.

4. Conclusion

This research study carried out has confirmed that Sunflower can be grown in Ekiti State, a rainforest zone of Nigeria. Since the plant is prone to lodging if planted during raining season, the best time to plant Sunflower is during the dry season to avoid yield lost. The proximate analysis result also revealed that the plant is rich and that it contains protein, fiber, moisture and ash. This study also showed that Sunflower has a low fat content and this is responsible for its reported uses in food preparation in different parts of the world. The presence of vitamin E which is a very powerful antioxidant also confirmed its use in preventing asthma. The plants take few months to get to maturity thus the attention

of farmers most especially in the southwest region of the country should be brought to this plant as a source of food and revenue.

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