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# Determination of Sesame Yield by Varying Irrigation Methods at Blooming Stages

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**ABSTRACT:** Most rural farmers in developing countries cultivate varieties of Sesame crops during raining season. At flowering stages, rain drops pluck most of the flowers down leading to poor yield at harvest. This might be due to wrong timing during planting. This study was carried out to determine Sesame yield by using sprinkler and drip irrigation methods at flowering stages. Sprinkler irrigation method was initially used from planting period to bloom stage in two blocks (A and B) which contains two plots each. At bloom stage, Sprinkler irrigation method continued in Block (A), while drip irrigation was used in block (B). At harvest, block (A) had a mean plant height of 72cm, number of pod per plant 450 and yield per plot of size (3.07 x 2.07m) was 200g giving a yield of 40%; while in drip irrigated plots (block B), mean plant height was 81cm, number of pod per plant were 497 and yield per plot of same size was found to be 300g giving a yield of 60%. The highest yield of Sesame seed was recorded in block (B) because there was no water drop contact with the blooms whose pressure impact could have dropped some. In sprinkler irrigation, at the bloom stage, water drops comes in contact with the blooms, pressure impacts drops some of the blooms leading to poor yield. It is recommended that farmers should be timing the planting period of Sesame so that flowering stages will start at tail end of raining season to minimize dropping of flowers by impact of rain drops.

**KEY WORDS:** Sesame seed, Blooms, Drip, sprinkler, Irrigation, Yield.

## I.INTRODUCTION

Sesame (*Sesamum indicum* L.), otherwise known as Sesamum or Benniseed, belong to the family *Pedaliaceae*, and is one of the most ancient oil seeds crop known to mankind. The major world producers are: India, Sudan, China, Burma (who contribute about 60% of the total world production) and Ethiopia,[1]. Sesame is an important agricultural crop in Nigeria; it is extensively cultivated in middle and northern Nigeria mainly as commercial crops for export [2; 3].

Sesame seeds are small, almost oblate in shape and have a mild and delicious aroma and taste. Its colour varies from white, yellow, red or brown [4]. Sesame seed is used whole in cooking and also yields sesame oil [5]. It has a rich nutty flavour (although such heating damages their healthful polyunsaturated fats) and is used mainly as a food ingredient in whole, broken, crushed, shelled, powdered and paste forms. Its use is country based, in the US; it is used as a form of whole seed product for the confection and baking industries. In Nigeria, the seeds are consumed fresh, dried, fried or when blended with sugar. It is also used as a paste in some local soups[6; 1].

A small percentage of total production is however processed into oil, meal or flour[5]. Sesame seed is approximately 50 percent oil (out of which 35% is monounsaturated fatty acids and 44% polyunsaturated fatty acids) and 45 percent meal (out of which 20% is protein) [7; 5]. [8] Analyzed and found the chemical composition of sesame to have contained oil (44-58%), protein (18-25%), carbohydrate (13.5%) and ash (5%), fiber and some minerals. The oil seed is renowned for its stability because it strongly resists oxidative rancidity even after long exposure to air [9], the protein has disable amino acid profile with good nutritional value similar to soybean[10].

Thus, as an edible vegetable oil – it usages differs in various countries. It is used as cooking oil in South India and Asia and often as a flavour enhancer in China, Japan, Korea, and to a lesser extent Southern Asia cuisine. It is stable and free from undesirable nutrition or flavour component. Benniseed oil has a natural oxidant which prevents aging and is vital for the production of liver cells [11; 10]. After the extraction of oil, the cake is mostly used for livestock feed or often as manure.

Sesame seeds are also used in traditional medicines for their nutritive, preventive and curative properties. Its oil seeds are sources for some phyto-nutrients such as omega-6 fatty acids, flavonoid phenolic anti-oxidants, vitamins and dietary fibre with potent anti-cancer as well as health promoting properties.

Sesame yields are affected greatly by poor climatic conditions. The potential for benniseed production in Nigeria is very high [12]. Estimated 3.5million hectares of the country's agricultural land are suitable for the production of

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benniseed. But the average yield of this crop is about 300 kg/ha which is four times lower than the average yield of other oil seed crops like groundnut and soybean[13; 14; 15 and 16].
The production steadily increased from 15,000 metric tons in 1960 to 50,000 metric tons in 1980 but remained at this level until recently [17; 18](Annon, 2008; NH, 2009). In order to increase the production of benniseed to take advantage of the market potentials; some practices need to be implemented by the farmers[19; 20]. In the tropics, the annual amount of rainfall ranges from 600 to 1600 mm. Climate change have drastic effect on annual rainfall and soil fertility, affect the yield of sesame on its 'normal' periods[21; 22]. The duration, amount, intensity and pattern of rainfall during blooming (flowering) stage of sesame leads to fallen off of the flowers thereby affecting the yield of sesame.
The objective of the study was to determine Sesame yield by varying irrigation method at bloom (flowering) stages in order to investigate the Sesame yield using drip irrigation at bloom stage to maturity and compare the yield with that of sprinkler irrigation (mimicking rainfall) from bloom stage to maturity.

## II. MATERIALS AND METHOD

**Experimental Plot Location**

The experiment was conducted at a demonstration field, Department of Agricultural and Environmental Engineering, University of Agriculture Makurdi, located on latitude $7.41^0$N and longitude $8.28^0$E, and 97m above sea level. The materials that were used to carry out the experiment are shown in Table (1) .

**Table 1: Materials and Uses**

| S/N | Material | Uses |
|---|---|---|
| 1 | Sesame seed | Planted seed |
| 2 | Water source | For irrigation of plots |
| 3 | Measuring tape | Measurement of leave, height, length. |
| 4 | Machete | For site clearing |
| 5 | Nozzle | For sprinkling water on crops |
| 6 | PVC pipes | For conveying water |
| 7 | West African hoe | For making ridges |
| 8 | Meter rule | For measurement |
| 9 | Graduated cylinder | For measuring amount of water |
| 10 | Hacksaw | For cutting PVC pipes |
| 11 | PVC gum | For holding the pipes together |

### A. EXPERIMENTAL PLOT

The experimental plots were laid out in two blocks (A and B). The layout was designed to be irrigated using sprinklers as block (A) and drip irrigation as block (B). Both blocks have two plots each (plot1, plot 2) and (plot 3 and plot 4) as shown in the experimental set up (Figure 1). The soil type of the experimental area was found to be sandy loam [23; 24].

### B. EXPERIMENTAL PROCEDURE

Planting was done at an inter-row spacing of 75cm and intra-row spacing of 15cm respectively [25]. The irrigation was done twice a day, (morning and evening), three times in a week. From the planting day, sprinkler irrigation was used throughout for both blocks up to bloom stage. At blooming stage, block (A) was irrigated continuously using sprinkler irrigation while block (B) was irrigated using drip system.

**Data Collection**

Data were collected and recorded during the conduct of the experiment from the following parametres .

**A. PLANT HEIGHT:** Five plants heads were selected at random from each plot and their height were measured using meter rule and their mean were recorded to obtain the weekly plant height from vegetative stage to harvest stage.

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**B. LEAF SURFACE AREA:** Five leaves were randomly selected from some selected plant stand in each plot and their mean were recorded to give the weekly leaf surface area from vegetative stage to maturity. The length and width of the leaves were measured using meter rule, and the surface area was calculated using the relation[26];

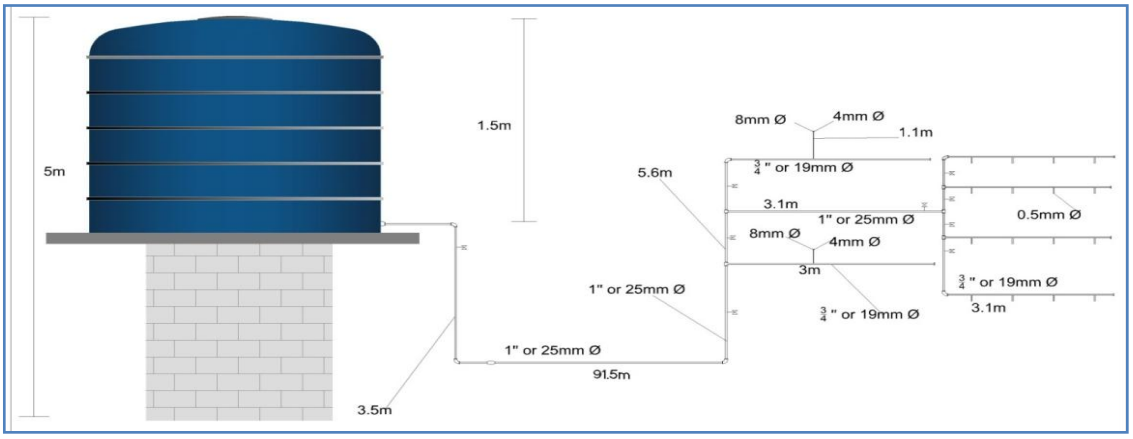


Figure.1: Design layout of the experimental irrigation plots for sesame research

Leaf Surface Area (LSA) = $\frac{3(L \times w)}{4}$ 1

Or LSA = L x W x 0.75 2

Where: L = Length of leaves (cm)
W = Width of leaves (cm)
0.75 is the coefficient
LSA = Leaf surface area ($cm^2$)

**C. BLOOMS DROPPING DURING IRRIGATION:** The blooms dropping during irrigation were counted and recorded for each plot. Five plant stands were selected randomly per plot and the numbers of pods were counted and recorded (Plate 1 ).

**D. GRAIN YIELD:** The weight of grain yield per plot was taken after threshing and winnowing of the harvested sesame by using an electric weighing balance.

## III. RESULTS AND DISCUSSION

**RESULT**

At the juvenile stage, the length and width of the leaves were measured in both block (A) and (B) and the leaf surface area were calculated and recorded as shown in Table (2) below.



**(a) Sprinkler irrigated (block A) (b) Drip irrigated (block B) (c ) Sesame pods**

**Plate 1: Irrigation of Sesame crops for various parameters studied.**

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**Table 2: Leaf Surface Area at Juvenile Stages**

| Block A | | | | Block B | | |
|---|---|---|---|---|---|---|
| Week | Length(cm) | Width(cm) | Area($cm^2$) | Length(cm) | Width(cm) | Area($cm^2$) |
| 1 | 4.5 | 0.4 | 1.35 | 5.2 | 0.5 | 1.95 |
| 2 | 5.5 | 0.8 | 3..30 | 6.5 | 1.0 | 4.88 |
| 3 | 6.7 | 1.6 | 8.04 | 7.9 | 1.4 | 8.30 |
| 4 | 8.5 | 1.8 | 11.48 | 10.0 | 1.7 | 12.75 |

At the flowering and maturity stages, the irrigation method was varied to sprinkler and drip irrigation for block (A) and block (B), the leaf surface areas were measured and the result was recorded as shown in Table (3) below.
The plant height at juvenile stage was measured and recorded as shown in Table (4) while at the bloom stages, the result were recorded as shown in Table (5).The number of blooms dropping during each irrigation time in each plot was counted and recorded as shown in table (6).The weekly number of pods per plant are shown in Table (7). After the crops were harvested, threshed and winnowed, the weight of seed yield per plot was measured and recorded using an electric weighing balance and the result were recorded as shown in Table (8).

**Table 3: Leaf Surface Area at Flowering to Maturity Stages using varied Irrigation Method**

| **Block A Sprinkler Irrigation** | | | | **Block B Drip Irrigation** | | |
|---|---|---|---|---|---|---|
| **Week** | **Length(cm)** | **Width (cm)** | **Area ($cm^2$)** | **Length(cm)** | **Width (cm)** | **Area ($cm^2$)** |
| 5 | 10.40 | 1.90 | 11.82 | 10.50 | 2.00 | 15.75 |
| 6 | 10.60 | 1.50 | 11.93 | 10.90 | 1.80 | 14.21 |
| 7 | 10.90 | 2.00 | 16.35 | 11.00 | 2.10 | 17.33 |
| 8 | 11.50 | 2.30 | 19.84 | 12.00 | 2.50 | 22.50 |
| 9 | 11.00 | 3.00 | 24.75 | 11.50 | 4.30 | 37.09 |
| 10 | 11.90 | 3.80 | 33.92 | 12.70 | 4.00 | 38.10 |
| 11 | 12.00 | 4.00 | 36.00 | 13.00 | 4.50 | 43.88 |
| 12 | 12.00 | 4.00 | 36.00 | 13.00 | 4.50 | 43.88 |

**Table 4: Weekly Plant Height at Juvenile Stage**

| **Block A Sprinkler Irrigation** | | | **Block B Drip Irrigation** | |
|---|---|---|---|---|
| **Week** | **Plot1 (cm)** | **Plot 2 (cm)** | **Plot 3 (cm)** | **Plot 4 (cm)** |
| 1 | 9 | 10 | 10 | 11 |
| 2 | 18 | 16 | 19 | 20 |
| 3 | 25 | 20 | 27 | 28 |
| 4 | 31 | 37 | 34 | 36 |

**Table 5: Weekly Plant Height from Flowering to Maturity Stages using Sprinkler and Drip Irrigation Methods.**

| **Block A Sprinkler Irrigation** | | | **Block B Drip Irrigation** | | **Mean Height(cm)** | |
|---|---|---|---|---|---|---|
| **Week** | **Plot1 (cm)** | **Plot 2 (cm)** | **Plot 3 (cm)** | **Plot 4 (cm)** | **A** | **B** |
| 5 | 42 | 39 | 45 | 49 | 41 | 47 |
| 6 | 45 | 49 | 53 | 50 | 47 | 52 |
| 7 | 51 | 60 | 55 | 58 | 56 | 57 |
| 8 | 58 | 62 | 64 | 67 | 60 | 66 |
| 9 | 68 | 65 | 79 | 77 | 67 | 78 |
| 10 | 80 | 75 | 88 | 90 | 78 | 89 |
| 11 | 108 | 115 | 125 | 129 | 113 | 127 |
| 12 | 110 | 112 | 126 | 130 | 115 | 128 |
| **Block Mean** | **70** | **73** | **80** | **81** | **72** | **81** |

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**Table 6: Blooms Dropping During Irrigation**

| Block A Sprinkler Irrigation | | | Block B Drip Irrigation | | No of Bloom Drop | |
|---|---|---|---|---|---|---|
| **Week** | **Plot1 (cm)** | **Plot 2 (cm)** | **Plot 3 (cm)** | **Plot 4 (cm)** | **A** | **B** |
| 6 | 6 | 5 | 0 | 2 | 36 | 12 |
| | 7 | 6 | 3 | 0 | | |
| | 5 | 7 | 4 | 3 | | |
| 7 | 4 | 5 | 3 | 2 | 39 | 20 |
| | 7 | 8 | 5 | 4 | | |
| | 8 | 7 | 2 | 4 | 45 | 23 |
| 8 | 7 | 6 | 5 | 3 | | |
| | 5 | 8 | 4 | 2 | | |
| | 9 | 10 | 6 | 3 | | |
| 9 | 8 | 7 | 3 | 5 | 55 | 26 |
| | 10 | 11 | 6 | 4 | | |
| | 11 | 8 | 5 | 3 | | |
| 10 | 12 | 10 | 6 | 2 | | |
| | 8 | 9 | 8 | 4 | 54 | 33 |
| | 5 | 10 | 7 | 6 | | |
| 11 | 4 | 9 | 5 | 8 | | |
| | 11 | 12 | 4 | 7 | 51 | 29 |
| | 7 | 8 | 3 | 2 | | |
| **Total Drop** | 134 | 146 | **79** | **64** | **280** | **143** |

**Table 7: Number of Pods per Plant**

| Block A Sprinkler Irrigation | | | Block B Drip Irrigation | | Total | |
|---|---|---|---|---|---|---|
| **Week** | **Plot 1** | **Plot 2** | **Plot 3** | **Plot 4** | **A** | **B** |
| 6 | 4 | 8 | 6 | 5 | 12 | 11 |
| 7 | 10 | 12 | 12 | 11 | 22 | 23 |
| 8 | 16 | 15 | 12 | 17 | 31 | 34 |
| 9 | 27 | 23 | 33 | 34 | 50 | 67 |
| 10 | 38 | 40 | 47 | 44 | 78 | 91 |
| 11 | 55 | 63 | 59 | 68 | 118 | 127 |
| 12 | 69 | 70 | 73 | 71 | 139 | 144 |
| **Total** | **219** | **231** | **247** | **250** | **450** | **497** |

**Table 8: Weight of Seed Yield and Percentage Yield per Plot**

| | Block A | | Block B | | Total (g) | |
|---|---|---|---|---|---|---|
| Harvest | Plot1 | Plot 2 | Plot 3 | Plot 4 | A | B |
| Yield(g) | 90 | 110 | 130 | 170 | 200 | 300 |
| Percentage Yield (%) | 18 | 22 | 26 | 34 | 40 | 60 |

## DISCUSSION

### A. INITIAL IRRIGATION USING SPRINKLER METHOD.

At the juvenile stage, overhead irrigation (sprinkler irrigation) method was used generally for both block A and B and the leaf surface area were measured and recorded. There was a trend in the length and width of leaves in both blocks from week 1 to week 4.

The highest leaf length (10.0cm) was measured in block A at the fourth week, which also gives the highest leaf surface area of 12.75cm$^2$. The highest leaf width (1.8cm) was measured in block B at the same week as shown in Table 6 above. There is an increase in leaf surface area from week 1 to week 4 respectively. The trend noticed in leaf surface area at juvenile stage is an indication that growing is in progress since there is an increase in length and width of the leaves. The leaf surface area at juvenile stage as shown in (Table 6) above was calculated using the formula:

Leaf surface area (LSA) $= \frac{3(L \times w)}{4}$ 3

$LSA = L \times w \times 0.75$

where,

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L = length of leaves (cm)
W = Width of the leaves (cm)
0.75 = the coefficient

Plant height at juvenile stage was measured using a meter rule, by selecting the tallest plants stand in each head per plot and the mean was recorded weekly as shown in Table 4.The growth was properly monitored and the trend observed is that block A has the highest plant height of 37cm at week 4.

**B. EFFECT OF IRRIGATION VARIATION ON GROWTH/ HEIGHT OF PLANTS FROM FLOWERING TO MATURITY.**

The plant height continued to be measured from flowering stage to maturity stages and the results were recorded as shown in Table 5. The crop started flowering at the 5$^{th}$ week, after planting. At this stage, irrigation method was varied to sprinkler and drip irrigation for block (A) and (B). Progressive plant growth was recorded from week 5 to week 11 after planting, but the growth begin to retard from week 11 to week 12 and this is an indication that the crop has fully matured and due for harvest at this stage.

The highest plant height was recorded at block (B) in plot 2(Drip irrigation method), which have the height of 130cm at week 12 and mean height of 81cm ( Figure 1), possibly because there is enough moisture conservation at the root zone of the crops. The decrease observed in sprinkler irrigation system is probably as a result of insufficient irrigation due to surface flow and high evapotranspiration rate in the area due to environmental temperature [25].

**C . EFFECT ON LEAF SURFACE AREA AT FLOWERING TO MATURITY STAGES**

The leaf surface area continued to be measured (from week 5 -12).. There was a significant change in leaf surface development at week 6,( Table 3) leading to a slide reduction in the leaf surface area which might be as a result of the irrigation method that was varied. The growth continued as the area keeps increasing from week 7 to 11. At week 11 and 12 block (B) had highest leaf surface area of 43.88cm$^2$, while at same week 11 to 12 block (A) had the same leaf surface area of 36.00 cm$^2$( Table 3). After these weeks no further significant plant growth was recorded at this stage [20].

**D. BLOOMS DROPPING AT FLOWERING STAGE**

At the flowering stage, the number of blooms dropping during each irrigation time was counted and recorded as shown in table 6. The counting of the blooms started at week 6 and continued to week 11. At week 12, there was no bloom formation because the stage had reached the final dry down of the crop and due for harvest [22].

The drip irrigation block B (plot 1 and plot 2) showed less blooms dropping while sprinkler irrigation block A (plot 3 and plot 4) showed high blooms dropping( Figure 2); the reason being that, in drip irrigation system, water was applied at the base of crops without contact with the flowers. While in sprinkler irrigation system, the water that jetted out from the nozzle has a direct contact with the flowers, and the pressure forces some of the blooms to drop.

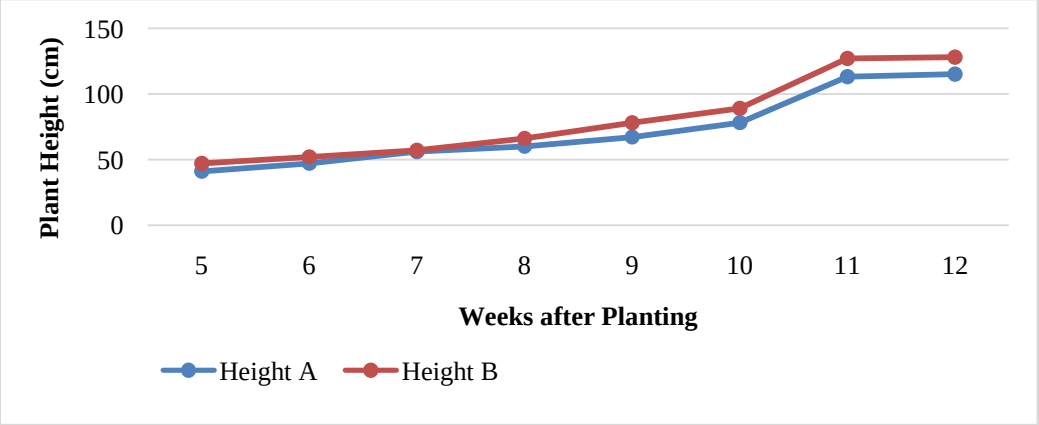


Fig.1: The graph of plant height against weeks after planting.

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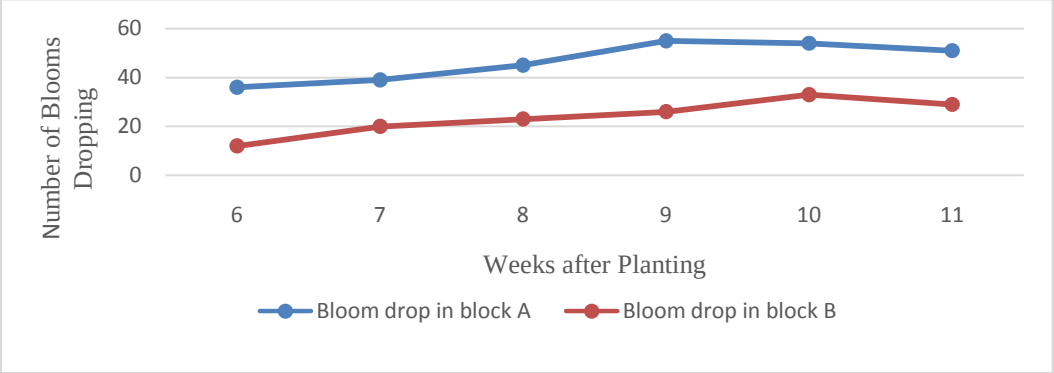


Fig.2: The graph of blooms drops against week after planting.

**E. PODS VARIATION IN BLOCKS.**

The crop started poding at week 6 [25] and the weekly number of pods per plant were counted and recorded as shown in Table 7. The numbers of pods were counted by selecting the tallest plant from each plot and their pods were counted and record showed that block (B) which used drip irrigation system had the highest total number of pods (250) in plot 2, while block (A) shows less at harvest, as also shown in Figure 3.

**F. SEED YIELD IN PLOTS.**

After the crops were harvested, threshed and winnowed, the weight of seed yield per plot was measured and recorded using an electric weighing balance and the result were recorded as shown in Table 8 above.
The yield record for each of the plot1, 2, 3 and plot 4 are 130g, 170g, 90g and 110g respectively. The total weight of seed yield in block (B) was 300g while that of block A was 200g respectively. The total seed yield for both blocks was 500g. The percentage yield per plot as shown in Table 8 above is calculated using the formula:

$$\text{Percentage yield (\%)} = \frac{\text{Seed yield (g)}}{\text{Total yield (g)}} \times 100 \qquad 4$$

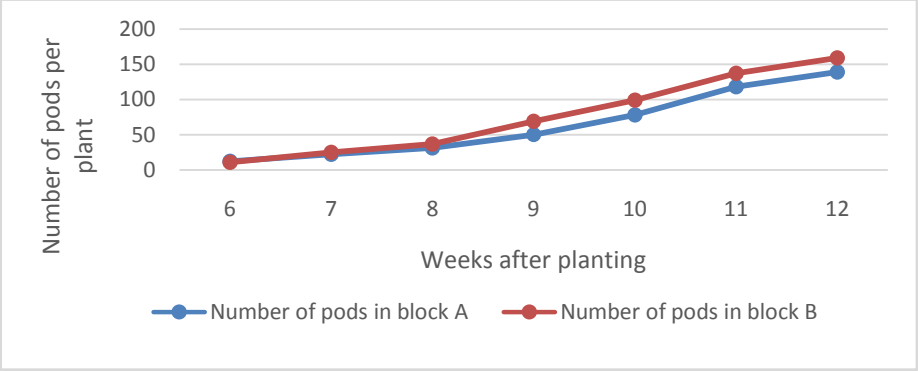


Fig.3: The graph of number of pods per plant against weeks after planting.

## IV. CONCLUSION AND RECOMMENDATION

**CONCLUSION**

From the study carried out, the initial irrigation gave the crop a nearly uniform growth at the juvenile stage. When the irrigation methods were varied into sprinkler and drip at the bloom stages, there was a significant variation in the agronomical features of the crop on plant height, pods production and blooms. The growth variations were significantly better in drip irrigated plots.

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The number of blooms dropping during irrigation was highly significant in sprinkler irrigated plots than in drip irrigated. This is because there was no direct water contact with the flowers in drip irrigation, while in sprinkler irrigation, the water jetted out from the nozzle had direct contact with the flowers and the pressure force the blooms to drop. At harvest, higher seed yield was recorded from drip irrigated plots compare than from sprinkler irrigated plots.

## RECOMMENDATION

Base on the studies the following recommendations are therefore made:

i. Farmers should be delaying the period of planting Sesame because the crop matures within three months; therefore planting should be done three months to end of raining season such that flowering starts at tail end of rainfall to minimize dropping of flowers by rain drops.

ii. In irrigation farming of Saseme, suitable type of irrigation method (drip or furrow) irrigation should be used by farmers to avoid bloom droppings by springler irrigation system.

iii. Since irrigation is expensive to practice by rural farmers, government should subsidize irrigation materials/inputs such as borehole drilling machine, pumps, electricity, etc, for farmers to carry out meaningful and profitable agricultural farming practices.

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