

## Effect of Planting Dates and Plant Spacing on Growth, Yield and Yield Components of Sunflower (*Helianthus annuus L.*) in Iraqi Kurdistan Region.



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### Abstract:

A field study was conducted in spring of 2011, at Kanipanka and Bakrajo, in the province of Sulaimani to evaluate the impact of planting dates and spacing on growth and yield of oilseed sunflower (*Helianthus annuus L.*), variety "Flame". The experiment comprised of three planting dates (March 15<sup>th</sup>, 30<sup>th</sup> and April 15<sup>th</sup>), and three-plant spacing (15, 20, and 25 cm). Seed yields obtained from earlier planting date and narrow plant spacing were significantly higher. The results also showed that the early planting date March 15<sup>th</sup> has a significant positive effect on plant height, stem diameter, head size, and seed weight than the late planting date April 15<sup>th</sup> as an average of both locations. The interaction between planting dates and plant spacing as an average of both locations, showed that March 15<sup>th</sup> planting date and 25 cm plant spacing had significantly higher 1000 seed weight and seed weight per plant, while the highest seed yield gained by the interaction of March 15<sup>th</sup> and plant spacing 15cm. Percentage seed oil content collected as an average of both locations was significantly higher from plants with late planting date April 15<sup>th</sup> at 20 cm plant spacing. All the studied characters except seed oil percentage shows higher significant values at Kanipanka location due to the favorable agro- climatic condition compared to Bakrajo location.

**Key words:** *Sunflower, Planting Date, Plant Spacing, Yield and Yield Components.*

### Introduction:

Sunflower (*Helianthus annuus L.*) is among the important economic oil seed crop in the world. It is a short season plant that is grown for confectionary seed, and oil content. Global production of sunflower seed oil is about 9.6 million ton (8.7 million MT) [1]. The demand for sunflower oil is increasing in Kurdistan-region of Iraq, due to consumption of this main edible oil and higher import from other countries. Sunflower oil has an ideal combination of saturated and poly-unsaturated fatty acid, which is important for the reduction of high serum cholesterol level, its oil cake contains higher amount of protein (40-44%)

and balanced amino acids [2]. Several studies have demonstrated the effect of planting date and plant spacing on higher seed yield and oil content under different climate conditions [3, 4, 5, 6]. In delayed sowing date, high temperature inhibited pollen germination and pollen tube growth, which result in lower seed yield [7]. Dixon and Lutman [8] reported that delay in planting date reduced the morphological characteristic of plant, including plant height, stem, and head diameter. Early planting allows the plants benefit from late winter rainfall. A change in environmental condition during the seed-filling period potentially affects sunflower yield components [9]. Plant spacing

is among factors affecting sunflower seed yield and seed oil percentage. With the increasing of plant population per unit area of sunflower crop, decreased planting height, head diameter [10]. It was noted that there are yield different between sowing time and plant spacing.

The objective of this study were to evaluate the effect of planting date and plant spacing on growth, seed yield and yield component.

### Materials and Methods

In order to find out the effects of planting date and plant spacing on seed yields and yield components. A field experiments was carried out in Spring of (2011) in two different locations, The first location was at Kanipanka Experimental Stations at Sharazoor, 35 km Southeast of Sulaimani and the second location was at Bakrajo Experimental Farm of Faculty of Agricultural Sciences, University of Sulaimani. The experimental plots were ploughed twice, harrowed and well leveled. The variety " Flame " was used in this study. A brief account of some physical and chemical properties of the experimental soil is given in (Table 1). Moreover, the average temperature and monthly rainfall precipitation at Kanipanka and Bakrajo are presented in (Table 2). The experiment at each location was laid out as a factorial experiment in Split Plot

Design with planting dates in main plots and planting space in sub plots within three replication. Sub plot size was 8.4 square meters that contained 4 furrows. Each experiment plot included 9-treatment combinations, 3 planting dates combined with 3-plant spacing. Seeds were sown in rows 70 cm apart. Planting date were March 15<sup>th</sup>, 30<sup>th</sup>, and April 15<sup>th</sup>. Plant spaces were 15, 20 and 25 cm between plants on each row. Nitrogen fertilizer as Urea 46% at a rate of 160 kg h<sup>-1</sup> were hand broadcasted in the experimental plots at the time of planting. Mechanical weed control was carried out three times to keep the experimental plots free from weeds. Irrigation depended mainly on available rainfall during planting up to March 30<sup>th</sup>. After that the experimental plots were irrigated weekly till harvest. Ten plants in each experimental plot were randomly sampled and labeled for data collection. Seed oil content was obtained using soxhlet Standard B-811 Instrument. Data were collected and statistically analyzed. All possible comparison among averages were carried out using LSD at 5% significant level. The mature plants of March 15<sup>th</sup>, 30<sup>th</sup> and April 15<sup>th</sup> planting dates were harvested on July 25<sup>th</sup>, 30<sup>th</sup> and August 5<sup>th</sup>, of 2011 respectively for estimated seed yields, yield components and growth rate at both location.

**Table 1:** Some physical and chemical properties of the soils used in field experiments

| Soil properties            |                            |                               | Kanipanka  | Bakrajo    |
|----------------------------|----------------------------|-------------------------------|------------|------------|
| PSD                        | Sand                       | g kg <sup>-1</sup> soil       | 34.40      | 81.10      |
|                            | Silt                       |                               | 548.70     | 499.80     |
|                            | Clay                       |                               | 416.90     | 419.10     |
| Texture Class              |                            |                               | Silty Clay | Silty Clay |
| pH                         |                            |                               | 7.75       | 7.70       |
| EC <sub>e</sub>            | dS m <sup>-1</sup> at 25°C |                               | 0.27       | 0.42       |
| O.M                        | g kg <sup>-1</sup>         |                               | 12.50      | 10.30      |
| Total Nitrogen             |                            |                               | 1.03       | 0.66       |
| Total CaCO <sub>3</sub>    |                            |                               | 239.00     | 329.00     |
| Available P                | mg kg <sup>-1</sup>        |                               | 4.86       | 3.58       |
| Soluble cations and anions | mmol L <sup>-1</sup>       | Ca <sup>2+</sup>              | 1.16       | 2.62       |
|                            |                            | Mg <sup>2+</sup>              | 0.41       | 0.60       |
|                            |                            | K <sup>+</sup>                | 0.08       | 0.11       |
|                            |                            | Na <sup>+</sup>               | 0.40       | 0.50       |
|                            |                            | CO <sub>3</sub> <sup>2-</sup> | 0.00       | 0.00       |
|                            |                            | HCO <sub>3</sub> <sup>-</sup> | 3.03       | 4.16       |
|                            |                            | Cl <sup>-</sup>               | 0.42       | 0.60       |

**Table 2:** Average air temperature and rainfall during the season of 2011 at both locations

| Month | Kanipanka                |         |               | Bakrajo                  |         |               |
|-------|--------------------------|---------|---------------|--------------------------|---------|---------------|
|       | Average temperature (°C) |         | Rainfall (mm) | Average temperature (°C) |         | Rainfall (mm) |
|       | Maximum                  | Minimum |               | Maximum                  | Minimum |               |
| March | 23.548                   | 2.483   | 48.600        | 17.900                   | 7.500   | 60.700        |
| April | 24.733                   | 8.466   | 121.300       | 22.200                   | 12.200  | 214.800       |
| May   | 33.220                   | 12.354  | 29.000        | 28.500                   | 17.200  | 37.300        |
| June  | 41.700                   | 18.566  | 0.000         | 36.400                   | 23.700  | 0.00          |
| July  | 45.516                   | 21.677  | 0.000         | 40.700                   | 27.300  | 0.00          |

### Results and Discussion:

The effect of planting date on some growth characters shown in Table 3. Plant height, and stem diameter were significantly higher at the both locations. However number of leaves per plant at Kanipanka location was not significantly different, but significantly higher in Bakrajo location.

The early planting date March 15<sup>th</sup> exhibited maximum values for all characters. While the late planting date April 15<sup>th</sup> showed minimum values for all studied characters, with the exception of number of leaves per plant at the second location in which maximum number of leaves per plant produced by the late planting dates. Generally it was observed that the early planting date showed superior values for the characters in compare to late planting date.

Regarding to the plant height at the both locations and their average, the first planting date March 15<sup>th</sup> predominated the last planting date April 15<sup>th</sup> by 17.686 %, 11.788 %, and 15.017 % respectively.

Several studied have demonstrated that plant heights in sunflower strongly reduced when planting dates are delayed [11, 12]. These different in plant height may be due to temperature fluctuations and photoperiod. It has been found that water and temperature stress had been shown to reduce plant height by increasing respiratory losses [13].

Stem diameter was reduced with delay in planting dates. Concerning to the both locations and their average, March 15<sup>th</sup> predominated the April 15<sup>th</sup> by 28.528 %, 24.169 %. And 26.482 % respectively. Delay in planting date reduced the morphological characteristics of the plant, including plant height, and stem diameter [14].

Moreover, number of leaves per plant significantly affected by planting date at Bakrajo location. March 15<sup>th</sup> and April 15<sup>th</sup> predominated March 30<sup>th</sup> by 5.416 % and 7.222 %.

**Table 3:** The effect of planting date on growth characters

| Planting dates                   | Plant height (cm) | Stem diameter (mm) | Number of leaves per plant |
|----------------------------------|-------------------|--------------------|----------------------------|
| <b>Kanipanka location</b>        |                   |                    |                            |
| <b>March 15th</b>                | 217.000           | 19.422             | 37.000                     |
| <b>March 30th</b>                | 198.055           | 16.288             | 37.000                     |
| <b>April 15th</b>                | 184.388           | 15.111             | 34.555                     |
| LSD (0.05)                       | 23.594            | 2.877              | N.S                        |
| <b>Bakrajo location</b>          |                   |                    |                            |
| <b>March 15th</b>                | 170.388           | 16.666             | 32.444                     |
| <b>March 30th</b>                | 160.718           | 13.422             | 30.777                     |
| <b>April 15th</b>                | 152.420           | 13.422             | 33.000                     |
| LSD (0.05)                       | 4.499             | 1.148              | 0.503                      |
| <b>Average of both locations</b> |                   |                    |                            |
| <b>March 15th</b>                | 193.694           | 18.044             | 34.722                     |
| <b>March 30th</b>                | 179.386           | 14.855             | 33.888                     |
| <b>April 15th</b>                | 168.404           | 14.266             | 33.777                     |
| LSD (0.05)                       | 9.974             | 1.286              | N.S                        |

Table (4) confirm the presence of significant effect of planting dates in all yield characters with the exception of head diameter, and seed oil percentage in the first locations, indicating the out yielding of the first planting date in these characters. While at the second location the effect of planting dates was significant in all characters except 1000 seed weight, confirming the exceeding the first planting date in all characters except seed oil percentage in which the last planting date gave maximum values, regarding to the average of both location all characters respond significantly to planting date effect except seed oil percentage in which the first planting date exhibited maximum values, and the minimum values produced by the last planting date. Head diameter decreased with delay in planting date from March 15<sup>th</sup> to April 15<sup>th</sup>. Maximum head diameter of 14.966 and 15.983

cm was recorded at the early planting date while the minimum head diameter 13.033 and 13.822 cm was recorded at late planting date for the second location and the average of both location respectively. This could be due to higher temperature, which occurred during flowering stage, resulting in increased flower and seed abortion and decline in sunflower head diameter. And obviously reducing the head diameter with late planting date was due to shorter growth season. Sometimes the size of head diameter belongs to the different cultivars and weather conditions the location of experiment. This result is similar to [11, 12, 2, 14].

The highest 1000 seed weight was obtained from early planting date while the low 1000 seed weight was obtained at delayed planting dates and could be this due to the cooler weather condition occurring during the early

growth stage and flowering. The other characters such as seed weight influenced by environmental condition during the pollination period.

Therefore dry matter accumulation might affected by planting date [15, 12, 2, 14].

Early planting date had significantly higher seed yield than late planting date. The best seed yield was obtained from planting

date on March 15<sup>th</sup> followed by March 30<sup>th</sup> and the poorest seed yield was obtained from April 15<sup>th</sup> planting date. This might be due to the different temperature during flowering and seed development, radiation and daylength [4, 15].

Seed oil content was not significantly different from first location and the average of both locations; the result was similar to [16].

**Table 4:** The effect of planting date on yield characters

| Planting date                    | Head diameter (cm) | 1000 Seed weight (g) | Seed weight Per plant (g) | Seed yield Kg ha <sup>-1</sup> | Seed Oil Percentage |
|----------------------------------|--------------------|----------------------|---------------------------|--------------------------------|---------------------|
| <b>Kanipanka location</b>        |                    |                      |                           |                                |                     |
| March 15th                       | 17.000             | 55.116               | 79.435                    | 5716.222                       | 46.477              |
| March 30th                       | 15.711             | 53.123               | 67.254                    | 4903.777                       | 47.422              |
| April 15th                       | 14.611             | 50.541               | 59.606                    | 4351.333                       | 45.411              |
| LSD (0.05)                       | N.S                | 3.191                | 12.214                    | 934.939                        | N.S                 |
| <b>Bakrajo location</b>          |                    |                      |                           |                                |                     |
| March 15th                       | 14.966             | 46.317               | 51.387                    | 3705.444                       | 43.144              |
| March 30th                       | 13.400             | 44.640               | 42.664                    | 3107.555                       | 44.933              |
| April 15th                       | 13.033             | 44.513               | 41.407                    | 2982.555                       | 47.477              |
| LSD (0.05)                       | 0.79               | N.S                  | 6.684                     | 419.89                         | 2.987               |
| <b>Average of both locations</b> |                    |                      |                           |                                |                     |
| March 15th                       | 15.983             | 50.716               | 65.411                    | 4710.833                       | 44.810              |
| March 30th                       | 14.555             | 48.881               | 54.954                    | 4005.666                       | 46.177              |
| April 15th                       | 13.822             | 47.527               | 50.506                    | 3666.944                       | 46.444              |
| LSD (0.05)                       | 1.072              | 2.891                | 5.78                      | 425.619                        | N.S                 |

Some growth characters, which affected by plant spacing at both locations along with their average was showing in (Table 5). At the first location the stem character responded significantly to plant spacing of 25 cm. At the second location and the average of both locations all characters responded significantly to higher plant spacing, with the exception of plant height in average of both locations.

Regarding to the character plant height, the plant spacing of 25 cm gave maximum values. The increase of plant height from 158.947 cm to 163.681 cm with the increasing of plant spacing from 15 to 25 cm in Bakrajo location was observed in (Table 5). This result collaborate with the result found by Amjed, et al., [10]. This increase mainly may due to more supply of nutrient, light, moisture and air as compared to narrow spacing. Similar results

also were reported by other researcher Al- Thabet [17]. While decreasing plant spacing from 25, 20, to 15 cm had negatively affected stem diameter. These results collaborate with those reported by [18, 17].

The effect of plant spacing on number of leaves per plant was not significant at the first location, similar result obtained by [10]. While plant spacing of 20 cm gave maximum values of number of leaves per plant

**Table 5:** The effect of plant spacing on growth characters

| Plant spacing                    | Plant height (cm) | Stem diameter (mm) | Number of leaves per plant |
|----------------------------------|-------------------|--------------------|----------------------------|
| <b>Kanipanka location</b>        |                   |                    |                            |
| 15 cm                            | 201.944           | 15.577             | 36.111                     |
| 20 cm                            | 200.777           | 17.111             | 36.222                     |
| 25 cm                            | 196.722           | 18.133             | 36.222                     |
| LSD (0.05)                       | N.S               | 0.801              | N.S                        |
| <b>Bakrajo location</b>          |                   |                    |                            |
| 15 cm                            | 158.947           | 12.644             | 32.111                     |
| 20 cm                            | 160.898           | 14.711             | 32.777                     |
| 25 cm                            | 163.681           | 16.155             | 31.333                     |
| LSD (0.05)                       | 4.982             | 1.467              | 0.503                      |
| <b>Average of both locations</b> |                   |                    |                            |
| 15 cm                            | 180.445           | 14.110             | 34.111                     |
| 20 cm                            | 180.837           | 15.911             | 34.499                     |
| 25 cm                            | 180.201           | 17.144             | 33.777                     |
| LSD (0.05)                       | N.S               | 0.791              | 0.979                      |

The result in table (6) confirm that all yield characters significantly respond to plant spacing at both locations and their average with the exception of seed oil percentage at the first location and the average of both locations. It was observed that plant spacing of 25 cm apart plants recorded maximum values for the characters head diameter, 1000 seed weight, seed weight per plant, and seed oil percentage for the both location and their average. Seed yield were significantly higher at 15 cm than 25 cm plant spacing. Maximum seed yield were 5460.111, 3428.333, and 4444.222 kg ha<sup>-1</sup> using 15 cm apart plant. While the minimum seed yield was 4510.000, 2943.222, and

3726.611 kg ha<sup>-1</sup> using 25 cm apart plants at both locations and their average respectively. A similar results was reported by [19, 20]. Head diameter increased with increasing plant spacing from 15, 20, to 25 cm between the plants. Large head resulting from 25 cm was 17.122, 15.255, 16.188 cm at the both location and their average. This result is supported by [19, 11, 20, 18, 17, 10].

Results presented in Table (6) reveal that there was a liner increase in 1000 seed weight, and seed weight per plant with increase in plant spacing from 15 up to 25 cm. This may be due to lower number of plant that produced

significantly bold grains due to less oil percentage (Table 6 ) was not significantly competition and more availability of light, affected by plant spacing at first location and nutrient and feeding area per plant as the average of both locations. However it was compared to higher plant population. As significantly different at the second location. reported by Al-Thabet [17].The result of seed This may be due to climate condition

**Table 6:** The effect of plant spacing on yield characters

| Plant Spacing                    | Head diameter (cm) | 1000 Seed weight (g) | Seed weight Per plant (g) | Seed yield Kg ha <sup>-1</sup> | Seed Oil Percentage |
|----------------------------------|--------------------|----------------------|---------------------------|--------------------------------|---------------------|
| <b>Kanipanka location</b>        |                    |                      |                           |                                |                     |
| 15 cm                            | 14.288             | 49.075               | 57.336                    | 5460.111                       | 46.222              |
| 20 cm                            | 15.911             | 52.817               | 70.023                    | 5001.222                       | 46.755              |
| 25 cm                            | 17.122             | 57.887               | 78.936                    | 4510.000                       | 46.333              |
| LSD (0.05)                       | 0.816              | 1.111                | 5.746                     | 315.475                        | N.S                 |
| <b>Bakrajo location</b>          |                    |                      |                           |                                |                     |
| 15 cm                            | 12.322             | 41.702               | 36.002                    | 3428.333                       | 43.822              |
| 20 cm                            | 13.822             | 46.415               | 47.942                    | 3424.000                       | 45.611              |
| 25 cm                            | 15.255             | 47.353               | 51.515                    | 2943.222                       | 46.122              |
| LSD (0.05)                       | 0.934              | 4.111                | 11.240                    | 416.850                        | 1.830               |
| <b>Average of both locations</b> |                    |                      |                           |                                |                     |
| 15 cm                            | 13.305             | 45.388               | 46.669                    | 4444.222                       | 45.022              |
| 20 cm                            | 14.866             | 49.616               | 58.982                    | 4212.611                       | 46.183              |
| 25 cm                            | 16.188             | 52.620               | 65.225                    | 3726.611                       | 46.227              |
| LSD (0.05)                       | 0.587              | 2.016                | 5.976                     | 247.491                        | N.S                 |

The interaction effect between planting dates and plant spacing are shown in (Table 7) indicated a significant effect on the number of leaves per plant at the second location and the average of both locations only. Maximum number of leaves per plant produced by the interaction between the third planting dates

with the first plant spacing gave 33.333 leaves at the second location. While in the average of both locations the number of leaves was 35.333. The interaction had no significant effect on plant height and stem diameter for both location and their average.

**Table 7:** The interaction effects of growth characters

| Plant spacing                    |       | Plant height (cm) | Stem diameter (mm) | Number of leaves per Plant |
|----------------------------------|-------|-------------------|--------------------|----------------------------|
| Planting date                    |       |                   |                    |                            |
| <b>Kanipanka location</b>        |       |                   |                    |                            |
| March 15 <sup>th</sup>           | 15 cm | 219.666           | 18.000             | 36.666                     |
|                                  | 20 cm | 218.333           | 19.800             | 36.333                     |
|                                  | 25 cm | 213.000           | 20.466             | 38.000                     |
| March 30 <sup>th</sup>           | 15 cm | 203.500           | 15.466             | 37.333                     |
|                                  | 20 cm | 197.166           | 15.800             | 37.666                     |
|                                  | 25 cm | 193.500           | 17.600             | 36.000                     |
| April 15 <sup>th</sup>           | 15 cm | 182.666           | 13.266             | 34.333                     |
|                                  | 20 cm | 186.833           | 15.733             | 34.666                     |
|                                  | 25 cm | 183.666           | 16.333             | 34.666                     |
| LSD (0.05)                       |       | N.S               | N.S                | N.S                        |
| <b>Bakrajo location</b>          |       |                   |                    |                            |
| March 15 <sup>th</sup>           | 15 cm | 165.666           | 15.000             | 32.333                     |
|                                  | 20 cm | 171.500           | 17.066             | 32.666                     |
|                                  | 25 cm | 174.000           | 17.933             | 32.333                     |
| March 30 <sup>th</sup>           | 15 cm | 159.750           | 10.933             | 30.666                     |
|                                  | 20 cm | 158.530           | 14.200             | 33.000                     |
|                                  | 25 cm | 163.876           | 15.133             | 28.666                     |
| April 15 <sup>th</sup>           | 15 cm | 151.426           | 12.000             | 33.333                     |
|                                  | 20 cm | 152.666           | 12.866             | 32.666                     |
|                                  | 25 cm | 153.166           | 15.400             | 33.000                     |
| LSD (0.05)                       |       | N.S               | N.S                | 0.872                      |
| <b>Average of both locations</b> |       |                   |                    |                            |
| March 15 <sup>th</sup>           | 15 cm | 192.666           | 16.500             | 34.499                     |
|                                  | 20 cm | 194.916           | 18.433             | 34.499                     |
|                                  | 25 cm | 193.500           | 19.199             | 35.166                     |
| March 30 <sup>th</sup>           | 15 cm | 181.625           | 13.199             | 33.999                     |
|                                  | 20 cm | 177.848           | 15.000             | 35.333                     |
|                                  | 25 cm | 178.688           | 16.366             | 32.333                     |
| April 15 <sup>th</sup>           | 15 cm | 167.046           | 12.633             | 33.833                     |
|                                  | 20 cm | 169.749           | 14.299             | 33.666                     |
|                                  | 25 cm | 168.416           | 15.866             | 33.833                     |
| LSD (0.05)                       |       | N.S               | N.S                | 1.696                      |

Data represent in Table (8) shows the effect of interaction between planting date and plant spacing on yield characters at both locations and their average. It was found that seed weights responded significantly in the first location. While at the second location only the seed oil content responded significantly.

Regarding to the average of both location the 1000 seed weights, seed weight per plant, seed

yield, and seed oil percentage responded significantly. Maximum values were due higher seed weight.

The interaction between March 15<sup>th</sup> combined with 15 cm plant spacing produced higher seed yields with 4894.833 kg ha<sup>-1</sup>. There was a correlation between the third planting date and the second plant spacing which produce higher seed oil percentage 48.033.

**Table 8:** The interaction effects of yield characters

| Plant Spacing             |       | Head diameter (cm) | 1000 Seed weight (g) | Seed weight per plant (g) | Seed yield Kg ha <sup>-1</sup> | Seed Oil Percentage |
|---------------------------|-------|--------------------|----------------------|---------------------------|--------------------------------|---------------------|
| Planting date             |       |                    |                      |                           |                                |                     |
| <b>Kanipanka location</b> |       |                    |                      |                           |                                |                     |
| March 15 <sup>th</sup>    | 15 cm | 15.133             | 50.680               | 60.993                    | 5808.333                       | 46.900              |
|                           | 20 cm | 16.966             | 55.010               | 84.633                    | 6045.000                       | 45.600              |
|                           | 25 cm | 18.900             | 59.660               | 92.680                    | 5295.333                       | 46.933              |
| March 30 <sup>th</sup>    | 15 cm | 14.333             | 50.366               | 58.843                    | 5603.333                       | 48.000              |
|                           | 20 cm | 16.033             | 51.806               | 65.956                    | 4710.667                       | 47.900              |
|                           | 25 cm | 16.766             | 57.196               | 76.963                    | 4397.333                       | 46.366              |
| April 15 <sup>th</sup>    | 15 cm | 13.400             | 46.180               | 52.173                    | 4968.667                       | 43.766              |
|                           | 20 cm | 14.733             | 51.636               | 59.480                    | 4248.000                       | 46.766              |
|                           | 25 cm | 15.700             | 53.806               | 67.166                    | 3837.333                       | 45.700              |
| LSD (0.05)                |       | N.S                | 1.925                | N.S                       | N.S                            | N.S                 |
| <b>Bakrajo location</b>   |       |                    |                      |                           |                                |                     |
| March 15 <sup>th</sup>    | 15 cm | 13.500             | 43.990               | 41.810                    | 3981.333                       | 44.633              |
|                           | 20 cm | 14.666             | 45.820               | 50.113                    | 3579.000                       | 41.933              |
|                           | 25 cm | 16.733             | 49.143               | 62.240                    | 3556.000                       | 42.866              |
| March 30 <sup>th</sup>    | 15 cm | 11.900             | 40.233               | 34.423                    | 3278.000                       | 41.766              |
|                           | 20 cm | 13.633             | 46.603               | 48.893                    | 3492.000                       | 45.600              |
|                           | 25 cm | 14.666             | 47.083               | 44.676                    | 2552.667                       | 47.433              |
| April 15 <sup>th</sup>    | 15 cm | 11.566             | 40.883               | 31.773                    | 3025.667                       | 45.066              |
|                           | 20 cm | 13.166             | 46.823               | 44.820                    | 3201.000                       | 49.300              |
|                           | 25 cm | 14.366             | 45.833               | 47.630                    | 2721.000                       | 48.066              |
| LSD (0.05)                |       | N.S                | N.S                  | N.S                       | N.S                            | 3.1                 |

| Average of both location |       |        |        |        |          |        |
|--------------------------|-------|--------|--------|--------|----------|--------|
| March 15 <sup>th</sup>   | 15 cm | 14.316 | 47.335 | 51.401 | 4894.833 | 45.766 |
|                          | 20 cm | 15.816 | 50.415 | 67.373 | 4816.500 | 43.766 |
|                          | 25 cm | 17.816 | 54.401 | 77.460 | 4425.666 | 44.899 |
| March 30 <sup>th</sup>   | 15 cm | 13.116 | 45.299 | 46.633 | 4440.666 | 44.883 |
|                          | 20 cm | 14.833 | 49.204 | 57.424 | 4101.333 | 46.750 |
|                          | 25 cm | 15.716 | 52.139 | 60.231 | 3475.000 | 46.899 |
| April 15 <sup>th</sup>   | 15 cm | 12.483 | 43.531 | 41.973 | 3997.167 | 44.416 |
|                          | 20 cm | 13.949 | 49.229 | 52.150 | 3724.500 | 48.033 |
|                          | 25 cm | 15.033 | 49.819 | 57.398 | 3279.166 | 46.883 |
| LSD (0.05)               |       | N. S   | 3.492  | 10.352 | 428.668  | 2.86   |

Data in Table (9) confirm the presence of significant effect of location in all growth characters, and indicating to out yielding Kanipanka location compare to Bakrajo location for the plant heights, stem diameter, and number of leaves per plant by 23.973 %, 28.625 %, and 12.817 % respectively. This might be attributed to availability of environmental factors prevailing at Kanipanka rather than Bakrajo location [9].

**Table 9:** The effect of locations on growth characters

| Locations  | Plant height (cm) | Stem diameters (mm) | Number of leaves per plant |
|------------|-------------------|---------------------|----------------------------|
| Kanipanka  | 199.814           | 16.940              | 36.185                     |
| Bakrajo    | 161.175           | 13.170              | 32.074                     |
| LSD (0.05) | 6.556             | 0.519               | 2.066                      |

The effect of location on some yield characters presented in Table (10) ratifying the exceeding of Kanipanka location in compare to Bakrajo location in all character significantly with the exception of seed oil content. Kanipanka location predominated Bakrajo location by 14.304 %, 17.206 %, 52.293 %, and 52.838 % for the character head diameter, 1000 seed weight, seed weight per plant, and seed yield kg ha<sup>-1</sup> respectively.

**Table 10:** The effect of locations in yield characters

| Locations  | Head diameter (cm) | 1000 Seed weight (g) | Seed Weight per plant (g) | Seed yield Kg ha <sup>-1</sup> | Seed Oil Percentage |
|------------|--------------------|----------------------|---------------------------|--------------------------------|---------------------|
| Kanipanka  | 15.774             | 52.927               | 68.765                    | 4990.444                       | 46.437              |
| Bakrajo    | 13.800             | 45.157               | 45.153                    | 3265.185                       | 45.185              |
| LSD (0.05) | 1.258              | 2.353                | 5.710                     | 679.397                        | N.S                 |

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