# EFFECT OF PLANT DENSITY ON YIELD AND YIELD COMPONENTS AND SEED CHEMICAL COMPOSITION OF SOME SUNFLOWER VARIETIES.

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**ABSTRACT**
The objective of this research is to study the effect of varieties (Mayak, Elorida 2000 and sigce 475), hill distance (20, 30 and 40 cm) and ridge width (50, 60 and 70 cm) on productivity of sunflower (*Helianthus annus* L.). The highest oil % was obtained by sowing sigco 475 at a 40 cm hills distince under 60 cm. ridge width and the highest oil yield feddan$^{-1}$* as well as seed yield feddan$^{-1}$ was obtained by sowing Mayak on 20cm hills under a 50cm ridge width.

**KEYWORDS**
Sunflower, varieties, hill distance, ridge width, plant density.

**INTRODUCTION**
In Egypt, great effects have been exerted for maximising productivity of oil crops in order to face the shortage of food requirements. The gap between the demand and the production was 74,500 metric tons in 1993.** Sunflower varieties are varied in their productivities (Badawi, 1994). Plant population is one of the most important management considerations that exerts a large effect on the yield, (Li et al., 1984; Sarmah et al., 1994). More information is needed for detemining the optimal spatial arrangement through the manipulation of both hill distance and ridge width when different varieties are used. Therefore, this study is aimed to investigate the performance of certain sunflower varieties under different spatial arrangements.

**METHODS**
In 1991 and 1992 summer seasons, two field experiments at Sakha Agriculture Research Station Farm, Agric. Res. Center (North of Egypt) were carried out. Each experiment included 27 treatments arranged in a split-split plot design, with six replications. These treatments were the combinations of three varieties (Mayak, Florida 2000 and Sigco 475, arranged in the sub-sub-plots), three hill distances (20, 30 and 40 cm arranged in the sub plots), and three ridge widths (50, 60 and 70 cm, occupying main plots). Seeds were planted on 21st June (after faba bean) and on 23rd June (after fallow) in the 1st and 2nd seasons, respectively. Seedlings were thinned 15 days after sowing to secure one plant hill$^{-1}$.

**Yield and yield components.** Plants from the three replicates were bagged at the end of pollination to prevent bird damage and used for estimating the yield and its components as well as seed chemical composition. Ten guarded plants were taken randomly from each experimental unit for estimating the following characters: head diameter, stem diameter (was measured at the third intermode above the soil surface level), number of seeds per head, 100-seed weight and seed weight per plant. Seed yield feddan$^{-1}$ was calculated from central ridges of each experimental unit and then transformed to tonne / feddan.

**Seed Chemical composition.** Oil percentage was determined using the Soxhlet method according to the A.O.A.C. (1975). Crude protein pertcentage: total nitrogen was determined using the improved Kjeldahl method of the A.O.A.C. (1975) and then crude protein percentage was calculated by multiplying the total nitrogen by 6.25. Carbohydrate percentage was determined according to the A.O.A.C. (1975). Afterward, seed yield per feddan was multiplied by the percent of oil, protein and carbohydrates for calculating the corresponding yields per unit area. The collected data was subjected to the proper statistical analysis according to Snedecor and Cochran (1980). For comparison between treatments, L.S.D. at 0.05 level of probability was used.

**RESULTS AND DISCUSSION**
**Yield and yield components.** A summary of sunflower production of three varieties grown under different hill distances and ridge widths is shown in Tables 1 and 2. There were significant ($P<0.05$) differences between varieties for all measured characters of yield and its compenents. Mayak and Florida 2000 varieties surpassed Sigco 475 in head diameter, and this result was also reflected in a similar superiority for number of seeds head$^{-1}$. However, stem diameter, 100-seed weight, seed yield plant$^{-1}$ and feddan$^{-1}$ were markedly different among each pair of varieties being more for Mayak and less for Sigco 475. Increasing 100-seed weight may be the cause of the increased increment for plant seed yield, which in turn was reflected on seed yield feddan$^{-1}$. Varietal differences in number of seeds/head, 100-seed weight, seed yield per both plant and feddan, head and stem diameter were found by Abdel-Aal (1992), Dixon and Lutman (1992), Gurbuz and Arslan (1993) and Sarmah et al. (1994). All yield and its components, except number of seeds head$^{-1}$ were statistically affected by changing the distances between hills (Tables 1 and 2). Plants 20 cm apart had values of head diameter significantly less than those 30 cm or 40 cm apart. These results are in general agreement with those obtained by Ali (1993) ; El- Tabbakh (1994) and Nasr-Allah et al. (1994). On the other hand, each increase in hill distance from 20 up to 40 cm markedly increased stem diameter, 100-seed weight and seed yield plant$^{-1}$. Similar results were reported by Nour El- Din et al. (1983); El -Mohands (1984); Zaffaroni and Schneiter (1991); and El- Hity et al. (1994). The improvements in plant growth due to wider distances (Noureldin et al., In press) may be responsible for the obtained increases in head and stem diameter as well as 100-seed weight. Seed yield plant$^{-1}$ may be increased due to the increment in 100-seed weight. However, reduction in hill distance resulted in increasing seed yield feddan$^{-1}$ being 0.91, 1.18 and 1.69 tonne seeds feddan$^{-1}$ when plants were grown 40, 30 and 20 cm apart, respectively. In this respect, it could be concluded that the increase in plant seed yield under thin density was not enough to compensate the decrease in plant population. The difference among ridge widths was significant regarding 100-seed weight and seed yield feddan$^{-1}$. The maximum 100-seed weight was recorded when sunflower plants grown on ridges arranged 50 or 70 cm apart. However, increasing plant density by closing ridge width from 70 down to 50 cm. significantly improved seed yield feddan$^{-1}$ being 1.1, 1.25 and 1.44 ton feddan$^{-1}$ for 70, and 50 cm, respectively. Although seed yield per plant was not affected by the studied ridge widths, increasing plant population as ridge width decreased may account much for the higher yields in the case. These results are in parallel with those reported by Schmidt and Silva (1986); Woon (1987); and Ulemale et al. (1991).

**Seed chemical composition.** The protein percentage and yields of oil, protein as well as carbohydrates, were significantly different among the tested varieties. The highest seed protein content was

* Feddan = 4200 m$^2$
** Counselor and attache reports, official statistics, USDA estimates

recorded for Florida 2000 (23.44%). Marked differences in protein content between sunflower varieties were also reported by Jadhav et al. (1991). Mayak surpassed the other two varieties in oil, protein as well as carbohydrate yields. Hill distances (i.e. 20, 30 and 40 cm) had a significant effect on oil percentage. The highest value (55.87%) was gained with sowing in 40 cm. These results are in general agreement with those obtained by Rao and Reddy (1985). Also, distances among hills significantly affected the oil protein and carbohydrate yields feddan$^{-1}$ for sunflower varieties. It is clear that there is a reversal relationship between hill distances and all chemical components. The highest yields were recorded for the smallest hill distance (20 cm). Similar results were obtained by El-Hity (1994). Effect of ridge widths (i.e. 50, 60 and 70 cm) was significant on protein percentage of sunflower varieties. The highest value was recorded at the 60 cm ridge width. There was a significant effect on oil, protein and carbohydrate yields feddan$^{-1}$. It was noted that increasing the width from 50 up to 70 cm decreased yields feddan$^{-1}$.

**The interactions.** Investigating the interactions among the involved factors, data revealed that there were significant ($P<0.05$) ridge widths x variety interactions with respect to head diameter, 100-seed weight (Table 1) as well as seed yield per feddan (Table 2), and among the three studied factors (i.e. ridge widths, hill distances and varieties) regarding chemical yields, i.e. oil , protein and carbohydrate (Table 2). We observed that maximum values were recorded by growing Mayak variety on ridge widgth of either 70 cm for head diameter and 100-seed weight or 50 cm for seed yield. On the other hand, the greatest chemical yields were detected with planting Mayak on ridge widths of 50 cm and in hills 20 cm apart.

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**Table 1**

Effect of plant density on head and stem diameter (cm), seeds No./head, 100 seed weight (g) and seed weight per plant of sunflower varieties (averages of 1991 and 1992 seasons).

| Ridge width (cm) | Hill distance (cm) | Head diameter (cm) | | | | Stem diameter (cm) | | | | Number of seeds per head | | | | 100-seed weight (g) | | | | Seed weight per plant (g) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Varieties | | | | Varieties | | | | Varieties | | | | Varieties | | | | Varieties | | | |
| | | Mayak | Florida 2000 | Sigco 475 | Mean | Mayak | Florida 2000 | Sigco 475 | Mean | Mayak | Florida 2000 | Sigco 475 | Mean | Mayak | Florida 2000 | Sigco 475 | Mean | Mayak | Florida 2000 | Sigco 475 | Mean |
| | 20 | 19.31 | 19.55 | 17.65 | 18.84 | 2.67 | 2.41 | 2.09 | 2.39 | 961.05 | 963.12 | 680.17 | 934.78 | 6.12 | 6.07 | 4.38 | 5.52 | 58.63 | 57.25 | 37.92 | 51.27 |
| 50 | 30 | 20.03 | 20.27 | 18.27 | 19.52 | 2.78 | 2.60 | 2.27 | 2.55 | 1000.69 | 1021.54 | 797.07 | 939.77 | 6.39 | 6.25 | 5.47 | 6.04 | 63.20 | 63.93 | 42.99 | 56.71 |
| | 40 | 19.95 | 20.65 | 19.10 | 19.90 | 2.99 | 2.86 | 2.44 | 2.76 | 1017.91 | 1043.33 | 797.28 | 952.84 | 6.97 | 6.13 | 5.75 | 6.38 | 71.12 | 66.96 | 45.53 | 61.20 |
| | mean | 19.78 | 20.16 | 18.34 | 19.42 | 2.81 | 2.62 | 2.27 | 2.57 | 993.22 | 1009.33 | 824.84 | 942.46 | 6.49 | 6.25 | 5.20 | 5.98 | 54.32 | 62.21 | 42.15 | 56.39 |
| | 20 | 19.15 | 18.61 | 17.43 | 18.40 | 2.44 | 2.32 | 2.13 | 2.30 | 1036.28 | 998.24 | 884.39 | 927.64 | 6.27 | 5.27 | 4.39 | 5.31 | 65.03 | 52.22 | 39.10 | 52.12 |
| 60 | 30 | 19.99 | 19.77 | 18.39 | 19.38 | 2.70 | 2.51 | 2.43 | 2.55 | 1130.03 | 1009.43 | 897.09 | 1912.18 | 6.59 | 5.78 | 4.62 | 5.66 | 70.68 | 57.86 | 41.50 | 57.68 |
| | 40 | 19.48 | 20.13 | 18.99 | 19.53 | 3.16 | 2.78 | 2.59 | 2.84 | 1040.90 | 1034.63 | 872.06 | 962.60 | 7.39 | 6.16 | 5.18 | 6.24 | 77.19 | 92.97 | 45.41 | 61.86 |
| | mean | 19.54 | 19.50 | 18.27 | 19.10 | 2.77 | 2.53 | 2.38 | 2.56 | 1069.74 | 1014.16 | 884.52 | 989.47 | 6.74 | 5.14 | 4.23 | 5.74 | 71.97 | 57.68 | 42.00 | 57.22 |
| | 20 | 19.52 | 17.86 | 17.26 | 18.21 | 2.62 | 2.33 | 2.06 | 2.34 | 912.66 | 957.07 | 959.01 | 942.98 | 6.56 | 6.09 | 4.66 | 5.78 | 59.74 | 48.29 | 45.45 | 54.49 |
| 70 | 30 | 20.71 | 19.38 | 18.55 | 19.55 | 2.75 | 2.45 | 2.39 | 2.53 | 1040.05 | 960.61 | 950.57 | 983.74 | 6.99 | 6.53 | 5.07 | 5.19 | 72.28 | 62.21 | 49.07 | 61.19 |
| | 40 | 21.65 | 19.10 | 19.74 | 20.16 | 2.91 | 2.70 | 2.45 | 2.69 | 1135.37 | 967.67 | 940.67 | 1014.65 | 7.13 | 6.62 | 5.44 | 5.46 | 92.91 | 54.10 | 52.04 | 66.35 |
| | mean | 20.63 | 18.78 | 18.52 | 19.31 | 2.76 | 2.49 | 2.30 | 2.52 | 1029.46 | 961.88 | 950.47 | 980.47 | 6.56 | 6.41 | 5.06 | 6.14 | 71.64 | 61.53 | 43.95 | 50.57 |
| Overall mean | 20 | 19.33 | 18.67 | 17.54 | 18.48 | 2.58 | 2.35 | 2.09 | 2.34 | 970.73 | 972.61 | 907.86 | 950.47 | 6.32 | 5.81 | 4.48 | 5.54 | 61.13 | 55.92 | 43.62 | 52.62 |
| for | 30 | 20.24 | 19.81 | 18.55 | 19.53 | 2.74 | 2.52 | 2.37 | 2.54 | 1056.93 | 997.19 | 881.58 | 978.56 | 6.66 | 6.19 | 5.05 | 5.97 | 69.72 | 61.33 | 44.52 | 58.52 |
| hill distance | 40 | 20.48 | 19.96 | 19.28 | 19.90 | 3.02 | 2.77 | 2.50 | 2.76 | 1064.76 | 1015.37 | 870.01 | 983.38 | 7.22 | 6.40 | 5.46 | 6.36 | 77.07 | 64.68 | 47.66 | 63.14 |
| Varieties | mean | 20.02 | 19.96 | 18.43 | | 2.78 | 2.55 | 2.32 | | 1030.60 | 995.12 | 889.48 | | 6.73 | 6.13 | 5.00 | | 69.31 | 60.64 | 44.33 | |

| LSD 0.05 | Varieties (V) | Hill distance (H) | Ridge width (R) | RXH | RXV | HXV | RXHXV |
|---|---|---|---|---|---|---|---|
| Head diameter (cm) | 0.57 | 0.64 | N.S. | N.S. | 0.99 | N.S. | N.S. |
| Stem diameter (cm) | 0.14 | 0.16 | N.S. | N.S. | N.S. | N.S. | N.S. |
| Number of seed weight (g) | 75.62 | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. |
| 100 seed weight (g) | 0.22 | 0.21 | 0.19 | N.S. | 0.33 | N.S. | N.S. |
| Seed weight plant (g) | 4.44 | 4.21 | N.S. | N.S. | N.S. | N.S. | N.S. |

**Table 2**

Effect of plant density on seed, oil, protein and carbohydrate yield per feddan (ton) of sunflower varieties (averages of 1991 and 1992 season).

| Ridge width (cm) | Hill distance (cm) | Seed yield/feddan (Ton) Varieties | | | | Oil yield Varieties | | | | Protein yield Varieties | | | | Carbohydrate yield Varieties | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Mayak | Florida 2000 | Sigco 475 | Mean | Mayak | Florida 2000 | Sigco 475 | Mean | Mayak | Florida 2000 | Sigco 475 | Mean | Mayak | Florida 2000 | Sigco 475 | Mean |
| 50 | 20 | 2.22 | 2.17 | 1.44 | 1.94 | 1.31 | 1.14 | 0.82 | 1.09 | 0.51 | 0.46 | 0.35 | 0.44 | 0.37 | 0.36 | 0.24 | 0.32 |
| | 30 | 1.50 | 1.52 | 1.07 | 1.35 | 0.65 | 0.83 | 0.53 | 0.74 | 0.36 | 0.35 | 0.23 | 0.31 | 0.27 | 0.25 | 0.16 | 0.23 |
| | 40 | 1.19 | 1.13 | 0.77 | 1.03 | 0.71 | 0.63 | 0.46 | 0.60 | 0.29 | 0.28 | 0.20 | 0.26 | 0.22 | 0.18 | 0.13 | 0.18 |
| | mean | 1.64 | 1.60 | 1.08 | 1.44 | 0.96 | 0.87 | 0.60 | 0.81 | 0.39 | 0.36 | 0.26 | 0.34 | 0.29 | 0.26 | 0.18 | 0.24 |
| 60 | 20 | 2.08 | 1.67 | 1.26 | 1.67 | 1.14 | 1.03 | 0.73 | 0.97 | 0.47 | 0.44 | 0.33 | 0.41 | 0.33 | 0.30 | 0.22 | 0.28 |
| | 30 | 1.49 | 1.17 | 0.64 | 1.16 | 0.83 | 0.69 | 0.49 | 0.67 | 0.35 | 0.29 | 0.20 | 0.28 | 0.26 | 0.20 | 0.14 | 0.20 |
| | 40 | 1.10 | 0.90 | 0.90 | 0.91 | 0.69 | 0.40 | 0.47 | 0.52 | 0.28 | 0.17 | 0.20 | 0.22 | 0.21 | 0.12 | 0.14 | 0.16 |
| | mean | 1.55 | 1.25 | 1.25 | 1.25 | 0.89 | 0.71 | 0.56 | 0.72 | 0.37 | 0.30 | 0.24 | 0.30 | 0.27 | 0.21 | 0.17 | 0.22 |
| 70 | 20 | 1.61 | 1.57 | 1.23 | 1.47 | 0.79 | 0.90 | 0.65 | 0.78 | 0.33 | 0.38 | 0.28 | 0.33 | 0.25 | 0.27 | 0.21 | 0.24 |
| | 30 | 1.23 | 1.06 | 0.84 | 1.04 | 0.68 | 0.54 | 0.48 | 0.57 | 0.27 | 0.24 | 0.21 | 0.24 | 0.21 | 0.16 | 0.14 | 0.17 |
| | 40 | 0.99 | 0.77 | 0.53 | 0.80 | 0.57 | 0.41 | 0.34 | 0.44 | 0.22 | 0.17 | 0.14 | 0.18 | 0.16 | 0.12 | 0.10 | 0.13 |
| | mean | 1.28 | 1.13 | 0.90 | 1.10 | 0.68 | 0.62 | 0.49 | 0.60 | 0.27 | 0.26 | 0.21 | 0.25 | 0.21 | 0.18 | 0.15 | 0.18 |
| Overall mean for hill distance | 20 | 1.97 | 1.80 | 1.31 | 1.59 | 1.08 | 1.03 | 0.73 | 0.95 | 0.43 | 0.43 | 0.32 | 0.39 | 0.32 | 0.31 | 0.22 | 0.28 |
| | 30 | 1.40 | 1.25 | 0.90 | 1.10 | 0.79 | 0.69 | 0.50 | 0.66 | 0.32 | 0.29 | 0.21 | 0.27 | 0.25 | 0.21 | 0.15 | 0.20 |
| | 40 | 1.09 | 0.93 | 0.71 | 0.91 | 0.55 | 0.40 | 0.42 | 0.52 | 0.27 | 0.21 | 0.18 | 0.22 | 0.20 | 0.14 | 0.13 | 0.16 |
| Varieties | mean | 1.49 | 1.33 | 0.97 | | 0.84 | 0.73 | 0.55 | | 0.34 | 0.31 | 0.24 | | 0.26 | 0.22 | 0.17 | |

| LSD 0.05 | Varieties (V) | Hill distance (H) | Ridge width (R) | RXH | RXV | HXV | RXHXV |
|---|---|---|---|---|---|---|---|
| Seed yield/feddan (Ton) | 2.09 | 0.09 | 0.10 | N.S. | 0.16 | N.S. | N.S. |
| Oil yield | 0.03 | 0.02 | 0.04 | 0.04 | 0.06 | 0.06 | 0.10 |
| Protein yield | 0.02 | 0.01 | 0.02 | 0.02 | 0.03 | 0.03 | 0.01 |
| Carbohydrate yield | 0.01 | 0.01 | 0.01 | 0.02 | 0.03 | 0.02 | 0.90 |