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# Effect of Intercropping Sunflower Cultivars with Different Plant Densities and Gurma Watermelon Pulp in Relation to Yield

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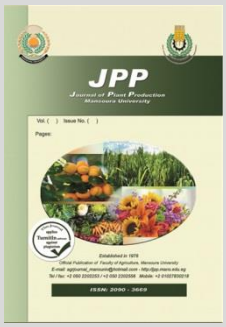


## ABSTRACT

A two - year study was carried out to determine the effects of intercropping Gurma watermelon pulp and sunflower cultivars with various plant densities in Itai El-Baroud, Research Station, El Behaira Governorate, Agriculture of Research Center Giza, Egypt during the summers of 2019 and 2020. Three sunflower plant densities (66%, 33%, and 16.50% ) and two sunflower cultivars ( Sakha 53 and Giza 102) Cultivation of watermelon pulp and sunflowers individually. A split plot design with three replications was adopted. The intercropping of 100% Gurma watermelon pulp with Giza 102 sunflower + 16.50 % plant density produced the maximum seed yield and watermelon pulp yield components in both seasons .While the lowest values of Gurma watermelon pulp were obtained by combining 100% Gurma watermelon pulp with Sakha 53 sunflower cultivars and 66% sunflower plant density. In terms of sunflower, intercropping 100% Gurma watermelon pulp with Sakha 53 at a plant density of 66% resulted in the highest values. The intercropping system of 100% watermelon pulp with Giza 102 sunflower, Relative crowding coefficient 3.694 and 4.177 in the two seasons, respectively, recorded the greatest values of for the land equivalent ratio 1.284and 1.324) in the two seasons. While The combination of 100% watermelon pulp, 16.50% sunflower plant density, and the Giza 102 sunflower cultivar produced the highest net return10718.41 and 13688.22 in the two seasons. To get the best return, it might be advised to use 100% Gurma watermelon pulp and 16.5% of the Giza 102 cultivar's sunflower plant density.

***Keywords*:** Intercropping, Land equivalent ratio , Aggressively , Relative crowding coefficient , net return.

## INTRODUCTION

Particularly following farmers resistance to growing cotton, Gurma watermelon pulp has recently become more widely planted. Compared to other summer crops, Gurma Watermelon pulp is a profitable cucurbit for farmers and has cheap growing costs. Southeast Nigeria is where egoist melon is primarily grown and manufactured using an intercropping strategy (Ijoyah *et al.*, 2012). The best time to intercrop sunflower was during the melon's fruit expansion stage, and the ideal planting density in the melon-sunflower combination was 40 cm between plants, which led to a high nitrogen use efficiency (Liu Bin *et al.*, 2016). Early melon sowing, when compared to late melon sowing, often improved soil moisture content, rhizosphere fungus and bacterial populations, melon growth, and seed output. In monocropping or intercropping systems, late sowing reduced melon seed production more than early sowing did, with the greatest effect occurring in intercropping both years (Olasantan and Babalola, 2007).

The sunflower (Helianthus annuus L.) is the fourth-best source of edible vegetable oils in the world. Almost 18% of the total production of edible vegetable oils worldwide comes from sunflower seed oil. Sunflower oil is comparable to the best olive oil for human consumption in terms of its nutritional value, lack of flavor, color, and ability to preserve food. It is among the best for salad oil, frying, canning, cooking, and medicinal uses. According *to* Osman and Awed (2010), sunflower plants with close spacing between them grow to their tallest possible height (10 cm). Wide spacing yielded the highest stem and head diameter, seed husk, and seed output per plant of sunflowers (30 cm).

Intercropping not only helps to address the issue of the production of pulses and oilseeds, but it also helps to increase farmer income. Beg *et al.* (2003) discovered that growing sunflower populations from 80,000 to 100,000 plants/ha considerably increased seed output.

The use of the land can be intensified in addition to obtaining greater benefits at reduced cultivation costs and utilizing the growth resources and time (duration) very *effectively* (Vishwanatha et al, 2011). The intercropping of sunflower with Gurma watermelon pulp is not well understood. Most of the time, the practice has little respect for any particular plant spacing arrangement or its competitive impacts (Ekwu and Nwokwu, 2012). (Orluchukwu and Udensi, 2013). *The majority of recent studies on intercropping systems have demonstrated a significant gain from the practice as increased land equivalent ratio (LER*) (Konlan *et al.*, 2013; Atabo and Umaru,2015).

A key component of agronomic methods is maintaining an ideal plant population. The goal of the current study is to determine how the growth characteristics of the sunflower cultivars Sakha 53 and Giza 102 in combination with Gurma watermelon pulp affect yield and yield-related variables for the two crops Itai El-Baroud, Research Station, El Behaira Governorate, Agriculture of Research Center Giza, Egypt.

## MATERIALS AND METHODS

Two field studies were conducted in the 2019 and 2020 growing seasons at the Etay El-Baroud Agricultural

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Research Station in the El-Beheira Governorate of the Agriculture Research Center (ARC) in Giza, Egypt, to examine the effects of intercropping Gurma watermelon pulp and sunflower cultivars with various plant

**Studied treatments and experimental design:**

The experimental design was a randomized split plot with three replications, where sunflower cultivars (Sakha 53 and Giza 102) were placed in main-plot units and sunflower plant density treatments were randomized to the sub-plot as follows

**D1:** Planting sunflowers at a density of one plant per hill, spaced 13 cm apart, on other side of the Gurma watermelon pulp raised beds (100% melon pulp + 66% sunflower)

**D2:** Planting sunflowers at a density of one plant per hill, spaced 26 cm apart, on other side of the Gurma watermelon pulp raised beds (100% melon pulp + 33% sunflower)

**D3:** Planting sunflowers at a density of one plant per hill, spaced 50 cm apart, on other side of the Gurma watermelon pulp raised beds (100% melon pulp + 16.5% sunflower)

Gurma watermelon pulp was planted on raised beds180 cm wide in the two sides at the recommended densities (100%) at 20 cm between hills. Sunflower was grown alone in rows 60 cm narrow on one side at 20 cm between apart between hills, for the Sakha 53 and Giza102 cultivars.

The soil of the experimental field was characterized as clayey- soil, where samples were randomly taken from the soil surface (0 - 30 cm) during soil preparation in both seasons. Then particle size distribution and chemical analyses were conceded by the method described by Page *et al.* (1982), and its results are exposed in Table 1.

**Table 1. Physical and chemical analysis of experimental soil during 2019 and 2020 seasons.**

| Soil properties | Soil texture | Sand % | Silt % | Clay % | PH | Organic matter% | Available N(ppm) | Available ppm) | Available ppm) | EC(mmhos $cm^{-1}$) (1;5) |
|---|---|---|---|---|---|---|---|---|---|---|
| 2019 | Clay | 7.11 | 32.23 | 60.68 | 8.01 | 2.22 | 18.10 | 13.50 | 277.11 | 1.83 |
| 2020 | Clay | 7.13 | 32.53 | 60.37 | 7.88 | 1.94 | 17.83 | 9.97 | 293.14 | 1.70 |

**Each sub-plot measured 16.20 m2 and had three ridges that were each 3.0 m long and 1.80 m wide (5.40 $m^2$). Wheat was the previous crop in both seasons.**

At a rate of 150 kg/fed, super phosphate (15.5% P2O5), a phosphoric fertilizer, was sprayed on all plots throughout the field preparation process watermelon pulp was sowed in the first and second seasons on May 30 and May 25, respectively. In the first and second seasons, sunflower was planted on July 6 and July 1 respectively, 37 days after Gurma watermelon pulp was planted with the first irrigation of melon. Sunflower seeds were soaked in water for 8 hours, then removed from the water and gathered for 4 hours, then planted, along with fast-irrigating Gurma watermelon pulp. Before the first irrigation, potassium sulphate (48% K2O) was added at a rate of 50 kg/fed. In all intercropped Gurma watermelon pulp and sunflower plants, nitrogen fertilizer was applied at rates of 70 kg N/fed+ 47 kg N/fed, 70 kg N/fed + 23.5 kg N/fed, and 70 kg N/fed + 12 kg N/fed for D1, D2, and D3 treatments, respectively. Urea (46.5% N) was applied in two doses, 50% at the first irrigation and 50% at the second irrigationor the production of Gurma watermelon pulp and sunflowers, all further agricultural activities were implemented as advised.

At age 15 days after sowing Gurma watermelon pulp, 57% malathion pesticide (KZ) was used for aphid resistance.

Gurma watermelon was treated twice with 80% Rodamil Plus insecticide (Syngenta) after intercropping sunflower in order to protect it from the fungi Peronospora farinose, Powdery farinosa, and Ascochyta hyalospora.

For Gurma watermelon pulp, both crops were manually harvested on September 20 and 15 at full maturity. Sunflower, however, was harvested according to the full maturity of each cultivar; Sakha 53 was harvested on October 7 and 2, and Giza 102 was harvested on September 19 and 14, respectively, in both seasons.

**At harvest time the following traits were estimated:**

**Gurma Watermelon pulp yield, yield components:**

1- Number of fruits / $m^2$.
2- Number of seeds / fruit.
3- Weight of seeds / fruit (g).
4- 100-seed weight (g).
5- Weight of seeds / $m^2$ (g).
6- Seed yield/fed (kg), was estimated in whole plot.

**Other characters were: Sunflower yield and yield components:**

1- Plant height (cm).
2- Head diameter (cm).
3- 100-seed weight (g).
4- Seed weight/head (g).
5- Seed yield/fed (kg).

**Evaluation of intercropping systems**

**A- Competition characters.**

**1- Land equivalent ratio (LER).**

The ratio of area need under solid cropping to that of intercropping at same management level to produce an equivalent yield, according to Mead and Willey (1980):

$$\mathbf{LER} = \frac{\mathbf{Yab}}{\mathbf{Yaa}} + \frac{\mathbf{Yba}}{\mathbf{Ybb}}$$

**Where,**

**$Y_{aa}$ and $Y_{bb}$ are the solid crop yields of crops Gurma watermelon pulp and significantly b, respectively, $Y_{ab}$ is the intercrop yield of crop Gurma Watermelon pulp, and $Y_{ba}$ is the intercrop yield of crop sunflower.**

**2- Relative crowding coefficient (RCC or K).**

$$\mathbf{K = (K_a \times K_b), \text{ where } K_a = \frac{Yab \times Zba}{(Yaa - Yab)x\ Zab} \text{ and } K_b = \frac{Yba \times Zab}{(Ybb - Yba)x\ Zba}}$$

**Where**

**$Z_{ab}$ and $Z_{ba}$ were the proportions of Gurma watermelon pulp a and sunflower b in the intercropping, respectively.**

When the values of LER and K were greater than1, there is a yield advantage; when LER and K were equal to 1, there is no yield advantage; and, when it is less than 1, there is a disadvantage ( Dhima *et al.*, 2007).

**3- The third index was aggressively (A)** which is often used to determine the competitive relationship between two crops used in mixed cropping (Willey, 1979). The aggressively was formulated as follows:

$$\mathbf{A_a = \frac{Yab}{Yaa \times Zab} - \frac{Yba}{Ybb \times Zba}, \text{ and } A_b = \frac{Yba}{Ybb \times Zba} - \frac{Yab}{Yaa \times Zab}}$$

(Dhima et al., 2007).

If $A_a = 0$, both crops are equally competitive, if $A_a$ is positive, then the a is dominant, if $A_a$ is negative, then the a is dominated .conomics evaluation .

The difference between the total net returns from intercropping and solid crops was used to compute the farmer's

benefit (L.E). Gurma watermelon seeds were priced at 30 and 35 L.E/kilogram in the first and second seasons, respectively, and sunflower seeds were priced at 6850 L.E/ton in both seasons (*Bulletin of Statistical Cost Production and Net Return, 2018 and 2019).* Total returns were determined by combining the yields of the Gurma watermelon pulp and the sunflower crop, whilst net returns were determined by deducting the total of the fixed costs for the watermelon pulp and the variable expenses for the sunflower crop in accordance with the intercropping method.

**Statistical analysis.**

The gathered data was examined in accordance with Snedecor and Cochron (1988). Using the CoStat V 6.4 (2005) application, the analysis of variance (ANOVA) was calculated. The least significant differences (LSD) least at 5% levels of probability were used to compare the treatment means.

## RESULTS AND DISCUSSION

**Gurma Watermelon pulp.**

Effect of sunflower cultivars on Gurma watermelon pulp, data in Table (2) showed that number of fruit/m2 was not significantly affected by water cropped sunflower cultivars, while weight of 100-seed was significantly affected by sunflower cultivars in 2020 season only. The highest weight of 100-seed (15.28g) was obtained when planted Gurma watermelon pulp with sunflower cultivar Sakha 53. These results are due to when the number of seeds per Gurma watermelon increases The sunflower cultivars considerably impacted both the number of seeds per fruit, the weight of the seeds per fruit, the weight of the seeds per m2, and the seed output per feeding. In comparison to intercropping Gurma watermelon with sunflower Sakha 53 (V1), which had the lowest values (94.88 and 96.95 seed, 13.74 and 14.95g, 70.71 and 80.75 g, and 292.37 and 335.07 kg, respectively), planting Gurma watermelon pulp with sunflower Giza 102 (V2) gave the highest values for number of seeds/fruit, weight of seeds/fruit, weight of seeds/m2, and seed yield/fed. Intercropping, which involves planting one crop beside another that is already established, is likely to put the newly planted crop at a competitive disadvantage, according to the results of intercropping studies (Gbaraneh *et al.,* 2004 and Kermah *et al.,* 2017). When Gurma melon was introduced to maize after the first two weeks of planting (WAP), the seed yield and other Gurma melon yield components were generally severely decreased (Gbaraneh, 2018). Compared to a pure crop, effective intercropping of oilseed and pulse crops increases overall productivity per unit area (Prasad K. and Srivastava, 1991).

Data in Table 2 demonstrated that all parameters of Gurma watermelon pulp that were tested were strongly impacted by sunflower densities when sunflower plants were intercropped. Only in the 2019growing season, sunflower intercropping densities had a significant impact on both the number of fruit per m2 and the weight of 100 seeds. The highest number of fruit per m2 (6.34 fruit) was obtained by intercropping sunflower at density 16.50% (D3), and the highest 100-seed weight (15.29g) was recorded by intercropping sunflower at density 33%. (D2). Under D2 and D3 treatments for densities, however, there were no 100-seed weight variations that could be considered significant.

**Table 2. Yield and yield components of Gurma watermelon pulp as affected by cultivars and densities of sunflower plants during 2019 and 2020seasons.**

| Characters<br>Sunflower cultivars (V) | No. of fruit s/m$^2$ | No. of seeds / fruit | Weight of seeds/ fruit(g) | weight of 100-seed (g) | Weight of seeds/m$^2$ | Seed yield/fed (kg) |
|---|---|---|---|---|---|---|
| | | | 2019 | | | |
| Sakha 53 (V1) | 5.22 | 94.88 | 13.74 | 14.89 | 70.71 | 292.37 |
| Giza 102 (V2) | 5.46 | 108.93 | 14.44 | 14.06 | 78.95 | 335.17 |
| F .test at 5% | NS | * | * | NS | * | * |
| Densities of sunflower plants (D) | | | | | | |
| $D_1$ (100%watermelon+66%sunflower) | 5.00 | 87.61 | 11.21 | 13.91 | 57.53 | 246.52 |
| $D_2$(100%watermelon+33%sunflower) | 5.17 | 101.96 | 14.19 | 14.84 | 72.12 | 292.90 |
| $D_3$(100%watermelon+16.50%sunflower) | 5.84 | 116.14 | 16.87 | 14.68 | 94.85 | 401.89 |
| LSD at 5% | NS | 2.15 | 0.68 | NS | 1.33 | 6.72 |
| Watermelon pulp alone | 6.67 | 98.72 | 17.94 | 14.47 | 120.81 | 513.34 |
| Interaction (V x D) | NS | 3.04 | 0.96 | NS | 1.89 | 15.72 |
| | | | 2020 | | | |
| Sunflower cultivars (V) | | | | | | |
| Sakha 53 (V1) | 5.67 | 96.95 | 14.95 | 15.28 | 80.75 | 335.07 |
| Giza 102 (V2) | 5.89 | 109.56 | 16.09 | 14.38 | 90.03 | 373.25 |
| f. test at 5% | NS | * | * | * | * | * |
| Intercropping densities of sunflower | | | | | | |
| $D_1$ (100%watermelon+66%sunflower) | 5.33 | 89.72 | 12.51 | 14.16 | 64.49 | 262.11 |
| $D_2$(100%watermelon+33%sunflower) | 5.67 | 103.43 | 15.83 | 15.29 | 83.72 | 350.30 |
| $D_3$(100%watermelon+16.50%sunflower | 6.34 | 116.62 | 18.23 | 15.05 | 107.95 | 450.09 |
| LSD at 5% | 0.79 | 2.78 | 0.79 | 0.75 | 2.06 | 5.60 |
| Watermelon pulp alone | 6.78 | 98.51 | 18.89 | 15.27 | 127.40 | 528.88 |
| Interaction (V x D) | NS | 3.93 | 1.11 | NS | 2.91 | 13.48 |

*** indicate P< 0.05**

The density of sunflower plants in both seasons had a substantial impact on seed yield/fed, weight of seeds/pod, weight of seeds/m2, and number of seeds/pod. When comparing the results of the various intercropping treatments, it was discovered that intercropping sunflower at 16.5 percent of its plant density with Gurma watermelon pulp produced the highest results (116.14 and 116.62 seeds, 16.87 and 18.23, 94.85 and 107.72 g, 401.89 and 450.09 kg for number of seeds/pod, weight of seeds/pod, weight of seeds/m2, and seed yield/fed), while producing the lowest results (87*).* Specifically at high sunflower density and low defoliation level, Wafaa Mohammed and Abd El Zaher (2013) discovered that sugar beet plants were shadowed by sunflower, which reduced sugar beet development attributes compared to solid culture.

According to *Liu Bin et al. (2016)*, compared to the same treatments of monocultures melon, partial nitrogen productivity of intercropping systems with three intercropping densities reduced by 29.6%, 15.6%, and 21.1%, respectively. When seeding was done from 4 weeks onward after planting corn, Gurma melon growth and yield were considerably decreased (Gbaraneh, 2018). Olasantan and Babalola (2007) found that late seeding in monoculture, mixed stands with maize, and mixed stands with cassava significantly decreased the number of fruits per plant, the number of seeds per fruit, and the seed yield of melons by 12-52, 10-75, and 10-67%, respectively. In mixed stands with maize and cassava, the yield of melon seeds and its constituent parts were frequently decreased by 18–66 and 8–31%, respectively.

Gurma watermelon pulp is affected by interactions between sunflower cultivars and density. Results from Table 3 showed that interactions in the first and second seasons had a substantial impact on the number of seeds per pod, weight of seeds per pod, weight of seeds per square meter , and seed yield per feed. The highest values were recorded for number of seeds/pod, weight of seeds/pod, weight of seeds/m2, and seed yield/fed when watermelon pulp was grown under sunflower cultivar Sakha 53 and 66% density (D1). The lowest values for these treats were recorded when watermelon pulp was grown under cultivar Giza 102, 16.50% density (D3), and 75.20 and 78.18 seeds, 10.29 and 11.42g, 51.80 and 56.54g, and 226.72 and These outcomes as a result of less inter- and intra-competition led to a reduction in shading

**Table 3. Effect of interaction between cultivars and densities of sunflower with Gurma watermelon pulp on watermelon pulp during 2019 and 2020seasons.**

| Treatments | No .of seeds / fruit | | weight of seeds / fruit (g) | | weight of seeds /$m^2$ | | seed yield /fed (kg) | |
|---|---|---|---|---|---|---|---|---|
| | 2019 | 2020 | 2019 | 2020 | 2019 | 2020 | 2019 | 2020 |
| Sakha 53 (V1) | | | | | | | | |
| $D_1$ (100%watermelon+66%sunflower) | 75.20 | 78.18 | 10.29 | 11.42 | 51.80 | 56.54 | 226.72 | 232.64 |
| $D_2$(100%watermelon+33%sunflower) | 96.01 | 98.55 | 14.13 | 15.62 | 70.77 | 80.07 | 271.85 | 333.21 |
| $D_3$(100%watermelon+16.50%sunflower) | 113.42 | 114.12 | 16.80 | 17.82 | 89.57 | 105.62 | 378.53 | 439.36 |
| Giza 102 (V2) | | | | | | | | |
| $D_1$ (100%watermelon+66%sunflower) | 100.01 | 101.26 | 12.13 | 13.60 | 63.25 | 72.44 | 266.32 | 291.57 |
| $D_2$(100%watermelon+33%sunflower) | 107.91 | 108.30 | 14.25 | 16.03 | 73.47 | 87.37 | 313.95 | 367.38 |
| $D_3$(100%watermelon+16.50%sunflower) | 118.85 | 119.11 | 16.93 | 18.63 | 100.13 | 110.28 | 425.25 | 460.81 |
| LSD at 5% | 3.42 | 3.93 | 0.96 | 1.11 | 1.89 | 2.91 | 15.72 | 13.48 |

**Sunflower**

The Gurma watermelon pulp effect on sunflower cultivars revealed that cultivars had a significant impact on all of the sunflower features ( 4). When Sakha 53 (V1) sunflower cultivars were planted with Gurma watermelon pulp, the highest values for head diameter, weight of seeds per head, and seed yield/fed were obtained. In contrast, the lowest values for these characteristics were obtained when Giza 102 sunflower cultivars were grown with Gurma watermelon in both seasons (16.61 and 16.10 cm, 66.42 and 62.60 g, and 746.79 and 718.30 kg, respectively). Sakha -53 significantly outperformed Giza-102 in plant height, stem diameter, head diameter, 100-seed weight, seed yield per plant, seed yield per hectare, and oil seed yield kg/ha, according to *Abdel-Motagally and Osman's (2010)* analysis of varietal differences. However, there was no discernible difference in oil percentage. Impact of sunflower plant intercropping densities on sunflower performance

**Table 4. Yield and yield components of sunflower as affected by cultivars and densities of sunflower plants with Gurma watermelon pulp of during 2019 and 2020 seasons.**

| Treatments | | Plant height (cm) | Head diameter (cm) | 100-seed weight (g) | Seed weight/head (g) | Seed yield/ fed(kg) |
|---|---|---|---|---|---|---|
| | | | 2019 | | | |
| Sakha 53 (V1) | | 168.69 | 18.53 | 9.12 | 71.38 | 837.41 |
| Giza 102 (V2) | | 140.69 | 16.61 | 9.01 | 66.42 | 746.79 |
| F .test at 5% | | * | * | NS | * | * |
| Densities of sunflower plants (D) | | | | | | |
| $D_1$ (100%watermelon+66%sunflower) | | 160.23 | 16.38 | 8.57 | 57.30 | 1108.29 |
| $D_2$(100%watermelon+33%sunflower) | | 152.51 | 17.75 | 9.12 | 66.76 | 797.28 |
| $D_3$(100%watermelon+16.50%sunflower) | | 151.33 | 18.59 | 9.52 | 75.16 | 470.74 |
| LSD at 5% | | 3.83 | 0.73 | 0.39 | 2.03 | 20.04 |
| Alone | Sakha 53 (V1) | 178.67 | 15.52 | 8.17 | 54.14 | 1460.24 |
| | Giza 102 (V2) | 160.17 | 15.24 | 8.03 | 48.23 | 1404.32 |
| Interaction (V x D) | | 5.41 | 1.03 | NS | 2.86 | 28.34 |
| Sunflower cultivars (V) | | | 2020 | | | |
| Sakha 53 (V1) | | 167.48 | 18.09 | 10.38 | 70.48 | 826.34 |
| Giza 102 (V2) | | 145.83 | 16.10 | 9.62 | 62.60 | 718.30 |
| F. test at 5% | | * | * | * | * | * |
| Densities of sunflower plants (D) | | | | | | |
| $D_1$ (100%watermelon+66%sunflower) | | 159.58 | 15.95 | 9.43 | 57.93 | 1100.75 |
| $D_2$(100%watermelon+33%sunflower) | | 157.34 | 17.06 | 9.99 | 67.52 | 776.88 |
| $D_3$(100%watermelon+16.50%sunflower | | 153.06 | 18.28 | 10.58 | 74.17 | 439.34 |
| LSD at 5% | | 3.16 | 0.85 | 0.27 | 1.63 | 25.36 |
| Alone | Sakha53(V1) | 177.78 | 15.04 | 8.53 | 51.04 | 1410.33 |
| | Giza 102 (V2) | 162.78 | 14.89 | 8.33 | 45.91 | 1343.30 |
| Interaction (V x D) | | 4.47 | 1.20 | 0.38 | 2.30 | 35.86 |

*** indicate P< 0.05**

According to Table (4), sunflower densities significantly influenced all of the evaluated sunflower attributes. As the number of sunflower plants in the combination (D1) treatment was increased, taller plants (160.23 and 159.58 cm) emerged as a result of intra- and inter-plant competition. Findings shown in Table (4) showed that

intercropping sunflower at various plant densities enhanced head diameter, 100-seed weight, and weight of seeds per head much more than sunflower monoculture did in both seasons. maximum values (18.59 and 18.28 cm, 9.52 and 10.58 g, and 75.16 and 74.17 g) when sunflower is grown under density (D3), while the lowest values (9.52 and 10.58 g) when sunflower is grown under D1 (16.38 and 15.95 cm, 8.58and 9.43 g and 57.30 and 57.93 g) when the characters from these seasons' respective intercropping densities (D1) were growing sunflower. Different plant densities had varying effects on the intercropped sunflower seed yield/fed. The yield of sunflower seeds increased when sunflower plant density was increased up to 66% (20 cm between plants and used two rows on watermelon ridge) (D1) treatment, giving (1108.29 and 1100.75kg/fed), and the yield of sunflower seeds decreased when sunflower plant density was decreased up to 16.50% (D3) treatment, giving (470.74 and 439.34kg/fed). The rise in sunflower plants per unit area may be to blame for this trend.( Sahoo et al ,.2003*).* found comparable outcomes in the intercropping sunflower-peanut in all seasons and in the combined analysis, variables including head diameter, 100 seed weight, and seed yield plant-1 exhibited the inverse tendency of plant height. When sunflower and sugar beetroot were intercropped at 50 and 33.3% plant density of its pure stand, the characteristics decreased by 24.8 and 8.3%, 14.4 and 8.3%, 23.7 and 9.4%, and 100 seed weight and seed yield plant-1, respectively, as opposed to 25% during combined analysis (Sheha *et al.*, 2017). The two hybrids were equally sensitive, according to but like with all other treatments, early defoliations were more harmful than late ones.

Effects of sunflower intercropping with watermelon pulp on cultivars and densities. Only 100 sunflower seeds' worth of the analyzed characteristics in the 2019 season were interacted with significantly in both seasons. According to data in Table (5), Sakha 53 (V1) sunflowers and intercropping densities of 16.50% (D3) of sunflower plants with watermelon pulp produced the highest values, whereas Giza 102 (V2) sunflowers and intercropping densities of 66% (D1) produced the lowest values. Highest thousand seed weight was attained at 6 plants per square meter of plant population. Lower thousand seed weight was obtained by planting at the greater rate (8 and 10 plants m-2*) (Zarea et al., 2005).*

**Table 5. Effect of interaction between cultivars and densities of sunflower at intercropping with watermelon pulp in 2019 and 2020 seasons.**

| Treatments | Plant height (cm) | | Head diameter (cm) | | Weight of 100-seed(g) | Seed weight/head | | Seed yield/ Fed (kg) | |
|---|---|---|---|---|---|---|---|---|---|
| | 2019 | 2020 | 2019 | 2020 | 2020 | 2019 | 2020 | 2019 | 2020 |
| Sakha 53 (V1) | | | | | | | | | |
| $D_1$ (100%watermelon +66%sunflower) | 171.20 | 168.33 | 16.75 | 16.56 | 9.23 | 59.47 | 60.01 | 1142.46 | 1163.50 |
| $D_2$(100%watermelon+ 33%sunflower) | 169.74 | 166.11 | 18.83 | 18.03 | 10.67 | 72.63 | 72.75 | 860.54 | 839.74 |
| $D_3$(100%watermelon+ 16.50%sunflower) | 165.13 | 168.00 | 20.01 | 19.67 | 11.23 | 82.05 | 78.67 | 509.22 | 475.78 |
| Giza 102 (V2) | | | | | | | | | |
| $D_1$ (100%watermelon+ 66%sunflower) | 149.25 | 150.82 | 16.01 | 15.33 | 9.63 | 55.12 | 55.85 | 1074.11 | 1038.01 |
| $D_2$(100%watermelon+33%sunflower) | 132.92 | 140.00 | 16.67 | 16.09 | 9.30 | 60.89 | 62.28 | 734.02 | 714.01 |
| $D_3$(100%watermelon+16.50%sunflower) | 139.89 | 146.67 | 17.17 | 16.89 | 9.92 | 68.26 | 69.67 | 432.25 | 402.90 |
| LSD . at 5% | 5.41 | 4.47 | 1.03 | 1.20 | 0.38 | 2.86 | 2.30 | 28.34 | 35.86 |

**Evaluation of intercropping advantages.**

**1- Land equivalent ratio (LER)**

The information in Table (6) demonstrates that increasing the land equivalent ratio (LER) over unity by using either intercropping system suggested that sunflower/Gurma watermelon pulp intercropping had a higher biological efficiency, translating into higher productivity per unit area.

**Table 6. Land equivalent ratio (LER) and relative crowding coefficient (K) as affected by sunflower cultivars and densities of sunflower plants during 2019 and 2020 seasons.**

| Character | | Sakha 53 | | | | Giza 102 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | D1 | D2 | D3 | Mean | D1 | D2 | D3 | Mean |
| | | | | | | 2019 | | | |
| LER | Lm | 0.442 | 0.530 | 0.737 | 0.570 | 0.519 | 0.612 | 0.828 | 0.653 |
| | Ls | 0.782 | 0.589 | 0.349 | 0.573 | 0.765 | 0.523 | 0.308 | 0.532 |
| | LER | 1.224 | 1.119 | 1.089 | 1.143 | 1.284 | 1.135 | 1.136 | 1.185 |
| LSD at 5% | | V = 0.038 | | | | D=0.022 | | | VxD= 0.031 |
| K | Km | 0.527 | 0.316 | 0.457 | 0.433 | 0.575 | 0.525 | 0.786 | 0.629 |
| | Ks | 5.393 | 4.305 | 3.289 | 4.329 | 4.879 | 3.285 | 2.732 | 3.632 |
| | K | 2.844 | 1.360 | 1.503 | 1.902 | 3.694 | 1.725 | 2.147 | 2.522 |
| LSD at 5% | | V = 0.091 | | | | D=0.107 | | | VxD=0.151 |
| Agg. | Am | -1.220 | -1.651 | -1.634 | -1.502 | -1.047 | -1.275 | -1.235 | -1.186 |
| | As | +1.220 | +1.65 | +1.634 | +1.502 | +1.047 | +1.275 | +1.235 | +1.186 |
| LSD at 5% | | V = 0.088 | | | | D=0.049 | | | VxD=0.169 |
| | | | | | | 2020 | | | |
| LER | Lm | 0.440 | 0.630 | 0.831 | 0.634 | 0.551 | 0.695 | 0.871 | 0.706 |
| | Ls | 0.825 | 0.595 | 0.337 | 0.586 | 0.773 | 0.532 | 0.301 | 0.535 |
| | LER | 1.265 | 1.225 | 1.168 | 1.220 | 1.324 | 1.227 | 1.172 | 1.241 |
| LSD | | V = NS | | | | D=0.032 | | VxD=NS | |
| K | Km | 0.524 | 0.568 | 0.799 | 0.630 | 0.819 | 0.758 | 1.102 | 0.893 |
| | Ks | 7.071 | 4.415 | 3.127 | 4.871 | 5.100 | 3.404 | 2.632 | 3.712 |
| | K | 3.705 | 2.508 | 2.499 | 2.904 | 4.177 | 2.580 | 2.900 | 3.219 |
| LSD at 5% | | V =0.079 | | | | D=0.057 | | | VxD=0.081 |
| Agg. | Am | -1.329 | -.542 | -1.444 | -1.438 | -1.013 | -1.200 | -1.129 | -1.114 |
| | As | +1.329 | +1.54 | +1.444 | +1.438 | +1.013 | +1.200 | +1.129 | +1.114 |
| LSD at 5% | | V=0.052 | | | | D=0.034 | | | VxD=0.105 |

**$D_1$= 66% density of sunflower, $D_2$= 33% density of sunflower and D3 = 16.50% density of sunflower. Lm= Relative yield of watermelon pulp. Ls = Relative yield of sunflower. Km = Relative crowding coefficient of watermelon Ks= Relative crowding coefficient of sunflower**

This showed that the intercrop systems for Gurma watermelon pulp and sunflower were more effective and compatible, especially with those systems that offered the greatest benefits. LER values increased (1.284 and 1.324) when Giza 102 sunflower cultivar (V2) and plant density 66% (D1) were intercropped, however LER values fell (1.089 and 1.18) when Giza 102 sunflower cultivar (V3) and plant density 16.50% (D3) were intercropped in both seasons.

**A = Aggressively**

Compared to monoculture crops, intercropping systems make better use of environmental resources such N, moisture, light, and nutrients. According to the results of (Sarkar et al., 2003).( Moreover, Mandal et al. ,1990*)* revealed that the mutual complementarity of the component crops is responsible for the yield benefit of intercropping over solitary cropping.

**2- Relative crowding coefficient (RCC or K).**

The data in (Table 6) showed that all intercropping systems had relative crowding coefficients (K) larger than one and that LER trends were similar across all systems. The greatest values (3.694 and 4.17) were obtained while intercropping Gurma watermelon pulp with Giza 102 sunflower cultivar (V2) and plant density 66% of sunflower plants (D1). Another study found that strawberry yields are unaffected by intercropping cucumber, summer squash, and muskmelon during the final week of February, which is 31 days before the end of the strawberry season *(Duval, 2005).* According to*( Liu Bin et al., 2016),* the melon fruit expansion period was the best time for sunflower intercropping, and 40 cm between plants was the ideal planting density in the melon-sunflower intercropping system, which led to good nitrogen use efficiency. So, for successful cropping on these soils, the component crops must be organized properly to prevent the complete suppressive influence of each component over the others and to promote the growth and development of the crops *(*Gbaraneh, 2018).

**3- Aggressively (A).**

According to the findings in Table (6), sunflower cultivars and intercropping densities have an adverse impact on the aggressively calculated Gurma watermelon pulp and sunflower seed yields. It is well known that a value of zero for aggressiveness means that both of the component crops are equally competitive. The difference in competitive abilities increases with increasing numerical value. The results in Table (6) show that there was unequal competition amongst the component crops. Nonetheless, the intercropping pattern was a positive sign for sunflower and a negative sign for watermelon pulp, indicating that sunflower intercropping systems were dominant while watermelon pulp intercropping systems were not. This indicates that under all different treatments in this investigation, sunflower was more aggressive than watermelon. Maximum values (1.651 and 1.542) were aggressively recorded with V1 at intercropping density D2, while the best values with minimal aggressiveness in V2 at all intercropping densities. Yet, the ability of the shorter component to compete with the taller component for available nutrients and light may be the reason for the negative indication for watermelon pulp and the positive one for sunflower. This further stresses that in the watermelon pulp-sunflower intercropping, sunflower is able to gain more resources than watermelon pulp. Sheha *et al.* (2017*)* discovered that of all intercropping patterns, sunflower was dominating and sugar beetroot was dominant. According to Saudy and El-Metwally (2009*)*, the aggressively (A) values for soybean (A soy) were higher than those for sunflower (A sun).

**4-Total income (L.E).**

According to data in Table (7), intercropping densities under sunflower cultivars, with the exception of intercropping density (D3) under sunflower cultivars Giza 102 (V2), which was (15718.41 and 18888.22 L.E) in the two studied seasons, respectively, were all less profitable than planting Gurma watermelon pulp in a monoculture crop.

**5- Net return.**

All intercropping densities under sunflower cultivars, with the exception of intercropping density (D3) under sunflower cultivar Giza 102 (V2), which was (10718.41 and 13688.22 L.E) in the two studied seasons, respectively, were outperformed by planting Gurma watermelon pulp in a monoculture crop in terms of net return. This is a result of sunflower having the lowest economics (the cost of sunflower seeds was 6850L.E/ton). In all intercropping systems, Marvel the LER and K were recorded values greater than unity. among Florida strawberry growers, there is a current trend is intercropping cucumber, summer squash, or muskmelon with strawberry. is intercropping cucumber, summer squash, or muskmelon with strawberry. Reusing plastic mulches may increase cost-effectiveness while reducing environmental impact and the risk of economic failure during a year of low-market demand for a crop grown alone (Brown *et al.*, 1985; Simms *et al.*, 2006). Beshay *et al.* (2000) reported that intercropping increased markedly farmer net and profitability per unit capital input (one LE).

**Table 7. Gross income (L.E) and net return (L.E) as affected by sunflower cultivars and densities of sunflower plants during 2018/219 and 2019/2020 seasons.**

| Character | | Total income (L.E.) | | Net return (L.E.) | |
|---|---|---|---|---|---|
| | | 2019 | 2020 | 2019 | 2020 |
| Sakga 53 | D1 | 14627.45 | 16112.38 | 9627.45 | 10912.38 |
| | D2 | 14050.20 | 17414.57 | 9050.20 | 12214.57 |
| | D3 | 14844.06 | 18636.69 | 9844.06 | 13436.69 |
| Giza 102 | D1 | 15347.25 | 17315.25 | 10347.25 | 12115.25 |
| | D2 | 14446.54 | 17749.27 | 9446.54 | 12549.27 |
| | D3 | 15718.41 | 18888.22 | 10718.41 | 13688.22 |
| LSD at 5% | | V=22.36 D=59.54 V xD=84.20 | V=14.34 D=11.53 VxD=16.31 | V=45.61 D= 22.63 VxD=32.01 | V=55.13 D=28.77 V xD=35.44 |
| Watermelon pulp alone | | 15400.20 | 18510.80 | 10400.20 | 13310.80 |
| Sunflower alone | S.53 | 10002.64 | 9660.76 | 5003.64 | 4460.76 |
| | G.102 | 9619.59 | 9201.61 | 4619.59 | 4001.61 |

**$V_1$=Sakha 53 and $V_2$= Giza 102. $D_1$= 66% density of sunflower, $D_2$= 33% density of sunflower and D3 = 16.50% density of sunflower .Alone m. = Gurma watermelon pulp pure stand and alone s.=sunflower pure stand.**

## CONCLUSION

It can be inferred that the cultivation of 100% pulp watermelon, 16.5% sunflower from this pure concentration of Giza 102cu cultivar under environmental circumstances of EL- Beheria Governorate, Egypt, resulted in the highest land equivalent ratio (LER), total income, and net yield.

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# تأثير تحميل عباد الشمس بكثافات نباتية مختلفة مع بطيخ اللب وعلاقة ذلك بالمحصول

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## الملخص

أقيمت تجربتين حقليتين لدراسة تأثير تحميل اصناف عباد الشمس بكثافات نباتية مختلفة مع بطيخ اللب وعلاقة ذلك بالمحصول في محطة البحوث والتجارب الزراعية بإيتاي البارود – البحيرة – مركز البحوث الزراعية- الجيزة – مصر, خلال موسمي الزراعة صيف 2019 و2020,. بثلاث كثافات لزراعة عباد الشمس (66٪ ، 33٪ ، 16.50٪ ) وصنفين من عباد الشمس ( سخا 53 وجيزة 102) زراعة لب البطيخ وعباد الشمس كل على حدة. تم استخدام تصميم القطعة المنقسمة مرة واحدة بثلاث مكررات. أنتجت زراعة لب بطيخ الجورما 100٪ مع عباد الشمس جيزة 102 + كثافة نباتية 16.50٪ أقصى إنتاجية للبذور ومكونات لب البطيخ الجورما في كلا الموسمين. تم الحصول على أقل قيم لب البطيخ الجورما عن طريق الجمع بين لب البطيخ 100٪ مع أصناف دوار الشمس سخا 53 وكثافة نبات دوار الشمس بنسبة 66٪. فيما يتعلق بزهرة عباد الشمس ، نتج عن زراعة لب بطيخ الجورما 100٪ مع سخا 53 بكثافة نباتية 66٪ أعلى القيم. سجل نظام الزراعة البينية لب البطيخ بنسبة 100٪ مع عباد الشمس جيزة 102 ، ومعامل الازدحام النسبي 3.694 و 4.177 في الموسمين على التوالي ، أعلى قيم لنسبة معدل استغلال الارض 1.284 و 1.324 في الموسمين. بينما أنتج مزيج لب البطيخ بنسبة 100٪ وكثافة نبات دوار الشمس 16.50٪ وصنف دوار الشمس جيزة 102 أعلى عائد نقدى 10718.41 و 13688.22 في الموسمين .يمكن التوصية: للحصول على أفضل عائد نقدى يُنصح باستخدام لب البطيخ الجورما 100٪ و 16.5٪ من كثافة نبات دوار الشمس في الصنف جيزة 102

***الكلمات الدالة***: التحميل , معدل استغلال الارض , العنوانية ؛ المكافئ الأرضي , صافي العائد