

## Yield Relationships in Confectionery Sunflower (*Helianthus annuus* L.)

Yalcin Kaya, Goksel Evci, Veli Pekcan, Tahir Gucer, Ibrahim M. Yilmaz

**Abstract:** *The obtained higher yield results in the study indicated that confectionery sunflower had more potential especially in irrigated conditions, due to that confectionery price 3 times more than oil type. The candidate hybrids revealed mostly requested parameters for confectionery such as lower oil content ( $\leq 30\%$ ) and bigger size and also having earliness like oil types. Mainly negative correlation coefficients were calculated among yield traits in the research. The 1000 seed weight had more significant relationships with other traits and it is only significant trait related with seed yield with flowering but in negative way.*

**Key words:** *Confectionery Sunflower, Seed Yield, Yield Traits, Correlation Analysis.*

### INTRODUCTION

Sunflower is mainly producing for oil production both in Turkiye and in the world. However, the use of human food of sunflower especially as confectionery also is common like the use of birdfood, ornamental purposes and also using in the cakes and breads, etc.. Confectionery sunflower is growing by farmers in manly Middle and Eastern Anatolia, Southern Marmara and Aegean Regions in Turkey [6,8]. Turkish people like sunflower seed as confectionery bigger sizes, white color with grey stripes consuming mostly in shell unlike Balkan countries such as Bulgaria, Romania, Serbia, etc.. preferring mostly black colors [2,7,9].

Confectionery sunflower is the most consuming seed among other crops such as pumpkin, peanut, pistachio, chickpea (leblebi), hazelnut, etc.. in Turkey. Although Turkey has very higher processing capacity and export possibility of modern confectionery industry, it has not enough domestic production especially in confectionery sunflower and import confectionery seeds from other countries [6,8].

Confectionery sunflower seed in shell should ideally be at least over 80 g 1000 seed weight and less than 30 % oil content. Additionally, confectionery seeds should have a lower cadmium rate, higher protein and vitamin E (Tocopherol) content to increase in the nutritional value of seed and in shelf life [3,4,5]. Therefore, newly developed cultivars should have higher yield capacity, larger seeds and the desired seed quality characteristics mentioned above [1]. Additionally, these new hybrids should be in white color with grey stripes to sell easily in Turkish market.

Vidhyavathi et al. (2005) indicated that simultaneous selection could be for non-oilseed or confectionery types due to that no association with between yield and seed characters, i.e. seed length, 100-seed weight and oil content (in both seeds and kernels). On the other hand, Kaya et al. (2003) mentioned that plant height, head diameter, seed weight and also earliness were the main yield traits determining seed yield in oil type sunflower.

The aim of this study was to determine of yield relationship in confectionery sunflower utilizing from correlation analysis.

### MATERIAL AND METHODS

The research was conducted in Trakya Region which is European part of Turkey in 2005 and 2006 to evaluate confectionery sunflower hybrids in National Sunflower Breeding Project by carrying out Trakya Agricultural Research Institute - Edirne. The experimental hybrids was obtained with crossing inbred CMS (Cytoplasmic Male sterile) A line used as female with restorer lines in the sunflower breeding nursery in institute field in Edirne . The 35 hybrids in 5 trials (21 hybrids in 3 trials in Edirne, 7 hybrids in one trial both in Kırklareli and Lüleburgaz) in 2005 and The 62 hybrids were evaluated in 3 trials (21 hybrids in Edirne, 20 in Kırklareli and 21 in Lüleburgaz) in 2006. Trials were conducted in irrigated

conditions in Edirne and in dry conditions in other locations. The experiments (6 m long and 70 cm x 45 cm plant density) were planted by hand with three rows (in April) and middle row was harvested (in September) except first plant at the plots. The experimental design was randomized complete block design with three replicates. Seed yield ( $\text{kg ha}^{-1}$ ), flowering and physiological maturity period (day), oil content (%), 1000 seed weight (g), and plant height and head diameter (cm), were measured in this research. Correlation analysis was performed using the procedures of JUMP Statistical Program.

## RESULTS AND DISCUSSION

The total 97 confectionery sunflower hybrids evaluated in the research. The higher yield results indicated that confectionery sunflower could be more profitable especially in irrigated field, because confectionery price 3 times more than oil type. The candidate confectionery hybrids revealed mostly requested characteristics for using confectionery such as lower oil content ( $\leq 30\%$ ) and bigger size ( $\geq 80$  g) (Table 1). The hybrids also exhibited normal phenological period like oil types (as 60-70 days flowering and 90-100 physiological maturity period) so these confectionery sunflower hybrids could be grown in most sunflower areas in Turkey. Due to very hot conditions and lower rain during sunflower vegetation period, the average seed yield was lower in 2006 than 2005s in the research (Table 2 and 3). On the other hand, there were no big differences among other yield traits between these two years.

Table 1: The values of yield traits of confectionery sunflower in two years.

| Yield Traits                       | #  | Minimum | Maximum | Mean   | Std Dev. | Median | 25% Quartile | 75% Quartile |
|------------------------------------|----|---------|---------|--------|----------|--------|--------------|--------------|
| Seed Yield ( $\text{Kg ha}^{-1}$ ) | 97 | 920.1   | 5497.0  | 2241.3 | 759.3    | 2150.0 | 1756.5       | 2510.0       |
| Oil Content (%)                    | 97 | 16.38   | 39.3    | 27.0   | 5.4      | 26.7   | 22.9         | 31.1         |
| Seed Weight (g)                    | 97 | 45.9    | 180.4   | 98.8   | 30.6     | 91.3   | 81.2         | 114.2        |
| Flowering (Day)                    | 90 | 61.0    | 80.0    | 68.3   | 4.3      | 68.0   | 64.0         | 72.0         |
| Phy Maturity (Day)                 | 90 | 92.0    | 116.0   | 103.7  | 5.4      | 103.7  | 100.0        | 108.0        |
| Plant Height (cm)                  | 90 | 110.0   | 291.0   | 180.9  | 20.3     | 181.5  | 172.0        | 189.0        |
| Head Diameter (cm)                 | 90 | 11.0    | 33.0    | 19.4   | 3.6      | 19.0   | 17.0         | 21.0         |

Table 2: The values of yield traits of confectionery sunflower in 2005.

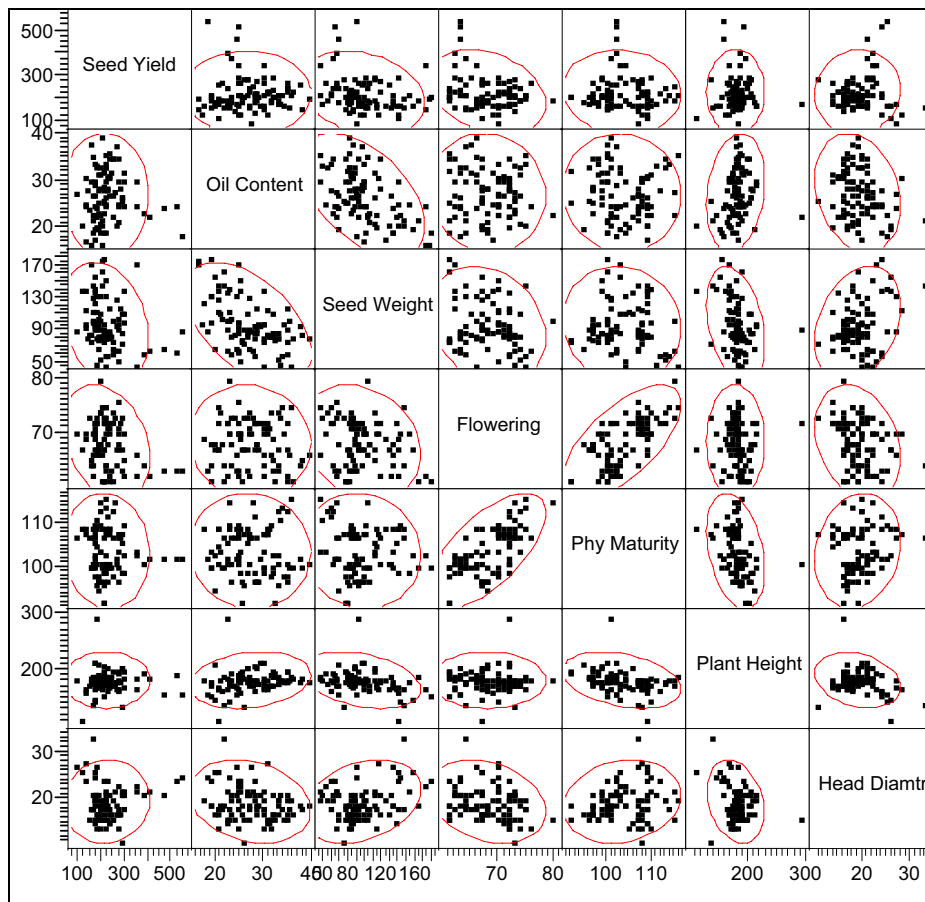
| Yield Traits                       | #  | Minimum | Maximum | Mean   | Std Dev. | Median | 25% Quartile | 75% Quartile |
|------------------------------------|----|---------|---------|--------|----------|--------|--------------|--------------|
| Seed Yield ( $\text{Kg ha}^{-1}$ ) | 35 | 920.1   | 5497.0  | 2354.8 | 1124.5   | 2043.0 | 1653.0       | 2703.0       |
| Oil Content (%)                    | 35 | 16.4    | 35.8    | 24.6   | 5.4      | 24.4   | 20.7         | 28.7         |
| Seed Weight (g)                    | 35 | 45.6    | 177.7   | 96.9   | 37.5     | 91.8   | 62.1         | 133.4        |
| Flowering (Day)                    | 28 | 62.0    | 75.0    | 68.6   | 4.0      | 69.0   | 64.5         | 72.0         |
| Phy Maturity (Day)                 | 28 | 100.0   | 116.0   | 106.6  | 5.1      | 107.0  | 102.0        | 110.8        |
| Plant Height (cm)                  | 28 | 110.0   | 291.0   | 176.6  | 29.3     | 178.5  | 163.5        | 186.5        |
| Head Diameter (cm)                 | 28 | 16.0    | 33.00   | 22.1   | 3.9      | 21.5   | 19.3         | 27.1         |

Table 3: The values of yield traits of confectionery sunflower in 2006.

| Yield Traits                       | #  | Minimum | Maximum | Mean   | Std Dev. | Median | 25% Quartile | 75% Quartile |
|------------------------------------|----|---------|---------|--------|----------|--------|--------------|--------------|
| Seed Yield ( $\text{Kg ha}^{-1}$ ) | 62 | 1520.0  | 3503.0  | 2177.8 | 437.1    | 2108.5 | 1834.5       | 2380.3       |
| Oil Content (%)                    | 62 | 19.1    | 39.3    | 28.3   | 4.9      | 28.4   | 24.9         | 31.9         |
| Seed Weight (g)                    | 62 | 65.1    | 180.4   | 99.8   | 26.2     | 91.2   | 82.4         | 111.2        |
| Flowering (Day)                    | 62 | 61.0    | 80.0    | 68.1   | 4.5      | 68.0   | 64.0         | 72.0         |
| Phy Maturity (Day)                 | 62 | 92.0    | 115.0   | 102.4  | 5.1      | 101.0  | 98.8         | 107.0        |
| Plant Height (cm)                  | 62 | 135.0   | 214.0   | 182.9  | 14.5     | 182.0  | 174.0        | 189.0        |
| Head Diameter (cm)                 | 62 | 11.0    | 26.0    | 18.2   | 2.7      | 18.00  | 16.00        | 20.0         |

The only significant correlations was observed but in negative way in 1000 seed weight and flowering period in between seed yields and yield traits in the research (Table 4). The highest significant correlation was calculated between flowering and physiological maturity period normally because of most related factors each others among yield traits. The 1000 seed weight was the most significant character related with other traits that revealed mostly significant negative correlations except with head diameter in all values together and flowering period and head diameter followed it respectively. On the other hand, plant height were significantly correlated in negative way with seed weight, head diameter, flowering and physiological maturity period. Furthermore, plant height was the least laid out trait among examined yield characteristics in the research (Figure 1).

Figure 1: The scatter matrix of pairwise correlations of all values at % 5 level.



To determine the relationships among yied traits examining of the differences between years, the correlations was performed in 2005 and 2006 separately. Similar to all values together, the highest positive correlation coefficient was observed in flowering-physiological maturity relationships and oil content with physiological maturity, flowering

and 1000 seed weight (negative way) relationships followed it respectively in 2005 (Table 5). The seed yield was correlated also with physiological maturity in 2005 unlike all values together. The seed yield relationships with other traits had higher correlation coefficients in 2005 than 2006s and also all values together. Like all values together, 1000 seed weight was the most significant characteristics among yield traits in 2005 correlated positively with flowering and physiological maturity period and negatively with oil content and seed yield. On the other hand, head diameter was observed as the least correlated character among yield traits in 2005 unlike all values together's.

There was no significant relationships between seed yield and other yield traits based on correlation values in 2006 in which yield traits could not exhibited any effect on seed yield most probably due to heavy drought during the sunflower growing season (Table 6). Therefore, yield characteristics performed less significant relationships when they compared 2005's and all values together. The highest positive correlation was calculated again expectingly in flowering-physiological maturity relationships among yield characters in 2006 and seed weight-head diameter relationships followed it.

Table 4: The total correlation coefficients of yield traits of confectionery sunflower.

| Yield Traits  | Seed Yield | Oil Content | Seed Weight | Flowering Period | Physio Maturity | Plant Height | Head Diameter |
|---------------|------------|-------------|-------------|------------------|-----------------|--------------|---------------|
| Seed Yield    | 1.0000     |             |             |                  |                 |              |               |
| Oil Content   | -0.0892ns  | 1.0000      |             |                  |                 |              |               |
| Seed Weight   | -0.2508*   | -0.4628**   | 1.0000      |                  |                 |              |               |
| Flowering     | -0.2936**  | -0.0626ns   | -0.2278*    | 1.0000           |                 |              |               |
| Phy Maturity  | -0.0738ns  | -0.0440ns   | -0.0808ns   | 0.6565**         | 1.0000          |              |               |
| Plant Height  | 0.0063ns   | 0.2026ns    | -0.3333**   | -0.0040ns        | -0.3354**       | 1.0000       |               |
| Head Diameter | 0.0597ns   | -0.2287*    | 0.2973**    | -0.2638*         | 0.1648ns        | -0.2552*     | 1.0000        |

\*\*=significant at %1 level, \*= significant at %5 level , ns = Non-Significant

Table 5: The correlation coefficients of yield traits of confectionery sunflower in 2005.

| Yield Traits  | Seed Yield | Oil Content | Seed Weight | Flowering Period | Physio Maturity | Plant Height | Head Diameter |
|---------------|------------|-------------|-------------|------------------|-----------------|--------------|---------------|
| Seed Yield    | 1.0000     |             |             |                  |                 |              |               |
| Oil Content   | -0.1735ns  | 1.0000      |             |                  |                 |              |               |
| Seed Weight   | -0.4340*   | -0.6571**   | 1.0000      |                  |                 |              |               |
| Flowering     | -0.5820**  | 0.6642**    | -0.3020ns   | 1.0000           |                 |              |               |
| Phy Maturity  | -0.4649*   | 0.6742**    | -0.1984ns   | 0.6960**         | 1.0000          |              |               |
| Plant Height  | 0.0716ns   | 0.1409ns    | -0.3975*    | 0.2513ns         | -0.2254ns       | 1.0000       |               |
| Head Diameter | -0.1255ns  | -0.0519ns   | 0.3036ns    | -0.3118ns        | 0.1920ns        | -0.5322ns    | 1.0000        |

\*\*=significant at %1 level, \*= significant at %5 level , ns = Non-Significant

Table 6: The correlation coefficients of yield traits of confectionery sunflower in 2006.

| Yield Traits  | Seed Yield | Oil Content | Seed Weight | Flowering Period | Physio Maturity | Plant Height | Head Diameter |
|---------------|------------|-------------|-------------|------------------|-----------------|--------------|---------------|
| Seed Yield    | 1.0000     |             |             |                  |                 |              |               |
| Oil Content   | 0.1030ns   | 1.0000      |             |                  |                 |              |               |
| Seed Weight   | 0.0778ns   | -0.4702**   | 1.0000      |                  |                 |              |               |
| Flowering     | -0.1315ns  | -0.3286**   | -0.1891ns   | 1.0000           |                 |              |               |
| Phy Maturity  | 0.1575ns   | -0.2449ns   | 0.0677ns    | 0.6805**         | 1.0000          |              |               |
| Plant Height  | -0.0426ns  | 0.1921ns    | -0.3004*    | -0.1920ns        | -0.4140**       | 1.0000       |               |
| Head Diameter | 0.0585ns   | -0.1627ns   | 0.5212**    | -0.3689**        | -0.1646ns       | 0.1815ns     | 1.0000        |

\*\*=significant at %1 level, \*= significant at %5 level , ns = Non-Significant

However, flowering and physiological maturity had higher significant relationships with other traits than others in 2005. Based on these correlation results, there is no big similarity with Vidhyavathi et al. (2005) research for confectionery type and also with Kaya et al. (2003) study on oil type conducting in even same region. Most probably,

confectionery types influenced more heavy droughts during the vegetation period than oil types due to losing seed weight and forming small size which was unpreferable.

### CONCLUSIONS

The highest correlations were observed in between flowering and physiological maturity period relationships in both in two years and together. The correlations among yield traits were generally in negative way. Plant height had less scattered values comparing with other yield traits in the research. However, while head diameter had comparably higher significant coefficients in all values together, when correlations separated two years, it exhibited very less significance. The less significant relationships were observed among yield traits each other in 2006 compared with 2005's.

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### About the authors

Yalcin KAYA, Ph D, Trakya Agricultural Research Institute, PO Box: 16, 22100. Edirne, Türkiye, Fax:(+90)284-2358210, Phone:(+90)284-2358182. *E-mail: yalcinkaya@ttae.gov.tr*

Goksel EVCI, Ph D, *E-mail: gokselevci@ttae.gov.tr*

Veli PEKCAN, *E-mail: velipekcan@ttae.gov.tr*

Tahir GUCER, *E-mail: tahirgucer@hotmail.com*

Ibrahim M. YILMAZ, *E-mail: yilmazmehmet22@hotmail.com*

**Докладът е рецензиран.**