Scientific Papers. Series A. Agronomy, Vol. LXIV, No. 1, 2021
ISSN 2285-5785; ISSN CD-ROM 2285-5793; ISSN Online 2285-5807; ISSN-L 2285-5785

RESEARCH ON THE INFLUENCE OF LEAF AREA ON SUNFLOWER YIELD CULTIVATED ON CARACAL CHERNOZEM IN THE PERIOD 2018-2020

Șerban Cătălin DOBRE

Agricultural Research and Development Station Caracal, 106 Vasile Alecsandri Avenue, 235200, Caracal, Romania

Corresponding author email: dobreserbancatalin@yahoo.com

Abstract

At ARDS Caracal, on chernozem type soil, for three years (2018-2020), 9 sunflower hybrids were tested to study the influence of leaf area on yield in the conditions in which the sowing was done at 3 different plant densities. The determination of the leaf area was done at 3 different moments spaced two weeks apart in June and July. The leaf area was determined on all the leaves on the plant, on 3 plants on each replication, using the formula of Rouphael et al. (2007). The correlation coefficients between the leaf area and yield were differentiated as direction depending on the year of experimentation being significantly positive in 2019 and significantly negative in 2018, given that the correlation was made between 27 values (9 hybrids x 3 densities) for each determination. When correlated, a percentage of 16-20% of leaf area variability was associated with yield variability. Although normally the leaf area is positively correlated with production, the results obtained in this experiment are supported by the fact that the production is higher at medium plant density but the leaf area is higher at low plant density. This aspect is highlighted by the leaf area / yield ratio which shows which leaf area of a plant contributes to the formation of one kilo of sunflower seeds. The highest values of this indicator (over 2 cm^2 / plant per kilo of seed) are found at the lowest density. The results suggest that the relationship between leaf area and yield at sunflower is influenced by climatic and technological factors and a large leaf area does not always lead to high yield.

Key words*: sunflower, chernozem, leaf area, correlation, ratio leaf area/yield.*

INTRODUCTION

The objectives of improving the sunflower are improve the productivity, by increasing the seed production and the oil content; genetic resistance to diseases and pests and increasing the level of ecological plasticity through adaptability to various environmental conditions (Bonciu, 2019). The leaf area is an important indicator of plant growth, being related to the accumulation of dry matter, perspiration, photosynthetic capacity. Currently, the aim is to obtain hybrids with 25-30 leaves, with large limb and grafted to increase the leaf surface index (ISF) to over 4, achieving an architecture of the leaf apparatus with a larger photosynthetic active surface. The largest foliar area of sunflower assimilation occurs during flowering, in late June - early July. The leaves have the property to withstand well the phenomenon of temporary wilting, determined by the insufficiency of water in the soil, returning to normal turgor when moisture completes. Partial or total defoliation causes a decrease in yield. If 12 leaves remain at the top of the stem, the negative influence on yield is reduced (Johnson & Tanner, 1972). The leaves and roots of the plants form the vegetative system that through specific growth processes puts in action the root and foliar sensors. The development of the leaf surface is of major importance on photosynthesis and transpiration. The total leaf surface area per plant is determined as a logistic function of the anthesis and the thermal time from sunrise, while the distribution of the solar radiation at the leaf level is determined by the ISF, the angular distribution of the leaves (Bonciu et al., 2020b). Genotype is one of the most dynamic indicators for sunflower cytogenetic research. This comes in support of genetic research for sustainable management of the agricultural system in general and sunflower crops in special. An intense mitotic activity is directly correlated with plant growth, development and fructification at optimal parameters. However, in addition to intense mitotic activity, environmental factors also play a decisive role (Bonciu et al., 2020).

Studies on the hybrid x density x moment of determination interaction in sunflower, conducted by Dobre and Marin in 2020, showed that to the first determination, in the other three, the leaf area showed very significant increases in all densities and all hybrids. At medium and high densities, only Neoma and FD15C27 hybrids had fast leaf surface growths. The leaf area was lush at low density in Neoma and FD116M1 hybrids while Euromis and Performer hybrids showed the same leaf area in both densities: low and medium. In Performer, the leaf areas at the first two seed density and at the first 3 moments of determination are equal. The FD15C27 hybrid is the only one in which the foliar development is much reduced indifferent of the seed density, it being around 6000 cm^2.

In sunflower, experiments on morphophysiological changes due to water stress (Pârjol, 1974) showed that the sharp reduction of the assimilating surface accompanied by slowing down the growth of the root system causes a substantial decrease in seed production. Felix and Select hybrids showed better drought resistance compared to other hybrids in culture (Ţerbea, 1996). Simultaneously with the reduction of the leaf area, the number of leaves also decreased. This response can be considered as a common reaction of sunflower plants in order to limit water consumption in drought conditions (Petcu et al., 2001a, 2001b).

MATERIALS AND METHODS

At ARDS Caracal, on chernozem type soil, for three years (2018, 2019 and 2020), 9 sunflower hybrids were tested to study the correlation between yield and leaf area of three moment of leaf area determination (in 2018 at 08.06, 20.06 and 3.07; in 2019 at 18.06, 28.06 and 12.07; in 2020 at 20.06; 03.07 and 14.07). Data was collected from three densities: 43000 plants/ha, 57000 plants/ha and 71000 plants/ha).

The hybrids tested were: Euromis (1), Generalis (2), Terramis (3), Neoma (4), Diamantis (5), Subaro (6), Performer (7), FD15C27 (8), FD116M1 (9).

The experiment was placed in randomized blocks, in 3 replications. The length of the plot was 10 m and the width - 2.8 m, the equivalent of 4 rows from which the marginal ones are removed.

The leaf area was determined on all the leaves on the plant, on 3 plants on each replication, using Rouphael formula: $LA = 6.72+0.65*w^2$ - where LA = leaf area, w = width of the leaf (Rouphael et. al., 2007).

The yield was determined by harvesting the two middle rows of the 10 m long plot (harvestable area = 14 m^2), the seeds were weighed, the humidity was determined and the yield was calculated to the STAS humidity of 9%.

The correlation was made between 27 values (9 hybrids x 3 densities) for each determination. Only significant correlations were presented.

The ratio between the leaf area and the obtained yield (represents which leaf area contributes to the formation of one kg of sunflower seeds) was also calculated.

RESULTS AND DISCUSSIONS

The correlation coefficients between yield and leaf area / plant, on the one hand, and leaf area / one single leaf, on the other hand, for each year and each moment of determination highlighted its different meanings: negative in 2018 and 2020; positive in 2019 (Table 1). These differences were due to different climatic conditions from one year to another for the period of sunflower vegetation. The rainfall regime of 2018 favored the development of sunflower culture and obtaining high yields. Both at sowing and in the essential phases for development (May, June, July) there was a excess of precipitation, almost double compared to the multiannual normal for the last 30 years. The rainfall regime of 2019 partially favored the development of sunflower culture, obtaining normal productions. At sowing and then the following month, sufficient rainfall was provided for a good emergence of the crop. In the essential phases for development (May, June, July) there was a excess of precipitation, almost double compared to the multiannual normal for the last 30 years, but in August and

September, the lack of precipitation was acute. The precipitation that fell in 2020 during the vegetation period of the sunflower (April-September) - 275 mm, was the lowest of the three years experienced. Yields, as well as the leaf area, were diminished compared to the other two years, and the correlations were not present at any time of the determination.
Significance was the correlations that showed values of correlation coefficients above 0.380 at P <5% and over 0.490 for P <1%.

Table 1. Coefficients of correlation between leaf area and yield, 2018-2020 period for three time of determination

Year	first determ.		second determ.		third determ.	
	leaf area/ pl	leaf area/ single leaf	leaf area/ pl	leaf area/ single leaf	leaf area/ pl	leaf area/ single leaf
2018	-0.338	-0.155	-0.417	-0.407	-0.382	-0.438
2019	0.456	0.419	0.401	0.517	0.439	0.448
2020	-0.318	-0.325	-0.302	-0.402	-0.210	-0.365

The variability of the leaf area, in the climatic conditions of 2018, is associated with 17% of the variability of yield, in a negative sense. The increase of the leaf area by 1000 cm^2 over 3767 cm^2 leads to the decrease of the yield by 96 kg/ha, at the end of the second decade of June (Figure 1).

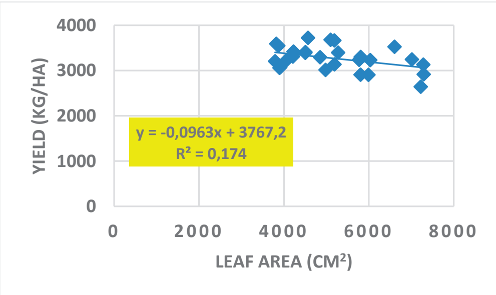

Figure 1. Relationship of leaf area with yield in 2018, second time of determination (20.06.2018)

In 2018, in the third moment of the determination, the variability of the leaf area is associated with 14% of the variability of yield, in a negative sense. The increase of the leaf area by 1000 cm^2 over 3696 cm^2 leads to the decrease of the yield by 62 kg / ha, at the end of the second decade of June (Figure 2).

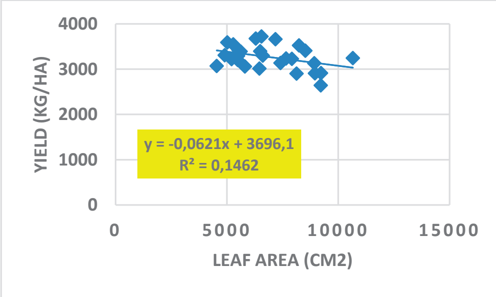

Figure 2. Relationship of leaf area with yield in 2018, third time of determination (3.07.2018)

In 2019, at the first determination, the variability of the leaf area is associated with 16% of the variability of yield, in a positive sense. The increase of the leaf area by 1000 cm^2 over 3200 cm^2 leads to the increase of the production by 82 kg / ha, at the end of the second decade of June (Figure 3).

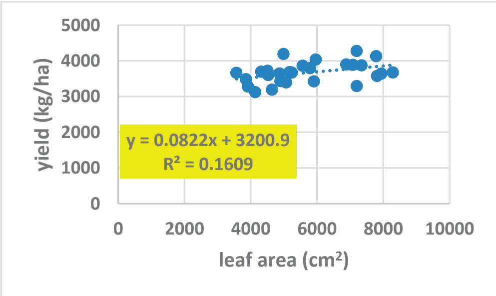

Figure 3. Relationship of leaf area with yield in 2019, first time of determination (18.06.2019)

The variability of the leaf area, in the climatic conditions of 2019, is associated with 21% of the variability of yield, in a positive sense. The increase of the leaf area by 1000 cm^2 over 3104 cm^2 leads to the increase of the yield by 78 kg/ha, at the end of June, for the studied interval (Figure 4).
The variability of the leaf area, in the climatic conditions of 2019, is associated with 19% of the variability of yield, in a positive sense. The increase of the leaf area by 1000 cm^2 over 3114 cm^2 leads to the increase of the yield by 86.5 kg/ha, in the middle of June, for the studied interval (Figure 5).

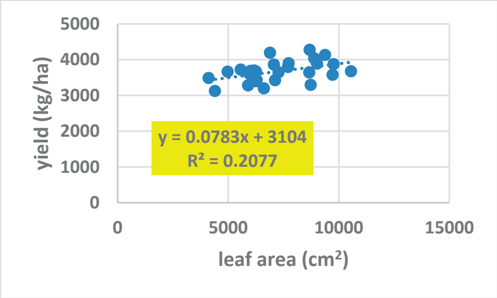

Figure 4. Relationship of leaf area with yield in 2019, second time of determination (28.06.2019)

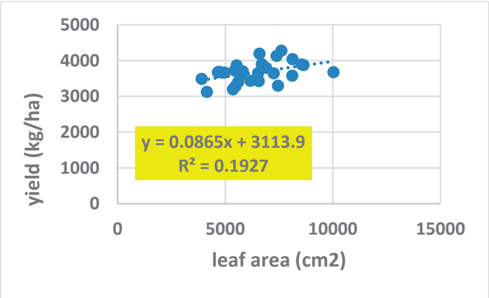

Figure 5. Relationship of leaf area with yield in 2019, third time of determination (12.07.2019)

The graphical representation of the leaf area/yield ratio highlighted three different types from one year to another, depending on the density. In 2018, when the total precipitation during the vegetation period of the sunflower was 385.6 mm, the leaf area increased more accentuated at the first density and gradually from one moment of determination to another.

In 2019 (total rainfall during the vegetation period - 462.2 mm but irregular distributed, with 63 mm in July, August and September), the leaf area has a lower growth rate at the second determination which is located at the end of the June.

The year 2020, which was the poorest in precipitation - 275 mm during the vegetation period, presented another type of development of the leaf area. The increase was more pronounced from the first determination to the second but then experienced a decrease due to premature drying of the foliar apparatus due to the manifested drought, to the third determination (mid-July) (figure 6).

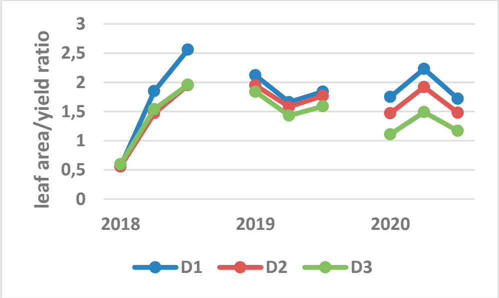

Figure 6. Leaf area / yield ratio (suprafața foliară ce contribuie la formarea unui kg de sământă) in 2018-2020 period at three densities and three moments of determination

The results suggest that the relationship between leaf area and yield at sunflower is influenced very strong by climatic conditions. De asemenea

When correlated leaf area and yield, a percentage of 16-20% of leaf area variability was associated with yield variability.

CONCLUSIONS

The correlation coefficients between the leaf area and yield were differentiated as direction depending on the year of experimentation being significantly positive in 2019 and significantly negative in 2018, given that the correlation was made between 27 values (9 hybrids x 3 densities) for each determination. When correlated, a percentage of 16-20% of leaf area variability was associated with yield variability. Although normally the leaf area is positively correlated with production, the results obtained in this experiment are supported by the fact that the production is higher at medium plant density but the leaf area is higher at low plant density. This aspect is highlighted by the leaf area/yield ratio which shows which leaf area of a plant contributes to the formation of one kilo of sunflower seeds. The highest values of this indicator (over 2 cm^2/plant per kilo of seed) are found at the lowest density. The results suggest that the relationship between leaf area and yield at sunflower is influenced by climatic and technological factors and a large leaf area does not always lead to high yield.

REFERENCES

Bonciu, E., (2019). The behavior of some sunflower genotypes under aspect of variability of the productivity elements, *Current Trends in Natural Sciences*, *8*(15), 68–72.

Bonciu, E., Pandia, O., Olaru, A.L., Rosculete, E., Sărăcin, I., & Rosculete, C.A., (2020 a). The correlation between mitotic activity and yield to *Helianthus annuus* L. *Scientific Papers. Series Management, Economic Engineering in Agriculture and rural development*, *20*(1), 101–104.

Bonciu, E., Pandia, O., Olaru, A.L., Sărăcin, I., Rosculete, E. (2020 b). Some aspects regarding the genetic and biotechnological progress of the *Helianthus annuus* L. *Scientific Papers. Series Management, Economic Engineering in Agriculture and rural development*, *20*(1), 105–110.

Dobre, Ș.C., Marin, I.D. (2020). The dynamics of the green biomass and her relationship with the yield, according to hybrid and plant density at an assortment of sunflower plant, tested on the chernozem of Caracal. *Scientific Papers. Series A. Agronomy, LXIII*(2), 97–102.

Johnson, D.R., Tanner, J.W. (1972). Comparisons of Corn (*Zea mays* L.) Inbreds and Hybrids Grown at Equal Leaf Area Index, Light Penetration, and Population. *Crop Science*, *12*(4), 482–485.

Pârjol Săvulescu, L., (1974). Variability of sunflower resistance to drought. *Proc. of 6th Intern. Sunflower Conference*, July 22-24, 1974, Bucharest, România: 133–143.

Petcu, E., Georgescu, F., Arsintescu, A., Stanciu, D., (2001a). The effect of hydric stress of some characteristics of sunflower plants. *Romanian Agricultural Research*, *16*. 15–22.

Petcu, E., Arsintescu, A., Stanciu, D. (2001b). The effect of drought stress on fatty acid composition in some Romanian sunflower hybrids. *Romanian Agricultural Research*, *15*. 39–42.

Rouphael, Y., Colla., G., Fanasca, S., Karam, F. (2007). Leaf area estimation of sunflower leaves from simple linear measurements. *Photosynthetica*, *45*(2), 306–308.

Ţerbea, M., Balotă, M., Micut, Gh., Petcu, E. (1996). The influence of genotype and sampling date on some physiological traits in wheat, maize and sunflower under drought. *Plant Physiol. and Biochem*., Special Issue: 281.