Scientific Papers. Series A. Agronomy, Vol. LXIII, No. 2, 2020
ISSN 2285-5785; ISSN CD-ROM 2285-5793; ISSN Online 2285-5807; ISSN-L 2285-5785

SEED AND OIL PRODUCTIVITY OF SUNFLOWER (*Helianthus annuus* L.) AS AFFECTED BY THE TIMING OF WEED REMOVAL

Panagiotis KANATAS

Agricultural Cooperative of Mesolonghi-Nafpaktia, 30200, Mesolonghi, Greece

Corresponding author email: pakanatas@gmail.com

Abstract

Sunflower, one of the most important oil crops, is generally considered to be very competitive against weeds. However, this is not valid for all hybrids, weeds and conditions, since in many cases there have been reported yield losses up to 70%. A field study was conducted in western Greece to evaluate growth, grain and oil productivity of sunflower under different weed management treatments (weed free, weed presence for 2, 4 and 8 weeks after sowing). Grain yield of the several treatments resulted to losses up to 64% compared with the weed free plots. Oil concentration was not affected by the presence of weeds, however oil yield was also significantly reduced in the plots with a late weed removal, probably due to the seed yield reduction. The findings of the present study reveal the significant reduction of seed and oil productivity in sunflower due to weed competition and highlight the need of an early weed management.

Key words*: sunflower, seed yield, oil yield, weed competition.*

INTRODUCTION

Sunflower (*Helianthus annuus* L.) is certainly among the most important oil and bioenergy crops with a high oil content and productivity, high non saturated fatty acids content and absence of cholesterol (De la Vega and Hall, 2002; Papatheohari et al., 2016). It is generally considered to be among the most important oil crops, while it has been already subjected to the improvement by plant breeders.

Biotic and abiotic factors such as weeds and water deficit, respectively, can result in huge yield losses to sunflower and consequently, the selection and cultivation of the most competitive and drought resistant hybrids is crucial (Breccia et al., 2011).

In general, sunflower is considered to be a crop of satisfactory competitive ability against the weeds, mostly due to its large height (Elezovic et al., 2012). However, under the real field conditions, competition with weeds can be high, especially with the earliest growing ones and result in seed yield reduction up to 60-70% (Soares et al., 2019). Competition with weeds begins shortly after emergence, while the low number of registered herbicides makes the situation more difficult. Pannacci et al. (2007) have reported high phytotoxicity of several herbicides to several sunflower varieties, while many herbicide-tolerant varieties (like Clearfield and ExpressSun technologies) have already been developed and globally used (Jocic et al., 2011). However, despite such achievements, there is still a lack of available information regarding the effects of weeds and the timing of their control on sunflower growth and productivity.

The main objective of the present study was to evaluate the growth, grain and oil productivity of a sunflower hybrid with a weed presence for different periods under the conditions of Greece.

MATERIALS AND METHODS

The field experiment was conducted during 2017 in Dokimi area of Agrinio (38º 37’ 13’’ N, 21º 22’ 44’’ E). Soil was a clay loam (CL), the physicochemical characteristics of which (0 to 15 cm depth increment) were clay 341 g/kg, silt 488 g/kg, sand 171 g/kg, pH (1:2 H_2O) 7.4, 1.61 g/kg total nitrogen, 0.054 g/kg available phosphorus (P-Olsen) and 0.98 g/kg available potassium. EC was 2810 μmhos, $CaCO_3$ 270 g/kg and organic matter content 19.4 g/kg (Walkley and Black, 1934). The field was irrigated as needed for the sunflower crop, while this year was of moderate rainfall and temperature (not very low and not very high).

Sunflower was sown on 23 April 2017. Sowing was performed by hand in 75 cm rows with

distances within rows of 20 cm. Before sowing, 28 kg N/ha, 15 kg P/ha and 30 kg K/ha were incorporated into the soil. Weed density was moderate, with the dominant weed species being *Chenopodium album*, *Amaranthus retroflexus* and *Echinochloa crus-galli*. These weeds are common for sunflower stands and has been reported by other researchers as well (Tyr and Vavrik, 2015; Jursik et al., 2017). Weed management treatments were: i) weed free, ii) weed presence for 2 weeks, iii) weed presence for 4 weeks and iv) weed presence for 8 weeks after sowing. Weed removal was done by hand-hoeing. The above-mentioned treatments with four replicates were arranged in a completely randomized design with a plot size of 8 m^2.

Several measurements of plant height, leaf area index (LAI) and above-ground plant part biomass were taken from plants in the two center rows of each plot at 40, 60, 80 and 100 days after sowing (DAS). Leaf area was estimated by means of DT-area meter (Delta-T Devices Ltd, Burwell Cambridge, UK), while dry weights were measured after 36 h at 70^{o}C. Harvest was made by hand at 119 DAS and grain yield was measured by harvesting the plants in the two middle rows. Near infrared method was used for oil content measurement. Oil yield was calculated by multiplying seed yields by the concentration of oil in seeds.

Analysis of variance (ANOVA) was conducted for all data and differences between means were separated using Fisher's LSD test at $p < 0.05$. All statistical analyses were conducted using the Statistica 11 software package (StatSoft, Inc. 2300 East 14th Street, Tulsa, OK 74104, USA).

RESULTS AND DISCUSSIONS

The findings of the present study revealed some significant ($p < 0.05$) differences between the several weed management treatments regarding the growth and the yield of sunflower. In particular, weed presence for two weeks had no adverse effects on sunflower's growth, at least for the most cases. However, when removal of the weeds was at 4 or 8 weeks after crop sowing, then plant height, leaf area and dry weight of the plants was significantly lower than the weed-free plots and the plots with a weed presence for two weeks (Table 1).

Table 1. Growth parameters for the several treatments at 60 DAS. Different low case letters in each row denote statistically significant differences between the means ($p < 0.05$)

Growth parameter	Weed free	Weed presence for 2 weeks	Weed presence for 4 weeks	Weed presence for 8 weeks
Plant height (cm)	133 a	125 a	109 b	98 c
LAI	2.6 d	2.1 e	1.7 f	1.4 g
Biomass (g)	128 h	116 h	97 i	78 j

Concerning seed yield, this was significantly reduced as a result of weed competition. Particularly, as shown in Table 2, grain yield of sunflower in the weed-free plots was up to 4.78 tn/ha. However, in the cases of weed removal at 2, 4 and 8 weeks after sowing, yield was reduced by 34, 53 and 64%, respectively. Regarding oil concentration, this was not affected by weed presence and ranged from 37.65 to 39.23%. On the contrary, oil yield was also significantly reduced in the plots with a late weed removal, probably due to the seed yield reduction. Thus, oil yield in the weed free plots was 32, 54 and 74% higher than the plots with a presence of weeds for 2, 4 and 8 weeks after sowing, respectively (Table 2).

Nalewaja et al. (1972) have sown that weed removal at 2, 4, 6 and 8 weeks after crop emergence resulted in yield reductions by 8, 25, 29 and 33% compared to the weed-free plots. Our findings are also in accordance with previous studies highlighting the importance of the first weeks after planting, with a total prevention period of interference ranging from 26 to 43 days (Elezovic et al., 2012). In all cases, yield reductions are related to the weed density, the weed species present (more or less competitive), the cultivated hybrids and varieties and the specific soil and climatic conditions.

It seems that despite the plant height, sunflower needs to emerge and grow at least for the first weeks with the minimum weed presence. Biotic factors like weeds and abiotic stresses are considered major yield limiting factors for sunflower crop and therefore ought to be taken into account. Our findings highlight the importance of early weed management and

agree with previous studies showing that the efficacy of several herbicides against many common weeds of sunflower crop (like *C. album*, *E. crus-galli* and *A. retroflexus*) was strongly affected by the growth stages of weeds (Jursik et al., 2017). Therefore, an earlier weed control ensures a higher efficacy of herbicides (in the case of chemical control) and allows a better growth and productivity of sunflower crop due to the absence of weed competition for a longer period.

Harvest measurements also showed that there was not any significant difference between the treatments regarding oil concentration. This is something that could be attributed to the fact that oil content (and even fatty acid profile) of sunflower is known to be mainly affected by the hybrid (Skoric, 1992; Izquierdo et al., 2002).

Table 2. Grain and oil productivity parameters for the several treatments. Different low case letters in each row denote statistically significant differences between the means ($p < 0.05$)

Yield parameter	Weed free	Weed presence for 2 weeks	Weed presence for 4 weeks	Weed presence for 8 weeks
Grain yield (t/ha)	4.78 a	3.17 b	2.24 c	1.72 d
Thousand grain weight TGW (g)	60.12 e	58.34 ef	58.14 ef	55.77 f
Oil concentration (%)	38.24 g	39.23 g	37.65 g	38.78 g
Oil yield (t/ha)	1.83 h	1.24 i	0.84 j	0.47 k

CONCLUSIONS

The results of the present study revealed that even the highly productive sunflower hybrids like 'PR63A90' suffer from weed competition. In particular, even a small delay of weed control can cause significant reductions to both the growth and productivity of the crop. Yield losses due to weed presence were from 34 to 64%. It is noticeable that even a delay of weed control for 2 weeks resulted in a yield reduction of 34%. On the contrary, oil concentration was not affected by the presence of weeds, however oil yield was significantly reduced in the plots with a late weed removal, probably due to the seed yield reduction. In particular, later weed removal resulted in oil yield reduction by 32 to 74%. Consequently, the need of an early weed management is imperative and crucial for the successful establishment, growth, productivity and quality of sunflower.

ACKNOWLEDGEMENTS

Thanks to the comments and suggestions of peer reviewers that gave of their time to ensure that the manuscript was strengthened via their insights.

REFERENCES

Breccia, G., Vega, T., Nestares, G., Mayor, M.L., Zorzoli, R., Picardi, L. (2011). Rapid test for detection of imidazolinone resistance in sunflower (*Helianthus annuus* L.). *Plant Breeding*, *130*, 109–113.

De la Vega, A. J., Hall, J. (2002). Effects of planting date, genotype, and their interactions on sunflower yield: I. Determinants of oil-corrected grain yield. *Crop Science*, *42*, 1191–1201.

Elezovic, I., Datta, A., Vrbnicanin, S., Glamoclija, D., Simic, M., Malidza, G., Knezevic, S.Z. (2012). Yield and yield components of imidazolinone-resistant sunflower (*Helianthus annuus* L.) are influenced by pre-emergence herbicide and time of post-emergence weed removal. *Field Crops Research*, *128*(3), 137–146.

Jocic, S., Malidza, G., Cvejic, S., Hladni, N., Miklic, V., Skoric, D. (2011). Development of sunflower hybrids tolerant to tribenuron methyl. *Genetika*, *43*, 175–182.

Jursik, M., Fendrychova, V., Kolarova, M., Andr, J., Soukup, J. (2017). Optimising Clearfield and ExpressSun sunflower technologies for central European conditions. *Plant Protection Science, 53*(4), 265–272.

Izquierdo, N., Aquirrezabal, L., Andrade, F., Pereyra, V. (2002). Night temperature affects fatty acid composition in sunflower oil depending on the hybrid and the phenological stage. *Field Crops Research*, *77*, 115–126.

Nalewaja, J.D., Collins, D.M., Swallers, C.M. (1972). Weeds in sunflowers. *Farm Research*, 3–6.

Pannacci, E., Graziani, F., Graziani, F., Covarelli, G. (2007). Use of herbicide mixtures for pre- and post-emergence weed control in sunflower (*Helianthus annuus*). *Crop Protection*, *26*, 1150–1157.

Papatheohari, Y., Travlos, I.S., Papastylianou, P., Argyrokastritis, I.G., Bilalis, D.J. (2016). Growth and yield of three sunflower hybrids cultivated for two years under Mediterranean conditions. *Emirates Journal of Food and Agriculture*, *26*(2), 136–142.

Skoric, D. (1992). Achievements and future directions of sunflower breeding. *Field Crops Research*, *30*, 231–270.

Soares, M.M., Freitas, C.D.M., De Oliveira, F.S., De Mesquita, H.C., Silva, T.S., Silva, D.V. (2019). Effects of competition and water deficiency on sunflower and weed growth. *Revista Caatinga*, *32*(2), 318–328.

Tyr, S., Vavrik, D. (2015). Chemical weed control of sunflower stands. *Research Journal of Agricultural Science*, *47*(1), 243–251.

Walkley, A., Black, I.A. (1934). An examination of Degtjareff method for determining soil organic matter and a proposed modification of the chromic acid titration method. *Soil Science*, *37*, 29–37.