THE INFLUENCE OF THE MICROCLIMATE CREATED BY THE FOREST BELT ON WEED INFESTATION IN THE SUNFLOWER CROPS

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Abstract: The establishment of protective belt and the setting of crops within the microclimate created by them, also favourable to sunflower crop, represent one of the most effective measures for mitigating the effects of drought in Dobroudja region. The researches were carried out at Amzacea, Constanta County, in sunflower crops cultivated in the forest belt system. For each plot there have been drawn up weed infestation sheets that indicate the density, participation and the constancy. The data has been centralized for the determination of dominant species and problem weed species that require treatments. Data analysis showed that 16 species of weeds were identified, which, due to the favorable microclimate created mainly by reducing evapotranspiration, exceeded 190 plants per square meters. The *Chenopodium vulvaria* species, which had a density of 8 plants per square meters in sunflower cultivated plots without belt, became the dominant weed exceeding 20 plants per square meters and participating with *C. album* species almost 20% in weed infestation process. Due to the water conservation in the soil, the black nightshade (*Solanum nigrum),* a moisture species has doubled its density from 6% in sunflower plots without belt to 15% in plots between belts. The problem weeds identified in sunflower cultivated within the forest belts were *C. vulvaria*, *C. album*, *Amaranthus* spp., *Polygonum* spp., *S. nigrum*, *Convolvulus arvensis* and *Setaria* spp. Species that predominantly spread by the wind had a higher density in the plots within forest belt: *Xanthium italicum*, *Cirsium arvense, Sonchus* spp.

Keywords: *Forest belts, weeds, sunflower crops*

INTRODUCTION

Nowadays, the effects of climate changes are already felt. They manifest in enduring hot summers along with long terms of droughts in summer mainly in the southern and eastern parts of the country. Maintainance of high level and good quality of agricultural productivity under these circumstances has become a great challenge for the present-day Romanian agriculture. In this context, Dobroudja is classified as agro-environmentally sensitive area (Albu et al., 2010). The high ratio of "risky" territories from Romania demonstrates the strong need for development in rural areas, among others the implementation of innovative agricultural technologies able to mitigate climate effects and increase social-economical sustainability. Agroforest has been seen as an option to work at the interface of these challenges. International studies have shown that this system has the potential to maintain productivity and improve ecological functions in agricultural landscapes, while helping to mitigate climate change impacts (Abrudan, 2007; Slee, 2012; Alam et al., 2014).

In Romania`s agriculture, the sunflower crop occupies a significant area, being the second, as a proportion, in the group of hoed crops. The productiveness potential of hybrids is influenced by the level of moisture, physical and chemical properties of the soil, as well as the previous crop (Vrânceanu & Stoienescu, 1972; Vrânceanu, 1974, 2000). Sunflower is very widespread owing to its ability to adapt to different environmental conditions.

Several sunflower crop areas are distinguished in Romania, including the Dobroudja area, which is in Favorable Area I, because it ensures optimal temperature requirements, the moisture requirements being covered only under irrigation conditions (Hera et al., 1989). In fact, one of the main risk factors for Dobroudja's agricultural crops is drought. One of the most effective measures for mitigating the effects of drought is the establishment of forest belts and the location of crops in the microclimate created by them (Whiteman, 2000; Dănescu et al., 2007). Numerous researches exist about the benefic part of forest-belt concerning the agricultural crops (Lupe, 1953), about reducing wind speed and the aerothermical regime of soil (Neșu, 1999). Protective belts play an important role in increasing crop yield by protecting the land against wind and snow, by restraining and controlling wind erosion, by increasing soil moisture at the beginning of the agricultural season, by reducing the depth and duration of frost, by reducing evapotranspiration and improving the microclimatic conditions for growth and development of agricultural crops.

When setting sunflower crop technology, it is of particular importance to establish the method of weed control, without neglecting the choice of hybrids, the sowing season, soil works, fertilizers, phytosanitary treatments against diseases and pests (Bîlteanu, 1974, 2001, 2003; Bîlteanu & Bîrnaure, 1989; Bîlteanu et al., 1991; Ștefan, 2003; Axinte et al., 2006; Ștefan et al., 2008). The sunflower has a slower growth rate of the stem until the floral button appears 30-40 days from the emergence, during this period there is a danger for the crop to be weed-infested (Gologan & Dornescu, 1981; Schneiter et al,. 1981, Berca, 2004). After this period, the danger of infestation disappears due to the fact that the plants cover the soil very well, preventing the emergence of weeds (Farizo et al., 1980). Research in many sunflower grower countries, including Romania, showed that weeds, depending on the degree of field infestation, reduce the biologic potential of hybrids by 70-90% (Ionescu-Şişeşti, 1955; Anghel et al., 1972; Şarpe, 1976; Berca, 1996, 1998, 2004; Ionescu et al., 1996, 2000; Berca &Tanase, 2000; Ionescu et al., 1997).

In this context, the research aimed to evaluate the weed species in the sunflower crops placed in the system with forest belts and to determine the influence of their microclimate on the density and the dynamics of the degree of weed infestation.

MATERIALS AND METHODS

Trials were conducted at Amzacea, Constanta County, where there are forest belts and farmers cultivate sunflower in the microclimate created by them. Identification and monitoring of weeds were carried out by mapping using the numerical method in spring in sunflower crops with and without forest belts, 8 determinations/ha being made.The sunflower fields were cultivated by private farmer according to its own technologies. For each field, lists of weed infestation have been done and they present both general data on the location, the soil type, the previous crop and specific data on the density, participation and constancy of weed species, class (monocotyledonous or dicotyledonous) as well the life period of each weed (annual, biennial, or perennial). For sampling and weeds inventory, the metric frame was used. Each sampling point was established by going through the field in 1-2 diagonals according to the number of specified samples. At the final stage, the data obtained from all the analyzed samples were centralized. Finally, the weeds were distributed in density categories in descending order to identify the dominant species and the problem weeds, the results obtained by mapping being an important tool in making the most appropriate weed control measures in a crop.

RESULTS AND DISCUSSIONS

Being a hoed plant, sunflower is infested every year by monocotyledonous and dicotyledonous weed species, some of them being problem weeds, difficult to combat (Coste, 1998; Chirila, 2001; Berca, 2004; Slonovschi et al., 2001, Roman et al., 2012). Sunflower, compared to other crops, has a peculiarity concerning weed competition, in the sense that they can compete with plants only for 3-5 weeks after emergence, called the critical period of infestation. By proceeding with control measures during this period, the plant grows normally without being competing (Bondarev, 1987). Following the determinations made in the sunflower crop grown out of forest belts, 22 weed species were identified which, due to the drought, had a moderate density of 145 plants/sqm (Table 1).

Table 1. Weeds in sunflower crop grown without forest belts

No. crt.	Species	No.plants/ sqm	P (%)	K (%)	Botanical group
1.	*Chenopodium album*	16	14.5	87.5	AD
2.	*Amaranthus blitoides*	12	10.5	50.0	AD
3.	*Chenopodium vulvaria*	8	6.0	37.5	A D
4.	*Polygonum convolvulus*	8	6.0	25.0	AD
5.	*Solanum nigrum*	6	4.0	25.0	AD
6.	*Sinapis arvensis*	6	4.0	25.0	AD
7.	*Sonchus oleraceus*	5	3.0	25.0	AD
8.	*Xanthium strumarium*	5	3.0	25.0	AD
9.	*Amaranthus retroflexus*	4	3.0	12.5	AD
10.	*Galisoga parviflora*	4	2.0	12.5	AD
11.	*Hibiscus trionum*	4	2.0	12.5	AD
12.	*Xanthium italicum*	2	1.0	12.5	ADI
13.	*Abutilon theophrasti*	2	1.0	12.5	AD
14.	*Polygonum persicaria*	2	1.0	12.5	AD
15.	*Raphanus raphanistrum*	2	1.0	12.5	AD
16.	*Convolvulus arvensis*	10	8.0	50.0	PD
17.	*Cirsium arvense*	8	6.0	50.0	DP
18.	*Sonchus arvensis*	5	2.0	25.0	PD
19.	*Setaria spp.*	16	10.0	87.5	AM
20.	*Echinochloa crus-galli*	10	6.0	50.0	AM
21.	*Digitaria sanguinalis*	5	3.0	12.5	AM
22.	*Sorghum halepense*	5	3.0	12.5	PMI
Total		145	100	-	-

Legend	**No. plants/sqm** = density
	P% = the proportion in which each species participates to general infestation
	K% = the proportion in which each species is found in observation points regardless of their number
	PM = perennial monocotyledonous
	AM = annual monocotyledonous
	AD = annual dicotyledonous
	PD = perennial dicotyledonous; **I** = invasive species

In order to identify the problem weed species to which specific control measures must be applied, the weed species determined were divided into three density categories (Table 2).

The first category (red color) included 5 species that are actually the problem weeds identified in sunflower crops grown without forest belts, with densities ranging from 10 to 20 plants/sqm: *Chenopodium album*, *Amaranthus blitoides*, *Convolvulus arvensis*, *Setaria viridis* and *Echinochloa crus-galli*. The second category (green color) with a density of 5-10 plants/sqm was the most numerous comprising 10 species of weeds and the third category with low densities of 1-5 plots/sqm included 7 species of weeds (blue color).

Table 2. Distribution of weed species by density (Sunflower without protective belts)

Density (no.plants/sqm)	Species
10 - 20	*Chenopodium album, Amaranthus blitoides, Convolvulus arvensis, Setaria viridis, Echinochloa crus-galli*
5 - 10	*Chenopodium vulvaria, Polygonum convolvulus, Solanum nigrum, Sinapis arvensis, Sonchus oleraceus, Sonchus arvensis, Xanthium strumarium, Cirsium arvense, Digitaria sanguinalis, Sorghum halepense*
1 - 5	*Amaranthus retroflexus, Galisoga parviflora, Hibiscus trionum, Xanthium italicum, Abutilon theophrasti, Raphanus raphanistrum, Polygonum persicaria*

When sunflower was placed in forest belts system, there were identified only 16 weed species, which due to favorable microclimate, especially by reducing evapotranspiration, were more numerous and vigorous, exceeding 190 plants/sqm (Table 3).

Thus, the *Chenopodium vulvaria* species, which in sunflower crop grown without forest belts had a density of 8 plants/sqm, became dominant weed exceeding 20 plants/sqm and participated with *C. album* with almost 25% to the general weed infestation of the crop.

Table 3. Weeds present in sunflower cultivated plots within forest belts

No. crt.	Species	No.plants/ sqm	P %	K %	Botanical group
1.	*Chenopodium vulvaria*	22	14.5	100	AD
2.	*Chenopodium album*	18	10.0	87.5	AD
3.	*Amaranthus spp.*	20	12.5	87.5	AD
4.	*Polygonum spp.*	20	12.5	87.5	AD
5.	*Solanum nigrum*	15	8.5	62.5	AD
6	*Xanthium italicum*	7	2.0	25.0	ADI
7.	*Xanthium strumarium*	5	1.5	12.5	AD
8.	*Ambrosia artemisiifolia*	4	1.0	12.5	ADI
9.	*Convolvulus arvensis*	16	8.0	62.5	PD
10.	*Cirsium arvense*	12	6.0	50.0	PD
11.	*Cardaria draba*	4	1.0	12.5	PD
12.	*Rubus caesius*	4	1.0	12.5	PD
13.	*Setaria spp.*	20	12.5	87.5	AM
15.	*Echinochloa crus-galli*	10	4.0	12.5	AM
14.	*Sorghum halepense*	10	4.0	12.5	PMI
16.	*Agropyron repens*	4	1.0	12.5	PM
Total		**191**	**100**	-	-

The weeds of the *Chenopodiaceae* family were followed as dominancy by the *Amaranthus* and *Polygonum* species with a density of 20 plants/sqm each. Compared to the species determined in sunflower cultivated plot without belts, several species were present in the Amaranthaceae family: *A. clorostachis*, *A. blitoides*, *A. retroflexus* and *A. albus*, and in *Polygonaceae*: *P. convolvulus*, *P. lapathifolium* and *P. aviculare*. Due to the conservation of water in the soil, *S. nigrum* species doubled its density from 6% in plots without belts to 15% in sunflower cultivated plots within belts (Table 3).

Owing to the forest belts that prevent the spread of weed seeds, the species that predominantly spread by the wind had a higher density: *X. italicum*, *C. arvense*, *Sonchus* spp. It also emergenced weed species that found optimal growth conditions and development even within the belts, respectively *Cardaria draba* from Brassicaceae family, a dangerous perennial weed which was included in the list of quarantine weeds in 1972 and *Rubus caesius* from the Rosaceae family, perennial weeds difficultly to fight against. The invasive species *Xanthium italicum* had a much higher density, exceeding 7 plants/sqm. In addition to the invasive species *S. halepense*, there was also found *Agropyron repens* of the same class, respectively perennial monocotyledonous with a low density but hard to fight and which became permanent in the forest belts and at the edge of them, from where they easily get into agricultural crops. There was also the broomrape, a parasitic species (*Orobanche*) but in small numbers and especially in plots sowed with more sensitive hybrids. Due to the preservation of water in the soil, some *C. albus* weeds heights excedeed 2 m being robust and vigorous. *Ambrosia artemisiifolia* with low density was also present. The annual ragweed showed the tendency to invade crops and produces major damages to corn, cereals, potato, sugar beet crops, but predominates in sunflower crops because both species belong to the Asteraceae family. In Romania the species was included in the list of quarantine weeds in 1972 but the measures for the prevention and control of its invasion either completely lacked or were ineffective or not fully researched (Dihoru, 2004).

In order to identify the problem weed species, they were assigned to 4 density categories (Table 4). The problem weeds identified in Constanta County, in the sunflower plots within the belts and against which specific measures of control should be taken, were *C. vulvaria*, *C. album*, *Amaranthus* spp., *Polygonum* spp., *S. nigrum*, *C. arvensis* and *Setaria* spp.

Table 4. Distribution of weed species by density (Sunflower within protective belts)

Density (no.plants/sqm)	Species
15 - 20	*Chenopodium vulvaria, Chenopodium album, Amaranthus* spp., *Polygonum* spp., *Solanum nigrum, Convolvulus arvensis, Setaria* spp.
10 - 15	*Cirsium arvense, Sorghum halepense, Echinochloa crus-galli*
5 - 10	*Xanthium italicum, Xanthium strumarium*
1 - 5	*Ambrosia artemisiifolia, Agropyron repens*

Compared to sunflower without belts, a new density category of 10-15 plants/sqm also occurs, which includes furthermore difficult species to fight, harmful to crop: *C. arvense* perennial with adventitious root buds, *S. halepense* perennial with rhizomes and *E. crus-galli* annual with a great twin capacity found in all areas and in all crops.

Regarding the distribution of weeds by botanical groups in sunflower without protective belts the annual dicotyledonous prevailed, being present 15 species with a density of 86 plants/sqm and a percentage of participation in the general weed infestation of 62%, followed by the annual monocotyledonous group containing 3 species with a density of 31 plants/sqm and the perennial dicotyledonous group also with 3 species but with a density of 16 plants/sqm. In the sunflower plots within the forest belts the annual dicotyledonous predominated, too, with only 8 species present with a percentage participation in the general infestation higher than 62%, followed by the perennial dicotyledonous species with 36 plants/ sqm and annual monocotyledonous group with 36 plants/sqm (Figure 1 and Figure 2).

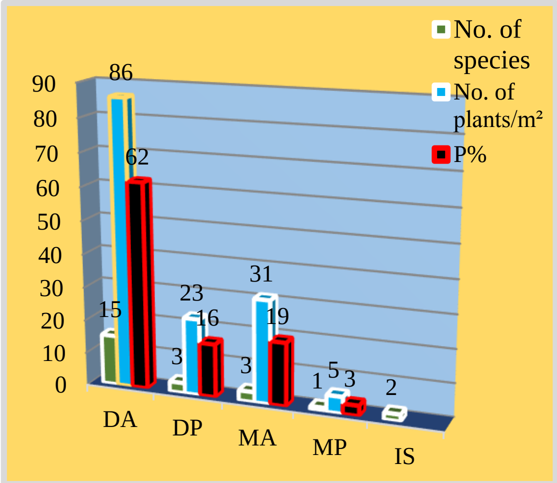

Figure 1. Distribution of weeds by botanical groups in sunflower without protective belts

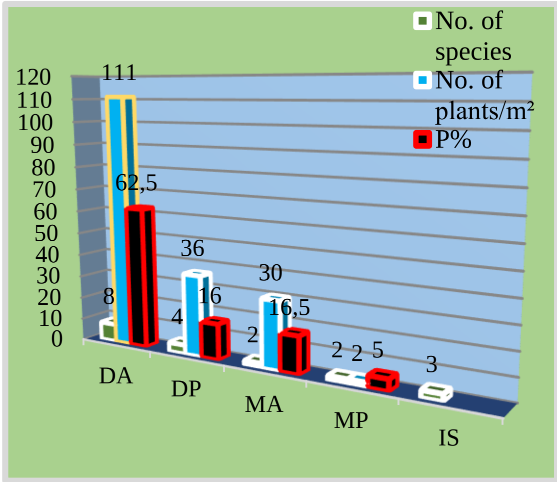

Figure 2. Distribution of weeds by botanical groups sunflower within protective belts


Xanthium italicum


Solanum nigrum


Chenopodium album


Chenopodium vulvaria


Orobanche spp.


Polygonum convolvulus and *Orobanche* spp.

Figure 3. Weeds species found in sunflower crops grown in forest belts system

CONCLUSIONS

In the sunflower crop without forest belts 22 weed species were identified which 145 plants/sqm respectively.

Annual dicotyledonous weeds prevailed, 15 species being present with a density of 86 plants/sqm and a degree of participation in general weed infestation of 62%, followed by the group of annual monocotyledonous ones which had 3 species with a density of 31 plants/sqm and the group of the perennial dicotyledonous ones again with 3 species but with a density of 16 plants/sqm.

Problem weeds in sunflower crops without forest belts in Constanta County were: *Chenopodium album, Amaranthus blitoides, Convolvulus arvensis, Setaria viridis* and *Echinochloa crus-galli*.

In the sunflower crop within forest belts, only 16 species of weeds were identified, which due to the favorable microclimate created mainly by reducing evapotranspiration, were more numerous and vigorous, exceeding 190 plants/sqm.

The species *Chenopodium vulvaria*, which in sunflower plots without belts had a density of 8 plants/sqm, became the dominant weed of more than 20 plants/Sqm and together with *Chenopodium album* to almost 25% of crop general weed infestation.

In the forest belts and at the edge of them, the species of *Festuca* genus were predominant, accompanied by other species with lower density*: Hypericum perforatum, Anthemis tinctoria, Veronica hederifolia, Rubus caesius, Lithospermum officinale, Melilotus* spp., *Agropyron repens, Lapsana communis* and *Trifolium pratense*.

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