MILK THISTLE (*SILYBUM MARIANUM* (L.) GAERTN.) AS A WEED IN SUSTAINABLE CROP ROTATION

T. VEREŠ, Š. TÝR

Slovak Agricultural University in Nitra, Slovak Republic
Faculty of Agrobiology and Food Resources,
Slovak Agricultural University in Nitra,
Tr. A. Hlinku 2, 949 76 Nitra, Slovak Republic,
E-mail: Tomas.Veres@uniag.sk

Abstract: *Milk thistle – Silybum marianum (L.) Gaertn. can be a winter annual or a biennial medicinal plant. The assessment of the occurrence of milk thistle in sustainable crop rotation was conducted at the Experimental Base of Faculty of Agrobiology and Food Resources, SUA in Nitra in the years 2008- 2011. This study was focused on milk thistle as a weed in the sustainable farming system with the crop rotation of maize for grain, pea for grain, durum wheat and milk thistle. An actual weed infestation of maize, pea and durum wheat stands with milk thistle was evaluated before preemergence application of herbicides, in the spring time. Second screening of actual weed infestation of all stands in sustainable crop rotation with milk thistle was done before crops harvest. Screening of each field was made on 1 m^2 area with three replications. The three randomly established sample quadrants were situated minimally 10 m from field margin and apart from each other, respectively. The level of infestation was evaluated according to average density of weeds per square meter. Obtained data was statistically analyzed by Statistica 7.0, ANOVA, LSD test (p=0.05). As a plant from the family Asteraceae has a great anticipation to have vital seeds in soil profile for long time as well as Helianthus annus. On the base of our 4 vegetation periods research, we can conclude that the S. marianum seeds are vital in soil profile for three and more years. We can also conclude that in third year after milk thistle cropping was no infestation of durum wheat, but S. marianum germinate after the harvest of durum wheat at the stubbles in August or September. According to statistical analyses in the year 2010 was the maize stands infested with the highest, statistically very significant amount of Silybum marianum (7 plants per m^2). Stands of pea for grain in the second year after milk thistle cropping were infested in the years 2008-2010 only with 0.33 plants per m^2. Durum wheat stands were not infested with milk thistle. In the spring time the infestation of maize for grain, pea for grain and durum wheat stands with milk thistle falled very significantly down from 17.78 plant pre m^2 in maize stand to 2.56 plant pre m^2 in durum wheat stand. The originality of this paper is in the examination of new perspective crop in sustainable farming systems and in evaluating of its weed potential.*

Key words**:** *weed infestation, Sylibum marianum L. Geartn., sustainable crop rotation*

INTRODUCTION

Milk thistle (*Silybum marianum* [L.] Gaertn.) can be a winter annual or a biennial herb (YOUNG et al., 1978; AUSTIN et al., 1988; GROVES, KAYE 1989). Its current distribution includes most temperatures areas of the world (CHAMBREAU, MACLAREN, 2007). It is a broad-leaved species belonging to *Asteraceae* that reaches a height of 200-250 cm (OMIDBAIGI, NOBAKHT, 2001). Milk thistle is grown commercially as a medicinal plant in Europe, Egypt, China and Argentina but it has been reported as a noxious weed in many other countries (KHAN et al., 2009).

Milk thistle is a medicinal plant cultivated in agriculture. It is the most researched plant for the treatment of liver disease. The achenes, i.e. fruits of the plant, are commonly used as a medicinal drug; they are the raw material for isolation of different substances with liver-protection activity. Its therapeutic properties are due to the presence of silymarin. The seeds

contain the highest amount of silymarin, but the whole plant is used medicinally. Milk thistle is grown successfully on a range of soil types, from sandy soils to much heavier clay soils. Milk thistle is directly seeded in soils. Sowing occurs in autumn and spring, and row spacing is usually 40 – 75 cm, with 20 – 30 cm between plants in the row. Nutrient requirements of this crop are low to moderate since it is adapted to poor quality soils and many different growing conditions. Milk thistle is good forecrop for maize in sustainable agricultural system. A limiting factor in milk thistle production is weed interference. Pendimethalin and metribuzin herbicides are safe for weed control in milk thistle, both alone and in combination. Milk thistle is considered drought resistant and normal rainfall will often suffice. In a Mediterranean environment, under severe drought conditions, the crops should be irrigated during seed growth and filling. Moreover, a few varieties of milk thistle have been developed (CARRUBBA et al., 1987; HABÁN et al., 2009; KARKANIS et al., 2011; MACÁK et al., 2007).

It is considered to be ruderal, or weedy, in its native range, is found in dense stands along roadsides and waste areas, and it prefers fertile soils (GABAY et al., 1994).

In this study we focused on milk thistle as a weed in the sustainable farming system with the crop rotation of maize for grain, pea for grain, durum wheat and milk thistle.

MATERIAL AND METHODS

The assessment of *Silybum marianum* (L.) Geartn occurrence in sustainable crop rotation (Table 1) was conducted at the Experimental Base of Faculty of Agrobiology and food resources, Slovak University of Agriculture in Nitra in the years 2008- 2011. Experimental base is situated in cadastre of Dolná Malanta village near Nitra, Slovakia (18°07'E, 48°19'N). Geographically, this locality is situated in the western part of the river Žitava upland. The experimental locality has flat character with little declination to south. The altitude is 177 – 180 m above sea level (Hanes et al., 1993).

The weed mapping was realized in the framework of agri-climatic areas in the territory with the following features: Macro area: warm with the sum of temperature during days when t > 10°C in a range of 3,100 – 2,400°C; Area: predominantly warm with temperature t > 15°C in a range of 3,000 – 2,800°C; Sub area: very dry with climatic humidity factor for the months June–August KVI – VIII = 150 mm; Ward: predominantly mild winter with the average of absolute temperature minimum Tmin. = from – 18 to – 21°C. The average annual temperature in 2004 was 10.0°C, in 2005: 9.6°C, in 2006: 10.1°C, and in 2007: 11.4°C. The sum of annual precipitations was: in 2004: 514.5 mm, in 2005: 633.0 mm, in 2006: 507.0 mm, and in 2007: 606.4 mm. The average long – term (1961–1990) annual precipitation is 532.5 mm, for the vegetation period it is 309.4 mm. The average long – term (1961 – 1990) annual temperature is 9.8°C and for the vegetation period it is 16.4°C (Špánik et al., 1996).
Type of the soil is brown soil; selected soil properties were: proportional soil weight 2.60 – 2.63 $t.m^{-3}$ content of humus in arable soil/topsoil 1.95 – 2.28%; soil reaction 5.03 – 5.69 (acidic, almost mild acidic). The experimental soil was created at the proluvial sediments. The soil profile of brown soil contains three genetic horizons (Ap, Bt, C). Their stratography is following: humus horizon (Ap) with the depth of 0–0.32 m; underneath is the main diagnostic luvisolic horizon (Bt), which was created as a result of alluvial accumulation of translocated colloids, and whose depth is from 0.33 to 0.65 m; then, there is a transitional horizon (Bt/C) with the depth from 0.66 to 0.85 m followed continually with the soil forming substrate up to the depth of 1.5 m. The studied brown soil is clayey in its sub – layer and in its topsoil is mildly firm. Humus is of a humo – phulvate type (HANES et al., 1993).

An actual weed infestation of maize, peas and durum wheat stands with milk thistle was evaluated before preemergence application of herbicides, in the spring time. Second screening of actual weed infestation of all stands in sustainable crop rotation with milk thistle

was done before crops harvest. Screening of each field was made on 1 m^2 area with three replications. The three randomly established sample quadrants were situated minimally 10 m from field margin and apart from each other, respectively. The level of infestation was evaluated according to average density of weeds per square meter (Table 2). Obtained data was statistically analyzed by Statistica 7.0, analysis of variance (ANOVA), LSD test (p=0.05).

Table 1

Sustainable crop rotation on the Experimental Base Dolná Malanta

2008	2009	2010	2011
Pea for grain	Durum Wheat	Milk Thistle	Maize for grain
Maize for grain	Pea for grain	Durum Wheat	Milk Thistle
Milk Thistle	Maize for grain	Pea for grain	Durum Wheat
Durum Wheat	Milk Thistle	Maize for grain	Pea for grain

Table 2

Evaluation scale of actual weed infestation

Group of weeds*	Actual weed infestation				
	none	weak	low	medium	heavy
	Infestation level				
	0	1	2	3	4
	Number of weeds per m^2				
Excessively dangerous	-	≤ 2	3-5	6-15	≥ 16
Less dangerous	-	≤ 4	5-8	9-20	≥ 21
Less important	-	≤ 8	9-15	16-30	≥ 31

*- weed species checklist Hron-Vodák, 1959, modified by authors Smatana-Týr, 2011.

RESULTS AND DISCUSSIONS

Milk thistle (*Sylibum marianum* L. Gaertn.) was in sustainable crop rotation the forecrop for maize for grain. Because of this the highest infestation with *S. marianum* was determined in maize for grain stands. The amount of *Sylibum marianum* seeds in the soil seed bank fall statistically significantly down during the planting of cultural crops in the second and third year after milk thistle (Table 3).

Table 3

Number of *Sylibum marianum* (L.) Gaertn. plants per m^2 in sustainable crop rotation in the spring time in three different crops (LSD test, p=0.05)

Crop	Number of SYLMA plants per m^2 in the spring time
Maize for grain	17.78 C
Pea for grain	8.11 B
Durum Wheat	2.56 A

The highest amount of *Sylibum marianum* weeds before harvest was statistically very significant in the year 2010 and in maize for grain stand (table 4; table 5).

Table 4

Number of *Sylibum marianum* (L.) Gaertn. plants per m^2 in sustainable crop rotation before harvest in the years 2008-2010 (LSD test, p=0.05)

Year	Number of SYLMA plants per m^2 before harvest
2008	0.9 A
2009	0.9 A
2010	2.5 B

Table 5

Number of *Sylibum marianum* (L.) Gaertn. plants per m^2 in sustainable crop rotation before harvest in different crops (LSD test, p=0.05)

Crop	Number of SYLMA plants per m^2 before harvest
Maize for grain	3.89 B
Pea for grain	0.33 A
Durum Wheat	0 A

According to statistical analyses (Table 6) in the year 2010 was the maize stands infested with the highest statistically very significant amount of *S. marianum* (7 plants per m^2). Stands of pea for grain in the second year after milk thistle cropping were infested in the years 2008-2010 only with 0.33 plants per m^2. Durum wheat stands were not infested with *Sylibum marianum*.

Table 6

Interaction between year and crop affected by number of *Sylibum marianum* (L.) Gaertn. plants per m^2 in sustainable crop rotation before harvest in different crops (LSD test, p=0.05)

Number of SYLMA plants per m^2 before harvest	2008	2009	2010
Maize for grain	2.33 B	2.33 B	7.0 C
Pea for grain	0.33 A	0.33 A	0.33 A
Durum Wheat	0 A	0 A	0 A

Silybum marianum is not only cultivated crop which suffer from crop – weed competition but *Sylibum marianum* is also important weed of grains (winter wheat) (MARTWAT et al., 2007). It's a serious weed in many areas of North and South America, Africa, Australia, Asia and Middle East (HOLM et al., 1997). It can be found as a garden ornamental and shows up in flower and vegetable seed packets. Once milk thistle has found a niche, it is a competitive thistle and tends to establish in tall dense patches that eliminate other plant species, either by shading or by competition for water and nutrients (BERNER et al., 2002).

CONCLUSIONS

Milk thistle (*Silybum marianum* (L.) Gaertn.) was ranged into sustainable crop rotation, because of integrated soil management and economical rentability of its cropping. *S. marianum* as medicinal plant is used in pharmacy for silymarin isolation from its fruits. But the cropping of milk thistle has several disadvantages: the first is its morphological characteristics (it can heart skin through its thistles), the second is that milk thistle has potential to become serious weed in arable land.

As a plant from the family *Asteraceae* has a great anticipation to have vital seeds in soil profile for long time as well as *Helianthus annus* L.. On the base of our 4 vegetation periods research, we can conclude that the *S. marianum* seeds are vital in soil profile for three and more years. We can also conclude that in third year after milk thistle cropping was no infestation of durum wheat stands, but *S. marianum* plants germinate after the harvest of durum wheat at the stubbles in August or September. On the base of statistical analyses we concluded that: the very significant highest infestation with *S. marianum* was in maize for grain stand in the year 2010. In the spring time the infestation of maize for grain, pea for grain and durum wheat stands with milk thistle falled very significantly down from 17.78 plant pre m^2 in maize stand to 2.56 plant pre m^2 in durum wheat stand.

ACKNOWLEDGEMENTS

This paper was supported by VEGA project no. 1/0513/12: „Research of sustainable agroecosystems for mitigation of climate change, production of bioproducts, improvement of human nutritional and health parameters".

BIBLIOGRAPHY

1. AUSTIN, M.P.; FRESCO, L.F.M.; NICHOLLS, A.O.: GROVES, R.H.; KAYE, P.E.: Competition and relative yield estimation and interpretation at different densities and under various nutrient concentrations using *Silybum marianum* and *Cirsium vulgare*. In: J. Ecol., vol. 3, 1988, pp. 157-171.
2. BERNER, D.K.; PAXON, L.K.; BRUCKART, W.L.; LUSTER, D.G.; MCMAHON, M.B.; MICHAEL, J.L.: First report of *Silybum marianum* as a host of *Puccinia punctiformis*. In: Plant Dis., vol. 86, 2002, p. 1271.
3. CARRUBBA, A.; LA TORRE, R.: Cultivation trials of milk thistle (*Silybum marianum* Gaertn.) into the semiarid Mediterranean environment. In: Agricoltura mediterranea, vol. 133, no. 1, 1987, pp. 14-19, ISSN 0394-0438.
4. CHAMBREAU, D.; MACLAREN, P.A.: Got milk thistle? An adaptive managment approach to eradicating milk thistle on dairies in King county, Washington state. In: Meeting the Challenge: Invasive Plants in Pacific Northwest Ecosystems, 2007, pp. 83-84.
5. GABAY, R.; PLITMANN, U.; DANIN, A.: Factors affecting the dominance of Sylibum marianum L. (Asteraceae) in its specific habitats. In: Flora, vol. 189, 1994, pp. 201-206.
6. GROVES, R.H.; KAYE, P.E.: Germination and phenology of seven introduced thistle species in Southern Australia. In: Aust. J. Bot., vol. 37, 1989, pp. 351-359.
7. HABÁN, M.; OTEPKA, P.; KOBIDA, Ľ.; HABÁNOVÁ, M.: Production and quality of milk thistle (*Silybum marianum* [L.] Gaertn.) cultivated in cultural conditions of warm agri-climatic macroregion. In: Hort. Sci. (Prague), vol. 39, no. 2, 2009, pp. 25-30.
8. HANES, J.; MUCHA, V.; SISÁK, P.; SLOVÍK, R.: Charakteristika hnedozemnej pôdy na výskumno-experimentálnej báze AF VŠP Nitra, Dolná Malanta. VES VŠP: Nitra, 1993, pp. 49.
9. HOLM, L.G.; DOLL, J.; HOLM, E.; PANCHO, J.; HERBERGER, J.: World weeds. In: Natural Histories and Distribution, Wiley, New York, 1997.
10. KARKANIS, A.; BILALIS, D.; EFTHIMIADOU, A.: Cultivation of milk thistle (*Silybum marianum* L. Gaertn.), a medicinal weed. In: Industrial Crops and Products, vol. 34, no. 1, 2011, pp. 825-830.
11. KHAN, M.A.; BLACKSHAW, R.E.; MARWAT, K.B.: Biology of milk thistle (*Sylibum marianum*) and management options for growers in north-western Pakistan. In: Weed Biology and Management, vol. 9, 2009, pp. 99-105.
12. MACÁK, M.; DEMJANOVÁ, E.; HUNKOVÁ, E.: Forecrop value of milk thistle (*Silybum marianum* [L.] Gaertn.) in sustainable crop rotation. In: 1st International Scientific Conference on Medicinal, Aromatic and Spice Plants (Book of Scientific Papers and Abstracts). Nitra, Slovak University of Agriculture, 2007, pp. 102–104.
13. MARWAT, K.B.; KHAN, M.A.: Climatic variation and growth of holy thistle (*SILYBUM MARIANUM* GAERTN.). In: Pak. J. Botany, vol. 39, no. 2, 2007, pp. 319-327.
14. OMIDBAIGI, R.; NOBAKHT, A.: Nitrogen fertilizer affecting growth, seed yield and active substances of milk thistle (*Sylibum marianum*). In: Pak. J. Biol. Sci., vol. 4, 2001, pp. 1345-1349.
15. SMATANA, J.; TÝR, Š.: Základy herbológie. 1. vyd. Nitra : Slovenská poľnohospodárska univerzita, 2011. 125 s. ISBN 978-80-552-0579-3.
16. ŠPÁNIK, F.; REPA, Š.; ŠISKA, B.: Klimatické a fenologické pomery Nitry (1961–1990). Nitra, Vydavateľské a edičné stredisko Slovenskej poľnohospodárskej univerzity: 62 p..
17. YOUNG, J.A.; EVANS, R.A.; HAWKES, R.B.: Milk thistle (*Silybum marianum*) seed germination. In: Weed Science, vol. 26, 1978, pp. 395-398.