http://doi.org/10.7427/DDI.25.12

12. The economic and ecological effect of special foliar fertilisation to the sunflower crop

CHIURCIU Irina-Adriana[1], DANA Daniela[2], VOICU Valentina[3,4], CHEREJI Aurelia-Ioana[5], COFAS Elena[1]

[1]University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Marasti Blvd, District 1, Bucharest, Romania
[2]Ion Maiorescu National College, Giurgiu, Romania, Mihai Eminescu School, Giurgiu, Romania
[3]National Research-Development Institute for Soil Science, Agrochemistry and Environment Protection, 61 Marasti Blvd, District 1, Bucharest, Romania
[4]"Dunărea de Jos" University of Galați, Faculty of Engineering and Agronomy of Brăila, 29 Călăraşilor St., 810 017, Brăila, Romania
[5]University of Oradea, Faculty of Environmental Protection, 26 Gen. Magheru St., 410048, Oradea, Roomania

**Address of author responsible for correspondence: CHIURCIU Irina-Adriana, University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Marasti Blvd, District 1, Bucharest, Romania, e-mail: irina.chiurciu@yahoo.ro*

Abstract: Nowadays, special foliar fertilisation has become widespread because it is distinguished by a high economic efficiency, especially in: conditions of soils with low accessibility of nutrients, calcareous and alkaline soils where foliar fertilisation represents an efficient mean of curative treatment for iron, zinc and manganese deficiencies; semiarid areas where the water and thermal stress drastically limits the accessibility of plants at nutrients from the soil; the reproductive period of the plants, when the root activity is low.

The paper presents the results obtained by applying special foliar fertilisers, under pedoclimatic conditions in Iași. These foliar fertilisers were tested on the sunflower crops, HS Rapid and HS PR 475 hybrids, in order to correct the micronutrients disorders (Mo and B) on inbred sunflower lines in hybrid sunflower seed production, having the following chemical composition:

- ICF 624 (g element or substance / kg of fertilizer): 183 N, 62 P, 114 K, 21 S, 0.4 Fe, 0.5 Mn, 0.35 Zn, 0.25 Cu, 0.01 Co, 0.80 B, 0.15 Mo;
- ICF 624 a (g element or substance / kg of fertilizer): 217 N, 73 P, 96 K, 21 S, 0.4 Fe, 0.5 Mn, 0.35 Zn, 0.25 Cu, 1.50 B, 0.66 Mo.

The tested fertilisers have determined a significant specific yield increase and have assured a high environmental protection effect, quantified as the net exports of macronutrients from soil with the obtained yield increases. Thus, the average yield increases were between 292-587 kg/ha and the specific yield increases were between 19.50-39.15 kg seed / kg or liter of foliar fertiliser. From a practical point of view, using this method of special foliar fertilisation, we obtain besides the important production increases, significant effects of reducing the phenomenon of chemical pollution of the environment.

However, due to the high nutrient consumption, the use of such a method and mean, under poorly supplied soils with nutrients (without basic fertilization in the soil), can contribute to the degradation of soil fertility.

Therefore, it is recommended the concomitant use of soil fertilisation and foliar fertilisation with these special compositions, the optimal ratio between basic and foliar fertilisation being 90:10.

The paper also presents and analyses a series of indicators related to the cultivation and to the production of sunflower seeds in Romania.

Keywords: *economic, environment, Romania, sunflower area and production*

INTRODUCTION

The importance that farmers grant to the sunflower cultivation comes from the analysis of cultivated areas worldwide, which indicates that sunflower is on the fourth place after corn, wheat and rice. The reason for occupying large areas for this plant is the use of sunflower seeds in many fields, mainly for human consumption, animal husbandry and biofuel production. (Soare and Chiurciu, 2018).
The emergence and cultivation of hybrids, resistant to certain diseases and specific pests, with high productivity, has favored the expansion of the areas occupied by this crop. But, at the same time, these hybrids have higher requirements in terms of need for nutrients, which must be provided in certain phases of vegetation (Yara.ro, 2020).
The data presented on the specialized sites indicated Romania as the main cultivator and producer of sunflowers seeds in the E.U.. Thereby, in 2019, Romania cultivated a quarter of the total area occupied by sunflowers in the E.U. and also in the same year harvested a third of the total production of sunflowers seeds of the E.U. (Eurostat, 2020).
The largest area with sunflower in Romania is located in Macroregion Two (South-East Region), which totaled 444,296 ha (2018). Also here was obtained the largest production - 1,406,633 tons (2018).
At present, special foliar fertilisation has become widespread also at the sunflower crop because it is distinguished by a high economic efficiency, especially in:

- conditions of soils with low accessibility of nutrients, calcareous and alkaline soils where foliar fertilisation represents an efficient mean of curative treatment of iron, zinc and manganese deficiencies (Marschner, 1995; Goss and Johnson, 2000; Dana and Gaina, 2006);
- semiarid areas where the water and thermal stress drastically limits the accessibility of plants at nutrients from the soil;
- the reproductive period of the plants, when the root activity is low.

The foliar application of nitrogen in the form of urea, in the late stages of growth, is a well-known technique to increase the production and the protein content in cereals.
Also, applying diluted solutions containing calcium on apple fruits is a technique for preventing and reducing the incidence of the disease called „bitter pit" (Woolfolk et al. 2002; Bly and Woodard, 2003; Dana et al., 2019).
The purpose of this paper is to show the importance of Romania as a cultivator and producer of sunflowers in the E.U. and to present the experimental results concerning the economic and the ecological effect of special foliar fertilization in this culture.

MATERIAL AND METHOD

The special foliar fertilisers were elaborated in National Research-Development Institute for Soil Science, Agrochemistry and Environment Protection based on the residual protein hydrolyzates. In function of the manufactured method were obtained two foliar fertilisers with the next chemical composition:

- ICF 624 (g element or substance / kg of fertilizer): 183 N; 62 P; 114 K; 21 S; 0.4 Fe; 0.5 Mn; 0.35 Zn; 0.25 Cu; 0.01 Co; 0.80 B; 0.15 Mo;
- ICF 624 a (g element or substance / kg of fertilizer): 217 N; 73 P; 96 K; 21 S; 0.4 Fe; 0.5 Mn; 0.35 Zn; 0.25 Cu; 1.50 B; 0.66 Mo.

These compositions were tested in the rigorous field experiments from Iaşi Experimental Station at sunflower crop, HS Rapid and HS PR 475 hybrids, in order to correct the micronutrients disorders (Mo and B) on inbred sunflower lines in hybrid sunflower seed production. The soil of the experimental field was a cambic chernozem soil.
In order to estimate the ecological effect of the special foliar fertilisation, the net exports of macronutrients from soil with obtained yield increases were calculated.
The main indicators that led to the realization of this study were: total area cultivated with sunflower in E.U., total sunflower seed production in E.U., yield per hectare for sunflower seeds; surface cultivated with sunflowers seeds in the Macro-Regions of Romania and the obtained production. The indicators in this paper had been studied and analysed for the years 2018-2019.
For the analysis of areas, total productions and average productions of sunflowers seeds, at the level of E.U. and for Romania, was used the data presented on specialized sites, such as Eurostat and NIS.

RESULTS AND DISCUSSION

According to Eurostat, in the period 2018-2019 Romania was the main sunflower cultivator in the European Union, with an area of 1,306.5 thousand ha in 2019, respectively 1,006.99 thousand ha in 2018 (Figure 1). It was followed by Bulgaria (800.00 thousand ha in 2019 and 788.66 thousand ha in 2018) and Spain (700.88 thousand ha in 2019 and 691.28 thousand ha in 2018). Other large sunflower cultivators, with areas over 100 thousand ha, were France, Hungary and Italy.
With the exception of Hungary, there has been a growing trend in areas at the main E.U. cultivators.

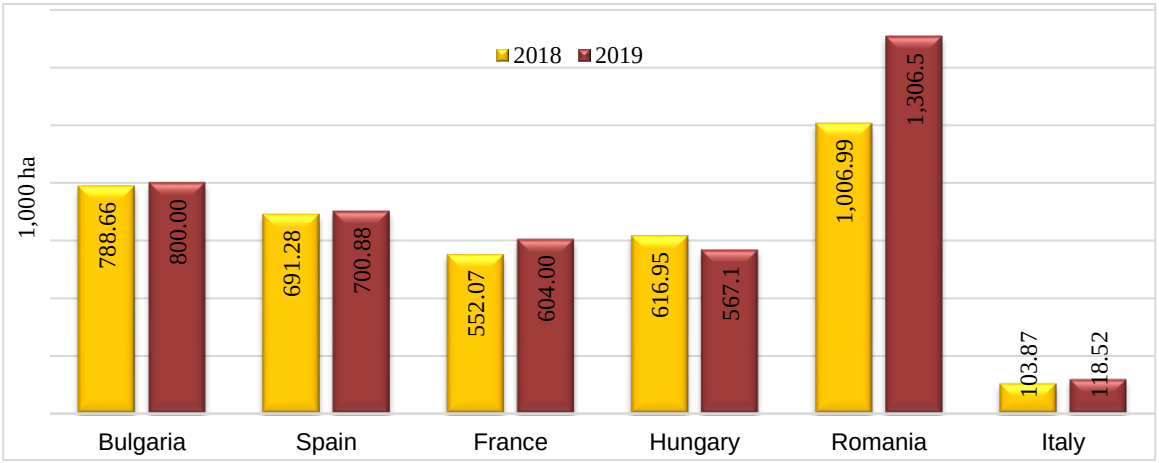

Figure 1. Area cultivated with sunflower in the main growing countries from E.U. (Source: Eurostat, 2020)

Regarding the production of sunflowers seeds, as shown in Figure 2, Romania was on the first place, with a quantity of 3,450.14 thousand tons in 2019 (3,062.69 thousand tons in 2018). Bulgaria and Hungary were on the next places, in 2019 registering 1,870.33 thousand tons (Bulgaria), respectively 1,701.69 thousand tons (Hungary). In the top major sunflower seed manufacturers in the E.U., France, Spain and Italy were also found. The main producers, which showed increases in production in the agricultural campaign in 2019, compared to 2018, were France, Romania and Italy.

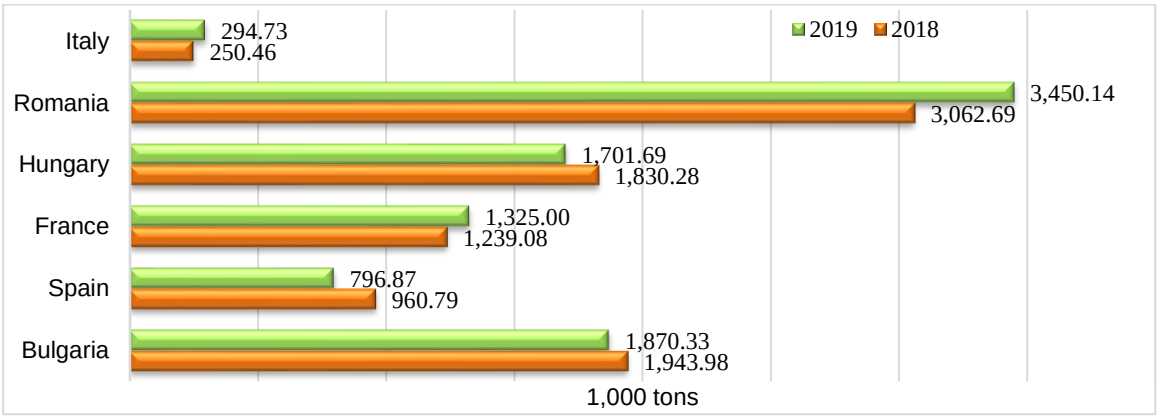

Figure 2. Sunflower seeds production in the main growing countries from E.U. (Source: Eurostat, 2020)

Figure 3 shows the average yields per hectare, with the highest values recorded in the E.U. Member States, for sunflowers seeds. In 2019, Austria obtained 3.04 tons/ha, thus recording the highest average production/ha in the E.U. and was followed by Croatia and Hungary, with 3.00 tons/ha. Romania, eventhough it was on the first position in the ranking of sunflowers seeds producers, registered a decrease in the average production/ha, from 3.04 tons/ha in 2018, to 2.64 tons/ha in 2019.

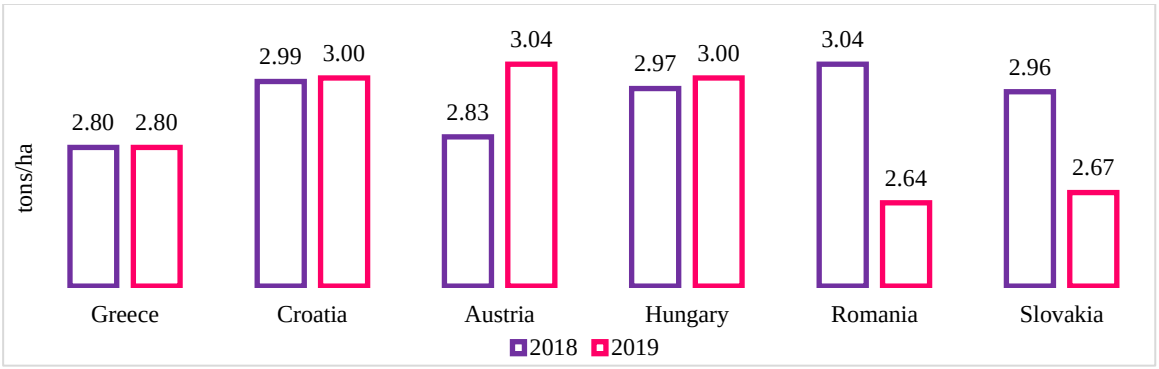

Figure 3. Sunflower seeds average yields in the main growing countries from E.U.(Source: Eurostat, 2020)

For Romania, the situation was presented in 2018, as follows: the largest area cultivated with sunflowers was in Macroregion Two, of 444,296 ha and represented 44% of the total areas cultivated by our country (Figure 4). Within this Macroregion, Region South-East had the largest areas, 315,363 ha, and the other region, Region North-East 128,933 ha.

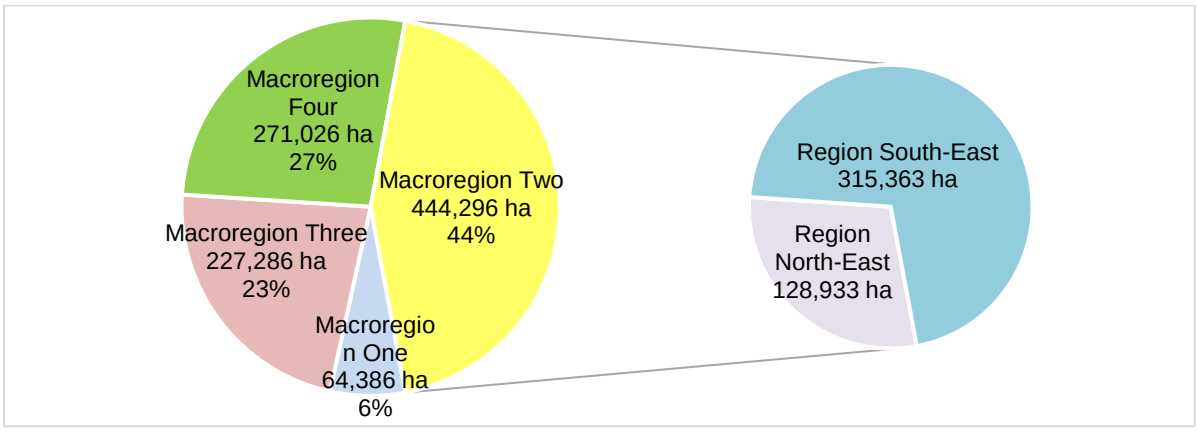

Figure 4. Area cultivated with sunflower in Romania's Macroregions (Source: NIS, 2020)

Macroregion Four recorded 27% and Macroregion Three 23% of the total sunflower areas. In Macroregion One was found the smallest area, of 64,386 ha, which represented 6%.
The production of sunflowers seeds obtained in 2018 by Romania was distributed as follows (Figure 5): 46% - Macroregion Two - 1,406,633 tons; 26% - Macroregion Four - 781,255 tons; 22% - Macroregion Three - 695,132 tons and on the last place, 6% - Macroregion One - 179,670 tons.

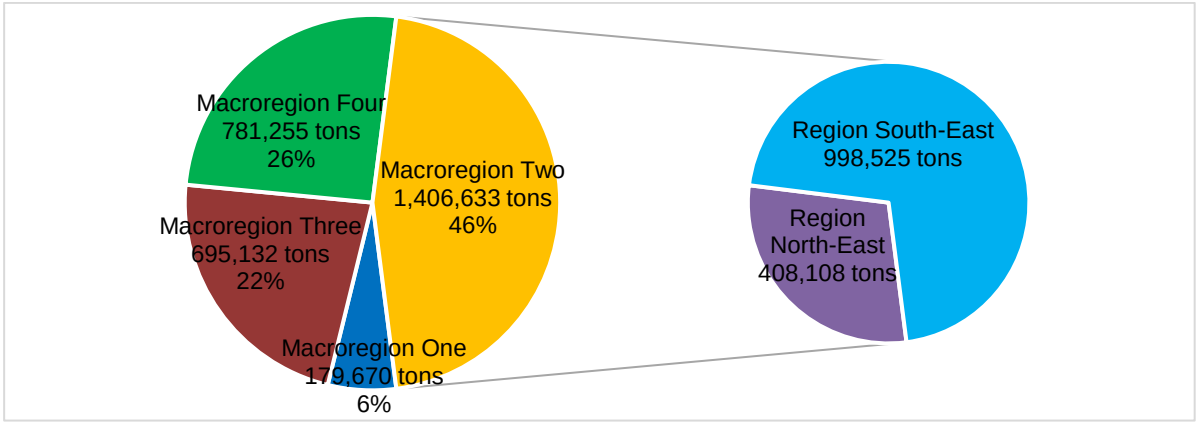

Figure 5. Sunflower seeds production obtained in Romania's Macroregions (Source: NIS, 2020)

In the 2 Regions of Macroregion Two, the situation was as follows: the Region North-East obtained 408,108 tons and the South-East Region registered a double harvest, 998,525 tons.

The experimental results concerning the economic effect of special foliar fertilisation are presented in the tables 1-3.

It should be mentioned that SC Moldova Tiganasi SA has its headquarters in Țigănași village, Iași County, Macroregion Two, Region North-East.

From these it may be observed that, the application of the special foliar fertilisers have assured a positive increase of yield in comparison with the control. Thus, the average yield increases were between 292-587 kg/ha and the specific yield increases were between 19.50 - 39.15 kg seed/kg or liter of foliar fertilizer.

Table 1. The economic effect of special foliar fertilisers obtained on inbred sunflower lines in hybrid sunflower seed production, SC Moldova-Țigănași SA (average data on two hybrids) (Source: Dana and Gaina, 2006)

Variants	Average yield increase (kg/ha)	Specific yield increase (kg seed / kg or liter of foliar fertiliser)
Control	-	-
Folplant 231	292	19.50
ICF 624	489	32.60
ICF 624 a	587	39.15

For HS Rapid hybrid the yield increases recorded, as a result of the remaining effect of the special foliar fertilisation, varied between 317 kg/ha (Folplant 231) and 846 kg/ha (ICF 624 a), being significant and distinctly significant compared to the control.

Table 2. Experimental data regarding the production obtained to sunflower crop, as a result of the remaining effect of the special foliar fertilization for HS Rapid, SC Moldova-Țigănași SA (Source: Dana and Gaina, 2006)

Variants	Yield (kg/ha)	Yield increase	
		kg/ha	%
Control	1.527	-	-
Folplant 231	1.844	317	21
ICF 624	2.151	624	41
ICF 624 a	2.373	846	55
LSD 5% 277			
LSD 1% 321			

Also, for HS PR 475 hybrid the obtained yield varied between 293 kg/ha (Folplant 231) and 536 kg/ha (ICF 624 a), being distinctly significant compared to the control.

Table 3. Experimental data regarding the production obtained to sunflower crop, as a result of the remaining effect of the special foliar fertilization for HS PR 475, SC Moldova-Țigănași SA (average data on three years) (Source: Dana and Gaina, 2006)

Variants	Yield (kg/ha)	Yield increase	
		kg/ha	%
Control	1,805	-	-
Folplant 231	2,098	293	16
ICF 624	2,285	480	27
ICF 624 a	2,341	536	30
LSD 5% 147			
LSD 1% 222			

The experimental data concerning the ecological effect of special foliar fertilisation are presented in the tables 4-5. From the presented data it can be seen that foliar fertilization ensures (in effect remanente) important effects of environmental protection, evidenced by the large export of nutrients from the soil with the yield increases, realized only as a result of the use of a seed with a content optimized by Mo and B.

Table 4. The environmental protection effect, quantified as the net exports of macronutrients from soil with the yield increases obtained to sunflower crop, HS Rapid hybrid, SC Moldova-Țigănași SA (Source: Dana and Gaina, 2006)

Variants	Yield increase compared to unfertilised foliar control (kg/ha)	The net productive export of macronutrients from the soil in the obtained yield increases (kg/ha)		
		N	P	K
Folplant 231	317	11.57	2.41	13.15
ICF 624	624	22.77	4.76	25.89
ICF 624 a	846	30.87	6.45	35.10

Table 5. The environmental protection effect, quantified as the net exports of macronutrients from soil with the yield increases obtained to sunflower crop, HS PR 475 hybrid, SC Moldova-Țigănași SA (Source: Dana and Gaina, 2006)

Variants	Yield increase compared to unfertilised foliar control (kg/ha)	The net productive export of macronutrients from the soil in the obtained yield increases (kg/ha)		
		N	P	K
Folplant 231	293	10.69	2.23	12.15
ICF 624	480	17.52	3.66	19.92
ICF 624 a	536	19.56	4.08	22.24

From a practical point of view, using this method of special foliar fertilization, we obtain besides important production increases and significant effects of reducing the phenomenon of chemical pollution of the environment.
However, due to the high nutrient consumption, the use of such a method and means, under poorly supplied soils with nutrients (without basic fertilization in the soil), can contribute to the degradation of soil fertility.
Therefore, it is recommended the concomitant use of soil fertilisation and foliar fertilisation with these special compositions, the optimal ratio between basic and foliar fertilization being 90:10.

ACKNOWLEDGEMENTS

This research work was carried out with the support of National Research-Development Institute for Soil Science, Agrochemistry and Environment Protection Bucharest, Romania and many thanks to Dr. Mihail Dumitru.

CONCLUSIONS

During the analyzed period, Romania was on the first place regarding the areas cultivated with sunflower and the total production obtained. The yield per hectare has been declining, which requires the application of modern cultivation technologies, in which the use of fertilizers plays an important role.
The application of the special foliar fertilisers have assured a positive increase of yield in comparison with the control. The average yield increases were between 292-587 kg/ha and the specific yield increases were between 19.50-39.15 kg seed / kg or liter of foliar fertiliser.
The special foliar fertilisation ensures important effects of environmental protection, evidenced by the large export of nutrients from the soil with the yield increases, realized only as a result of the use of a seed with a content optimized by Mo and B.
It is recommended the concomitant use of soil fertilisation and foliar fertilisation with these special compositions, the optimal ratio between basic and foliar fertilisation being 90:10.

REFERENCES

Bly G. A., Woodard J. H., 2003, Foliar nitrogen application timing influence on grain yield and protein concentration of hard red winter and spring wheat, Agronomy Journal 95 (2), 335-338.
Dana, D., Gaina, V., 2006, Foliar fertilisation an efficient measure in order to averting and correcting the mineral nutritional deficiency in maize and sunflower plants, Ed. Cartea Universitara, Bucuresti, p. 67-97.
Dana D., Chiurciu, I.A., Voicu V., Soare E., Popescu, O.M., Popescu C., 2019, The effect of special foliar fertilisation on inbred sunflower lines in hybrid sunflower seed production, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development Vol. 19, Issue 1, 2019 PRINT ISSN 2284-7995, E-ISSN 2285-3952, p. 123-126.
Eurostat, https://ec.europa.eu/eurostat, Accessed on 27.03.2020.
Goss R. J., Johnson E. B., 2000, A comparison of three methods for reducing iron deficiency chlorosis in soybean, Agronomy Journal, 92 (6), 1135-1139.
NIS (National Institute of Statistics), www.insse.ro, accessed on 12.03.2020.
Marschner H., 1995, Mineral nutrition of higher plants, Londra.
Soare E., Chiurciu I.A. 2018, Considerations concerning worldwide production and marketing of sunflower seeds. Scientific Papers. Series "Management, Economic Engineering in Agriculture and rural development", Vol. 18 Issue 3, Print ISSN 2284-7995, 421-428.
Woolfolk W. C., Raun R. W., Johnson V. G., Thomason E. W., Mullen W. R., Wyun J. K., Freeman W. K., 2002, Influence of late-season foliar nitrogen applications on yield and grain nitrogen in winter wheat, Agronomy Journal, 94 (3), 429-434.
Yara, https://www.yara.ro/nutritia-plantelor/floarea-soarelui, Accessed on 25.03.2020.

Received: 04.05.2020
Revised: 25.05.2020