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THE ESSENTIAL ROLE OF NITROGEN FERTILIZATION UPON PROTEIN AND OIL CONTENT OF MAIZE AND SUNFLOWER YIELDS IN BANAT PLAIN, WESTERN ROMANIA

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Abstract

The cereals as maize and oil crops as sunflower are characterized from the point of view of quality parameters by their content in protein and oil. This two important quality parameter are related by the nitrogen fertilization level, the genotype cultivated and environmental, pedological and meteorological conditions during the vegetation period. The experimental fields were located in the Banat Plain, Western Romania, on two different soil types. In the experiment were applied solid nitrogen fertilizers based on urea in different amounts. The experiment results emphasize that three fertilizers UREA-NP, UREA and UREA-ZL were the most efficient ones in case of our studied crops, maize and sunflower.

Key words*: nitrogen fertilizers, protein content, oil content, maize, sunflower.*

INTRODUCTION

Seed protein and oil content of cereals and oil crops are known to be different from one genotype to the other. The amount of those two parameters is strictly influenced by the level of fertilization, the climate and the fertility of the soil.

In our days, the three leading oilseed crops are soybean, rapeseed and sunflower, the last one being recognized as a major source of high quality edible oil importantly used for culinary purposes. Sunflower contribute almost to 87% of vegetable oil production worldwide, being preferred over other oilseed crops.

Crude sunflower oil has many benefits over the human health, such as: a source of natural antioxidants, anti-inflammatory effects, antidiabetic, antimicrobial and antihypertensive (Adeleke et al., 2020).

The expansion of sunflower crop worldwide is due to a constant evaluation of new cultivars obtained through identification of superior materials capable of expressing high yield and acceptable quality parameters.

Sunflower crops has a great capacity for adaptation and it has interesting characteristics such as: higher drought resistance than maize, high disease and insect resistance and can improve soil conditions for following crops (Rosa et al., 2009).

One of the most important quality indicator of the sunflower seeds is protein content. The protein content depends on the genotype that is cultivated and the agro-ecological conditions (Balalic et al., 2016; Șmuleac et al., 2020; Ilie et al., 2012).

After FAO, oil type sunflower seeds contain about 38-50% oil and 20% protein, fact that was confirmed also by other authors as Guo et al. (2017), who specify an oil content ranged from 35% to 42%.

After Rosa et al. (2009), the content in protein of sunflower seeds is ranged between 14.73% and 18.23% and oil content may varies from 36.14% to 44.08%.

Maize is a globally important cereal with a high production and productivity, being cultivated in more than 160 countries worldwide, under different agro-climatic conditions. Crop rotation and nitrogen application are among the management methods that can increase maize grain yields. From the nutritional point of view,

maize may contain 7-13% protein and 2-6% oil (Chaudhary et al., 2014).
Nitrogen fertilization strategies for maize is variable, depending on the farmer strategy, but greater than 50% of the dose is applied before planting. Nitrogen losses from denitrification, leaching, volatilization and surface run-off increase with increasing nitrogen availability at planting. A greater synchrony between plant nitrogen demand and nitrogen fertilizer supply can reduce nitrogen losses and improve nitrogen recovery and nitrogen internal efficiencies at a crop level (Fernandez et al., 2020).
Being influenced by the genetic of the hybrid, after the researches made by Marta et al. (2017) in Indonesia, the protein content in maize grain varies between 8.83% and 11.84% and oil content from 4.45% to 7.17%, but most likely, maize seeds may contain 3-5% oil (Ogori, 2020).
Some researchers concluded that after foliar fertilisation the sunflower oil content is increasing from 47.6% to 49.3%.

MATERIALS AND METHODS

The areas chosen for the establishment of the experimental fields were not random because we followed the effect of the fertilizers tested in different climatic and edaphic conditions.
Testing of solid nitrogen fertilizers was performed in three experimental fields, located in the Banat Plain, Western Romania, during 2019-2020.
Gataia Plain is characterized as a transition zone from the flat plain to the hilly area, located in the southern part of Timiș County, being characterized by the presence of soils classified in the third and fourth quality class, as predominant soil types being: Haplic Luvisol, Haplic Vertisol, Haplic Fluvisol and Haplic Gleysol.
The Mureș Plain which includes the soils belonging to the Cenad locality, is characterized as a low plain, located in the western part of Timiș County. As predominant soil types are found: Haplic Luvisol, Haplic Vertisol, Haplic Fluvisol and Eutric Cambisols. Their fertility is strongly influenced by the presence of the Mureș River, by the presence of a high clay content and by the seasonal variations of the groundwater level.
The type of soil on which the experiments were placed are Haplic Luvisol in Gataia and Haplic Fluvisol in Cenad (Niță et al., 2018; David et al., 2018).
The solid nitrogen fertilizers used in the experiment were of the urea type, in different concentrations, and with one or two nitrification inhibitors or without one (Tables 1 and 2).
Fertilizers were distributed to both crops in the 6-8 leaf vegetation phase.
From solid nitrogen fertilizers, the same dose were distributed regardless of the type of fertilizer used, for the same crop plant and in all experimental fields.

Table 1. Fertilization variants for sunflower

UREA-Z	350 kg/ha N16:P16:K16 (sowing period)	20 kg	During the vegetation period on each 2000 m^2 experimental plot
UREA-ZL		20 kg	
UREA-NP		20 kg	
UREA-NDP		20 kg	
UREA		20 kg	

Table 2. Fertilization variants for maize

UREA-Z	300 kg/ha 20:20:0+0.05% Zn (sowing period)	30 kg	During the vegetation period on each 2000 m^2 experimental plot
UREA-ZL		30 kg	
UREA-NP		30 kg	
UREA-NDP		30 kg	
UREA		30 kg	

Samples of the plant (seeds) were taken from the harvesting of crops, having a moisture content of 11% and all the necessary conditioning stages were completed before performing the analyses.
Protein content of the seeds was calculated on dependence of the total nitrogen, which was determinate after SR ISO 1871:2002 method. The oil content of the samples was established using SR EN ISO 659.
The statistical analysis used to comment the experimental results of this study, consists in applying the t-Test to compare two averages. This is a null hypothesis test in which the significance limit taken into account is α = 0.05. As is well known, the existence of significant differences between averages, at the accepted limit α, is ensured by obtaining a calculated value lower than 0.05. Otherwise, with the same statistical certainty, we will decide that, there are no significant differences between the averages values.

RESULTS AND DISCUSSIONS

Testing of solid and foliar fertilizers in sunflower and maize crops led to the elaboration of some conclusions regarding their effect on crop quality indicators.

In 2019 was identified a higher protein content in Cenad experimental field, but in 2020 the obtained research data are appropriate for sunflower crop.

The results after the t-Test: Two-Sample Assuming Equal Variances, indicate that we found significant differences between the averages for $\alpha = 0.05$, in the experimental field from Cenad, where it was cultivated sunflower, as it is presented in Table 3.

Table 3. The results of the protein content in sunflower seeds (experimental field Cenad)

	Cenad, 2019	*Cenad, 2020*
Mean	21.082	17.542
Variance	2.39027	3.17207
Observations	5	5
Pooled Variance	2.78117	
Hypothesized Mean Difference	0	
df	8	
t Stat	3.35629015	
P(T<=t) one-tail	0.0049933	
t Critical one-tail	1.85954804	
P(T<=t) two-tail	0.00998661	
t Critical two-tail	2.30600414	

In the experimental field data from Gataia, we observed the same significant differences between the fertilization variants, as they were in Cenad, applying the statistical method, which conclude us to the hypothesis that the fertilizers behave in the same regardless the soil type and climatic conditions, in case of sunflower crop (Table 4).

Table 4. The results of the protein content in sunflower seeds (experimental field Gataia)

	Gataia, 2019	*Gataia, 2020*
Mean	20.066	17.416
Variance	0.15153	1.61513
Observations	5	5
Pooled Variance	0.88333	
Hypothesized Mean Difference	0	
df	8	
t Stat	4.45814704	
P(T<=t) one-tail	0.00105813	
t Critical one-tail	1.85954804	
P(T<=t) two-tail	0.00211627	
t Critical two-tail	2.30600414	

The results after the t-Test: Two-Sample Assuming Equal Variances, emphasize significant differences between the averages for $\alpha = 0.05$, in Cenad experimental field, for the maize crop, as can be observed in Table 5.

Table 5. The results of the protein content in maize seeds (experimental field Cenad)

	Cenad, 2019	*Cenad, 2020*
Mean	8.41	7.38
Variance	0.0837	0.7686
Observations	5	5
Pooled Variance	0.42615	
Hypothesized Mean Difference	0	
Df	8	
t Stat	2.49474398	
P(T<=t) one-tail	0.01862292	
t Critical one-tail	1.85954804	
P(T<=t) two-tail	0.03724585	
t Critical two-tail	2.30600414	

Regarding the protein content of maize seeds, that it can be observed in Tables 5 and 6, highlights amounts almost identic in the both experimental years.

Table 6. The results of the protein content in maize seeds (experimental field Gataia)

	Gataia, 2019	*Gataia, 2020*
Mean	8.242	7.726
Variance	0.03082	0.68818
Observations	5	5
Pooled Variance	0.3595	
Hypothesized Mean Difference	0	
Df	8	
t Stat	1.36072467	
P(T<=t) one-tail	0.105347359	
t Critical one-tail	1.859548038	
P(T<=t) two-tail	0.210694718	
t Critical two-tail	2.306004135	

The data collected from Gataia experimental field, in case of maize does not emphasize significant differences, as we observed in Cenad. This result can be explained in the following way: even if the same fertilizers were applied in the same amounts, the delayed period of sowing caused by the climatic conditions lead to this experimental results.

After the t-Test results that we obtained by comparing the oil content of sunflower seeds, we can specify that the differences between the averages are not significant, which mean we obtained almost the same amounts of oil regardless the dose and the type of nitrogen fertilizer (Table 7).

Table 7. The results of oil content in sunflower seeds (experimental field Cenad)

	Cenad, 2019	*Cenad, 2020*
Mean	28.446	28.066
Variance	10.64583	1.15553
Observations	5	5
Pooled Variance	5.90068	
Hypothesized Mean Difference	0	
df	8	
t Stat	0.247345	
P(T<=t) one-tail	0.405436	
t Critical one-tail	1.859548	
P(T<=t) two-tail	0.810871	
t Critical two-tail	2.306004	

As for the oil content of sunflower seeds, the conditions from Gataia experimental field were more conductive in 2019, but in the following year we observed an unchangeable value of the analysis data (Table 8).

Table 8. The results of oil content in sunflower seeds (experimental field Gataia)

	Gataia, 2019	*Gataia, 2020*
Mean	30.718	28.066
Variance	9.03137	1.15553
Observations	5	5
Pooled Variance	5.09345	
Hypothesized Mean Difference	0	
df	8	
t Stat	1.8579649	
P(T<=t) one-tail	0.0501217	
t Critical one-tail	1.859548	
P(T<=t) two-tail	0.1002434	
t Critical two-tail	2.3060041	

In case of sunflower cultivated in Gataia, it was found a more favourable response to nitrogen fertilization, regarding the oil content, as in case of Cenad. This fact can be explained that the year 2019 was more favourable for sunflower crop as 2020. Also the climate conditions during the vegetation period of sunflower were more favourable to plant requirements in this period.

CONCLUSIONS

After interpreting the results obtained from the study, we can formulate the following conclusions: the most effective fertilizer for sunflower in Cenad was UREA-NP and for maize it was UREA.

In the experimental field from Gataia the fertilizer with the best results for sunflower was UREA-NP and for maize UREA-ZL.

We can also conclude that the observed differences are also due to the different pedo-climatic conditions in the two experimental areas, even if the same culture technology and the same fertilization doses were applied.

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