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PARTIAL RESULTS CONCERNING THE INFLUENCE OF THE SEED RATE AND FOLIAR FERTILIZATION ON THE BEHAVIOR OF SOME MILLET GENOTYPES IN THE PEDOCLIMATE CONDITIONS OF S.C.D.A. SECUIENI

Andreea ENEA[1], Teodor ROBU[2], Simona-Florina ISTICIOAIA[1], Alexandra LEONTE[1], Paula-Lucelia PINTILIE[1]

[1]Agricultural Research and Development Station Secuieni, 371 Principala Street, Secuieni, Neamt, Romania
[2]Iasi University of Life Sciences "Ion Ionescu de la Brad", 3 Mihail Sadoveanu Alley, Iasi, Romania

Corresponding author email: andra29nt@yahoo.com

Abstract

Starting with 2022 at the Secuieni Agricultural Research-Development Station, millet (Panicum miliaceum L.) was introduced for study. In this paper are presented partial results obtained regarding the behavior and yields obtained with two millet genotypes experimented with different rates of seeds and foliar fertilization applied products. The obtained results showed that the millet has a good adaptability to the Secuieni pedoclimatic condition registered in 2022. Thus, the millet average yields was of 3144 kg/ha when it was sown with a seed rate of 10 kg/ha, 3324 kg/ha at a seed rate of 14 kg/ha and 3517 kg/ha when the seed rate was 18 kg/ha. Regarding the foliar fertilization of the millet crop, the yields values, both the highest and the lowest, were recorded for the Marius variety sown with a seed rate of 10 kg/ha and foliar fertilized with the commercial product Terra Sorb (2.0 l/ha) (3687 kg/ha), respectively with the commercial product Albit (0.04 l/ha) (3048 kg/ha).

Key words*: millet, adaptability, yields, foliar fertilization, seed rate.*

INTRODUCTION

Panicum miliaceum L. is one of the world's first domesticated crops and was cultivated before the spread of rice, maize and wheat (Crawford, 2006; Sage et al., 2011).

Ten thousand years ago, it appeared as a staple food in the semi-arid regions of East Asia and later spread throughout the Eurasian region (Lindquist et al., 2005; Cavers et al, 2016).

In Europe, archaeobotanical finds of millet have previously been reported for Neolithic sites whose occupation began as early as the late 7th millennium B.C. (e.g. in the southern and eastern Balkans), as well as for a number of later sites, before the 2nd millennium B.C.

In Romania, archaeological research shows that, in the Neolithic - a period in which people gave up the nomadic life and became sedentary, moving from the lifestyle of hunter - gatherers to that of shepherds and plant growers - people farmed in today's territory of Romania, wheat (more species than today), barley, oats, rye, millet, along with legumes such as beans, lentils.

Among the C_4 panicoids (subfamily: *Panicoideae*), millet (*P. miliaceum* L.) is known to possess morpho-physiological traits that confer tolerance to abiotic stress and show greater adaptability than other cereal crops in different environmental conditions (Bandyopadhyay et al., 2017; Vetriventhan et al., 2018).

The most popular name of *P. miliacum* L. is "proso millet" comes from the general Pan-Slavic name for millet (Croatian: proso, Serbian: просо).

Millet differs from other cereals (maize, wheat, triticale) being considered a low-input ingredient because it requires low production costs (it can be grown on marginal lands) having special agrotechnical advantages: resistance to drought and pest attack, minimum requirements in regarding fertilization (Amadoubr et al., 2013; Changmei and Dorothy, 2014). Adding to these the short

vegetation period, between 60-100 days (Baltensperger, 2002).
Cereal consumption currently supports approximately 50% of the world's total calorie intake and is largely provided by wheat, rice and maize (Das, 2019). At the same time, climate change accelerates land degradation and desertification, and extreme weather events reduce yields (Habiyaremye, 2017).
Given the current and future scenarios, scientists suggest that an effective strategy could be to replace cereal crops that have high water requirements with others adapted to drought conditions (Ndiku, 2014).

MATERIALS AND METHODS

At the Agricultural Research and Development Station Secuieni, in 2022, the millet experiences placed that the aim to:
- establishing the adaptability of some millet genotypes to the pedoclimatic conditions in Central Moldova;
- establishing the optimal seed rate;
- establishing optimal foliar fertilization.

The trifactorial experiment, of the 2 x 3 x 5 type, was located according to the method of subdivided plots, consisting in:

- Factor A - genotypes;
- Factor B - seed rates;
- Factor C - foliar fertilization.

The distance between rows was 12.5 cm in the sowing of the experiment.
P. miliaceum L., today in the Official List of Cultivated Varieties in Romania, has as its representative only the variety Marius.
The genotypes used in the field experiment consisted of:

- the Marius variety (from N.A.R.D.I. Fundulea);
- the local population Secuieni (here referred as "Secuieni").

For sowing these two varieties, three different seed rates were used:

- 10 kg/ha;
- 14 kg/ha;
- 18 kg/ha.

During the vegetation period, foliar fertilization with commercial products was applied to the tested variants:

- Terra Sorb (2.0 l/ha);
- Asfac (1.0 l/ha);
- Albit (0.04 l/ha, respectively 0.06 l/ha).

The experience was placed in the experimental fields of A.R.D.S. Secuieni characterized by a soil of cambic phaeosium type, weakly acid (pH = 6.14), with a low content in humus (2.3%), poorly fertile, little supplied with nitrogen (0.134%), but with a considerable content of phosphorus (77 ppm) and potassium (221 mg/kg) in forms accessible to plants (Trotuș E. et al., 2022).
The millet crop was sown in the optimal epoch for this geographic area, the beginning of May, in a dry land as a result of rainfall deficit recorded in 2022.
The crop was harvested in mid-August, the vegetation period for millet under the conditions of A.R.D.S. Secuieni was 95 days.
The obtained data were processed and statistically interpreted according to the variation analysis method (Jităreanu G., 1994).

RESULTS AND DISCUSSIONS

From a climatic point of view, the 2021-2022 year was characterized as hot and very dry, with the trend being aridification (Figures 1 and 2).

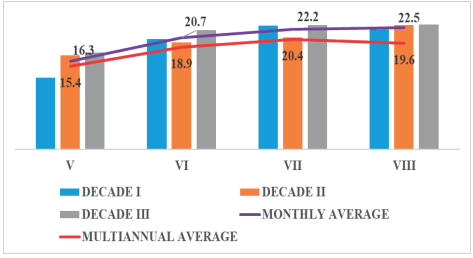

Figure 1. Average temperatures during the millet vegetation period, A.R.D.S. Secuieni, 2022

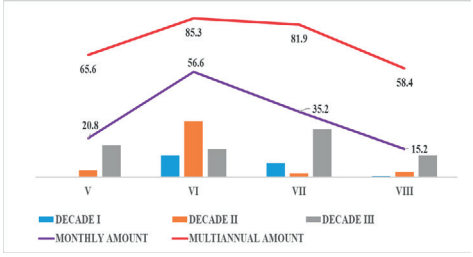

Figure 2. Average precipitation during the millet vegetation period, A.R.D.S Secuieni, 2022

The average temperatures recorded at the meteorological station of A.R.D.S. Secuieni

during the millet vegetation period (May-August, 20.5ºC) had a deviation of +1.9ºC compared to the multiannual average from the last 60 years of the same period of the year (18.6ºC).

The temperature difference recorded in May, the month when the millet crop was sown, was 0.9ºC (Figure 1).

June and July, critical months for most agricultural crops, had average temperatures 1.8ºC higher than the multi-year average (Figure 1).

In August, when the millet crop was harvested, the average temperature was 2.9 Celsius degrees higher than the multiannual average (Figure 1).

Regarding the rainfall regime, in the period from the sowing of the millet crop to its physiological maturity, 127.8 mm were unevenly distributed, comparing this value with the multi-year average specific to the same period, of 291.2 mm we note that the deviation has a value of -163.4 mm.

From Figure 2 it can be seen that in the months of May and July, the precipitation had values 3 times lower than the multi-annual average.

In August, when the millet crop was also harvested, the rainfall was approximately 4 times lower than the multi-annual average (Figure 2).

The yield stability in field crops is given by the varieties with a high yield potential, with a superior yield quality and a better adaptability to the biotic and abiotic environmental conditions.

The experimented variants had as a control the local Secuieni population, sown with a seed rate of 14 kg/ha, in an unfertilized system (Table 1).

The results obtained varied from one variant to another.

The unfertilized variants had yields values between 2342 kg/ha (Marius variety sown with rate seed of 10 kg/ha) and 3453 kg/ha (Secuieni sown with rate seed of 18 kg/ha), which they varied depending on the genotype and seed rate.

The yields obtained from the interaction between the three studied factors, genotype x seed rate x foliar fertilization indicated as the optimal variant the interaction between the Marius variety, sown with a seed rate of 10 kg/ha and to which a foliar fertilization with the commercial product was applied Terra Sorb (2.0 l/ha), the yield obtained being 3687 kg/ha (Table 1).

Table 1. Variants tested and yield obtained

Factor A	Factor B (kg/ha)	Factor C (product)	Dozes (l/ha)	Yield kg/ha	Rel. yield %	Dif. kg/ha	Semn
Marius	10	Unfertiliz		2342	76	-745	ooo
		Terra sorb	2.0 l/ha	3687	119	600	**
		Asfac	1.0 l/ha	3677	119	590	**
		Albit 1	0.04 l/ha	3048	99	-39	
		Albit 2	0.06 l/ha	3316	107	229	
	14	Unfertiliz		3337	108	250	
		Terra Sorb	2.0 l/ha	3438	111	351	*
		Asfac	1.0 l/ha	3447	112	360	*
		Albit 1	0.04 l/ha	3480	113	393	*
		Albit 2	0.06 l/ha	3394	110	307	
	18	Unfertiliz		3279	106	192	
		Terra Sorb	2.0 l/ha	3523	114	436	*
		Asfac	1.0 l/ha	3637	118	550	**
		Albit 1	0.04 l/ha	3584	116	497	**
		Albit 2	0.06 l/ha	3623	117	536	**
Secuieni	10	Unfertiliz		2581	84	-506	oo
		Terra Sorb	2.0 l/ha	3366	109	279	
		Asfac	1.0 l/ha	3165	103	78	
		Albit 1	0.04 l/ha	3134	102	47	
		Albit 2	0.06 l/ha	3122	101	35	
	14	Unfertiliz		3087	100	CT	
		Terra Sorb	2.0 l/ha	3253	105	166	
		Asfac	1.0 l/ha	3300	107	213	
		Albit 1	0.04 l/ha	3246	105	159	
		Albit 2	0.06 l/ha	3257	106	170	
	18	Unfertiliz		3453	112	366	*
		Terra Sorb	2.0 l/ha	3487	113	400	*
		Asfac	1.0 l/ha	3513	114	426	*
		Albit 1	0.04 l/ha	3527	114	440	*
		Albit 2	0.06 l/ha	3547	115	460	**
LSD (kg/ha)	5 %		331				
	1 %		456				
	0.1 %		645				

The lowest yield was obtained with the variant sown with the same variety, the same seed rate, but in an unfertilized system, of 2342 kg/ha.

The yield difference between these two variants is 1345 kg/ha (Figure 3).

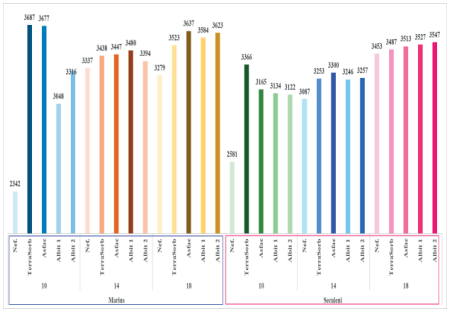

Figure 3. Yields dynamics according to the fertilizer used

Compared to the experience control, the yields differences obtained were ensured and statistically interpreted as follows:

-significant yields increases were obtained at interaction between:

- Marius variety x 14 kg/ha x Terra Sorb (2.0 l/ha) - with a yield increase of 351 kg/ha;
- Marius variety x 14 kg/ha x Asfac (1.0 l/ha) - with a yield increase of 360 kg/ha;
- Marius variety x 14 kg /ha x Albit (0.04 l/ha) - with a yield increase of 393 kg/ha;
- Marius variety x 18 kg/ha x Terra Sorb (2.0 l/ha) - with a yield increase of 307 kg/ha;
- Secuieni population x 18 kg/ha x unfertilized - with a yield increase of 366 kg/ha;
- Secuieni population x 18 kg/ha x Terra Sorb (2.0 l/ha) - with a yield increase of 400 kg/ha;
- Secuieni population x 18 kg/ha x Asfac (1.0 l/ha) - with a yield increase of 426 kg/ha;
- Secuieni population x 18 kg/ha x Albit (0.04 l/ha) - with a yield increase of 440 kg/ha;

-significant yields increases were obtained at interaction between:

- Marius variety x 10 kg/ha x Terra Sorb (2.0 l/ha) - with a yield increase of 600 kg/ha;
- Marius variety x 10 kg/ha x Asfac (1.0 l/ha) - with a yield increase of 590 kg/ha;
- Marius variety x 18 kg/ha x Asfac (1.0 l/ha) with a yield increase of 550 kg/ha;
- Marius variety x 18 kg/ha x Albit (0.04 l/ha) - with a yield increase of 497 kg/ha;
- Marius variety x 18 kg/ha x Albit (0.06 l/ha) - with a yield increase of 497 kg/ha;
- Secuieni population x 18 kg/ha x Albit (0.06 l/ha) - with a yield increase of 460 kg/ha;

- a distinctly significant negative difference was obtained in the variant sown with Secuieni x 10 kg/ha x unfertilized - with a yield difference of - 506 kg/ha;

- very significant negative difference was obtained in the variant sown with Marius variety x 10 kg/ha x unfertilized - with a yield difference of - 745 kg/ha.

A good reaction to foliar fertilization was observed at the tested variants, the lowest yield values being thus recorded in the unfertilized variants, namely:

- average yield for Secuieni population - 3040 kg/ha, with variations between 2581 kg/ha (10 kg/ha rate seed and 3453 kg/ha (18 kg/ha rate seed) (Figure 4);
- average yield for Marius variety - 2986 kg/ha, with variations between 2342 kg/ha (10 kg/ha rate seed) and 3337 kg/ha (14 kg/ha rate seed) (Figure 4).

Figure 4. Yield dynamics for unfertilized variants

For the variants foliarly fertilized with the Terra Sorb (2.0 l/ha) commercial product, the yields had maximum values:

- 3687 kg/ ha - Marius variety sown with 10 kg/ha rate seed (Figure 5);
- 3487 kg/ha - Secuieni population sown with 18 kg/ha rate seed (Figure 5).

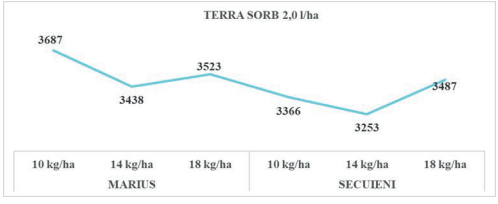

Figure 5. Yield dynamics for variants foliarly fertilized with Terra Sorb (2.0 l/ha)

Following the foliar application of the commercial product Asfac, in a dose of

1.0 l/ha, the highest yield was obtained on the following variants, where yields of:

- 3677 kg/ha - Marius variety sown with 10 kg/ha rate seed (Figure 6);
- 3513 kg/ha - Secuieni population sown with 18 kg/ha rate seed (Figure 6).

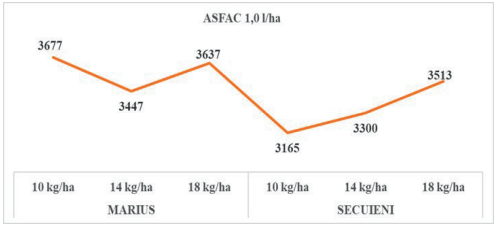

Figure 6. Yield dynamics for variants foliarly fertilized with Asfac (1.0 l/ha)

The application of the commercial product Albit in a dose of 0.04 l/ha generated maximum productions of:

- 3584 kg/ha - Marius variety sown with 18 kg/ha (Figure 7);
- 3527 kg/ha - Secuieni population sown with 18 kg/ha (Figure 7).

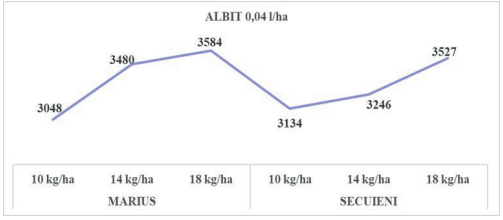

Figure 7. Yield dynamics for variants foliarly fertilized with Albit (0.04 l/ha)

The application of the commercial product Albit in a dose of 0.06 l/ha generated maximum productions of:

- 3623 kg/ha - Marius variety sown with 18 kg/ha (Figure 8);
- 3547 kg/ha - Secuieni population sown with 18 kg/ha (Figure 8).

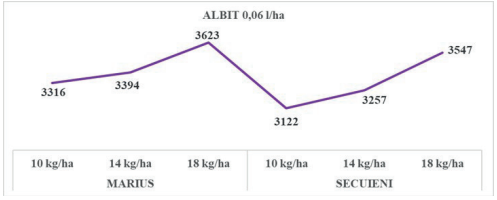

Figure 8. Yield dynamics for variants foliarly fertilized with Albit (0.06 l/ha)

Increasing the dose of Albit (from 0.04 to 0.06 l/ha) generated yields increases of:

- 268 kg/ha - for Marius variety sown with 10 kg/ha;
- 86 kg/ha - for Marius variety sown with 14 kg/ha;
- 39 kg/ha - for Marius variety sown with 18 kg/ha;
- 11 kg/ha - for Secuieni population sown with 14 kg/ha;
- 20 kg/ha - for Secuieni population sown with 18 kg/ha.

CONCLUSIONS

From a climatic point of view, the 2021-2022 year was characterized as hot and very dry.

The tested millet genotypes adapted well to the culture conditions at A.R.D.S. Secuieni.

The yields obtained were between 2342 and 3687 kg/ha.

Yields varied from one technological parameter to another.

At the control variant (interaction: Secuieni population x 14 kg/ha x unfertilized) a yields value of 3087 kg/ha was obtained.

The highest yields value was obtained at the interaction between Marius variety x 10 kg/ha x Terra Sorb (2.0 l/ha) of 3687 kg/ha.

The lowest yields value was obtained at the interaction between Marius x 10 kg/ha x unfertilized of 2342 kg/ha.

For unfertilized variants the highest yields were obtained at the sowing rates of 14 and 18 kg/ha.

The products Terra Sorb and Asfac, administered foliar have a positive influence on millet yields.

Increasing the dose of Albit (from 0.04 to 0.06 l/ha) did not generate significant increases in grain production in the millet culture. This increase not being economically justified.

REFERENCES

Amadoubr, I., Le, M. (2013). Millets: Nutritional composition, some health benefits and processing - A Review. *Emirates Journal Food and Agriculture*, 25. 501.

Baltensperger, D.D. (2002). Progress with proso, pearl and other millets. *ASHS Press, Alexandria, VA.*

Bandyopadhyay, T., Muthamilarasan, M., Prasad, M. (2017). Millets for Next Generation Climate-Smart Agriculture. *Front. Plant Science*. *8*. 1266.

Cavers, P.B., Kane, M. (2016). The biology of Canadian weeds: 155. *Panicum miliaceum* L. *Canadian Journal of Plant Science*. 96. 939–988.

Changmei, S., Dorothy, J. (2014). Millet-the frugal grain. *International Journal of Scientific Research and Reviews, 3*(4), 75–90.

Crawford, G.W. (2006). East Asian Plant Domestication, In Archaeology of Asia; *Blackwell Publishing Ltd: Malden, MA, USA,* pp, 77–95.

Das, S., Khound, R., Santra, M., Santra, D. (2019) Beyond Bird Feed: Proso Millet for Human Health and Environment, *Agriculture, vol. 9, Academic Open Acces Publishing.*

Habiyaremye, C., Matanguihan, J.B., D'Alpoim Guedes, J., Ganjyal, G., Whiteman, M.R., Kidwell, K.K., Murphy, K.M. (2017). Proso Millet (Panicum miliaceum L.) and Its Potential for Cultivation in the Pacific Northwest, *U.S.: A Review. Frontiers Plant Science*, *7*. 1–17.

Jităreanu, G. (1994). Tehnică experimentală. *Universitatea Agronomică Iași.*

Lindquist, J.L., Arkebauer, T.J., Walters, D.T., Cassman, K.G., Dobermann, A. (2005). Maize Radiation Use Efficiency under Optimal Growth Conditions. *Agronomic Journal, 97.* 72–78.

Ndiku, M.H., Jara, E., Sabaté, J. (2014) Formative Research on Acceptability of Pearl Millet in Rural Eastern Kenya -A Pilot Study. *Sustainable Agriculture Research,* vol 3.

Sage, R.F., Zhu, X.G. (2011). Exploiting the engine of C4 photosynthesis, *Journal of Experimental Botany.* 12, 2989–3000.

Trotuș, E. (2022). *60 de ani de Cercetare-dezvoltare. Volum omagial*, Ed. Ion Ionescu de la Brad, Iași.

Vetriventhan, M., Upadhyaya, H.D. (2018) Diversity and trait-specific sources for productivity and nutritional traits in the global proso millet (Panicum miliaceum L.) germplasm collection. *The Crop Journal*. 6, 451–463.