

RELATIONSHIPS BETWEEN NITROGEN SUPPLY, DRY MATTER ACCUMULATION AND MICRO ELEMENT CONTENT OF SILAGE SORGHUM (*Sorghum bicolor* L./Moench.)

Tamás NÉMETH

Tessedik Samuel College, Faculty of Agricultural Water and Environmental Management, P.O.B. 3, Szarvas, Hungary, H-5541

Introduction

Because of relatively low number of research results dealing with the relationships between the fertilization, crop yield and quality of silage sorghum, it is extremely important to analyse the nutrient demand, fertilizer reaction and dry matter accumulation as well as to determine the specific nutrient demand and the relationships between the crop yield, quality and nutrient supply if you want to develop the fertilization consultancy system of this plant species. At present the sorghum has the 5th biggest production area in the world next to the wheat, rice, maize and barley. It is produced on about 45 million hectares in the world in the tropic, sub-tropic and in some parts of the moderate climate zone (Africa, Asia, America and some parts of Europe). In Hungary the production area of sorghum is under 8,000 ha. In the future this group of plants might be grown on much bigger area because of its high sugar content. Its use as a fodder for the ruminant animals helps the digestion of urea supplemented feeds containing a lot of raw fibre (Józsa 1976). The silage sorghum (sugar sorghum) can be used as a fodder similarly to the silage maize. It is harvested at the end of the milky stage, or the beginning of wax-ripe stage. The fodder sorghum needs high amount of nitrogen which helps the development of vegetative parts (Siklósiné, Harmati 2001). However the higher N-supply results in more amino-acid and amide production, thus the raw protein content increases as well. As a result of the abundant nutrient supply the production yield is increased, but after reaching the maximum of the yield the protein content increases further (Györi, Györiné 2002). To develop the quality oriented and environment friendly nutrient supply, it is very important to study the following fields which were summarized by Izsáki (1999, 2001, and 2003) as follows:

- Determination of specific nutrient demand of plants based on the parameters of yield and quality,
- Research on the relationships between the nutrient supply, the crop yield and the quality,
- Elaboration of nutrient supply limits in more details and calibration of different categories of habitats,
- Differentiation of limits of nutrient supply levels of soils for each species and groups of plants,
- Research on relationships between the nutrient supply level, nutrient concentration and quality of plants respectively.

Materials and methods

The experiment was started at the Experimental farm of Plant Production and Ecological Farming Department of Faculty of Agricultural Water and Environmental Management (Tessedik Samuel College) on chernozem meadow soil with four different N, P and K supply levels, in total combination of treatments, i.e. with 64 different fertilizer treatments in split-split plots and in three replications. In the frame of this experiment 15 of the 64 fertilizer treatments were selected in 2002, in which the height of plants, the number of shoots and leaves, the leaf surface, the green mass and the dry matter yield as well as the nutrient content

of above ground parts of plants (N, P, K, Na, Ca, Mg, Cu, Zn, Mn, Fe) were studied. The total area of plots was 20.2 m², while the net area was 10.4 m². The mathematical and statistical evaluation of the results was carried out by Sváb's (1973) method of variance analysis. In the year 2002 the daily average temperatures were generally higher than the year-long averages, while the monthly average precipitation values were under the year-long averages till July. The aim of this experiment was to identify the relationships between the nutrient supply, yield and quality of sugar sorghum. In this presentation we would like to demonstrate the effect of nitrogen supply on dry matter yield and Cu-, Zn-, Mn-, Fe- uptake of four different silos sorghum varieties, as well as to give information on the specific micro-element demand of the studied variety.

Results and conclusions

Table 1. demonstrates the changes in dry matter yield during the growing season as a function of nitrogen supply. Based on the data of the table it can be stated that the plant stand of the control plots was characterized by the lowest dry matter yield on the NO₃-N supply level of 62.7 kg ha⁻¹ in the upper 60 cm layer of the soil in each sampling time and it was statistically proven as well. The more intensive period of dry matter accumulation in sorghum is the second half of the growing season, as about 50 % of the total dry matter yield was accumulated in the last 30 days before the harvesting. Concerning the maximum of dry matter, on the 111th day of the growing season significant yield increase was found compared to the control if the fertilizer dose was 80 kg ha⁻¹ of nitrogen at the 89.5 kg ha⁻¹ NO₃-N supply level in the upper 60 cm layer of the soil. However the further increase of the supply level did not result in the increase of the yield. The relationship between the nitrogen supply and growth dynamics is demonstrated in Table 1. The plant stand of the control plots showed more moderate development during the growing season if the NO₃-N supply level was 62.7 kg ha⁻¹ in the upper 60 cm layer of the soil. The moderate early development phase, which is characteristic to the sorghum, was the shortest at the N₂₄₀ treatment, at the 206.1 kg ha⁻¹ NO₃-N supply level in the upper 60 cm layer of the soil.

Table 1. Effect of N-supply to the dry matter yield of silage sorghum during the growing season.
(Szarvas, 2002)

Nitrogen supply level in the upper 60 cm soil layer	Dry matter yield tha ⁻¹					
	Number of days from germination					
	30th	44th	60th	75th	85 th	111th
N ₀ = 62.7 kg ha ⁻¹ NO ₃ -N	1.28	1.51	3.29	6.36	7.07	14.88
N ₈₀ = 89.5 kg ha ⁻¹ NO ₃ -N	1.50	2.34	5.22	7.79	14.28	18.18
N ₁₆₀ = 181.7 kg ha ⁻¹ NO ₃ -N	1.56	2.74	5.40	9.46	14.66	18.25
N ₂₄₀ = 206.1 kg ha ⁻¹ NO ₃ -N	1.59	2.78	5.21	10.99	14.80	18.24
LSD _{5%}	0.13	0.32	0.80	0.94	2.00	2.02
Average	1.48	2.34	4.78	8.65	12.70	17.39

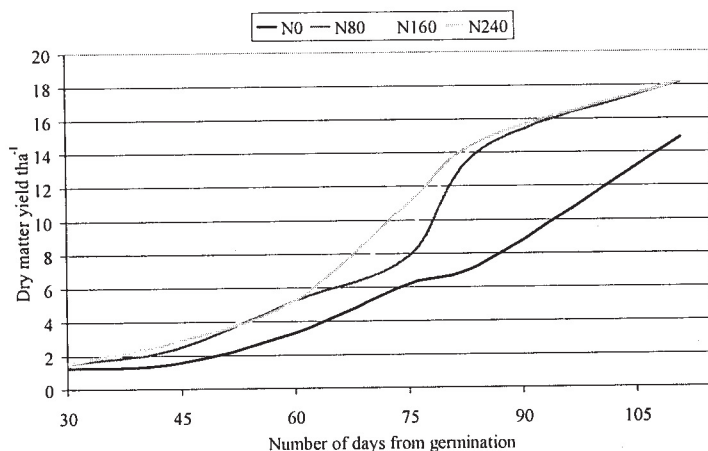


Figure 1. Effect of N-supply level on dry matter accumulation of silage sorghum (Szarvas, 2002)

The effect of nitrogen supply level on micro-element uptake can be seen in Table 2. Based on the experiences gained during the experiments it was found that the sorghum took up more micro-elements from the soil for the increasing amount of biomass owing to the improving nitrogen supply ($62.7\text{--}206.1 \text{ kg ha}^{-1} \text{ NO}_3\text{-N}$) compared to the plant stand of the control plots. The micro-element concentration of the plant tissues did not show close correlation to the nitrogen supply in the studied year. The silage sorghum took up 0.10 kg ha^{-1} copper, 0.42 kg ha^{-1} zinc, 0.81 kg ha^{-1} manganese and 1.67 kg ha^{-1} iron from the soil as an average of the studied treatments. The specific uptake of micro-elements as an average of the treatments and calculated in dry matter was as follows: Cu: 0.006 kg t^{-1} dry matter, Mn: 0.05 kg t^{-1} dry matter, Zn: 0.02 kg t^{-1} dry matter, Fe: 0.10 kg t^{-1} dry matter.

Table 2. Effects of nitrogen supply on micro-element uptake of silage sorghum (Szarvas, 2002)

Nitrogen supply in the upper 60cm soil layer	Micro-element uptake kg ha^{-1}			
	Cu	Zn	Mn	Fe
$\text{N}_0 = 62.7 \text{ kg ha}^{-1} \text{ NO}_3\text{-N}$	0.08	0.34	0.38	1.46
$\text{N}_{80} = 89.5 \text{ kg ha}^{-1} \text{ NO}_3\text{-N}$	0.11	0.41	0.74	1.62
$\text{N}_{160} = 181.7 \text{ kg ha}^{-1} \text{ NO}_3\text{-N}$	0.10	0.46	0.94	1.81
$\text{N}_{240} = 206.1 \text{ kg ha}^{-1} \text{ NO}_3\text{-N}$	0.12	0.47	1.19	1.80
$\text{LSD}_{5\%}$	0.01	0.13	0.12	0.30
Average	0.10	0.42	0.81	1.67

Acknowledgement

This research project was supported by the Hungarian Scientific Research Fund (OTKA T-034436).

References

- Győri, Z.-Győriné, M. I. 2002: A kukorica minősége és feldolgozása. Szaktudás Kiadóház, Budapest, p 40
- Izsáki, Z. 2001: A cukorrépa trágyázási szaktanácsadási rendszerének fejlesztése a diagnosztikai célú növényanalízis alkalmazásával. TSF Tudományos Közlemények, Tom. 1. No.1, p 1-14
- Izsáki, Z. 2003: A kukorica minőség-orientált tápanyagellátásának fejlesztése réti talajon. III. Növénytermesztési Tudományos Nap, MTA Növénytermesztési Bizottság, Prceedings, Budapest, p 29-33
- Izsáki, Z. 1999: A nitrogén és foszfor ellátottság hatása néhány szántóföldi kultúra fehérjetartalmára és aminosav összetételére. In: Ruzsányi, L.- Pepó, P.(edited): Növénytermesztés és Környezetvédelem. p 92-96
- Józsa, L. 1976: A takarmánycirkok termesztése és felhasználása. Mezőgazdasági Kiadó, Budapest, p 122
- Siklósiné Rajki, E.- Harmati, I.- Radics, L. 2001: Alternatív növények termesztése I. Mezőgazdasági Szaktudás Kiadó, Budapest, p 266-314
- Kádár, I. (2004): Szennyvíziszap-adagok hatása a növény (*Triticum vulgare* L.)-talaj rendszer néhány mikrobiológiai és biokémiai tulajdonságára (Impact of sludge treatments on some microbiological and biochemical properties of plant (*Triticum vulgare* L.)-soil system. – in *Hungarian*). Agrokémia és Talajtan. 53. 3-4. 331-342 pp
- Svetková, K.; Henselová, M.; Morvová, M. (2005): Effects of a carbonization product as additive on the germination, growth and yield parameters of agricultural crops. Acta Agron. Hun. 53. (3). 241-250 pp
- Tanács, L., Matuz, J., Gerő, L., Petróczi, I.M. (2005): Effect of NPK Fertilizers and Fungicides on the Quality of Bread Wheat in Different Years. Cereal Res. Commun. 33 (2-3): 627-634 pp