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IVANINA V.V., SYPKO A.O., candidate of agriculture science,
SINCHUK G.F., STRILETS O.P., ZATSERKOVNA N.S., researchers

Institute of Bioenergy Crops and Sugar Beet NAAS

E-mail: v_ivanina@meta.ua

THE INFLUENCE OF NITROGEN FERTILIZERS ON BIOENERGETICS PRODUCTIVITY OF SUGAR SORGHUM

In the article it was showed the investigation results of influence the doses of nitrogen fertilizers application on the yield of vegetative mass, sugar content and energetic productivity of sugar sorghum under growing on gray forest soil. It was determined that growing hybrid «Favorit» under application nitrogen fertilizers in pre-sowing cultivation at dose 90 kg/ha active substance was the highest energetic effective – the total energy output was 254 GJ/ha.

Key words: *sugar sorghum, nitrogen fertilizers, bioenergy, potential.*

Introduction. Strategy of energy independence of Ukraine many scientists see in ever wider development of bioenergy [1], [3]. Sugar sorghum becomes one of the most energetic undemanding to growing conditions crops whose products can be used for production of liquid and solid fuel.

At maturity in sugar sorghum stems it is accumulated of saccharose about 11%, reducing sugars – 3%, cellulose – 7%, starch – 5%, proteins – 3%, gum – 3%, pectin – 1%, ash elements – 1% [2].

High ability of this crop to adapt to the environment conditions opens a possibility for further increasing of areal of sugar sorghum growing on low productive soil of North Forrest-Steppe and Forrest Zones.

Purpose of investigation was to study the influence of nitrogen fertilizers doses application on bioenergy productivity of sugar sorghum while growing in the condition of North Central Forrest-Steppe Zone.

Materials and investigation methods. Investigations were carried out in microfield experiment (2011-2012 years) of Institute of Bioenergy Crops and Sugar Beet on gray forest soil, loamy texture. Agrochemical characteristic of topsoil (0-30 cm): organic matter content (for Turin) – 2,1-2,4%, hydrolytic acidity (for Kappen) – 3,6-4,1 mg на 100 g of soil, mobile phosphoric and potassium (for Chirikov) reciprocally – 11,3-14,1 and 12,8-14,7 mg/kg of soil.

Site accounting area – 2,0 м², repetition – four-times.

Fertilizers used: ammonium nitrate, simple granular superphosphate, potassium chloride. Phosphorus-potassium fertilizers were applied in autumn under plowing on the depth 0-30 cm, nitrogen – in spring under pre-sowing cultivation on 4-6 cm.

Investigation results ant their discussion. Investigation results show that sugar sorghum is able to develop dynamically in the conditions of sufficient moisture on the soils of middle level of fertility. Applying phosphorus-potassium fertilizers (P₆₀K₆₀) for sugar sorghum growing provided the yield of its vegetative mass – 34,4-39,7 t/ha, sugar content – 11,6-12,7%, plant height – 236-258 cm, dry matter content – 21,9-23,9%. Hybrids «Medovyi» and «Favoryt» for the yield of green mass were higher than sort «Sulosne 42» on 3,1-5,3 t/ha (table 1).

Applying nitrogen fertilizers from 60 to 120 kg/ha in active substance over the ground of phosphorus-potassium fertilizers increased the yield of green mass in comparing with applying phosphorus-potassium fertilizers: for hybrid «Medovyi» – on 3,3-5,4, «Favorit» – 3,4-5,9, sort «Sylosne 42» – 1,4-3,7 t/ha. Sugar sorghum hybrids reacted more intensely for applying nitrogen fertilizers and provided increase in a yield of green mass in comparing with sort «Sylosne 42» on 0,9-2,2 t/ha.

Nitrogen fertilizers had positive influence on crop development and dynamic of dry matter accumulation. For wax ripeness period (harvesting) the plants height in variants with nitrogen fertilizers application exceeded background variant on 10-33 cm, dry matter content – on 0,3-1,3%. Thus hybrids «Medovyi» and «Favorit»

were higher on 29-37 cm and contained dry matter more on 1,2-1,9% in comparing with sort "Sylosne 42".

Table 1

Sugar sorghum hybrids productivity as depending on doses nitrogen fertilizers application, IBCSB, 2011-2012 years

№ variant	Variant	Height of plants, cm	Dry matter content, %	Yield of vegetative mass, t/ha	Sugar content, %
Sylosne 42					
1	P ₆₀ K ₆₀ - background variant	236	21,9	34,4	11,6
2	background + N ₆₀ in pre-sowing cultivation	234	22,9	35,8	11,8
3	background + N ₉₀ - "	246	22,9	37,1	12,1
4	background + N ₁₂₀ - "	256	22,9	38,1	11,9
Medovyi					
5	P ₆₀ K ₆₀ - background variant	252	23,1	37,5	12,7
6	background + N ₆₀ in pre-sowing cultivation	271	24,1	40,8	13,0
7	background + N ₉₀ - "	284	24,4	42,0	12,9
8	background + N ₁₂₀ - "	285	24,4	42,9	12,8
Favoryt					
9	P ₆₀ K ₆₀ - background variant	258	23,9	39,7	12,7
10	background + N ₆₀ in pre-sowing cultivation	268	24,2	43,1	13,1
11	background + N ₉₀ - "	285	24,5	45,1	12,9
12	background + N ₁₂₀ - "	291	24,8	45,6	13,0
LSD ₀₅		8,6	0,7	1,5	0,3

Optimal dose of nitrogen fertilizers for growing sugar sorghum on gray forest soil was 90 kg/ha in active substance for applying in pre-sowing cultivation. The increase in a yield of green mass in pointed variant to control without nitrogen

fertilizers was 2,7-5,4 t/ha. Hybrid «Favorit» responded the best way to the nitrogen fertilizers application. Yield of green mass when applying N_{90} was 45,1 t/ha that was higher in comparing with hybrid «Medovyi» on 3,1, sort «Sylosne 42» – 8,0 t/ha.

Use of a complete mineral fertilizer including applying nitrogen from 60 to 120 kg/ha in active substance provided sugar content in sugar sorghum about 11,8-13,1%. Thus, sugar content in plants increased on 0,2-0,5% in comparing with background variant ($P_{60}K_{60}$). This feature of physiology of sugar sorghum indicates on a high efficiency of nitrogen fertilizers application in technology of this crop growing.

Applying nitrogen fertilizers in dose N_{120} caused only tendency to increase of green mass yield in sugar sorghum on 0,5-1,0 t/ha to the dose N_{90} and did not significantly alter the sugar content. It indicates on inexpediency to increase dose of nitrogen fertilizers in pre-sowing cultivation over 90 kg/ha in active substance when growing sugar sorghum on gray forest soils.

Calculations of receiving biofuel and energy show that the most energy-efficient on gray forest soils it was growing sugar sorghum hybrid «Favorit». When applying in pre-sowing cultivation nitrogen fertilizers N_{90} over background $P_{60}K_{60}$ for deep plowing provided output of bioethanol – 2,40 t/ha, solid fuel – 12,1 t/ha, total energy – 254 GJ/ha (table 2).

Growing hybrid «Medovyi» under mentioned system of fertilizers followed by decrease of bioethanol output in comparing with hybrid «Favorit» – on 0,16 t/ha, solid fuel – 0,8 t/ha, total energy – 17 GJ/ha; to sort «Sylosne 42» – reciprocally on 0,58 t/ha, 2,77 t/ha and 59 GJ/ha.

Use a dose of nitrogen fertilizers N_{60} decreased total energy output for all sugar sorghum hybrids in comparing with dose N_{90} on 8-12 GJ/ha, applying dose N_{120} increased total energy output to mentioned nitrogen dose (N_{90}) on 5-7 GJ/ha.

Table 2

**The output of bioethanol and energy as depending on doses nitrogen
fertilizers application, IBCSB, 2011-2012 years**

№ vari- ant	Variant	Output, t/ha			Energy output, GJ/ha		Total energy, GJ/ha
		juice	bioethanol	solid fuel	bioethanol	solid fuel	
Sylosne 42							
1	P ₆₀ K ₆₀ - background variant	17,2	1,60	8,27	40	132	172
2	background + N ₆₀ in pre-sowing cultivation	18,0	1,68	9,03	42	145	187
3	background + N ₉₀ - " -	18,6	1,82	9,33	46	149	195
4	background + N ₁₂₀ - " -	19,1	1,87	9,60	47	154	201
Medovyj							
5	P ₆₀ K ₆₀ - background variant	18,8	2,01	9,50	50	152	202
6	background + N ₆₀ in pre-sowing cultivation	20,4	2,18	10,8	55	173	228
7	background + N ₉₀ - " -	21,0	2,24	11,3	56	181	237
8	background + N ₁₂₀ - " -	21,5	2,30	11,5	58	184	242
Favoryt							
9	P ₆₀ K ₆₀ - background variant	19,9	2,03	10,4	51	166	217
10	background + N ₆₀ in pre-sowing cultivation	21,6	2,30	11,5	58	184	242
11	background + N ₉₀ - " -	22,6	2,40	12,1	60	194	254
12	background + N ₁₂₀ - " -	22,9	2,43	12,5	61	200	261

Conclusions. Applying nitrogen fertilizers in pre-sowing cultivation of sugar sorghum increased green mass yield on 1,4-5,9 t/ha, sugar content – 0,2-0,5%, total energy output – 15-44 GJ/ha.

Sugar sorghum hybrids «Favorit» and «Medovyi» for applying nitrogen fertilizers formed higher vegetative mass, had higher sugar content and differ higher energy productivity in comparing with sort «Sylosne 42» – reciprocally on 5,0-7,5 t/ha, 0,9-1,3% and 41-60 GJ/ha.

The most energy-efficient on gray forest soils was growing hybrid «Favorit». For applying in pre-sowing cultivation nitrogen fertilizers N_{90} over background $P_{60}K_{60}$ in deep plowing provided output of bioethanol – 2,40 t/ha, solid fuel – 12,1 tr/ha, total energy – 254 GJ/ha.

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Анотація

Іваніна В.В., Сипко А.О., Сінчук Г.А., Стрілець О.П., Зацерковна Н.С.,

Вплив азотних добрив на біоенергетичну продуктивність цукрового сорго

В статті висвітлено результати досліджень щодо впливу доз внесення азотних добрив на урожайність зеленої маси, вміст цукру та енергетичну продуктивність цукрового сорго за вирощування на сірих

лісових ґрунтах. Установлено, що найбільш енергетично ефективним було вирощування гібриду «Фаворит» за внесення азотних добрив у передпосівну культивуацію 90 кг/га діючої речовини – сумарний вихід енергії врожаю становив 254 ГДж/га.

Ключові слова: цукрове сорго, азотні добрива, біоенергетична продуктивність

Аннотація

Иванина В.В., Сыпко А.О., Синчук Г.А., Стрилец О.П., Зацерковная Н.С.

Влияние азотных удобрений на биоэнергетическую продуктивность сахарного сорго

В статье освещены результаты исследований о влиянии доз внесения азотных удобрений на урожайность зеленой массы, содержания сахара и энергетическую продуктивность сахарного сорго при выращивании на серых лесных почвах. Установлено, что наиболее энергетически эффективным было выращивание гибрида «Фаворит» за внесения азотных удобрений в предпосевную культивуацію 90 кг/га действующего вещества – суммарный выход энергии урожая составил 254 ГДж/га.

Ключевые слова: сахарное сорго, азотные удобрения, биоэнергетика, потенциал.