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Peculiarities of the formation of grain sorghum hybrids biometric indicators with the application of microfertilizers and growth regulators

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Abstract

The selection of elements of grain sorghum cultivation technology should be carried out taking into account its biological features, which are different from C3 crops of the photosynthesis type traditionally grown in the conditions of the forest-steppe of Ukraine. The laboratory similarity of the grain sorghum hybrids studied by us depended exclusively on the quality of the seed material, thats how for the Brigg hybrid it was 95.2%, and for the Yutami hybrid this indicator was 94.7%. The density of crops at the time of harvesting of grain sorghum plants was in the Brigg hybrid, the best indicators were obtained by treating plants foliar with microfertilizers Alpha-Grow-Extra 2 l/ha (1 treatment of 5 leaves, 2 - 9 leaves, 3 - throwing out panicles), or Intermag - Corn, 2 l/ha (1 treatment in the phase of 5 leaves, 2 and 3 - with an interval of 7 days). In the Yutami grain sorghum hybrid, the best level of conservation of crop density, similar to the other researched hybrid, was ensured by the use of foliar fertilization. By the end of the growing season, and in particular at the time of full maturity, the average height of the plants according to the experiment was 117.3 cm, and the use of additional elements of growing technology did not lead to a significant impact on the studied indicator at the later stages of the growing season. Thus, the height of the sorghum plants of the Brigg hybrid was within 118.5-124.1 cm, and in the Yutami hybrid - 111.7-117.2 cm.

Keywords: Grain sorghum, Hybrids, Micro fertilizers, Growth regulator, Laboratory germination, Plant density, Plant height.

Introduction

Grain sorghum, in contrast to traditional agricultural crops common in Ukraine, has a C4 type of photosynthesis, and hence a number of limitations and features of plant growth and development.

First of all, plants are resistant to high air temperatures, rationally use moisture. However, crops require a high level of purity to create conditions for a good supply of solar energy and actually have initial periods of slow growth, which are critical for the accumulation of an undesirable weed component in the agroceonosis (Kurylo and Gerasimenko, 2012; Makarov, 2006; Rozhkov and Sviridova, 2017).

Despite the fact that the culture is quite new, over the past 20 years it has become widespread in Ukraine not only in the conditions of the Steppe, but also in the Forest-Steppe region due to its unpretentiousness to growing conditions, and in particular, its resistance to conditions of water shortage and high air temperatures. After all, such conditions are increasingly common in the forest-steppe of Ukraine (Anon, 1987; Demydenko, 1963; Karazhbey et al., 2017).

Also, in the first half of the growing season, grain sorghum forms a fairly voluminous root system capable of penetrating the deep layers of the soil in search of moisture and nutrients. But before the beginning of flowering, it already absorbs about 70% of all the elements necessary for full-fledged growth and development. That is, if the conditions for a lack of nutrients are created in the first half of the growing season,

then their additional application after the flowering of the crop will not be able to correct the situation and improve the yield and quality of sorghum.

Therefore, optimization of nutrition conditions, including foliar application of various types of fertilizers in the first half of the growing season of the crop is a reliable way to provide plants and stimulate better conditions for their formation of a high level of productivity.

Also, when choosing grain sorghum hybrids suitable for cultivation in the conditions of a certain agro-climatic zone, the length of their growing season should be taken into account. After all, mid- and late-ripening hybrids can vegetate until the end of October, which is unacceptable in the conditions of the forest-steppe of Ukraine, since not every year there is good weather for an effective crop harvest.

Thus, the selection of elements of grain sorghum cultivation technology should be carried out taking into account its biological features, which are different from C3 photosynthesis type crops traditionally grown in the conditions of the Forest Steppe of Ukraine (Russo, 1978; Safarov, 1977; Steiner, 1986).

Material and Methods

In 2019-2021 field trials were carried out in the experimental field of SPC of Bila Tserkva NAU, situated in the Right-bank Forest-steppe zone – in Bug-Middle Dnipro area. The relief of the experimental field is a slightly wavy plain with a small slope of the surface from the south to the south-west.

In the years when the research was conducted (2019-2021) the weather conditions differed from long-term indicators. However, generally they were favourable for the growth and development of grain sorghum.

To reach the goal the following techniques were used: a field method – to identify the correlation of the plant with biotic and abiotic factors; a calculation method – to keep records of plant density by vegetation on replication plots I and III with the length of 14.3 m; a weighing method – to keep records of grain sorghum yield capacity; a statistical analysis of the research results was made with help of variation, disperse, correlation and regression methods using applied computer software Statistics.

Results and Discussion

Let's consider the parameters of germination, density and survival of grain sorghum obtained in our experiment (Table 1). Seed germination indicators of grain sorghum and their derivative, the density of crops during the growing season, are a measure of the effective application of the main, basic, elements of growing technology. And also, at the same time it can indicate that during the cultivation of plants, sufficient characteristics of the sowing obtained are necessary for its effective work.

Table1. Similarity, density and survival of grain sorghum, average for 2019-2021

Hybrid	Microfertilizer	Growth regulator	Laboratory germination, %	Field germination, %	Density at the time of full germination	Density at the time of harvesting	Plant survival, %
Brigg	Without microfertilizers	Without regulator	95,2	85,3	162,2	145,2	89,5
		Regoplant	95,2	85,2	162,0	146,6	90,5
		Stimpo	95,2	85,6	162,7	147,6	90,7
	Alpha-Grow-Extra	Without regulator	95,2	85,4	162,4	148,2	91,3
		Regoplant	95,2	85,2	162,0	150,2	92,7
		Stimpo	95,2	85,5	162,5	150,3	92,5
	Intermag	Without regulator	95,2	85,3	162,2	151,0	93,1
		Regoplant	95,2	85,5	162,5	152,8	94,0
		Stimpo	95,2	85,2	162,0	152,0	93,8
Yutami	Without microfertilizers	Without regulator	94,7	84,3	161,3	145,5	90,2
		Regoplant	94,7	84,2	161,1	146,3	90,8
		Stimpo	94,7	84,1	160,9	146,4	91,0
	Alpha-Grow-Extra	Without regulator	94,7	84,7	162,0	151,3	93,4
		Regoplant	94,7	84,3	161,3	152,6	94,6
		Stimpo	94,7	84,6	161,8	152,4	94,2
	Intermag	Without regulator	94,7	84,5	161,6	150,5	93,1
		Regoplant	94,7	84,6	161,8	151,9	93,9
		Stimpo	94,7	84,7	162,0	152,4	94,1
		$SSD_{0,05}$	0,4	0,6	1,2	1,1	0,8

The laboratory similarity of the grain sorghum hybrids we studied depended exclusively on the quality of the seed material and for the Brigg hybrid was 95.2%, and for the Yutami hybrid this indicator was 94.7%.

Accordingly, the field germination of seeds was somewhat lower and was generally initially determined by the basic laboratory germination. However, it also depended on the environmental conditions, since the experiments were laid out in the same way and we did not perform additional elements of agricultural technology in the initial period. Therefore, the field similarity was 85.2-85.6% for the Brigg hybrid, and 84.1-84.7% for the Yutami hybrid.

And therefore, at the time of the formation of full seedlings, the crops had sufficient density for their effective development in the future. Thus, in the Brigg hybrid, the density was 162.0-162.7, and for the Yutami hybrid - 160.9-162.0 thousand pcs./ha.

Accordingly, the basic parameters of the density of crops played a role in the preservation of plants during the growing season, but this indicator is also highly influenced by the factors of crop care, the presence of pests and diseases, and the weather conditions of the growing season.

So, according to the data received by A.O. Rozhkov, L.A. Sviridova 55% of the changes in survival depended on the rate of sowing, while sowing methods and hybrids determined about 15.5% of the changes (Rozhkov and Sviridova, 2017).

If we analyze the density of crops at the time of harvesting grain sorghum plants, then in the Brigg hybrid, the best indicators were obtained when the plants were treated foliarly with microfertilizers Alpha-Grow-Extra 2 l/ha (1 treatment of 5 leaves, 2 - 9 leaves, 3 - throwing out panicles), or Intermag - Corn, 2 l/ha (1 treatment in the phase of 5 leaves, 2 and 3 - with an interval of 7 days). Moreover, it was the application of Intermag - Maize, 2 l/ha (1 treatment in the 5-leaf phase, 2 and 3 - with an interval of 7 days) in combination with the growth regulator Regoplant, 50 ml/ha in the 5-leaf phase, that ensured the density of crops at equal to 152.8 thousand pieces/ha, and the survival of plants during the growing season is 94.0%.

In the Yutami grain sorghum hybrid, the best level of conservation of crop density, similar to the other researched hybrid, was ensured by the use of foliar fertilization. At the same time, by treating plants Alpha-Grow-Extra 2 l/ha (1 treatment of 5 leaves, 2 – 9 leaves, 3 – discarding panicles) in combination with the growth regulator Regoplant, 50 ml/ha in the phase of 5 leaves, the density of crops was preserved at the level of 152.6 thousand units/ha, and the survival of plants during the growing season is 94.6%. And for the application of foliar feeding Intermag - Corn, 2 l/ha (1 treatment in the phase of 5 leaves, 2 and 3 - with an interval of 7 days), the best combination option was a combination with Stimpo, 20 ml/ha in the phase of 5 leaves density of crops remained at the level of 152.4 thousand units/ha, and plant survival during the growing season was 94.1%.

The height of plants depends to a large extent on growing conditions, feeding area and other factors. Thus, Safarov T. shows that the height of sorghum increases by 18 cm due to thickening in a row, and according to the data of Krylov A.V. and Filatova V.I. a high number of plants in a row helps to increase the height of grain sorghum by 8.6 cm (Krylov and Filatov, 2002).

Let's consider the peculiarities of the formation of the height of grain sorghum plants under the influence of experimental factors (Table 2).

In the full seedling phase, the height of the Brigg hybrid sorghum plants was within 4.8-5.2 cm, and in the Yutami hybrid - 5.1-5.6 cm. Similarly, in the tillering phase, plant height differentiation did not depend on the factors of our experiment. yes, the height of the sorghum plants of the Brigg hybrid was within 12.2-13.2 cm, and in the Yutami hybrid - 12.0-13.2 cm.

In the tube emergence phase, the height of sorghum grain hybrids Brigg and Yutami was minimal in the control variants and also in the case of exclusively using growth regulators.

With Alfa-Grow-Extra foliar fertilization of 2 l/ha (1 treatment of 5 leaves, 2 - 9 leaves, 3 - throwing out panicles), the height of the sorghum hybrid Brigg was 61.4 cm, and the hybrid Yutami - 59.8 cm. And for the application as foliar fertilization with microfertilizer Intermag - Corn, 2 l/ha (1 treatment in the phase of 5 leaves, 2 and 3 - with an interval of 7 days), respectively 62.6 and 58.0 cm. Moreover, combined options for applying microfertilizers and regulators growth were better in terms of plant height formation.

In the phase of panicle shedding during foliar feeding of sorghum hybrid Brigg with microfertilizer Alpha-Grow-Extra 2 l/ha (1 treatment of 5 leaves, 2 – 9 leaves, 3 – panicle shedding) in combination with Stimpo growth regulator, 20 ml/ha in phase 5 the leaves of the plant formed a height of 111.3 cm, while in the control it was only 106.9 cm. And with the use of foliar fertilization Intermag - Corn, 2 l/ha (1 treatment in the phase of 5 leaves, 2 and 3 - with an interval of 7 days) in combination with Stimpo growth regulator, 20 ml/ha in the phase of 5 leaves - 111.0 cm.

Table 2. Peculiarities of grain sorghum plant height formation under the influence of experimental factors, average for 2019-2021.

Hybrid	Microfertilizer	Growth regulator	Development phase					
			Full shoots	Bushing	Exit to the tube	Ejection of the panicle	Flowering	Full ripeness of the grain
Brigg	Without microfertilizers	Without regulator	4,9	12,3	59,1	106,9	112,4	119,0
		Regoplant	5,1	12,6	60,0	111,7	114,6	122,5
		Stimpo	4,8	13,2	58,9	114,5	113,1	120,5
	Alpha-Grow-Extra	Without regulator	5,0	12,5	61,4	107,9	118,2	120,6
		Regoplant	4,9	12,2	62,7	109,2	111,3	119,0
		Stimpo	5,1	13,0	63,4	111,3	115,7	124,8
	Intermag	Without regulator	5,2	12,1	62,6	109,0	116,3	118,8
		Regoplant	4,7	12,4	63,0	109,0	111,1	118,5
		Stimpo	4,8	12,9	62,5	111,0	115,3	124,1
Yutami	Without microfertilizers	Without regulator	5,2	13,2	56,5	102,5	107,2	111,7
		Regoplant	5,3	12,5	57,4	107,1	110,4	115,0
		Stimpo	5,1	13,2	55,4	109,6	112,8	115,9
	Alpha-Grow-Extra	Without regulator	5,4	12,3	59,8	102,6	109,1	111,3
		Regoplant	5,2	12,0	58,1	104,7	107,1	111,6
		Stimpo	5,6	12,7	59,8	106,7	111,5	117,2
	Intermag	Without regulator	5,5	12,8	58,0	103,7	109,2	113,5
		Regoplant	5,2	12,4	57,1	104,5	106,9	111,1
		Stimpo	5,1	12,9	56,9	106,5	111,0	116,6
		$SSD_{0,05}$	0,4	1,0	1,5	2,0	4,3	7,5

In the Yutami hybrid, by treating plants with microfertilizer Alpha-Grow-Extra 2 l/ha (1 treatment of 5 leaves, 2 - 9 leaves, 3 - throwing out panicles) or Intermag - Corn, 2 l/ha (1 treatment in the phase of 5 leaves, 2 and the 3rd - with an interval of 7 days) in combination with the introduction of the growth regulator Stimpo, 20 ml/ha in the phase of 5 leaves, the height of the plants was obtained at the level of 106.7 and 106.5 cm.

In the flowering phase, sorghum plants formed a height of 111.8 cm, and the use of additional elements of the growing technology did not significantly affect the height of the plants. That is, the patterns obtained were of a more tendentious character and the best in terms of plant height in the Brigg hybrid were the options for applying Alpha-Grow-Extra 2 l/ha (1 treatment of 5 leaves, 2 - 9 leaves, 3 - throwing out panicles) - 118.2 cm and Intermag – Corn, 2 l/ha (1 treatment in the phase of 5 leaves, 2 and 3 – with an interval of 7 days) – 116.3 cm. But for the Yutami hybrid, we did not observe patterns associated with the introduction of a complex of microfertilizers or growth regulators in their combination. The best height was on the option of foliar feeding of plants with Stimpo growth regulator, 20 ml/ha in the phase of 5 leaves - 112.8 cm.

By the end of the growing season, and in particular at the time of full maturity, the average height of the plants according to the experiment was 117.3 cm, and the use of additional elements of growing technology did not lead to a significant impact on the studied indicator at the later stages of the growing season. Thus, the height of the sorghum plants of the Brigg hybrid was within 118.5-124.1 cm, and in the Yutami hybrid - 111.7-117.2 cm.

So, as we determined earlier, in the experiment, the average plant height of different grain sorghum hybrids had differences. Therefore, we will analyze the average height of grain sorghum in an interhybrid comparison (Figure 1).

On average, according to the experiment, in the phase of full seedlings, the plants of the Brigg hybrid were 0.3 cm higher than the Yutami hybrid, similarly, this dependence was preserved in the bushing phase. But in the phase of emergence into the tube, we did not observe differences between the studied hybrids.

However, during the period of active growth and development, the situation changed somewhat, and in the panic phase of the Brigg hybrid plant, it was 3.8 cm higher, in the flowering phase by 2.2 cm, and in the phase of full grain maturity, it was 3. cm higher than the Yutami hybrid. Considering the fact that the Yutami hybrid has a 10-day shorter growing season, the lower plant height is justified by its growth and development speed.

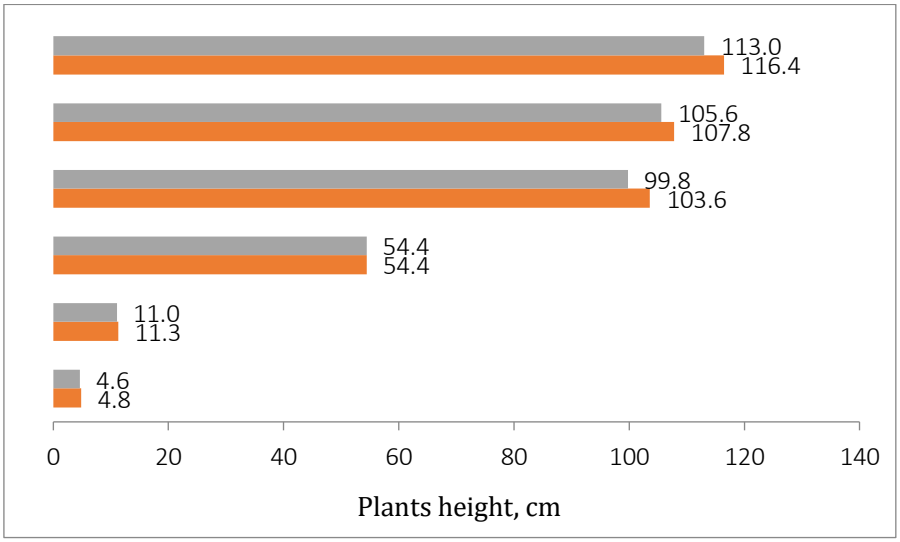

Figure 1. Average height of grain sorghum in an inter-hybrid comparison, 2019-2021.

Conclusion

The density of crops at the time of harvesting in the Brigga sorghum hybrid was better when treated with foliar microfertilizer Intermag - Corn, 2 l/ha in combination with the growth regulator Regoplant - 152.8 thousand pcs./ha, and plant survival during the growing season - 94.0%. In the Yutami hybrid, the best level of preservation of density was provided by the use of foliar feeding Alpha-Grow-Extra 2 l/ha in combination with the growth regulator Regoplant - 152.6 thousand pcs./ha, and plant survival - 94.6%.

It was investigated that the elements of the technology used by us influenced the formation of plant height only in the phase of throwing out panicles and flowering, and by the end of the growing season, and in particular at the time of full maturity, the average height of plants according to the experiment was 117.3 cm, and the use of additional elements of growing technology did not lead to a significant impact on the studied indicator in the late stages of vegetation. Thus, the height of sorghum plants of the Brigga hybrid was in the range of 118.5-124.1 cm, and in the Yutami hybrid - 111.7-117.2 cm.

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