

INFLUENCE OF THE VARIETY AND FERTILIZATION ON THE PRODUCTIVITY OF GRAIN SORGHUM IN MONOCULTURE CONDITIONS

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Abstract

Three grain sorghum varieties have been tested in field trials during the period 2017-2018 with variants of beet and sorghum (monoculture) forerunner crops, and mineral Nitrogen fertilization. The agro-climatic conditions are defining factor for the grain yield and the differences between the varieties in their reaction to fertilization and monoculture growing manifest themselves in the water deficiency conditions of the test period. The Nitrogen fertilization increases the average values of the yield to 113.0% when the applied dose is 20 kg N/da, and to 120.8% when 40 kg/da is the applied Nitrogen dose. The increase of the water deficit decreases the effects of mineralization and the influence of the forerunner crop. The yield of sorghum when grown in monoculture is with 11.6% less than the yield after good forerunner crop as the beet. The Nitrogen fertilization, even with lower doses of Nitrogen overcomes this negative effect. The variety Maxibel manifests the highest adaptability to the stress factors of monoculture growing and reacts with significant increase of the grain yield to fertilization.

Key words: sorghum, monoculture, fertilization, productivity.

INTRODUCTION

The optimization of effective crop rotation is a basic factor for the intensive and sustainable agriculture in the conditions of the new economic realities and the tendency for increase of the extremal deviations from the agro-meteorological norms (Vasilev, 1986).

The unique plasticity and drought resistance of sorghum makes actual its place in the agricultural crops structure. A basic factor for the drought resistance is its powerful root system, which absorbs intensively water and nutrition elements even from the deepest soil horizons (Tanchev, 1996).

The breeding of new varieties, the balanced fertilization and the optimization of the modern agro-technics disprove the old standpoint that sorghum is a bad forerunner crop. Thus the potential for ensuring the forage balance is increased in the agriculture in conditions of water deficiency (Hanssmans, 1998; Berenji and Dahlberg, 2004; Kikindonov and Slanev, 2008; Kikindonov et al., 2009).

The intensive market character of the agricultural practice in Bulgaria is concentrated in the narrow parameters of grain production, which brings the necessity of studying the

possibilities of monoculture growing of crops. The researches with sorghum started in the 80s of the last century and are concentrated on the agrochemical sequels from the sorghum as a forerunner crop (Zarkov, 1995; Ran et al., 2009). In the last years the accent is on breeding decisions by selection of forms with increased self-sustainability.

The aim of the study is to assess the genotypic reaction in terms of productivity of sorghum varieties when grown in conditions of monoculture compared to grown in optimal crop rotation with a beet forerunner crop.

MATERIALS AND METHODS

The research was conducted in 2017-2018 on the experimental field of Agricultural Institute - Shumen. The soil is carbonate black soil with weekly alkaline reaction.

In the tests are included the early variety Alise of Euralis Semences, the medium-late variety Maxired and the late variety Maxibel from the list of the Agricultural Institute.

The experimental field is part of a crop rotation wheat/corn/oats/beet/sorghum, and part of the sorghum area is maintained in monoculture. The experiment is conducted according to the

long plots method, in 4 repetitions, with a 3-rows plot of 12 m², with 50 cm inter-row space and a sowing rate of 30000 plants per da.

The sowing is at the beginning of May, and the fertilization is made after germination together with a manual hilling. The harvestings in technical maturity stage are made by hand at the end of October. After the threshing of the grain the moisture is measured and the yield is calculated for 13% moisture of grain.

Data are treated by dispersion analysis for calculating the limit values for discernment GD 1% and experimental exactness P%. The control for each variety is the non-fertilized variant after beet forerunner. For determination of the main action of the factors is used dispersion analysis with averaging of values for each variant.

RESULTS AND DISCUSSIONS

The agro-meteorological conditions in years of research are characterized with extreme and continuous drought in the active period of sorghum vegetation during July-August. This opens possibility of manifestation of sorghum as a drought resistant crop and to limit the

genotype's influence in the conditions of water deficiency and monoculture. In 2018 is registered a greater moisture retention from the rainfalls in June.

The results for the yield (Table 1) are strongly affected by the extreme drought during the vegetation of sorghum (end of May to September). The yield of the control non-fertilized variants after beet forerunner is 667 kg/da for the late Maxibel, 705 kg/da for the mean-late variety Maxired and 810 kg/da for the early variety Alise. The effect of fertilization is the strongest and statistically proved for the higher fertilizer dose, and for Maxired it reaches 127% of the control. In conditions of monoculture the yields decrease significantly, as the mean-early variety Maxired is the most strongly affected variety – 84% of the control variant. Even the lower dose of 20 kg N/da compensates the negative influence of the forerunner. Maxired is with the strongest reaction to fertilization, no matter the forerunner crop. Comparatively weaker is the reaction of the early Alise, and this affects the yields from the variants grown in monoculture.

Table 1. Influence of the variety, fertilization and the forerunner crop on the yield of grain sorghum, 2017

VARIETY	Variant	Beet forerunner		Sorghum forerunner - monoculture	
		kg/da	Rel. %	kg/da	Rel. %
MAXIBEL	Control	667	100.0	639	95.8
	+ 20 kg N	703	105.4	685	102.7
	+ 40 kg N	767	114.9	732	109.7
MAXIRED	Control	705	100.0	593	84.1
	+ 20 kg N	769	109.1	718	101.8
	+ 40 kg N	897	127.2	805	114.2
ALISE	Control	810	100.0	718	88.6
	+ 20 kg N	907	111.9	745	91.9
	+ 40 kg N	918	113.3	875	108.0
GD 1%	97.1 kg/da - 7.8%				
P %	3.10%				

The better moisture retention in 2018 reflects in the comparatively higher grain yields (Table 2). The differences between the control variants with beet forerunner are not proved statistically and vary from 815 to 855 kg/da. The effect of fertilization is high, but with small differences for the fertilization dose. The levels of monoculture influence remain between 82% and 88% of the control.

The late variety Maxibel manifests the strongest reaction to fertilization. The earlier varieties Maxired and Alise form equal to control variants' yield when the higher dose of Nitrogen fertilizer (40 kg) is applied.

On Table 3 are given the results of the dispersion analysis of the averaged data for determining the main action of the studied factors. The agro-meteorological conditions are

defining factor for the grain yield. In the water deficiency conditions of the test years the differences between the varieties are manifested depending on their early maturity. In the comparatively damper 2018 the differences significantly increase, and the high productivity of the late Maxibel shows itself. The fertilization significantly increases the averaged values of yield - mean of 113.1% for the 20 kg dose, and 120.8 - for the higher dose

of 40 kg N/da. The differences between the varieties regarding their reaction to fertilization are in narrow frames. More significant, but not proved statistically, is that difference for the Maxibel variety.

The averaged effect of monoculture growing of sorghum is a 11.6% decrease of the yield compared to the variants with a beet forerunner crop.

Table 2. Influence of the variety, fertilization and the forerunner crop on the yield of grain sorghum, 2018

Variety	Variant	Beet forerunner		Sorghum forerunner - monoculture	
		kg/ da	rel. %	kg/ da	Rel. %
Maxibel	Control	852	100.0	736	86.4
	+ 20 kg N	1056	123.9	916	107.5
	+ 40 kg N	1080	126.8	948	111.3
Maxired	Control	815	100.0	724	88.8
	+ 20 kg N	906	111.2	781	95.8
	+ 40 kg N	917	112.5	826	101.3
Alise	Control	855	100.0	704	82.3
	+ 20 kg N	970	113.5	809	94.6
	+ 40 kg N	1032	120.7	859	100.5
GD 1%	159 kg/da - 18.4%				
P %	7.43 %				

Table 3. Main action of factors variety, year, fertilization and forerunner on the yield of grain sorghum, 2017-2018

Year		Fertilization with N			Forerunner crop		Mean kg/da
2017 kg/da	2018 kg/da	Control kg/da	+ 20 kg N Rel. %	+ 40 kg N Rel. %	Beet kg/da	Sorghum Rel. %	
Maxibel variety							
699	931	724	116.0	121.8	854	90.9	815
Maxired variety							
747	828	709	111.9	121.4	834	88.8	788
Alise variety							
829	872	772	111.1	119.3	915	85.8	850
Average							
758	877	735	113.1	120.8	868	88.4	818
GD 1% - 56.4 kg/da, 6.94%							
P% - 3.77%							

CONCLUSIONS

The agro-meteorological conditions are defining factor for the grain yield and in water deficiency conditions the differences between the varieties are manifested in their reaction to fertilization and monoculture growing. The averaged values show increase of the yield to

113.0% for the 20 kg of nitrogen and to 120.8% for the 40 kg doses of nitrogen fertilizer application. The increase of the water deficit decreases the effects of fertilization and forerunner crop's influence.

The decrease of yield of monoculture growing is on the average of 11.6% in comparison with the yield after beet forerunner crop. The

fertilization with even smaller doses of nitrogen overcomes this negative effect. The variety Maxibel manifests itself with the highest adaptability to the stress factors of monoculture growing, reacting very positively to fertilization.

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