Bulgarian Journal of Agricultural Science, 27 (No 3) 2021, 588–592

Effect of mineral and organic fertilization on the dynamics of biomass accumulation of sugar and fodder beet

Elena Dimcheva, Stanimir Enchev[*] and Tzvetan Kikindonov

Agricultural Institute, 9700 Shumen, Bulgaria
[*]*Corresponding author:* stanimir_en@abv.bg

Abstract

Dimcheva, E., Enchev, S. & Kikindonov, Tz. (2021). Effect of mineral and organic fertilization on the dynamics of biomass accumulation of sugar and fodder beet. *Bulg. J. Agric. Sci., 27 (3)*, 588–592

It has been studied the effect of fertilization with a complex of organic fertilizers (0.5% Arbanassy Ecosyst + 0.7% Aminobest + 1% Unistim) and mineral fertilizer NPK (30 kg/da) on the dynamics of biomass accumulation of Standard sugar beet (Diex, Peshtera) and fodder beet (Hybrid 56 and Sasha) varieties.

The period of testing (2015-2017) includes seasons with different abro-climatic conditions and vegetation duration, which allows determination of the tendencies for biomass accumulation in the comparatively favorable conditions of 2015 and the extreme droughts in 2016 and 2017.

The temp of biomass accumulation is positively affected by the organic fertilization in droughts conditions. And significantly positive is the influence of the mineral fertilization in more favorable for the crops conditions of the climate.

The sugar beet is more adoptive to water deficit during the vegetation, while the fodder beet forms react more strongly to mineral and organic fertilization.

Keywords: sugar beet; fodder beet; mineral and organic fertilization; varieties; agro-climatic conditions

Introduction

One of the ways of solving the problem with the balanced feeding is the inclusion of fodder, sugar and semi-sugar beets in the day rations of livestock (Tanosiunier & Noskaitit, 2000). The high yields and concentrations of nutritive substances and vitamins, and the good taste qualities condition the use of fodder and semi-sugar beets for fresh forage and their inclusion in the autumn-winter period's rations of the ruminant animals (Badawi et al., 2002).

The high sugar content, combined with high productivity makes actual the significance of the sugar beet for the production of organic sweet syrups. The preferred source of raw material for bio-ethanol production in the European countries is the sugar beet (Hinkova & Bubnik, 2001; Oktay & Ozturk, 2004).

The beet is a plant of the moderate climate and the most favorable for its development average day temperature is 15-20°C, and the temperature sum, necessary for the entire vegetation is about 2800°C. The soil's humidity is the key factor for the beets growing because of the dry continental climate in our country. For its optimum development this crop needs rainfalls of about 550-600 mm for the year. The rainfalls sum in Northern Bulgaria is in the norm, but during the last years there is an uneven distribution of their quantities during the beets development. Unfavorable for the quality indices are the late September rainfalls, causing secondary vegetation and decrease of the sugar and dry matter content in the roots. The summer droughts in July-August are also very unfavorable for the crop development, especially when accompanied by comparatively high daily temperatures and low atmospheric humidity. The results of our researches show (Kikindonov, 2011a) that in extreme climatic conditions of continuous drought the yield of beets is at serious risk.

The monogerm varieties, hybrids of monogerm male-sterile lines and multigerm pollinators are confirmed to be the best in the beets breeding (Uchkunov et al., 2006). In Europe usually the triploid hybrids are higher yielding and with better technological qualities than the diploid hybrids, while the diploid hybrids have higher seeds germination (Kikindonov, 2012). The controlled inclusion of sugar beet varieties of normal and high yield direction in the forage balance increases the productivity of the ruminants without side effects and that is proved. The fodder beet, with its high yields and forage value is a traditional source of fresh forage (Morvan et al., 2000). The semi-sugar beet hybrids combine successfully the high productivity of the fodder beet pollinators with the increased dry matter content and monogermity of the sterile maternal components of sugar beet. This makes them appropriate for mechanized intensive production on bigger areas. (Hagihara et al., 2001; Kikindonov, 2011b).

The use of biologically active substances and bio-preparations in plant growing is an alternative of the mineral fertilization and the treatments with pesticides, the high dosages of which violate the ecological balance in the agrocenoses (Alves et al., 2009). The organic agriculture in Europe is developing very dynamically because of the enhancing interest from the farmers and the increased demand for ecologically clean eatables. The foliar fertilization is widely applied in the schemes of intensive agriculture – the nutritional substances are supplied much faster to plants in comparison with the soil fertilization. Many authors have studied the influence of natural biologically active substances, bio-fertilizers and bio-pesticides (Enchev & Kikindonov, 2015). Different bio-preparations have been tested on sugar, fodder and table beets (Hashemi et al., 2013; Sayed-Ahmed et al., 2016; Ingole et al., 2018). It has been established improvement of growth, the physiological status, productivity and resistance of crops in stress conditions, caused by biotic and abiotic factors. The application of different organic fertilizers brings to increase of the biochemical and physiological indices and the yield of plant production (Vlahova et al., 2011). It is considered that the use of bio-preparations is necessary as a new approach in plant protection (Ujvary, 2002).

The aim of the present scientific study is to research the dynamics of biomass accumulation during the vegetation of Standard varieties of sugar and fodder beet after application of organic and mineral fertilization.

Material and Methods

Two varieties of fodder beet- triploid monogerm semi-sugar beet Hybrid 56 and tetraploid sugar beet pollinator Sasha, and the Standard sugar beet varieties – the diploid hybrid Diex and the triploid monogerm hybrid Peshtera- have been tested. The field tests are realized on a carbonate black soil with a weekly alkaline reaction of the soil solution, under non-irrigation conditions. The randomization of the test field is according the long plot method, in four repetitions; the area of the harvest plot is 10.8 m^2.

The tested variants are:

1. Without fertilization – control
2. Treated in a developed leaf rosette stage with a complex of organic fertilizers:
   - Arbanassy ecosyst – containing several *Bacillus subtilis* strains, as well as the bacteria *Bacillus licheniformis, Azotobacter chroococum* and *Azotobacter vinelandii* – in 200 ml/da dosage.
   - Aminobest – with dry matter 9.5-12.5%; pH 9.0-13; 1.65% humine compounds – 4.02%, amino-acids; total nitrogen 0.4-0.75%; micro- and macro-elements in 200 ml/da dose.
   - Unistim – extract of processed with Californian worm plant residues – in a 0.5 ml/da dose.
3. Fertilized with combined mineral fertilizer before sowing with 30 kg/da dose.

The weight of the roots and the leaves' mass has been measured on: 10.08, 04.09 and 16.11 in 2015, 15.08, 13.09, 15.10 in 2016, 21.06, 17.07, 7.08, 7.09, 20.10 in 2017. The results are treated statistically by dispersion analysis according to Lidanski (1988). The Group Standard includes the variants without fertilization, harvested on the first date.

Results and Discussion

The differences of the agro-meteorological conditions during the test period makes it possible to assess the influence of the media factors on the dynamics of growth of the tested varieties, hybrids and pollinators of sugar and fodder beet.

The years 2015, 2016 and 2017 started with continuous, rainy and cool spring, which delayed the sowing for the beginning of May. The quantity and the distribution of the rainfalls are unfavorable for the normal vegetation of beets; the years 2016 and 2017 are among the top water deficit years in our records. The drought after the sowing in 2015 and 2016 slows down the germination and brings to irregular sowings forming. The lack of rainfalls during the most active vegetation period – June-August affects negatively the normal development and biomass accumulation. The starting period of the vegetation in 2017 is characterized by sufficient for the development soils moisture in May-June. The oncoming of hot and extremely dry period from July to October of 2016 and 2017 hampers the enlargement of the root and brings to leave withering. The rich rainfalls in August 2015 and the warm autumn compensated to certain extent the initial unfavorable conditions, and that reflects on the final productivity.

The results of the roots and leaves enlargement dynamics on Tables 1 and 2 for 2015 and 2016 show identical values for the first date in August with insufficient differences

Table 1. Dynamics of growth of standard varieties of sugar and fodder beet in dependence of the fertilization, 2015

Variants	Mass, kg/da:					
	Roots			Leaves		
	Control	Organic fertilization	Mineral fertilization	Control	Organic fertilization	Mineral fertilization
I date-10.08						
Diex-2x	2271	1986	2689	1034	758	1245
Peshtera-3x	2925	2996	2995	1210	942	1285
Hybrid 56-3x	2466	2879	2764	497	1056	1115
Sasha 4x	2796	2832	2418	570	874	1225
II date-04.09						
Diex-2x	2668	3546	3618	697	1013	818
Peshtera-3x	3473	4664	3354	907	1130	883
Hybrid 56-3x	3050	3346	3218	475	832	768
Sasha -4x	2689	4702	3061	418	948	893
III date-16.10						
Diex-2x	3507	3779	4521	933	663	745
Peshtera-3x	4254	5654	4325	810	795	1038
Hybrid 56-3x	3289	4779	3793	503	905	873
Sasha -4x	3325	5396	4486	465	788	1100
GD 1%	503					
P %	5.92					

Table 2. Dynamics of growth of standard varieties of sugar and fodder beet in dependence of the fertilization, 2016

Variants	Mass, kg/da					
	Roots			Leaves		
	Control	Organic fertilization	Mineral fertilization	Control	Organic fertilization	Mineral fertilization
I date-15.08						
Diex-2x	1848	1940	1940	1268	1285	1388
Peshtera-3x	1884	2077	1958	1374	1285	1380
Hybrid 56-3x	2250	2387	2512	1160	1126	1206
Sasha 4x	2333	2476	2557	1166	1326	1217
II date-13.09						
Diex-2x	2027	2140	2214	920	998	940
Peshtera-3x	1896	2092	2045	816	1000	916
Hybrid 56-3x	2533	2807	2738	729	767	821
Sasha -4x	2473	2818	2735	785	787	848
III date-15.10						
Diex-2x	1973	2128	2236	472	618	476
Peshtera-3x	1902	2152	2289	595	607	690
Hybrid 56-3x	2479	2726	2869	369	369	392
Sasha -4x	2107	2679	2979	404	474	452
GD 1%	246					
P %	3.68					

between the control and the fertilized variants. This is due to the quite unfavorable conditions in the starting period of vegetation with extreme drought in May-June which hampers the manifestation of the genotypic differences and the fertilization influence.

The rainfalls in June, 2015 affect the dynamics of enlargement for the next dates. The roots grow with average of 1000 kg/da monthly with a decrease of leaves mass. That is indicative for intensive metabolism and biomass accumulation in the reserve tissues of root. Proved differences are formed for the root mass of the varieties and the fertilized variants. The highest are the effects of fertilization on the final yield, and the variants with organic fertilization, except for Diex, exceed in their values the mineral fertilizer treatment.

The extreme drought during the summer and autumn months of 2016 strongly affects the dynamics of enlargement. For the sugar beet, with a big extent of proof, is the increase of root productivity for the fertilized variants. The yield increase in dynamics of two dates through a month is week, and even the final productivity measured on 15.10 is decreased. Even stronger is the effect of the extreme drought on the leaves mass, which sharply decreases for two months. The diploid variety Diex grows more evenly in its control variant, compared to the triploid variety Peshtera.

The fodder beet varieties are more susceptible to the influence of the water deficit, and for the third date the increase of the differences between the control and the fertilized variants are proved.

In 2017 the growth dynamics is counted on 5 dates from 21.06 to 20.10 (Table 3). The results indicate intensive enlargement of roots mass on the first three dates to 07.08. In parallel the absolute values and the relative part in the total leaves mass are comparatively high. The indices for the leaf

Table 3. Dynamics of growth of standard varieties of sugar and fodder beet in dependence of the fertilization, 2017

Variants	Mass, kg/da					
	Roots			Leaves		
	Control	Organic fertilization	Mineral fertilization	Control	Organic fertilization	Mineral fertilization
I date-21.06						
Diex-2x	1476	1577	1571	3439	3576	3564
Peshtera-3x	1249	1303	1470	3171	3225	3656
Hybrid 56-3x	1541	1523	1729	3314	3505	3998
Sasha 4x	1678	1685	1809	3332	3356	3570
II date-17.07						
Diex-2x	2118	2285	2356	3023	3499	4069
Peshtera-3x	1642	1833	1975	3094	3035	3403
Hybrid 56-3x	3094	3261	3356	3618	3891	4165
Sasha -4x	2856	3273	3915	3380	3380	3808
III date-07.08						
Diex-2x	2523	2808	3070	2071	1714	1689
Peshtera-3x	1726	2321	2475	1547	1737	1999
Hybrid 56-3x	3142	3760	4129	1404	1428	1618
Sasha -4x	3332	4046	4903	1071	1333	1404
IV date-07.09						
Diex-2x	2321	2844	3050	1023	1194	1448
Peshtera-3x	2209	2491	2757	1135	1178	1095
Hybrid 56-3x	4046	4165	4295	932	1023	1071
Sasha -4x	3887	4165	4363	346	899	944
V date-20.10						
Diex-2x	2463	2761	3046	666	887	1244
Peshtera-3x	2439	2493	2713	946	976	881
Hybrid 56-3x	3677	4183	4439	736	702	815
Sasha -4x	3677	4046	4272	863	875	981
GD 1%	358 kg/da					
P %	2.75					

mass for the second date (17.07) are indicative for the influence of the fertilization on the intensity of growth. After that it is registered a sharp slowdown on the second date, and decrease at the end of the vegetation. In result of the drought from the end of July to October the roots also slow down their growth, and on 07.09 is registered even a decrease in the mass of the control and the variants with mineral fertilization. Together with that, despite of the unfavorable conditions in the second half of the vegetation, is preserved the positive effect of the proved differences of over 400 kg/da for the organic and mineral fertilization.

Conclusions

It is registered a strong variation in the dynamics of growth depending on the genotype, and it is more significant for the tested fodder beet forms. The sugar beet is more adoptive to water deficit during vegetation, while the fodder beet forms reaction to mineral and organic fertilization is stronger. The hybrids have more stable to the media factors biomass accumulation than the direct varieties.

The temp of biomass accumulation is positively affected by the organic fertilization in drought conditions. The effect of mineral fertilizers application is more sufficient in favorable agro-climatic conditions.

Acknowledgements

The publishing of the present scientific paper is co-financed by "Scientific Researches" Fund Contract № 01/19 from 23.08.2018.

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Received: February, 20, 2020; *Accepted:* March, 27, 2020; *Published:* June, 2021