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PRODUCTIVE CAPACITY OF THE MAIZE FOR SILAGE CROP GROWN IN DISTURBED IRRIGATION REGIME

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Abstract

An experiment was conducted with maize for silage as a main irrigation culture in the experimental field of the Agricultural Institute - Stara Zagora. The following variations have been tested: variation 1 - no irrigation (sentinel); variation 2 - optimal irrigation, 80%-85% of FC (100% irrigation); variation 3 - Irrigation as variation 2 but with first irrigation cancelled; variation 4 - irrigation as variation 2 but with second irrigation cancelled; variation 5 - irrigation as variation 2, but with third irrigation cancelled. On the basis of a chemical analysis of the sudangrass forage for the raw protein content, FUM, FUG and PDI were defined. It was found that the highest yield of raw maize protein grown as the main crop was obtained from the optimal irrigation variation, both in the non-fertilized and the fertilized variation, respectively with 1023.5 kg / ha and 1303.5 kg / ha. The optimal water supply of maize provides the highest energy efficiency of the forage expressed in FUM -15022.8 kg / ha, FUG -15584.4 kg / da, PDI - 1060 kg / ha for non fertilized variations and FUM -16873.5 kg / ha, FUG -17516.3 kg / ha, PDI-1219 kg / ha with fertilizer applied.

Key words: maize for silage, irrigation rate, fertilization, yield, productivity

INTRODUCTION

Maize harvested at an appropriate stage of development is a valuable raw material for silage, long-term storage and feeding of ruminants throughout the year. Maize for silage, compared to grain maize, has a three times higher production capacity of dry matter, NFE (nitrogen free extracts), raw fiber and mineral substances. Crude protein yield is also 1.5 - 1.7 times higher. In addition, maize for silage has a shorter vegetation period than grain maize, which makes it applicable in different regions of the country.

A number of studies have been conducted with maize for silage in the country. They take into account the importance of factors such as soil, hybrid, agrotechnics, meteorological conditions, etc. (Vedeva, M., et al., 1980, Dimov, S., 1980; Kerikova, D., T. Kertikov, 2011, Georgieva Hr, 2008, Likipudis, 1984, Nankov M., L. Glogova, 2000, Yanchev I, D. Penkov and others, 1999)

A number of studies have also been conducted in relation to the cultivation of maize, but mainly for grains under optimal and unsatisfactory water supply (Eneva, S., 1991, Zhivkov G., 1995, Matev A., 2001)

Studies on the cultivation of maize for green fodder and silage in Bulgaria are few and do not provide sufficient information on the rational use of its productive capacity under conditions of various irrigation regimes, including optimal and insufficient water supply.

The purpose of the study was to determine the yield of maize for silage grown under a disturbed irrigation regime for the South Central Region.

MATERIALS AND METHODS

An experiment was carried with the first crop maize for silage on meadow cinnamon soil in the experimental field of the Agricultural Institute in Stara Zagora. The soil in the experimental field is characterized by a averagely developed humus horizon. It has a poor nitrogen content (31.3-38.1 mg / kg soil), poorly stocked with utilizable phosphorus (3.1 - 4.3mg / kg soil) and well stocked with utilizable potassium (42.3 - 48.1mg / 100g soil). This type of soil is characterized by the following water - physical properties: FC-26,57%., drying rate (KZ) - 18,19%, porosity - 47% and bulk density - 1,45. The soil preparation for maize sowing was done by a triple tillage of the area with a disc harrow. The sowing was done at the optimal agrotechnical time for the area. Phosphorous fertilizer at a rate of 8 kg /da active substance was implemented prior to the main processing of the preceding crop. The nitrogen fertilizer was implemented manually in the "third - fifth" maize leaf stage at a rate of 9 kg / da active substance. The experiment was set according to the block method in four repetition, with a crop area size of 25 m2. Maize was harvested in the lactation phase. Irrigation was performed gravitationally with a seasonal stationary installation. The dynamics of soil moisture in order to determine the irrigation rate was monitored by taking soil samples from variation 2. The rest variations were irrigated simultaneously with the same variation, with the respective irrigation rates.

The following variations have been studied (Table 1): Variation 1 - no irrigation; Variation 2 - optimal irrigation, 70-75% of FC (100% irrigation rate); Variation 3 - Irrigation as Variation 2, but with first irrigation cancelled; Variation 4 - Irrigation as Variation 2 but with second irrigation cancelled; Variation 5 - irrigation as Variation 2 but with third irrigation cancelled. In the initial stages of maize development, 80 per cent of FC was maintained, and, during the period of active growth, along with the increase in the water needs of the plants, 85 per cent of FC was maintained. Irrigation Variations were investigated in the conditions of natural reserve of the soil and optimal nitrogen fertilization. The irrigation intervals were consistent with the available moisture in the soil, which depends on the temperature and the amount of rainfalls during vegetation.

Table 1. Energy and protein value of maize for silage, per 1 kg / DM 2014 – 2016, average.

Variants	FUM		FUG		PDI	
	Without fertilization	Fertilization	Without fertilization	Fertilization	Without fertilization	Fertilization
1 - - -	10.6	10.6	11.0	10.9	764	772
2+++	10.7	10.5	11.1	10.9	751	759
3– + +	10.7	10.5	11.1	10.9	755	763
4+ – +	10.7	10.5	11.1	10.9	757	767
5+ + –	10.7	10.5	11.1	11.0	758	769

The chemical composition analysis of the grain was performed using the classic Weende method. The content of the main components - crude protein, crude fat, crude fiber and ash - was determined. NFE was calculated using the difference of up to 100 of the listed nutrients. The energy and protein content of the feed was calculated according to the formulas of Todorov, 2007 based on the data obtained from chemical analyzes.

By the formulas of Todorov et al. (2004, 2007) the FUM, FUG and PDI content of ruminants were calculated.

$$GE = 0{,}0242\ CP + 0{,}0366\ EE + 0{,}0209\ CF + 0{,}017\ NFE$$

$$ME = 0{,}0152\ DP + 0{,}0342\ DEE + 0{,}0128\ DCF + 0{,}0159\ DNFE$$

$$q = ME / GE$$

$$FUM = ME\ (0{,}075 + 0{,}039q)$$

$$FUG = ME\ (0{,}04 + 0{,}1q)$$

PDI = 1,11CP (1 - Deg) Dsi + 0,093 FOM

FOM = DOM - DEE - CP (1 - Deg)

RESULTS AND DISCUSSION

The distribution of precipitation during the maize vegetation stage is uneven during the three experimental years of the study (Figure 1). The highest precipitation in the period May - September took place in 2014 - 446.1 mm and compared to the same months of the multiannual period this amount was 175.09 mm larger. What was typical for the year was a precipitation amount of approximately 170 mm in September, but it had no value since maize was in the process of harvesting during this period. For the other two years (2015 and 2016) rainfalls compared to the multiannual period were smaller, respectively 22.21 mm and 40.71 mm. As a result of the specific natural conditions of moistening and the provision of vegetative rainfalls, maize was provided three irrigations during the vegetation period for each of the three experimental years. For the 2014 season one irrigation was performed in July and two irrigations were performed in August. For the other two experimental years (2015 and 2016), two irrigations were implemented in July and one in the first 10 days of August with a irrigation rate of 100 mm.

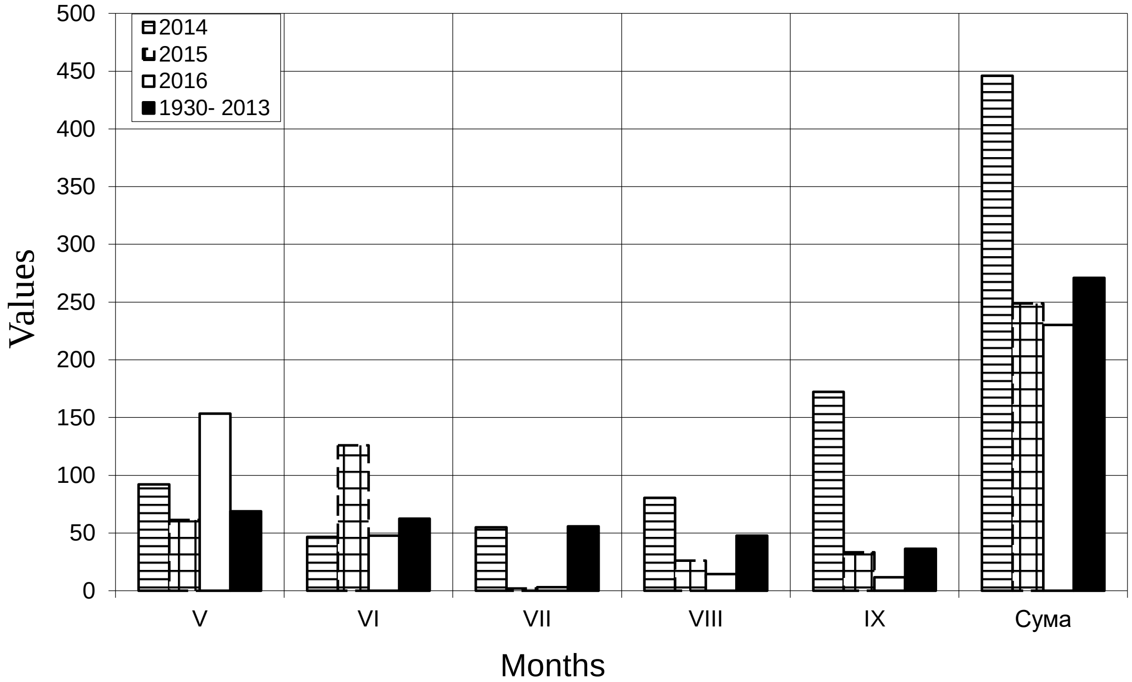

Fig.1 Sum of rainfall during the vegetation od maize of silage.

The maize vegetation period, which includes the months: May, June, July, August and September in terms of rainfall supply (P in per cent), could be described as moderately humid compared to the humid year of 2014 (P = 43.9%). The same period of the following years could be described as moderately humid compared to the dry year of 2015, (P - 43,0 per cent) and dry compared to the dry year of 2016 respectively (P - 87,0 per cent).

Crude protein yields from natural water supply ranged from 821.7 kg / ha obtained in 2015 for non-fertilized variation to 1195.22 kg / ha in 2014 obtained with the optimal fertilization variation. (Table 2)

Table 2. Yield of crude protein (CP) kg/ha by years and average over 2014 - 2016 without fertilization and optimum fertilization.

Variants	2014	2015	2016	Average	% to var.1	% to var.2
without fertilization						
1var - - -	882.3	**821.7**	847.4	**850.4**	100	830.8
2var + + +	1046.1	1006	1018.4	**1023.5**	1203.5	100
3var – + +	921.6	932.4	941.7	931.9	1095.8	910.5
4var + – +	884.4	835.7	910.1	876.7	1030.9	856.5
5var + + –	913.8	8690	942.1	908.3	1068	887.4
fertilization						
1var - - -	**1195.2**	1012.7	1153.3	**1120.4**	100	862.2
2var + + +	1378.7	1232.7	1299.2	1303.5	1163.3	100
3var – + +	1276.0	1153.3	1263.8	1231	1098.7	944.3
4var + – +	1220.6	1117.9	1136	1158.1	1033.6	888.4
5var + + –	1250.1	1148.1	1130.7	1176.3	1049.8	902

For B_0 GD 5% - 6.316 ; 1% - 8.637 ; 0.1% - 11.725 kg/ha
B_1 GD 5% - 6.181 ; 1% - 8.225 ; 0.1% - 11.186 kg/ha

The average yield from the experiment recultivated with non-irrigation and non-fertilized variations was 850.4kg / ha dry biomass, and with fertilization applied -1120.4 kg / ha. In the variation with the optimal provision of the sungrass water needs (var. 2), an average yield of 1023.5 kg / ha and 1303.5 kg / ha crude protein was provided, respectively for the untreated and fertilized variations. The average yields of CP from the first lime Variation (lime 3) were 8.95 per cent and 5.57 per cent lower respectively, compared to the yields obtained from the optimally irrigated untreated and fertilized variations.

When watering with cancellation of the second irrigation (var. 4), average yields of 876.7 kg / ha and 1158.1 kg/ha respectively were obtained in the non and fertilized variations, which were with respectively 14.35 per cent and 11.16 per cent units lower than yields from the optimally irrigated variations. In the case of cancellation the third irrigation (var. 5), the average yield was 908.3 kg / ha (88.7 per cent) and for fertilizers – 1176.3 kg / ha (90.2 per cent)

The results obtained show that the yields from the cancelled irrigation variations vs. the optimal variation did not have the same percentage reduction. Closest to the optimal variation (100 per cent) both in the non and the fertilizer variations, was the yield obtained from the variation with the first irrigation cancelled - 91.05 per cent for the non-fertilizer ones and 94.43 per cent respectively for fertilized variants, followed by the variations with the third and the second irrigation cancelled, respectively 88.74% and 85.65% for the non-fertilizer variants and 90.2% and 88.84%, respectively for the fertilizer variations.

The applied fertilization increased the yield of CP in non-irrigated variations by 24.1 per cent. In the optimally irrigated variation the yield increase was 34.77 per cent for the fertilizer application and 16.92% for the non fertilizer variations.

Feed units per milk (FUM), feed units per gain (FUG) and protein digestible in the intestine (PDI) are an indicator of the energy and protein nutritive values of forage. Against the background of natural storage of the soil with nutrients and without irrigation the energy productivity of the forage is the lowest, respectively FUM – 11893.2 / ha, FUG - 123420 / ha and PDI – 859.4 kg / ha. (Fig. 2). With an optimal provision of maize with water, the energy productivity per one da of forage is the highest, both in the non - fertilized and the fertilized variations for the sudangrass. The cancellation of irrigation has led to a reduction in the energy productivity of maize. In the case of cancelling the first irrigation (var. 3) the yield of maize was reduced to FUM-13845.8 / ha, FUG 14363.4 / ha and PDI -980.8 kg / ha in the non fertilized variations and to FUM-15802.5 / ha, FUG-16404.5 / ha and PDI-1148kg / ha for fertilized variations.

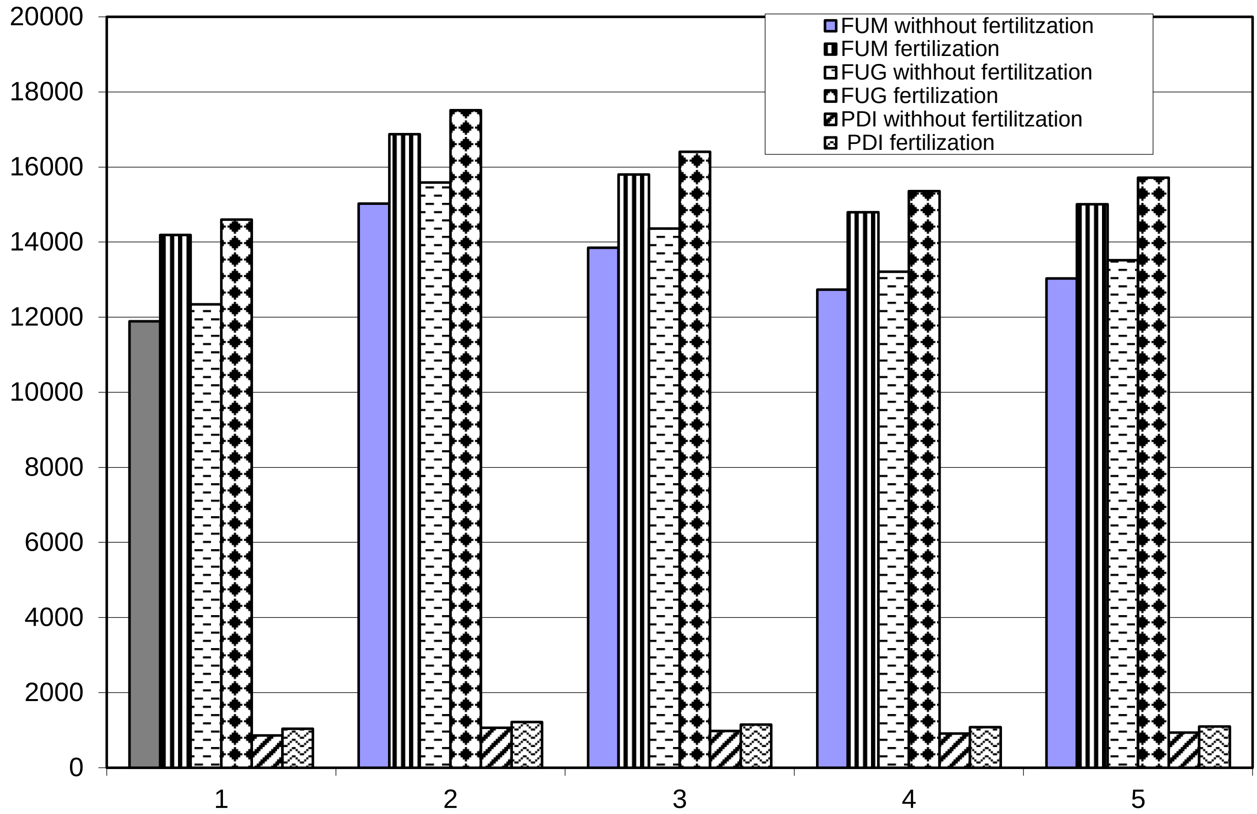

Fig. 2 Energy productivity of forage at FUM and FUG for 1 ha.

CONCLUSION

In the optimally irrigated variation of maize for silage, the highest yield of cride protein was obtained both in the non-fertilized and the fertilized variation, 102.87 kg / da and 1303.5 kg / ha respectively.

The natural water provision of maize led to the lowest yield of crude protein, both in the non fertilizer and the fertilizer application variations, 850.4 kg / ha and 1027 kg / ha respectively.

Crude protein yield when watering maize by the first irrigation cancelled in the case of the non-fertilized variation was decreased by 8.95 per cent, and for the fertilized one – with 5.57 per cent. Cancellation of the third irrigation resulted in a decrease of the yield in the non-fertilized variation by 11.26 per cent and in the fertilized one - by 9.8 per cent compared to the optimally irrigated variation.

The optimal water provision of maize provides the highest energy productivity of the forage expressed in FUM – 15022.8 kg / ha, FUG – 15584.4 kg / ha, and PDI - 1060kg / da for non fertilizer variations and FUM - 16873.5, FUG - 17516.3 kg / ha and PDI - 1219 kg / ha for variations with fertilizer application.

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