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Evapotranspiration of corn crop for silage

R. Bazitov[1], A. Stoyanova[2]*

[1]Agricultural Institute, 6000 Stara Zagora, Bulgaria
[2]Department of Plant Prductiuon, Faculty of Agriculture, Trakia University, 6000 Stara Zagora, Bulgaria

Abstract. *During the period of 2009–2012 in the experimental field of the Agricultural Institute, Stara Zagora on soil type meadow cinnamon soil was conducted experiment with silage corn first crop. Corn was grown after predecessor wheat - pea mixture. Five options of irrigation regime of maize were examined. It has been found that during the years of prolonged drought when sowing of corn is in non-irrigated evapotranspiration embodiments in the range of 301.5 to 308.4 mm, and in average wet years with uniform distribution of precipitation greater than 350 mm. Under conditions of irrigation evapotranspiration of culture was increased to an optimal embodiment irrigated reaches values 471.4 mm, and an irregular irrigation regime - 397.2 mm and 372.3 mm, respectively, in 60% M, and 40% M. Average for the three years of study, evapotranspiration reaches maximum average values during the second ten days of August - 6.13 mm at the optimal option and 3.76 mm for versions without irrigation in phase tasseling-dark silks, and then at the end of the vegetation gradually decreases and reaches values of 3.70 mm to 2.20 mm.*

Keywords: corn silage, irrigation, water deficit, evapotranspiration

Introduction

Evapotranspiration is an expansive component in the water balance of the soil, on which the number of irrigations between irrigation period and size of irrigation in each crop depend, including maize. Over the years, research by many domestic and foreign authors have shown that maintaining optimum humidity and sufficient amount of mass, evapotranspiration depends mainly on two factors - weather conditions and vegetation (Varlev and Popova, 2003; Davidov, 1998; Zhivkov and Gaidarska, 1985). The latter is crucial, especially in recent years when the country introduced largely new foreign varieties with different growing season. Eneva (1980, 1987) found that evapotranspiration (ET) of late corn hybrids with optimum irrigation is from 468 to 586 mm, but without irrigation – from 291 to 427 mm. Higher preliminary humidity and increase of the distance between the irrigation furrows leads to a higher rate of flow of water in the soil (Eneva and Todorova, 2001; Matev and Petrova, 2012) found that evapotranspiration of non-irrigated corn significantly affected by the conditions of the year, and in years with prolonged summer droughts is in the range from 274 to 284 mm, and in moist and evenly distributed rainfall years - more than 400 mm.

The object of this study was to establish evapotranspiration on corn for silage first crop grown under optimum conditions and inadequate water provision on meadow - cinnamon soil.

Material and methods

During the period 2009 – 2012 in the experimental field of Agricultural Institute Stara Zagora on meadow cinnamon soil type an experiment was conducted with maize silage moderately late hibrid.LG 34 .88 FAO group 490. The soil type was characterized by the following water - Physical properties: PP – 26.57%, coefficient of wither (CW) – 18.19%., porosity – 47% and density – 1.45. It was found that the soil type has good soil productivity class for growing row crops (Todorova and Popova, 2009). Maize was grown after predecessor pea - wheat blend.

The experiment was embedded in the block method in four replications, the size of the plots of 25 m^2. Corn returning (accumulate, gather) to their stage of wax ripeness. Irrigation was done with gravity seasonal stationary installation. We studied the following options: 1. Without irrigation (control) 2. Optimal irrigation - 80% PP (100% irrigation rate – 60 mm) 3. In furrow irrigation with 100% irrigation rate (60 mm) 4. In each furrow irrigation with 60% of the calculated irrigation rate (36 mm) 5. In each furrow irrigation with 40% of the estimated irrigation rate (24 mm). Water distribution in irrigation furrows through perforated pipes mounted thereon hoses to direct irrigation streams in their respective grooves. To achieve an even distribution of the necessary irrigation rate water protruded?? through variable flow. Irrigations in all variants were made simultaneously, an appropriate adjustment was made to the irrigation rate, according to the respective option. ET in all variants of the experiment was established by water balance calculations. The use of rainfall was determined by the method of successive approximations (Krafti, 1964). Groundwater wasn't included in the balance of soil moisture as it was located at a relatively great depth (more than 3 m). Irrigation levels for the corresponding variants were added in calculation of the final revenue elements.

Results and discussion

Evapotranspiration of maize depends largely on both the weather conditions experienced during the three years, as well as applications in various versions of irrigation regime. In Figure 1 the amount of rainfall is represented by months, years, and for the total study period. Regarding the provision of rainfall in 2009 it was characterized as medium moist, but 2011 and 2012 as dry years for provision, respectively 36.8%, 92.3% and 82.4%. Distribution of

* e-mail: toni_1219@abv.bg

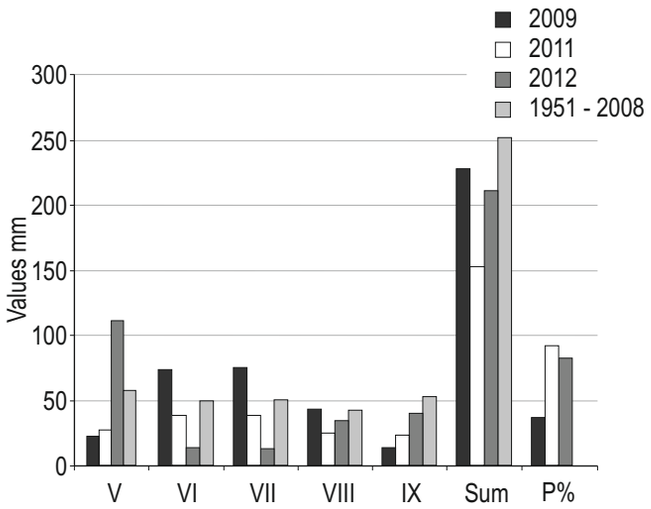

Figure 1. Sum of rains, mm

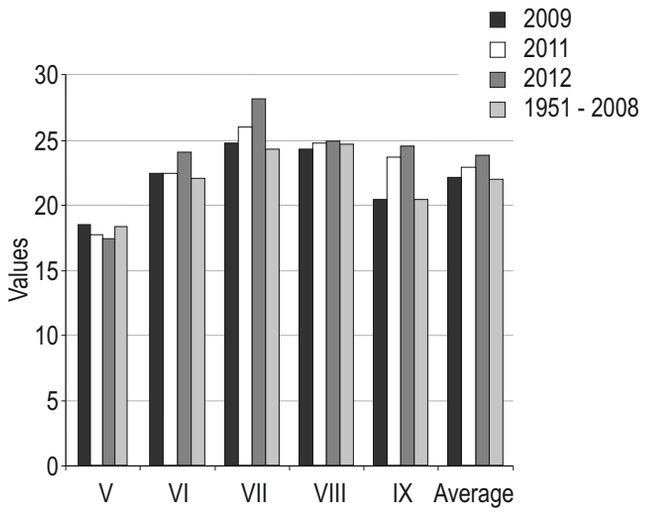

Figure 2. Sum of daily average air temperature, °C

rainfall during the growing season of maize is relatively uniform in 2011 and unevenly in the next two years. Best - plenty of rainfall during May – the first ten days of September were registered in 2009 and compared with the same months of the multiannual period this amount was - 24,5 mm less. In the other two years (2011 and 2012) the amounts of rainfall compared to the multiannual period were also smaller, 99,9 mm and 40,9 mm, respectively. In response to specific natural conditions of humidity and rain provision of vegetation in 2009 3-fold irrigations were carried out, and in 2011 and 2012 - 4 irrigations. The average daily air temperatures during the years of study did not differ significantly from those of the multi-annual period. (Figure 2).

Quantified ET on corn crop I-st culture is a reflection of the specific features of the hybrid and meteorological conditions (Table 1). In a variant without irrigation, the impact of weather is substantial, while the average precipitation in 2009 was 364,5 mm, and the other two dry years 2011 and 2012, respectively 301.5 and 308,4 mm, or respectively 63,0 and 56,1 mm more. In 2009 3 irrigations were made. In view of the weather situation and the submitted watering rates, evapotranspiration increases gradually, while the optimum irrigated variant increase was 22% compared to non-irrigated. In the experimental years 2011 and 2012, characterized by similar weather and prolonged drought during the active growing season of maize phase tasseling-dark silks additional watering was applied. Under these conditions the values of the total evapotranspiration had increased from non-irrigated variant with 56.1% for 2011 and 61.7%, respectively, for 2012. Average for the three years the increase in value of the total evapotranspiration was experienced for variants with 100% applied irrigation rate was 45.1% compared to non-irrigated variant.

For the purpose of irrigation in addition to the total evapotranspiration process the dynamics of average daily evapotranspiration during the different periods of crop development is also very important. Data by years and average for the experimental period are presented in Figures 3, 4, 5 and 6.

To the realization of the first irrigation, the course of average daily evapotranspiration for all variants is comparatively identical to the first. Changes occurred after the completion of the irrigation season, because the different irrigation rates have different influence. Figure 3 illustrates the average daily changes of evapotranspiration of maize in 2009, which was characterized by relatively favorable distribution of rainfall. Under these conditions

Table 1. Evapotranspiration by variants and years

Variants	ET mm	%		ET mm	%	
		to 1	to 2		to 1	to 2
	ET from 2009			ET from 2011		
1.without irrigation	364.5	100	81.9	301.5	100	64.0
2.100% M	444.8	122.0	100	470.8	156.1	100
3.100% M across furrow	412.7	113.2	92.7	422.7	140.1	89.7
4.60% M	390.3	107.0	87.7	399.7	132.5	84.8
5.40% M	372.4	102.2	83.7	383.4	127.1	81.4
	ET from 2012			Average for 2009 - 2012		
1.without irrigation	308.4	100	61.8	324.8	100	68.9
2.100% M	498.7	161.7	100	471.4	145.1	100
3.100% M across furrow	433.6	140.6	86.9	423.0	130.2	89.7
4.60% M	401.8	130.2	80.5	397.2	122.2	84.2
5.40% M	390.7	126.6	78.8	372.3	114.6	78.9

M – irrigation rate

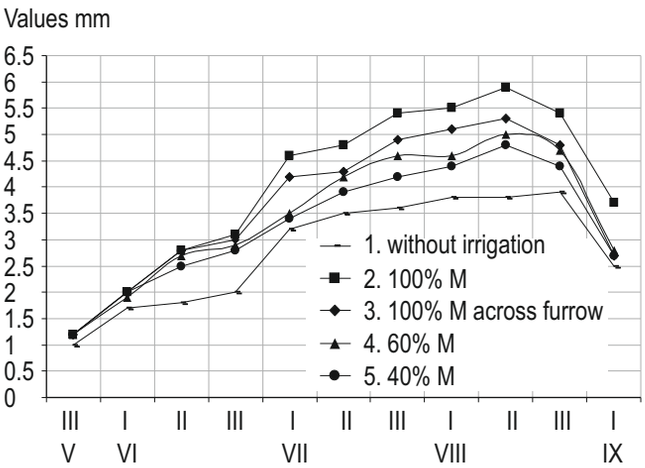

Figure 3. Daily ET from 2009

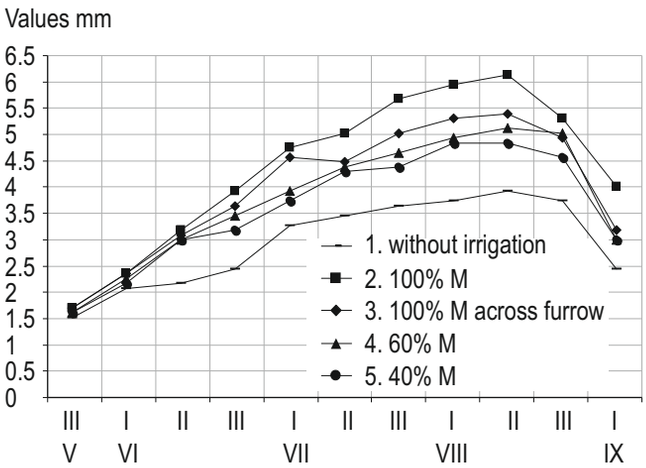

Figure 4. Daily ET from 2011

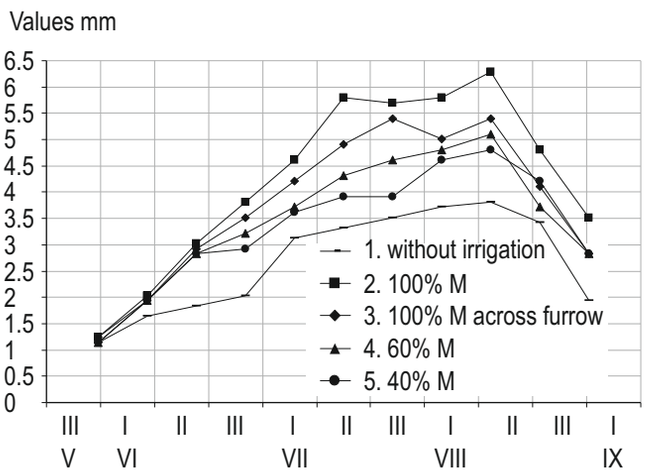

Figure 5. Daily ET from 2012

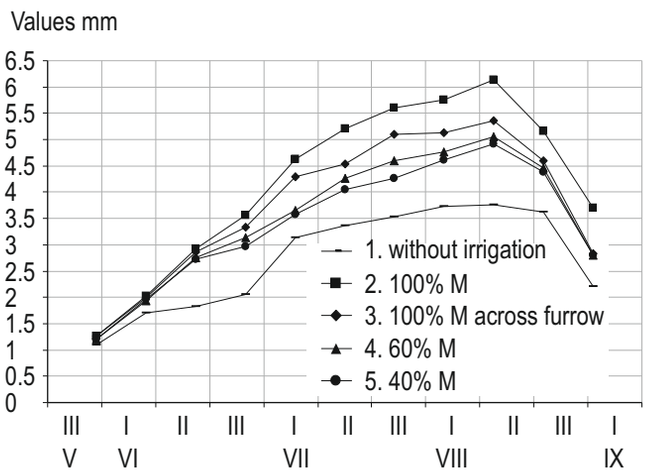

Figure 6. Daily ET from three average years

daily average evapotranspiration in the non-irrigated variant and variants with small irrigation rates (60% and 40%) reaches maximum values during the second half of August, 3,6, 4,8 and 5,0 mm, respectively. When options with optimum irrigation rate have been increased to the maximum ET, reaching 5,9 and 5,3 mm, respectively, for the same period (var. 2 and var. 3), and gradually began to decrease and reached 2,5 mm at the end of vegetation (var. 1). The average daily move of evapotranspiration in 2011 in all embodiments also reaches its maximum during the second ten days of August (Figure 4). The same trend was observed in the third year of the study because of the relatively uniform meteorological conditions and realized irrigation rates. In that year most of the daily average is focused again in August (Figure 5), and then again it gradually begins to decline. In Figure 6 the average of the three experimental years average 24 hours evapotranspiration values of maize in ten days. The resulting curves are specific and give an idea of the impact of irrigation regime on its absolute value.

Conclusion

In the years of prolonged drought during the active growing season of maize evapotranspiration under non-irrigated variants ranged from 301.5 to 308.4 mm. In average wet years with an even distribution of rainfall evapotranspiration is over 350 mm. In terms of irrigation on crop evapotranspiration increases, the optimum irrigated variant reaches values 471.4 mm. When applying an irregular irrigation regime evapotranspiration is 397,2 mm and 372.3 mm, for 60% M and 40% M, respectively. Average for the three years of study, evapotranspiration reaches maximum average values during the second ten days of August – 6.13 mm at the optimum option and 3.76 mm for versions without irrigation in phase tasseling – dark silks, and then at the end of the vegetation it gradually decreases and reaches values of 3.70 mm to 2.20 mm.

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CONTENTS 1 / 2

Genetics and Breeding

Investigation on the possibility to efficiently use Ukrainian cultivars for developing of early winter wheat lines 351
I. Grain productivity
N. Tsenov, T. Petrova, E. Tsenova

Combinig ability for grain yield of late maize lines 358
N. Petrovska

Use of recurrent selection in middle late synthetic maize population 362
I. Results of the first cycle in synthetic "1/2005"
N. Petrovska, V. Valkova

Genetic diversity and distance between two Bulgarian local sheep breeds assessed by microsatellite markers 367
S. Georgieva, E. Todorovska, D. Hristova, I. Dimitrova, N. Stancheva, Ts. Yablanski

Testing of new Bulgarian sunflower hybrids under the conditions of North-East Bulgaria 371
I. Productivity and traits related to productivity
G. Georgiev, P. Peevska, E. Penchev

Comparative morphological study of new Burley tobacco lines 376
T. Radoukova, Y.Dyulgerski

Effect of genotypic and environmental factors on the inheritance of the main characters in chickpea and relationships between them 380
R. Sturzu, T. Nistot, Cr. Melucă, Fl. Bodescu, A. Stoilova

Evaluation of double haploid lines of winter malting barley using selection indices 384
B. Dyulgerova, D. Valcheva

Evaluation of the combining ability of grain yield of mutant maize lines 388
M. Ilchovska

Comparative study of some biochemical indicators in Karakachan and Copper-Red Shumen sheep breeds 391
G. Angelov, I.Dimitrova, T. Mehmedov, P. Stamberov, N. Stancheva, S. Georgieva, Zh. Nakev

Nutrition and Physiology

Impaired pancreatic function in mulard ducks with experimental aflatoxicosis 394
I. Valchev, N. Grozeva, D. Kanakov, Ts. Hristov, L. Lazarov, R. Binev, Y. Nikolov

Comparative investigations on feeding efficiency in growing and fattening DanBred and Topigs hybrid pigs 400
G. Ganchev, A. Ilchev

Blood parameters in yearling sheep fed Paulownia (*Paulownia* spp.) leaves 405
I. Varlyakov, V. Radev, T. Slavov, G. Ganchev

CONTENTS 2 / 2

Changes in some blood parameters in yearling rams fed diets with different protein and lipid levels 410
V. Radev, T. Slavov, I. Varlyakov

Production Systems

Effect of the sowing norm and nitrogen fertilization on the yield from dry bean (*Phaseolus vulgaris* L.) cultivar Beslet 415
G. Milev

Evapotranspiration of corn crop for silage 420
R. Bazitov, A. Stoyanova

Productivity and economic traits of winter oilseed rape (*Brassica napus var. biennis*) under the conditions of Dobrudzha 424
G. Georgiev, G. Georgiev, P. Chamurliyski

Feasibility of the use of heat energy from alternative sources for air conditioning in sows facility 428
K. Peichev, R. Georgiev

Productivity of green beans, irrigated at different pre-irrigation soil moisture 432
R. Petrova, A. Matev, K. Koumanov, B. Harizanova-Petrova

Agriculture and Environment

Comparative assessment of plant resources as substrates for bioshlam production 438
Z. Shindarska, V. Kirov, G. Kostadinova, B. Baykov

The influence of organic carbon on bioremediation process of wastewater originate from aquaculture with use of microalgae from genera *Botryococcus* and *Scenedesmus* 443
I. Sirakov, K. Velichkova, G. Beev, Y. Staykov

Sanitary hygienic assessment of drinking water from underground source at a pig farm 448
G. Kostadinova

Product Quality and Safety

Study of bee honey by spectral analysis in the near infrared spectrum 455
I. Zhelyazkova, S. Atanasova , K. Elencheva – Karaneycheva

Comparative GC/MS analysis of lavender (*Lavandula angustifolia* Mill.) inflorescence and essential oil volatiles 459
T. Zagorcheva, S. Stanev, K. Rusanov, I. Atanassov

Influence of key factors on the time of initial coagulation of cow's milk using milk-clotting enzyme of camel origin 463
P. Panayotov, K. Yoanidu, P. Boyanova, B. Milenkov

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