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Original scientific paper

THE INFLUENCE OF HYBRIDS AND SOWING TERM ON YIELD AND DRY DOWN OF CORN GRAIN

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The dry down rate of corn grain during maturation is influenced by a large number of environmental factors and properties of hybrids, and has a major effect on corn, reaching its full maturity. This is especially important for the timely soil tillage and planting of the next culture. The aim of this research was to determine the yield and dry down rate from corn grains depending on the hybrid and the sowing term, in the agro ecological conditions of South Serbia (Leskovac). For this purpose, an experiment was made during 2016 and 2017 on the territory of the municipality of Leskovac. Soil type was alluvium. The trial was planned according to the schedule of divided land plots, set up in three repetitions. This included 6 hybrids of different FAO maturity groups and three differing sowing terms. The results of the study show that the average content of water in the grain in physiological and technological maturity, at all the hybrids and sowing terms were in 2016 significantly lower than in 2017.

The highest average yields in 2016 were achieved with hybrids of the FAO maturity group 600, in the 2nd and 3rd sowing term, while in 2017, the highest yields were recorded with hybrids of the FAO maturity group 500, during the 1st and 2nd sowing term. The average rate of dry down in 2016, in all hybrids, was the highest recorded in the 1st sowing term, and in the year 2017, in 2nd and 3rd sowing term. The most intense dry down rate period in both years, at the hybrids of the FAO maturity group 400 was in

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the second and third week of physiological maturity, while in FAO maturity hybrids groups 500 and 600 in the third and fourth week of physiological maturity.

*Key words***:** corn, physiological maturity, technological maturity, dry down rate, yield.

INTRODUCTION

The dry down rate of corn grain during maturation has an important influence on reaching full maturity of corn. This is especially important for the timely wheat crop, due to the two-field rotation with corn. MELUT and ROSCA (2016), they emphasize that hybrids with higher dry down rate enable earlier harvest, which allows timely soil tillage for grain sowing. YANG *et al*., (2010) note that hybrids with quicker grain dry down are economically more desirable in production regions. After the dry matter is accumulated, black layer appears in the base of the grain and the dry down period begins (GEIER and THOMISON, 2006). JUKIĆ (2004) claims the stage of physiological maturity has been defined as a stage where 60% of the grains have a black layer, while DAYNARD and DUNCAN (1969) claim the stage of physiological maturity was determined as the moment when 50% of the grains have a black layer.

The dry down from the grain is influenced by a large number of environmental factors. Factors that positively influence the dry down rate of the grains are: temperature, sunlight, wind speed, evapotranspiration, while relative humidity, soil moisture, and plant density adversely affect the dry down of the grain (REID *et al*., 2010). Hybrids of corn differ among each other per the dry down rate of the grains. Therefore, BROOKING (1990) points out that the daily dry down rate from grains varies by months and depends on climatic conditions. So, in the months when the weather is cold and rainy, dry down rate is considerably lower. Similar data is also stated by HELLEVANG (2004) pointing out that the daily water loss in some seasons is less than 0.3% per day, and in favorable heat conditions this loss can be up to 1% per day. The dry down rate depends on the properties of grain pericarp. Thus, hybrids with glassy pericarp slowly release water from the grain (REID *et al.,* 2010). The dry down rate depends on the sum of the thermal units (GDU). When the daily volume of GDU is about 12°C the dry down rate is 0.5% per day. If the sum of GDU is 22°C daily then the dry down rate is 0.75% per day (LANA *et al.*, 2014). The dry down rate of grain water is in a positive correlation with the yield, and it is also dependent on the FAO group of maturation (MELUT and ROSCA, 2016). LOPANDIĆ *et al*. (1998), they emphasize that hybrids with fast release of grains water are desirable, which compensates for the shortening of the vegetation, but not prejudicial of the grain yield. A numerous of domestic and foreign authors dealt with this issue (VIDENOVIĆ and DUMANOVIĆ, 1994; SONMEZ 2002; JUKIĆ *et al*., 2004 and 2007; FILIPENKO *et al*., 2013).

The aim of this research was to determine the dry down rate of the grain and yields depending on the hybrid and the sowing term, in the agroecological conditions of the South of Serbia (Leskovac).

MATERIALS AND METHODS

The trial was set up in 2016 and 2017 on territory of the municipality of Leskovac, on alluvium soil type. Table 1 presents an experimental design examined in the experiment.

Before placing the experiments, soil samples from particular plots for chemical analysis were taken. The experiment was set according to the method of divided parcels in three repetitions. Sowing were in 4 rows of each hybrid in the length of 7 m, so the size of the elemental parcel is 19.6 m^2. The pre-culture in both years was winter wheat. Soil tillage meant the fall plowing at a depth of 30 cm, with application of 250 kg ha^{-1} NPK fertilizer (16:16:16). Pre-seeding preparation was carried out right before sowing with seedbed conditioner. Treatment of seeds against weeds was performed in pre-emergence phase, with preparations *Basar* and *Rezon*. Treatment against broadleaf weeds and narrow-leaved weeds was carried out in phase of 4-6 leaves, with preparations *Siran* and *Maton*. Nutrition with KAN was carried out after the first inter-row cultivation with the amount of 350 kg ha^{-1}. During the vegetation, there were no diseases and pests. During the experiment, the water content in physiological maturity was monitored, the dry down rate during maturation, as well as grain yields. Phase of physiological maturity is determined when 50% of the plants in the base of the grain appeared black layer (DAYNARD and DUNCAN, 1969). From the moment of physiological maturity, every seven days up to technological maturity, samples of ears from all hybrids and sowing dates were taken and the moisture content measured in the grain was measured with the moisture meter Dickey John. Thus, the following is determined: 1. Average water content in grain in physiological and technological maturity and yield of grain, 2. Dry down rate depending on hybrid and sowing term by periods (every 7 days from the moment of physiological maturity to technological maturity) and 3. Correlation between the rate of release of water from the grain and the sowing terms, for each hybrid. Corn harvest was done in technological maturity. The yield is calculated on each parcel and reduced to 14% of the grain moisture content. The obtained data were statistically analyzed using the analysis of variance and correlation, using the software package WASP 1.0.

Table 1. Experimental design

Years	Hybrids		FAO group maturity	Crop density	Sowing terms
2016	H1	ZP 434	400	70 x 20 cm	I – April 1
2017	H2	NS 4023	400	70 x 20 cm	II – April 15
	H3	ZP 555	500	70 x 25 cm	III - May 1
	H4	NS 5051	500	70 x 25 cm	
	H5	ZP 666	600	70 x 30 cm	
	H6	NS 6030	600	70 x 30 cm	

Climate and soil characteristics

The territory of the municipality of Leskovac belongs to southern Serbia, and it is located at about 43° north latitude and 21.95° eastern geographical longitude, with an altitude of 230 m. The Leskovac basin is about 50 long and about 45 km long and features fertile soil and favorable agro-climatic conditions for plant production.

Table 2 shows the total precipitation and average temperatures during the vegetation period of the corn. During 2016, which was more favorable for corn production, total rainfall during vegetation was 438.8 mm. Particular emphasis should be placed on the amount of precipitation in June, July and August (207 mm), which is very important for the formation of yield of corn. From the aspect of the total amount of precipitation (308 mm), 2017 was worse, especially in June, July and August (73 mm) and could be considered unfavorable for plant production in relation to 2016. Compared to the perennial average (246 mm), both years had a higher amount of precipitation. Average temperatures during corn vegetation in 2017 were slightly higher than in 2016, especially in July, August and September. The average temperatures, in both years, can be considered favorable for the production of corn. Compared to the perennial average, there are no major deviations, and temperatures are not a limiting factor in plant production, which cannot be said about precipitation.

Table 2. Precipitation (mm) and mean air-temp. (°C) in Leskovac

	Apr.	May	June	July	Avg.	Sep.	Oct.	Apr./Oct.
			The 2016 growing season					
mm	24.2	69.6	63	114	30	56	82	438,8
℃	13.7	14.7	21.9	22.8	21,4	17.9	11.9	17,7
			The 2017 growing season					
mm	69	82	19	34	20	20	64	308,0
℃	11.3	16.7	21.9	23.5	23.3	18.7	12.5	18.2
			Average 1985-2014					
mm	48	46	37	25	24	30	36	246
℃	12.5	16.5	19.5	22.0	22.5	18.0	14.0	17.8

Table 3. Chemical properties of the soil

Depth (cm)	pH		Humus	Nitrogen	Available (mg/100g of soil)	
	H_2O	KCl	(%)	(%)	P_2O_5	K_2O
0-30	7.74	5.78	2.65	0.13	17.56	34.00
30-60	7.20	6.10	2.10	0.06	8.90	21.76

The acidity of the soil is determined by the Kappen method, the humus is determined by the Kotzman method, the total nitrogen by Kjeldahl method, and available phosphorus and potassium with Egner-Riehm Al method. According to pH_{KCl} (5.78) this soil belongs to a group of moderately acidic soils. According to the content of humus in the arable layer (2.65%) belongs among very humic soils (according to GRAČANIN and ŠKORIĆ). The total nitrogen content was 0.13% and the land is medium supplied with this element. The soil is optimally supplied by phosphorus (17.56 mg/100g) while with potassium (34.00 mg/100g) is highly supplied (Egnenr-Riehm). These soils belong to a group of alluvial soils, with moderately acidic chemical reactions. Although these soils belong to a group of potentially fertile soils, their intensive use generally requires the application of ameliorative measures. They are suitable for plant production and corn production as well.

RESULTS AND DISCUSSION

Water content in physiological and technological maturity and yield of corn grains

Content of water in physiological and technological maturity is an indicator of completion the accumulation of dry matter in grain, and it is an indicator of harvest time of the corn. These indicators are conditioned by external factors, agricultural practice and genetic predisposition of hybrids, and to a great extent affect the final yield of corn. Table 4 gives data on water content in physiological and technological maturity and yield, depending on the hybrid and the sowing term.

The average content of water in 2016, for all hybrids, in physiological maturity ranged from 32.6% in the 3rd sowing term to 34.1% in the 2nd sowing term, and these differences were not statistically significant. The average content of water in the grain for all sowing terms, depending on the hybrid, ranged from 29.6% to 35.7%. It was the lowest in hybrids of the FAO maturity groups 300 and 400, and the highest in hybrids of FAO maturity groups 500 and 600. The lowest content of grain water in physiological maturity (28.7%) had ZP 434 hybrid, in 1st sowing term, and the highest (36.8%), the NS 6030 hybrid in the 2nd sowing term. The average content of water in 2016, for all hybrids, in technological maturity ranged from 18.8% in the 1st sowing term (significantly less than in the 2nd and 3rd sowing terms) to 23.2% in the 3rd sowing term. The average water content of the grain for all sowing terms, depending on the hybrid, ranged from 17.8 to 24.9%. It was the lowest in hybrids of the FAO maturity groups 300 and 400, and the highest in hybrids of FAO maturity groups 500 and 600. Here were statistically significant differences among FAO maturity groups in the period of physiological maturity. The lowest water content in grain in technological maturity (14.2%) was in hybrid ZP 434 in the 1st sowing term, and the highest (26.2%) in the NS 6030 hybrid in the 3rd sowing term. The highest average water content for all hybrids in physiological maturity was in the 2nd sowing term (34.1%), while the highest average water content for all hybrids in technological maturity was in the 3rd sowing term (23.2%). The average content of water in grain, for all hybrids in technological maturity, was 10.8-11.8% lower in relation to physiological maturity.

The average content of grain water in 2017 was significantly lower than in 2016, due to the fact that in 2017 it was significantly drier, and with low precipitation. The differences between FAO maturity groups and hybrids in the average water content in grain in physiological and technological maturity were similar to those of 2016, while the average water content increased significantly from the 1st to the 3rd sowing term. The average content of water in grain, for all hybrids in technological maturity was 12.3-14.0% lower in relation to physiological maturity. The average low content of water in grain, for all hybrids in physiological maturity was 2.4-7.1% lower, and in technological by 5.5-5.6% compared to the previous year. Also, all hybrids in 2017, on average for all sowing terms, had lower water content in grain in physiological maturity by 3.6-4.1%, i.e. by 5.1-5.8% in technological maturity compared to 2016. These results are in line with results of JUKIĆ (2004) who points out that there are differences in the average content of water in physiological maturity between different vegetation seasons. SVEČNJAK *et al.* (2012) emphasize that the content of water in physiological maturity is not always a reliable indicator of the vegetation duration of individual hybrids, as significant variations can occur by the harvesting time. LOPANDIĆ *et al.* (1998) point out that the highest dry down is in the period at the beginning of milk stage of grain, and the lowest in the period from physiological to full maturity.

It was noticed that in both years, hybrids from the same group of maturation varied by the content of water, both in physiological and technological maturity. Thus, hybrids from the FAO maturity groups 500, in 2016, in physiological maturity, varied by 1.8%, or by 2.4% in technological maturity, while these differences were higher in 2017 (3% in technological maturity) and were statistically significant. JUKIĆ (2004) found that hybrids can significantly differ in water content in grains in physiological maturity, although they belong to the same FAO maturity groups.

Table 4. Average water content in grain and grain yield in corn

Year 2016												
A. Hybrids	Water content in physiological maturity (%)				Water content in technological maturity (%)				Grain yield with 14 % moisture (t ha^{-1})			
	B. Sowing terms											
	I	II	III	Aver.	I	II	III	Average	I	II	III	Average
ZP 434	28.7	30.1	30.2	29.6	14.2	19.1	20.1	17.8	11.38	12.35	12.18	11.97
NS 4023	30.7	31.5	31.2	31.1	15.8	19.9	21.5	19.1	10.49	11.21	11.54	11.08
ZP 555	33.1	34.3	31.5	32.9	18.1	22.8	21.8	20.9	12.16	12.80	13.10	12.68
NS 5051	34.3	35.7	34.0	34.7	21.2	24.3	24.5	23.3	11.58	11.85	12.06	11.83
ZP 666	34.7	36.1	33.9	34.9	20.4	25.0	25.0	23.5	12.01	12.56	12.78	12.45
NS 6030	35.3	36.8	35.1	35.7	23.2	25.3	26.2	24.9	12.22	12.96	13.05	13.74
Average	32.8	34.1	32.6		18.8	22.7	23.2		11.64	12.28	12.45	

Anova table							
		Physiological maturity		Technological maturity		Grain yield	
Source of variation	Degrees of freedom	F cal	F prob	F cal	F prob	F cal	F prob
Replications	2	4.663	0.016	7.528	0.002	7.450	0.002
Treatments	17	2937.655	0.000	218.913	0.000	2105.057	0.000
Factor A	5	9974.286**	0.000	741.812**	0.000	7136.208**	0.000
Factor B	2	9.100 ^{ns}	0.001	1.871**	0.169	10.677**	0.000
A X B	10	5.050**	0.000	0.872**	0.567	8.357**	0.000
Error	34	-	-	-	-	-	-
Total	53	-	-	-	-	-	-
Lsd		0.05	0.01	0.05	0.01	0.05	0.01
A		1.73	2.31	1.50	1.90	0.39	0.52
B		1.61	2.15	1.28	1.71	0.25	0.33
A x B		2.94	3.93	2.55	3.41	0.66	0.88

Table 4cont. Average water content in grain and grain yield in corn

Year 2017												
A. Hybrids	Water content in physiological maturity (%)				Water content in technological maturity (%)				Grain yield with 14 % moisture (t ha^{-1})			
	B. Sowing terms											
	I	II	III	Aver.	I	II	III	Average	I	II	III	Average
ZP 434	23.1	25.4	28.6	25.7	9.8	11.7	14.5	12.0	8.41	8.16	7.30	7.96
NS 4023	22.4	24.7	30.5	25.9	8.0	11.3	14.9	11.4	8.28	8.03	7.83	8.05
ZP 555	25.5	31.1	31.5	29.4	10.3	16.4	16.0	14.2	8.58	9.10	8.16	8.61
NS 5051	24.7	33.0	33.5	30.4	13.3	18.6	19.6	17.2	8.13	8.64	7.92	8.23
ZP 666	28.2	32.3	32.1	30.9	18.2	18.0	20.0	18.7	7.63	8.39	7.10	7.71
NS 6030	29.3	33.2	33.9	32.1	19.4	18.9	21.1	19.8	7.98	8.19	7.25	7.81
Average	25.5	29.9	31.7		13.2	15.8	17.7		8.17	8.42	7. 61	

Anova table							
		Physiological maturity		Technological maturity		Grain yield	
Source of variation	Degrees of freedom	F cal	F prob	F cal	F prob	F cal	F prob
Replications	2	6.561	0.004	5.332	0.010	5.769	0.007
Treatments	17	196.480	0.000	94.095	0.000	740.689	0.000
Factor A	5	666.038**	0.000	317.450**	0.000	2514.400**	0.000
Factor B	2	1.421**	0.255	1.718**	0.195	0.922**	0.407
A X B	10	0.712**	0.707	0.893**	0.549	1.788**	0.101
Error	34	-	-	-	-	-	-
Total	53	-	-	-	-	-	-
Lsd		0.05	0.01	0.05	0.01	0.05	0.01
A		1.45	1.94	1.20	1.60	0.28	0.37
B		1.31	1.75	1.10	1.50	0.26	0.35
A x B		2.46	3.21	2.00	2.68	0.47	0.63

Corn grain yield

Corn yield is preconditioned by a numerous factors, both agroecological and genetic. The goal of each production is to achieve high yields and good grain quality.

Table 4 shows the yield of several corn hybrids, different groups of maturation, depending on the sowing term. In 2016, average yields of hybrids, for all sowing terms, ranged from 11.08 t ha^{-1} (NS 4023) to 13.74 t ha^{-1} (NS 6030). That year, significant differences in yield between hybrids were registered, so that the hybrids of the longer maturation FAO groups, had significantly higher yields than those of the shorter ones. This is in accordance with the results of MADIC *et al.* (2010) that emphasize the hybrids from higher FAO maturity groups in favorable years have high yields. Similar results were obtained by VIDENOVIĆ *et al.* (2013). Significant differences in yield between hybrids which belong to the same FAO maturity groups have also been registered. So, the hybrids ZP 434, ZP 555 and NS 6030 had statistically significantly higher yields than hybrids NS 4023, NS 5051 and ZP 666. The sowing term significantly influenced the yield of corn, so yields from the 2nd and 3rd sowing terms were significantly higher in relation to the 1st sowing term. The highest average yield of corn (12.45 t ha^{-1}) was achieved in the 3rd sowing term, although it was not statistically significantly higher than the yield realized in the 2nd sowing term (12.28 t ha^{-1}). High yields of corn in the 3rd sowing term can be explained as a result of favorable climatic conditions of that year, especially considering rainfall and favorable autumn conditions. The highest average yield that year (13.10 t ha^{-1}) was achieved with hybrid ZP 555 in the 3rd sowing term and the lowest (10.49 t ha^{-1}) by hybrid NS 4023 in the 1st sowing term.

Corn yield in 2017 was significantly lower than in 2016. The reason for lower yields were the unfavorable climatic conditions, especially low precipitation in June, July and August, followed by dry periods during vegetation. Also, there are smaller differences in yield, both among hybrids and among sowing terms. Within the FAO 400 and 600 maturity groups, among the hybrids there were no statistically significant differences in grain yield, which cannot be said for the FAO group 500, where the highest yields in the year were statistically significantly higher than the yields of other hybrids. The lowest average yield for all hybrids was achieved in the 3rd sowing term (7.61 t ha^{-1}). The highest average yield for all hybrids was achieved in the 2nd sowing term (8.42 t ha^{-1}) and it was statistically significantly higher than the yield realized in the

3rd sowing term. There were no statistically significant differences between the average yields recorded in the 1st and 2nd sowing terms. The highest average yield that year (9.10 t ha^{-1}) was achieved by the ZP 555 hybrid in the 2nd sowing term and the lowest (7.10 t ha^{-1}) by hybrid ZP 666 in 3rd sowing term. VIDENOVIĆ *et al.* (2011) in their research on the influence of sowing terms and hybrids on corn grain yield, they concluded that the highest average yield was achieved in the 2nd sowing period (April 15), and that the water content at the time of harvest was higher in the hybrids of later groups of maturation, which agrees with our results.

Dry down rate in the period of physiology-technical maturity

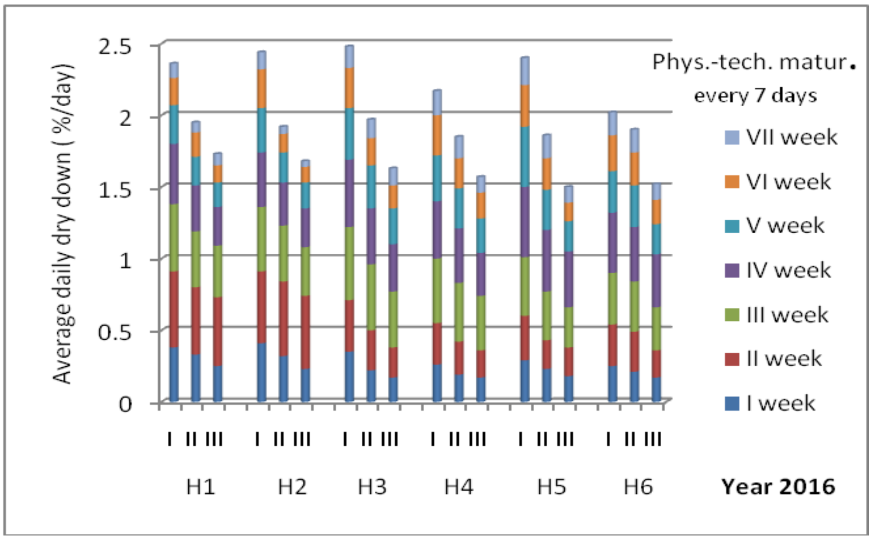
The dry down rate is significant due to a faster maturation and harvesting of corn, which free the soil for the next culture. Therefore, in production areas, hybrids are more desirable as they show higher dry down rate. Graf 1 shows the average rate of dry down after physiological maturity, depending on the hybrid and the sowing term, shown in periods of 7 days.

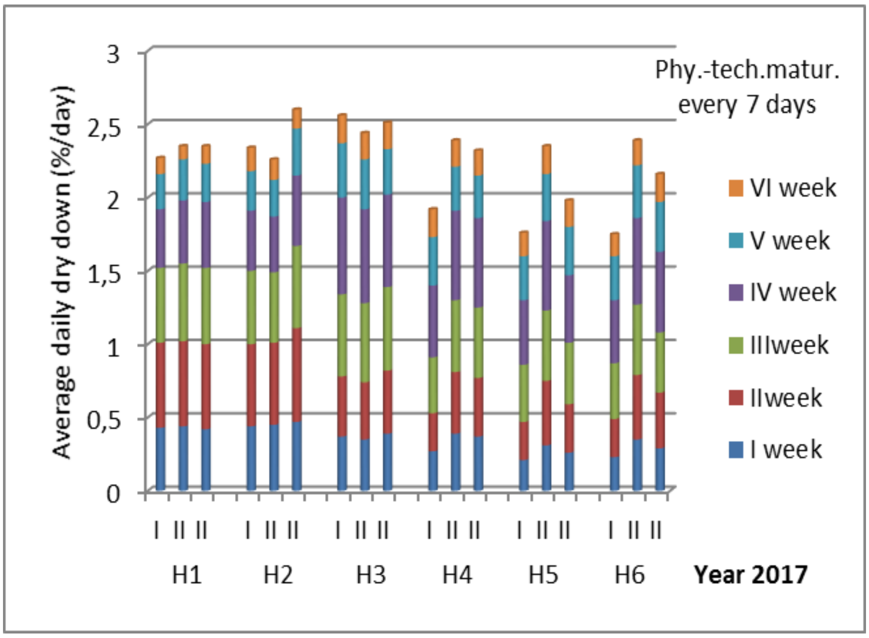
In 2016, the length of the period of physiological maturity-technological maturity lasted for a longer period of time (7 weeks), than in 2017 (6 weeks) due to a drier period and earlier maturation in 2017. The average rate of dry down in 2016, in all hybrids was the highest in the 1st sowing term and decreased in 2nd and 3rd terms. Hybrids from the FAO maturity groups 400 and 500 which had a more intense release of water from grains were recorded in 1st and 2nd seeding period, while in hybrids from FAO maturity groups 600, especially hybrid NS 6030 this intensity was less pronounced. The most intense dry down period in FAO 400 hybrids was in the second and third week of physiological maturity and in the FAO hybrids of 500 and 600 maturity groups in the third and fourth weeks of physiological maturity. The highest grain dry down rate (0.53%/day) was recorded in hybrids ZP 434 in the second week of physiological maturity in the 1st sowing term, and the lowest (0.04%/day) in the hybrid NS 4023 in the seventh week of physiological maturity of the 3rd sowing term.

The year 2017 was quite different in the rate of dry down compared to 2016. Thus, the highest average dry down velocity was recorded in 1st and 3rd sowing terms. The most intense dry down period in FAO 400 hybrids was in the second and third weeks of physiological maturity and in FAO hybrids of 500 and 600 maturity groups in the third and fourth weeks of physiological maturity. The highest rate of grain release (0.66%/day) was recorded in hybrid ZP 555 in the fourth week of physiological maturity in the 1st sowing term, and the lowest (0.09%/day) in hybrid NS 434 after six weeks of physiological maturity in the 2nd sowing term. The reason for faster dry down in the 2nd and 3rd sowing terms is a drier and warmer period at the time of maturation, losing water faster with shortening the maturation period.

In both years hybrids of earlier FAO maturity groups were losing water faster than hybrids from later FAO maturity groups, which coincides with the results of MELUTA and ROSCE (2016) emphasizing that early hybrids have the ability to faster dry down in comparison to late hybrids. The average rate of grain release for all hybrids and sowing terms in 2016 was 0.34 - 0.21%/day, and in 2017 from 0.44 - 0.29%/day. These results are in line with the results of JAGER *et al.* (2004), stating that the daily rate of dry down in normal months ranges from 0.4 - 0.8% per day, while in the months when the weather is cold and rainy it is much less.

Table 5 shows the interconnection between the rate of dry down and sowing term for each hybrid, as well as the correlation between the rate of dry down from the grain and the grain yield of the hybrids of different maturity groups. This correlation is expressed by the Pearson coefficient of correlation.





I,II,III – sowing terms, H1- ZP 434, H2- NS 4023, H3- ZP 555, H4- NS 5051, H5- ZP 666, H6- NS 6030

Graf 1. Average dry down rate from the corn grain (%/day) in the period of physiological-technological maturity

Table 5. Correlations between the dry down rate, the sowing terms and yield.

Correlations between		Hybrids	Pearson coefficient of correlation (r)	
			2016	2017
dry down rate	Sowing terms	ZP 434	r = - 0.97	r = 0.86
		NS 4023	r = - 0.96	r = 0.77
		ZP 555	r = - 0.99	r = - 0.50
		NS 5051	r = - 0.99	r = 0.80
		ZP 666	r = - 0.99	r = 0.93
		NS 6030	r = - 0.92	r = 0.62
dry down rate of hybrids FAO 400-600	Yield hybrids FAO 400-600		r = - 0.62	r = 0.99

Correlation coefficients show that the relationship between individual properties varies considerably by year of research. The reason for this is the different climatic conditions in the years of research, where the year 2017 was dry, with a lack of precipitation, especially in the period of accumulation of dry matter and maturation, as opposed to 2016. In 2016, all hybrids had a strong negative correlation between the dry down rate and the sowing terms (-0.92 to -0.99), due to the faster release of water from the grains in the 1st and 2nd sowing terms in relation to the 3rd term. In 2017, all hybrids (except NS 555 and NS 6030) had a strong positive correlation between the dry down rate and the sowing term (0.77 to 0.93). The reason for this is high temperature and drought during the maturation period, so hybrids in such conditions dry down from the grains more intensively in the 2nd and 3rd sowings in relation to the 1st term. The relationship between the rate of grain release and grain yield in 2016 was expressed through a mean negative correlation (r= -0.62) in contrast to 2017, where a strong positive correlation was established (r =0.99). This is justified by the fact that the hybrids of longer FAO maturity groups yield more and that in such hybrids the dry down rate is lower than in hybrids of lower FAO maturity groups. In the extremely dry 2017, hybrids from longer FAO maturity groups (especially from sowing terms 2nd and 3rd) had a more intense dry down compared to earlier hybrids. MELUT and ROSCA (2016) point out that there is a positive correlation between the grain yield of the hybrid and the dry down rate, but that these differences are not statistically significant.

CONCLUSION

The water content in physiological and technological maturity varied depending on the hybrid, the sowing term and the year. The average water content in grain in physiological and technological maturity, of which all hybrids and sowing terms were in 2016, was significantly lower than in 2017. The highest average yields in 2016 were recorded by the hybrids of the FAO maturity groups 600 during the 2nd and 3rd sowing terms, while in 2017 the highest yields were achieved by hybrids from the FAO maturity groups 500, and in the 1st and 2nd sowing terms. The average dry down rate in 2016, in all hybrids, was the highest in 1st sowing term, and in 2017, in the 1st and 3rd sowing term. The most intensive dry down period, in both years, in the hybrid of the FAO maturity groups 400 was in the second and third week of physiological maturity, and in hybrids of FAO maturity groups of 500 and 600 in the third and fourth weeks of physiological maturity. In case of breeding the corn in crop rotation with wheat, in this region for recommendation are FAO maturity groups 400 and 500 (especially hybrid ZP 555). In case of breeding in crop rotation with spring crops, hybrids of the 600 FAO maturity group are recommended, especially in favorable years.

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REFERENCES

DAYNARD, T.B. and W.G. DUNCAN (1969): The black layer and grain maturity in corn. Crop Sci., *9*:473–476.

ELMORE, R., L. ABENDROTH (2007): How fast can corn drydown? Iowa State University Extension.

FILIPENKO, A., V. MANDACHE, G. VÂLSAN, F. IVAN, I. CIOCĂZANU (2013): Efficiency of utilization of aselection index in assessment of drydown of corn genotypes (*Zea mays* L.). Scientific Papers. Series A. Agronomy, Vol. LVI.

GEYER, A., P.THOMISON (2006): Corn drydown. C.O.R.N. Newsletter 2006-28. The Ohio State University.

HELLEVANG, K.J. (2004): Post-harvest tips for late maturing corn. NDSU Extension Service, North Dakota State University.

JAGER, B., C.Z. ROUX, H.C. KÜHN (2004): An evaluation of two collections of South African maize (Zea mays L.) germ plasm: 2. The genetic basis of dry-down rate. South African Journal of Plant and Soil. Plant Grond, *21*(2).

JUKIĆ, Ž. (2004): Water relase from corn kernel in the field and drier during convention drying. Doktorska disertacija. University of Zagreb, Faculty of Agriculture.

JUKIĆ, Ž., V. JANJUŠIĆ, A. MATIN, F.TOMIĆ (2007): Water released rate from corn kernel affected by cropping intensity. VI Alps- Adria Scientific Workshop, p. 569-572. Obervellach, Austria.

LANA, M.R., J. MORRISON, X. ZHU, J. WU, T. WOLDEMARIAM, C-TIN VOLOACA, K. XIANG (2014): Selecting maize for rapid kernel drydown: timing of moisture measurement. Maydica, 59.

LOPANDIĆ, D. (1998): Effect of genotype on the length developmental stages and dry matter accumulation on maize kernel (Zea *mays* L.). Plant Breeding and Seed Production, Vol. *5*, p. 1-2: 63-68. Novi Sad.

MADIĆ, M., D. ĐUROVIĆ, V. STEVOVIĆ, N. BOKAN (2010): Stability parameters for grain yield of maize hybrids (Zea mays L.). Genetika, *42*, (1): 137-144.

MELUT, L.C. and A.E. ROSCA (2016): Drydown Coefficient Analysis in Some Commercial Corn Hybrids. "Ion Ionescu de la Brad" University of Agricultural Sciences and Veterinary Medicine, seria Agronomie, *59*(2): 213-218.

REID, L.M., X. ZHU, M.J. MORRISON, T.WOLDEMARIAM, C.VOLOACA, J.WU, K. XIANG (2010): A nondestructive method for measuring maize kernel moisture in a breeding program. Maydica, *55*:163- 171.

ROOKING, I.R. (1990): Maize ear moisture during grain filling, and its relation to physiological maturity and grain drying. Field Crops Res., *23*: 55- 68.

SONMEZ, F. (2002): Responses of four corn hybrids to plant density. Cereal Res. Comm., *30* (3–4): 447–454.

SVEČNJAK, Z., S. BARENIĆ, B. VARGA, D. JAREŠ (2012):Growing degree days from planting tophysiological maturity of corn hybrids belongingto fao 200-500 groups. Sjemenarstvo, *29* (1-2): 25-36. Zagreb.

VIDENOVIĆ, Ž., Z. DUMANOVIĆ (1994): The effect of planting date on dray down rate in maize. J. Sci. Agric. Res., *55*: 11-18. Belgrade.

VIDENOVIĆ, Ž., Z. DUMANOVIĆ, M. SIMIĆ, J. SRDIĆ, M. BABIĆ, V. DRAGIČEVIĆ (2013): Genetic potential and maize production in Serbia. Genetika, *45* (3): 667-677.

VIDENOVIĆ, Ž., M. SIMIĆ, J. SRDIĆ, Z. DUMANOVIĆ, M.PAVLOV (2011): Effect of Sowing Time on yield of zp maize hybrids. J. Processing and Energy in Agriculture,*15* (1): 23-26.

YANG, J., M.J. CARENA, J. UPHAUS (2010): Area Under the Dry Down Curve (AUDDC): A Method to Evaluate Rate of Dry Down in Maize. Crop Science Society of America, *50* (6): 2347-2354.

UTICAJ HIBRIDA I ROKA SETVE NA PRINOS I BRZINU OTPUŠTANJA VODE IZ ZRNA KUKURUZA

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Izvod

Brzina otpuštanja vode iz zrna kukuruza je posebno važna za raniju zriobu i pravovremenu obradu zemljišta za setvu naredne kulture. Cilj ovih istraživanja je bio da se utvrdi prinos i brzina otpuštanja vode iz zrna kukuruza u zavisnosti od hibrida i roka setve, u agroekološkim uslovima Juga Srbije (Leskovac). U tu svrhu postavljen je ogled tokom 2016. i 2017. godine na teritorije opštine Leskovac, na zemljištu tipa aluvijum. Ogled je bio postavljen po planu razdeljenih parcela u tri ponavljanja i uključivao je 6 hibrida različitih FAO grupa i tri roka. Prosečni sadržaj vode u zrnu u fiziološkoj i tehnološkoj zrelosti, kog svih hibrida i rokova setve u 2016. godini, bio je značajno manji nego u 2017. godini. Najveće prosečne prinose u 2016. godini imali su hibridi FAO grupe zrenja 600 i to u II i III roku setve, dok su u 2017. godini nejveće prinose ostvarili hibridi iz FAO grupe zrenja 500 i to u I i II roku setve. Prosečna brzina otpuštanja vode u 2016. godini, kod svih hibrida, bila je najveća u I roku setve, a u 2017. godini u II i III roku setve. Najintenzivniji period otpuštanja vode bio je od druge do četvrte nedelje od početka fiziološke zrelosti i razlikovao se u zavisnosti od FAO grupe zrenja. Ukoliko kukuruz gajimo u plodoredu sa pšenicom za preporuku, na ovom području, su hibridi iz FAO grupa zrenja 400 i 500. Ukoliko ga gajimo u plodoredu sa jarim kulturama poželjni su hibridi iz FAO grupe 600, posebno u povoljnim godinama.

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