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WATER USE BY SOYBEAN VARIETIES OF DIFFERENT MATURITY GROUPS

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Summary. The seasonal change in soil moisture reserves in dependence on the genetic form of soybeans was studied. It has been established that the deep layers of the soil (40-150 cm) more consistently reflect the influence of the plant component than the surface ones. In 2021, water reserves decreased in the 0-150 cm layer: for the Pentata variety - by 103 mm, and for the Onika variety- by 53 mm. Thus, Onika variety (MG I) retained 50 mm more water in the field for the next season compared to variety Pentata (MG III).

Keywords: *field soybean, soil moisture, deep soil horizons, maturity group.*

Introduction. Any decrease in non-beneficial water consumption must result in increased production per unit of consumed water [6]. Increasing the efficient water use by cultivated soybean *Glycine max* (L.) Merr. requires an accurate assessment of the moisture reserves of soybean fields in different seasons [12]. Soybean is a warm-season crop, and heat has a great influence on the adaptation, yield, and seed quality of soybean [9]. The maturity group (MG) system was used to group soybean varieties according to their photothermal response [8]. The aim of the work was - at the end of the season (harvesting-2021) to determinate the differences in soil water content between soybean varieties of different maturity groups.

Materials and methods. The studies were carried out in 2021-2022 at the fields of the Institute of Genetics, Physiology and Plant Protection with different soybean varieties (Onika, Ştefanel, Pentata) and traditional cultivation technology ($400*10^3$ plants/ha, row spacing 45 cm). To assess meteorological conditions was used the relative precipitation index *(RPI*) - the ratio of precipitation sum for the given period *P* and the long term average for the same period $\underline{P}$ expressed in

percent, *RPI* = *P*/$\underline{P}$*100%; for long period (from quarter to year) are such criteria of RPI value: 0-49,9% (extremely dry), 50,0-74,9% (very dry), 75,0-89,9% (dry) and 90,0-110,0% (average) [5; 1]. Gravimetric soil moisture samples were taken by hand drill AM-26 at 10 cm depth increments to 150 cm deep. For each horizon, soil samples were taken in triplicate. To determine gravimetric soil moisture, the samples were dried in an oven at 105 °C to constant weight [2]. Oven, heated and ventilated, capable of maintaining a temperature of 105±2 °C. To reduce the effect of random scatter, a one-time smoothing procedure using the "moving average" method was applied to the gravimetric soil moisture results before presentation in a graphical form: in this case, each point of the curve is consistently the average result of the experimental tabular data for this point and two adjacent (upper and lower 10cm layers). To determine the volumetric soil moisture content, the gravimetric data were multiplied by the soil density values, obtained experimentally [11; 4].

Maturity was measured at the date when 95% of the pods turned brown, stage R8 [3].

Results and discussions. In the 0-150 cm layer, three layers with different colors were identified. Taking into account the differences between the soil layers, the bulk density of the entire layer of 0-150 cm on average can be characterized by the value of 1.26±0.08 g/cm3. Such bulk density is typical for loamy chernozem soils: In general, the density of loamy soils is in the range from 1.0-1.1 to 1.3-1.4 g/cm3 [10]. Thus, our data on the density of the studied soils are in good agreement with the known literature data. Soil density data were used by us to calculate volumetric soil moisture from experimental data on gravimetric soil moisture.

Table 1 presents data on the amount of precipitation for the "autumn-spring" (September-April) and "spring-summer" (May-July) periods in different years.

Table 1. The amount of precipitation for the "autumn-spring" and "spring-summer" periods in different years.

Years (autumn-spring)	Autumn-spring precipitation, *mm*			
	autumn-spring		spring-summer	
	Rainfall, mm	*RPI*, %	Rainfall, mm	*RPI*, %
Average (*1886-2022)	306	100	186	100
2020-2021	309	101	307	165
2021-2022	168	`55	110	59

As can be seen from the data in Table. 1, the season-2021 was moisture-provided (101% of norm in the «winter» period of accumulation and 165% during the growing season).

≥10 °C active accumulated temperature (≥10 °C AAT) is important index to quantify the effects of temperature on soybean development [9]. The required AAT showed an increasing trend from early to late maturity groups; for each increase of 1 (one) MG, AAT could potentially increase by 254.2 °C and the AAT for MG I, MG II, and MG III are 2336-2589, 2590-2843 and 2844-3097 °C [9]. The average value for two years (2021-2022) AAT of soybean variety Onika was 2374±52 °C, that corresponds to MG I. Variety Pentata belongs to MG III. The phenological differences between varieties Onika and Pentata on various days after planting (DAP) are shown in Figures 1-2.



Figure 1. The soybean variety Onika (MG I) in 2022 (left – plants 11/08/2022, 118 DAP; on right - pod 10/08/2022, 117 DAP).



Figure 2. The soybean variety Pentata (MG III) in 2022 (left – plants 21/08/2022, 127 DAP; on right - pods 20/08/2022, 126 DAP).

Fig. 3 shows distribution of water in different soil layers of a soybean field at sowing and harvesting (2021, varieties Onika and Pentata).

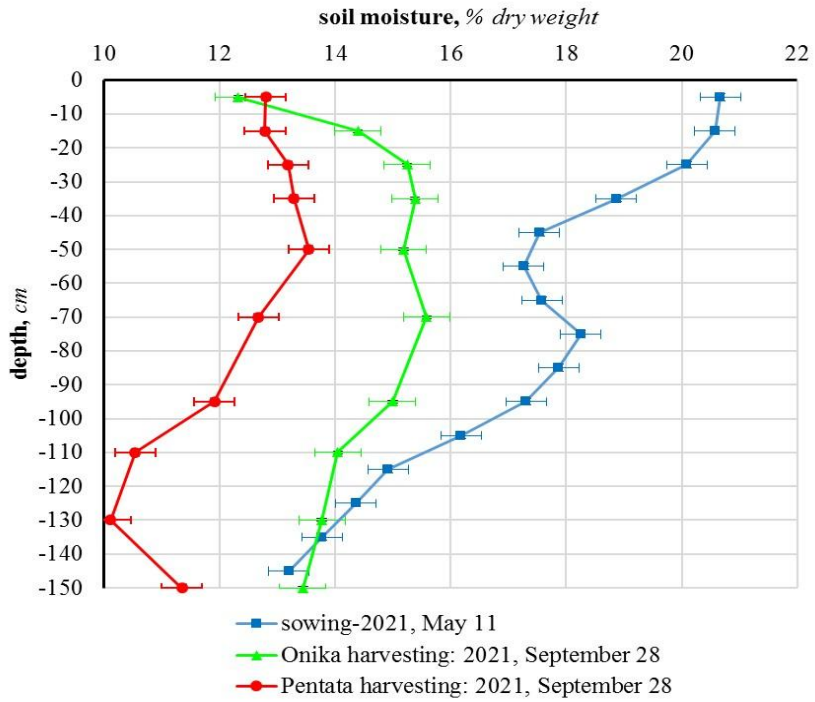


Figure 3. Distribution of water in different soil layers of a soybean field at sowing and harvesting (2021, varieties Onika and Pentata).

At sowing-2021 soil moisture was significantly high (19-21%) in surface layers of soil, from 0 to 40 cm. High soil moisture at sowing promotes plant growth. Under favorable conditions, the primary root and several major laterals grow rapidly and may reach a depth of 2.5 to 3.25 feet by stage V6 [7].

During the sowing-2021 soil moisture significantly decreased in deep layers, especially from 100 to 150 cm. Pre-sowing soil moisture reserves in the 0-150 cm layer were 331 ± 6 mm. These water reserves were more than critical level (~300 mm) in accordance with *RPI* value, 101%. At the vegetative stages the water consumption of both soybean varieties, Onika and Penata, occurred primarily from surface soil horizons, and later was also facilitated by precipitation (June -87 mm; July - 83 mm).

For soybean Onika variety residual (when harvesting in 2021) soil moisture reserves in 0150 cm layer amounted to 278±5 mm, significantly more than critical level (~200 mm). The seasonal decrease in soil water reserves from the 0-150 cm layer was 53±3 mm. The decrease in soil moisture reserves by 40 mm in the 40–100 cm layer partially reflects the activity of roots in this layer. The use of water from deep (100-150 cm) soil layers for the Onika variety was

insignificant. For soybean Pentata variety residual (when harvesting in 2021) soil moisture reserves in 0150 cm layer amounted to 228±4 mm, also more than critical level (~200 mm). The seasonal decrease in soil water reserves from the 0-150 cm layer was 103±3 mm, and this is significantly less (~50 mm) than for soybean variety Pentata. The decrease in soil moisture reserves in the 40–150 cm layer reflects higher roots activity of variety Pentata in deep layers compared variety Onika.

At the same time, in the soybean cenosis the soil moisture reserves of the 0-150 cm layer decreased to a different extent for different genetic forms: for the Pentata variety (MG III) by 103 mm, for the Stefanel variety (MG II) by 82 mm, while for Onika variety (MG I) - only by 53 mm.

Conclusions. The deep layers of the soil reflect the influence of the plant component more consistently than the surface layers. Seasonal change in soil moisture reserves depends on the genetic form of soybean. In 2021, water reserves decreased in the 0-150 cm layer: for the Pentata variety by 103 mm, and for the Onika variety by 53 mm. Thus, the Onika variety (MG I) retained 50 mm more water in the field for the next season compared to variety Pentata (MG III).

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