УДК 633.174:631.5
DOI 10.31395/2310-0478-2018-1-23-28

С. П. Полторецький
доктор с.-г. наук,
професор кафедри рослинництва,
Уманський національний університет садівництва
e-mail: poltorec@gmail.com

В. М. Бурдига
кандидат с.-г. наук,
Подільський державний аграрно-технічний університет
e-mail: ndikk@ukr.net

В. Я. Білоножко
доктор с.-г. наук,
професор кафедри екології та агробіології,
Черкаський національний університет імені Богдана Хмельницького
e-mail: bilonogko1952@gmail.com

ВПЛИВ СТРОКУ І СПОСОБУ СІВБИ НА ОСОБЛИВОСТІ ВЕГЕТАЦІЇ СОРГО ЗЕРНОВОГО І СОРИЗУ

Анотація. *У зв'язку зі змінами клімату на території України, що супроводжуються високими температурами повітря, незначною кількістю або повною відсутністю опадів у критичні періоди вегетації озимих і ярих зернових культур, проблему виробництва достатньої кількості зерна можна за рахунок розширення посівних площ жаро- і посухостійких культур, в тому числі й сорго зернового і сориз. У зв'язку з цим актуальним є питання добору високопродуктивних сортів цих культур, а також розробка ефективних прийомів вирощування. Мета дослідження полягала в створенні оптимальних агротехнічних умов для повноцінного продукційного процесу рослин сорго зернового і сориз в Лісостепу західному за рахунок оптимізації строку і способу сівби. Методика досліджень включала використання польового, лабораторного і статистичного методів. Результати досліджень дозволили встановити, що польова схожість насіння залежить в основному від строку сівби і найвищою вона була за сівби сорго та сориз в другий строк, коли середньодобова температура ґрунту на глибині 10 см була на рівні +12–14 °С – 79,5–84,9 %. Способи сівби на польову схожість насіння не впливають. Серед досліджуваних сортів найбільш тривалий вегетаційним періодом мав сорт сорго зернового Перлина (143 доби), а найменшим – сориз сорту Вінець (134 доби).*

Ключові слова: *сорт, сорго зернове, сориз, строк сівби, спосіб сівби, польова схожість, тривалість вегетації.*

С. П. Полторецкий
доктор сельскохозяйственных наук,профессор кафедры растениеводства,
Уманский национальный университет садоводства
В. Н. Бурдыга
кандидат сельскохозяйственных наук, Подольский государственный аграрно-технический университет
В. Я. Белоножко
доктор сельскохозяйственных наук, профессор кафедры экологии и агробиологии, Черкасский национальный университет имени Богдана Хмельницкого

ВЛИЯНИЕ СРОКОВ И СПОСОБОВ СЕВА НА ОСОБЕННОСТИ ВЕГЕТАЦИИ СОРГО ЗЕРНОВОЕ И СОРИЗА

Аннотация. *В связи с изменениями климата на территории Украины, сопровождающихся высокими температурами воздуха, незначительным количеством или полным отсутствием осадков в критические периоды вегетации озимых и яровых зерновых культур, проблему производства достаточного количества зерна можно решить за счет расширения посевных площадей жаро- и засухоустойчивых культур, в том числе сорго зернового и сориза. В связи с этим актуальным является вопрос отбора высокопродуктивных сортов этих культур, а также разработка эффективных приемов выращивания. Цель исследования заключалась в создании оптимальных агротехнических условий для полноценного продукционного процесса растений сорго зернового и сориза в Лесостепи западной за счет оптимизации срока и способа сева. Методика исследований включала использование полевого, лабораторного и статистического методов. Результаты исследований позволили установить, что полевая всхожесть семян зависит в основном от срока сева и высокой она была при посеве сорго и сориза во второй срок, когда среднесуточная температура почвы на глубине 10 см была на уровне +12–14 °С – 79,5–84,9 %. Способы сева на полевую всхожесть семян не влияют. Среди исследуемых сортов наиболее длительный вегетационным периодом имел сорт сорго зернового Жемчужина (143 суток), а наименьший – сориза сорта Венец (134 суток).*

Ключевые слова: *сорт, сорго зерновое, сориз, срок сева, способ посева, полевая всхожесть, продолжительность вегетации.*

S. P. Poltoretskyi
Doctor of Agricultural Sciences, Professor of Department of Plant Production, Uman National University of Horticulture
V. M. Burdyha,
PhD in Agriculture Sciences, Podilsky State Agrarian Technical University
V. Y. Bilonozhko
Doctor of Agricultural Sciences, Professor of Department of Ecology and Agrobiology, Cherkasy National University named after Bogdan Khmelnytsky

INFLUENCE OF DURATION AND THE SOWING METHOD ON THE FEATURES OF VEGETATION OF GRAIN SORGHUM AND SORIZ

Abstract. *Due to the climatic changes in Ukraine accompanied by high air temperatures, insignificant or total absence of precipitation during the critical periods of vegetation of winter and spring cereal crops, the problem of producing a sufficient amount of grain can be due to the expansion of sown areas of heat and drought-resistant crops, including grain sorghum and soriz. In this regard, the issue of selection of high-yielding varieties of such crops is relevant, as well as the development of effective cultivation techniques. The purpose of the study is to create optimal agrotechnical conditions for a complete production process of grain sorghum and soriz plants in Western Forest Steppe due to the optimization of the time and method of sowing. The research methodology included the use of field, laboratory and statistical methods. The study results allowed us establish that the field germination of seeds depends mainly on the time of sowing and it was the highest after sowing sorghum and soriz in the second term, when the average daily temperature of the soil at a depth of 10 cm was at the level of +12–14 °C (79.5–84.9 %). Seeding methods do not affect the seed germination. Sorghum grain of Perlyna variety had the most prolonged vegetation period (143 days) and soriz grain of Vinets variety had the smallest one (134 days).*
Key words: *variety, grain sorghum, soriz, time of sowing, method of sowing, field germination, duration of vegetation.*

Problem statement. In recent years, due to the unfavorable weather conditions prevailing on the territory of Ukraine and accompanied by high air temperatures, insignificant or total absence of precipitation during critical periods of vegetation of winter and spring crops and corn, the production of sufficient quantities of grain is problematic. One of the ways to solve this problem is to grow drought and heat-resistant millet crops (millet, sorghum and soriz). Thus, in the long term, an increase in the area under sorghum to 0.5 million hectares and an increase in yields to 4.7 t/ha is planned [1].

In this connection, the issues of selection of the most productive varieties of grain sorghum and soriz for the regional conditions of the Western Forest Steppe and the development of effective methods of its cultivation on the basis of optimization of the sowing period are of particular ***relevance.***

Actual scientific researches and issue analysis. One of the main conditions for the formation of the optimal amount of panicles in a high yield sowing is a certain number of plants per unit area which in turn depends on the seed rate and germination. The seed germination depends on such factors as the quality of sowing material, germination conditions, seedling emergence, time and method of sowing, depth of seeding, damage to diseases, etc. [2].

According to N. A. Shepel [3], in the early days of sowing sorghum its seedlings become thin and are overgrown with weeds. During sowing in not warmed soil, at temperatures of +7–8 °C at a depth of 10 cm, seedlings appear after 30–35 days and the field germination is reduced by 30 %. At temperatures of +14–16 °C, seedlings appear after 10–12 days and when the soil warms up to 25–28 °C they are after 5–6 days of sowing.

According to the results of research carried out at Institute of Irrigated Agriculture of NAAS, sowing grain sorghum on April 26–28, May 6–8, May 16–18 and May 26–28, the duration of the sowing-seedling period was 16–21 days, 7–13, 7–11 and 6–9 days, respectively [4].

Study of sowing terms, depending on the temperature regime of the soil under the conditions of the Lower Volga region, showed that sowing at an average daily temperature of the soil +6–8 °C, seedlings appear after 17 days and in some years after 19–21 days, they are not simultaneous and thin. For sowing in the warmed soil to 12–15 °C and 10 days later, seedlings were friendly and significantly reduced the period of their appearance. In late sowing, due to drying and strong warming of the soil to 25–28 °C, there were also thin seedlings [5].

The sowing time also affects the field germination of grain sorghum seeds. Thus, in the early terms it amounted to 58.8–67.5 % and in the middle and late ones it rose to 78.8–80.3 % [6]. According to the results of other studies [7], the field germination of seeds was 80.4–82.0 %, depending on the studied strains of soriz. The worst conditions were when sowing in late terms (May 25 and June 5), the level of the researched indicator dropped to 46.5–55.1 %.

For the most regions of southern Ukraine, the best time to sow for harvesting is when the average daily temperature of the soil at a depth of 10 cm is +12–15 °C. At the same time, seedlings appear on the 10th–11th day and the density of crops does not exceed 6–8 % [8].

Three year studies of sowing sorghum and soriz (the second ten day period of April – the first ten day period of June) under the conditions of Uman National University of Horticulture showed that the highest field germination of seeds was formed for sorghum sowing in the first ten day period of May (85.0 %). Both early and late terms of sowing negatively affected this indicator. So, when sowing in the extreme terms (the second ten day period of April and the first ten day period of June), the field germination was 58.0 and 76.0 %, respectively [9].

According to V. Y. Scherbakov [10], in the Ukrainian conditions sorghum should be sown from the first to the second ten day period of May, taking into account the specific soil-climatic conditions of the growing zone. Sorghum is a thermophilic crop, so sowing in insufficiently warmed soil or cooling after it causes a sharp decrease in field germination, lengthening the duration of sowing-seedling period and increasing crop weediness. So, when sowing on April 20, seedlings appeared on the 21st day and on May 20 they were on the 14th day. The largest field germination of seeds was when sorghum sowing on May 10 and amounted to 61.5 %. Early terms of sowing (April 20) led to a decline in field germination to 38.2 % and late terms (May 20) resulted in 60.9 %.

Studies on sowing time of grain sorghum under the conditions of Rostov region [11] showed that when sowing grain sorghum in the first term (soil warming at the depth of seeding up to +10–12 °C) the duration of the period of sowing-seedling is the longest and is 18–20 days; in the second term (+16–18 °C) it is reduced to 10–13 days; when sowing in the third term (+22–24 °C) it is the smallest and at the level of 7–10 days. In this case, the close inverse correlation dependence is established between the soil temperature and the duration of the period of sowing-seedling.

The purpose of the study is to create optimal agrotechnical conditions for a complete production process of grain sorghum and soriz plants in Western Forest-Steppe due to the optimization of sowing time and method.

Research methods. Field studies to study the effect of sowing time on the growth, development and production of grain sorghum and soriz were conducted in 2014–2016 under the conditions of the Western Forest-Steppe at the experimental field of Podilsky State Agricultural and Technical University.

The schematic course of the research is as follows: a variety

(A Factor) – Vinets (grain sorghum), Genicheske 209 (grain sorghum) and Perlyna (soriz); the sowing time *(B Factor)* – the first term (average daily temperature of the soil at the depth of 10 cm +10–12 °C), the second term (+12–14 °C, check variant) and the third term (+14–16 °C); the sowing method *(C Factor)* – usual row (row width of 15 cm) and wide row (row width of 30 cm, 45 and 70 cm) methods of sowing.

The predecessor of grain sorghum and soriz was winter wheat. After the precursor was harvested, stubble ploughing by disk plough-harrows was at the depth of 6–8 cm. After 3 weeks, plowing was carried out at the depth of 30 cm.

Early in the spring, moisture was closed with heavy harrows and cultivation (the first was to the depth of 10–12 cm, the second one was to 8–10 cm and the third one was to 3–5 cm). The fertilizer system consisted of the introduction of phosphoric and potash fertilizers ($P_{60}K_{60}$) under the plowing and nitrogen N_{60} fertilizers under the first cultivation. Seeds were wiped with Maxim XL 035 FS with the consumption rate of 1 l/ton to protect against diseases in the initial phases of plant growth. The seeding rate was 220 thousand similar seeds per hectare. The depth of seeding was 4–5 cm.

The registration area was 100 m^2. The number of replications was four. The variants were placed by split plot method.

Records, analyzes and observations were conducted in accordance with generally accepted methods [12, 13].

The soil of the experimental field, where the research was conducted, is podzolized heavy-loamy which is moisturized by atmospheric precipitation. Groundwater is chemically fresh and lies at a depth of 6–10 m. The arable layer contains 10.8 mg/100 g of light hydrolyzed nitrogen (according to Cornfield), mobile phosphorus (according to Chirikov) – 15.2 mg/100g, exchangeable potassium (according to Chirikov) 18.1 mg/100g, pH (salt) 6.7; the hydrolytic acidity is 1.6 mg/100 g of soil, the base saturation degree is 93.7 %, the humus content (according to Tiurin) is 4.74 %.

The experimental field is located in the Southern Forest-Steppe part of the Khmelnitsky region and under the conditions of water supply refers to the southern wet agro-climatic region of the region. According to Khmelnytsky Regional Center of Hydrometeorology, during the research, hydrothermal conditions were unstable and significantly different from the average multi-year indicators. This contributed to an objective assessment of the influence of the factors on the progress of growth processes, development and formation of productivity of grain sorghum and soriz.

Research results. The conducted researches have determined that for the duration of the sowing period, full seedlings of sorghum plants were mainly influenced by the sowing time. Sowing in the warmed soil reduced the duration of this period and, vice versa, at low temperatures of the soil the appearance of seedlings was delayed. The method of sowing grain sorghum and soriz did not affect the duration of seed germination. It was caused by a small seed rate (220 thousand of similar seeds per hectare) and, as a consequence, the lack of competition between plants in a row using different seeding methods (Table 1).

So, in the years of research, seeds, sown at the temperature of +10–12 °C, sprouted after 16–19 days, within the limits of sowing methods of studied varieties. Grain sorghum and soriz sowing during the average daily temperature of +12–14 °C accelerated the period of seed germination to 13–16 days and at a temperature of +14–16 °C it was up to 10–12 days.

On average, in 2014–2016 for the first sowing period, the duration of sowing-seedlings was 17.4–17.6 days; for the second sowing period it was 14.8–15.1 days and for the third one it was 11.1–11.4 days.

As regards the effect of the sowing method, as already noted, they had little effect on the duration of seed germination. The duration of this interphase period was 17.5–17.7 days, depending on the sowing method of all studied varieties.

It is established [14] that grain sorghum and soriz sowing in optimum terms ensures high field seed germination and, consequently, the formation of optimum plant density. The limiting factor for sowing in the early period is the low soil temperature, resulting in a decrease in the number of sprouted seeds, lengthening the duration of the period of seed germination and thinning crops. However, the delayed sowing due to excessive soil drying can also cause thinning crops.

As a result of the analysis of obtained data, optimum

Table 1

Influence of grain sorghum and soriz sowing term and method on the duration of sowing-seedlings (in 2014–2016), *days*

Sowing term (B)	Variety (A)			Average by sowing term	Average by sowing method
	Vinets	Genicheske 209	Perlyna		
Usual row – 15 cm (C)					
The first term	17.7	17.3	17.7	17.6	14.7
The second term *(check variant)*	15.0	14.7	15.3	15.0	
The third term	11.7	11.0	11.7	11.4	
Wide row – 30 cm (C)					
The first term	17.7	17.0	18.3	17.7	14.5
The second term *(check variant)*	14.7	14.3	15.3	14.8	
The third term	11.0	10.7	11.7	11.1	
Wide row – 45 cm (C)					
The first term	17.7	17.3	17.3	17.4	14.6
The second term *(check variant)*	14.7	15.0	15.7	15.1	
The third term	11.3	10.7	11.3	11.1	
Wide row – 70 cm *(C, check variant)*					
The first term	17.7	17.0	17.7	17.4	14.5
The second term *(check variant)*	14.0	15.0	15.3	14.8	
The third term	11.3	11.0	11.7	11.3	
Average in the variety	14.5	14.3	14.9	Average in the experiment – 14.6	

Table 2

Field seed germination of grain sorghum and soriz depending on the sowing term and method (in 2014–2016), %

Sowing term (B)	Sowing method (C)	Variety (A)		
		Vinets	Genicheske 209	Perlyna
The first term	Usual row (15 cm)	74.3±1.3	75.6±3.8	74.2±2.5
	Wide row (30 cm)	74.6±3.8	75.7±5.7	73.9±4.4
	Wide row (45 cm)	74.8±0.4	76.0±4.4	74.2±6.4
	Wide row (70 cm) *(check variant)*	74.8±1.3	75.5±6.4	74.4±0.6
The second term (check variant)	Usual row (15 cm)	79.5±0.8	84.0±1.9	78.6±3.8
	Wide row (30 cm)	79.9±2.5	84.3±0.6	79.0±2.5
	Wide row (45 cm)	80.2±1.1	85.8±1.3	78.7±2.5
	Wide row (70 cm) *(check variant)*	80.1±3.8	84.9±3.9	79.1±1.9
The third term	Usual row (15 cm)	77.6±2.5	82.8±3.2	77.0±3.8
	Wide row (30 cm)	77.2±5.7	82.5±1.9	77.1±1.9
	Wide row (45 cm)	77.6±3.2	83.0±2.5	76.8±4.4
	Wide row (70 cm) *(check variant)*	77.3±3.2	83.0±1.9	76.8±1.3

conditions for seed germination and obtaining grain sorghum and soriz seedlings can be achieved at an average daily temperature of soil +12–14 °C (Table 2).

Conditioned seeds of grain sorghum and soriz with a laboratory germination of 94–95 % were used for sowing.

According to the results of the analysis of studied varieties, on average, over the years of research, the highest field germination was observed in Genicheske 209 variety (75.5–85.8 %), slightly less germination was in Vinets variety (74.3–80.2 %) and the smallest one was in Perlyna variety (73.9–79.1 %), depending on the sowing term and method.

Depending on the sowing time, the smallest field germination was observed in variants where grain sorghum was sown at the average daily temperature of the soil at the depth of 10 cm +10–12 °C (73.9–76.0 %). The third term of sowing (the average daily temperature of the soil depth of 10 cm +14–16 °C) had somewhat higher indicators of field germination (76.8–83.0 %) and when the average daily temperature of the soil at the depth of 10 cm +12–14 °C, the indicators were significantly higher (78.6–85.8 %).

The sowing methods for grain sorghum and soriz had little effect on the field seed germination. Thus, for Vinets variety it amounted to 74.3–74.8 % for sowing in the first term; it was 79.5–80.2 % in the second term and 77.2–77.6 % for sowing in the third term. For Genicheske 209 variety, it was 75.5–76.0, 84.0–85.8 and 82.5–83.0 %, respectively; for Perlyna variety, it was 73.9–74.4, 78.6–79.1 and 76.8–77.1 % depending on the width of row spacing. Using the method of correlation-regression analysis, the average strength of the inverse relationship (r = –0.527 ± 0.001) was established between the duration of sowing-seedling period and the field seed germination (Fig. 1).

Regression equation (1):

$$y = 89.2 - 0.737 \times x \quad (1)$$

It reliably describes the relations and indicates that increasing the duration of the period from sowing to seedling

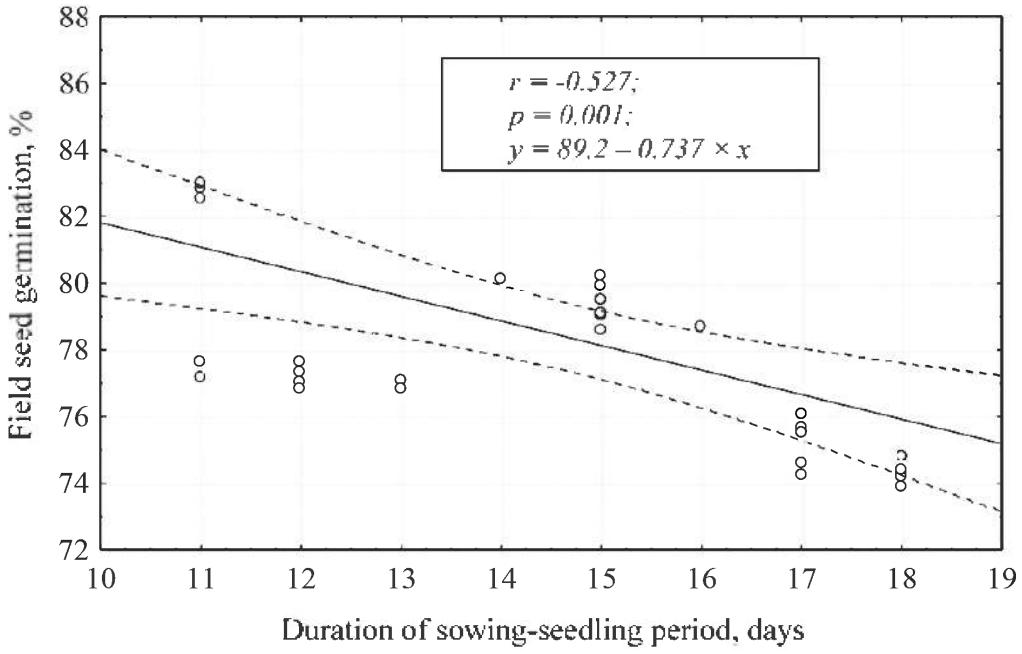

Fig. 1. **Correlation relations and regression equations between the duration of sowing-seedling period and the field seed germination of grain sorghum and soriz**

per day causes a decrease in field germination by 0.737 %.

The conducted researches have determined that under the conditions of the Western Forest-Steppe, the duration of the vegetation period of sorghum plants significantly depended on the biological characteristics of the variety, the time and method of sowing (Table 3).

Thus, among the studied varieties, the smallest duration of the vegetation season, on average, over the years of research was in Vinets variety (133.8 days), somewhat higher duration was in Genicheske 209 variety (138.3) and significantly longer one was in Perlyna variety (143.2 days).

Sowing terms and methods also significantly influenced the duration of the vegetation season. Thus, in particular, the least vegetation period was when sowing grain sorghum in the third term (123–149 days); it was somewhat higher in the second term of 126–148 days; and the largest one was in the first term (129–155 days), depending on the sowing method and weather conditions of the growing season.

In our opinion, the reason for this is that grain sorghum and soriz plants require a certain amount of active temperatures for their growth and development. When sowing in late terms with higher air temperatures, plants have faster growth and development. Early sowing, accompanied by a relatively low temperature regime, causes an extension of the duration of the vegetation period of grain sorghum and soriz plants.

Regarding the sowing method, sowing sorghum and soriz with an intermediate row of 70 cm was noted by the least vegetation period (123–148 days) and the largest one (131–155 days) when sowing with the width between rows of 15 cm, depending on the sowing time and meteorological conditions of the vegetation season of crops. In our opinion, the reason for this is that when sowing sorghum with a width of rows of 15 cm there is thinning of plants. This causes more intensive tillering and, as a consequence, grain matures later on newly formed shoots. When sowing with an intermediate row of 70 cm, the distance between plants in a row is small and there is less tillering and they are more likely to mature.

The results of the conducted researches indicate that the duration of vegetation of grain sorghum and soriz varieties significantly depended on the meteorological conditions of the growing season. An increase in the amount of precipitation delayed grain sorghum maturing and, vice versa, their smaller number accelerated complete maturing. Thus, in particular, in 2014, when there was the overgrowing amount of precipitation from seedlings to full maturing, the duration of the growing season was 132–155 days. In 2015, the amount of precipitation was less than the average annual indicator and the duration of vegetation was 123–144 days. In 2016, for a slight deviation from the average long-term values, this period was 125–152 days.

Using the correlation-regression analysis method, mathematical and graphical models were constructed that reliably describe the dependence of the duration of the growing season of sorghum and soriz studied varieties on the amount of precipitation for vegetation (Fig. 2).

The above calculations show that there is a direct correlation dependency between precipitation amount during the vegetation period of grain sorghum and soriz and its duration ($r = 0.512 \pm 0.000$). Regression equation (2):

$$y = 126.0 + 0{,}027 \times x, \quad (2)$$

y – is duration of the vegetation period (days);

x – is precipitation amount during the vegetation period (mm);

This reliably describes the specified dependence. All coefficients of the equation are reliable at 5 % level of significance.

Conclusions. Field seed germination depends mainly on the sowing time. It was the highest when sowing sorghum and soriz in the second term when the average daily temperature of the soil at the depth of 10 cm was +12–14 °C: 79.5–80.2 % of Vinets variety; 84.03–84.93 % of Genicheske 209 variety and 78.60–79.07 % of Perlyna variety. Sowing methods do not

Table 3

Duration of the vegetation period of grain sorghum and soriz depending on the sowing term and method (in 2014–2016), days

Sowing term (B)	Variety (A)			Average by sowing term	Average by sowing method
	Vinets	Genicheske 209	Perlyna		
Usual row – 15 cm (C)					
The first term	140.7	145.0	150.3	145.3	142.1
The second term *(check variant)*	137.7	142.3	146.0	142.0	
The third term	134.7	139.0	143.0	138.9	
Wide row – 30 cm (C)					
The first term	137.7	142.7	148.7	143.0	140.1
The second term *(check variant)*	135.0	140.0	145.0	140.0	
The third term	132.7	137.3	141.7	137.2	
Wide row – 45 cm (C)					
The first term	135.7	140.0	146.0	140.6	137.4
The second term *(check variant)*	132.7	137.3	142.0	137.3	
The third term	129.7	134.0	139.0	134.2	
Wide row – 70 cm *(C, check variant)*					
The first term	132.7	137.0	143.0	137.6	
The second term (check variant)	130.0	133.3	139.0	134.1	
The third term	126.7	131.0	134.7	130.8	
Average in the variety	133.8	138.3	143.2	*Average in the experiment – 138,4*	

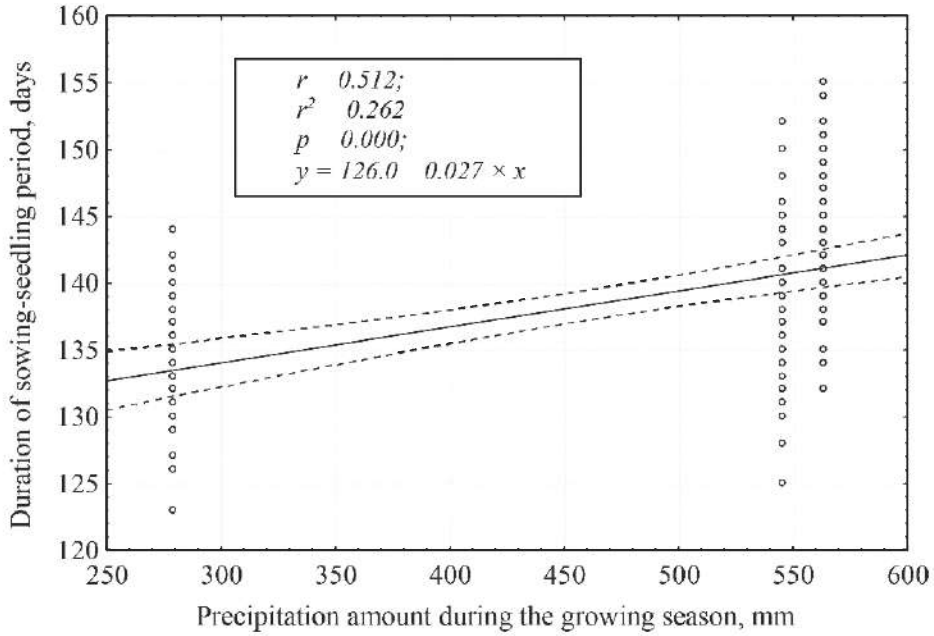

Fig. 2. **Correlation relations and the regression equation between precipitation amount during the growing season and its duration**

affect the seed germination.

Among the studied varieties of grain sorghum and soriz, the most vegetative period was in Perlyna variety (143 days); it was 138 days in Genicheske 209 variety and it was the least (134 days) in Vinets variety.

References

1. Karazhbej G. M. (2012). The state and prospects of grain sorghum in Ukraine. Selekciya i nasinnycztvo. Vol. 101, pp. 150–155. *(In Ukraine).*

2. Baer Ya. (1984). Formation of a crop of the basic agricultural crops. Moscow: Kolos. 366 p. *(In Russian).*

3. Shepel N. A. (1994). Sorghum. Volgograd, 1994. 448 p. *(In Russian).*

4. Bogata V. F., Babenko I. O., Prosvirna M. S. (1980). Influence of sowing dates on the grain sorghum yield and its quality. Stepove zemlerobstvo. Kiev: Urozhaj, №14, pp. 51–53. *(In Ukraine).*

5. Oleksenko Yu. F., Krasnyokov S. V. (1988). Sorghum for grain, silage and green forage. Scientifically based system of agriculture in the Dnipropetrovsk region. Dnepropetrovsk, pp. 251–252. *(In Ukraine).*

6. Tokhtarov VP (1972). Terms of sowing and depth of seeding of sorghum seeds in the Volgograd region. Bulletin of the All-Union Research Institute of Corn, pp. 51–54. *(In Russian).*

7. Makarov L. Kh., Skoryi M. V. (2002). Influence of sowing dates on the field similarity of sterile cut lines. Taurian scientific bulletin. Kherson: Ayalant. Vol. 22, pp. 44–47. *(In Ukraine).*

8. Makarov L. Kh., Skoryi M. V. (2009). Soriz – technology, breeding, seed production, processing: Monograph. Kherson: Ayalant. 223 p. *(In Ukraine).*

9. Klimovich PV, Sichkar A.O., Kononenko L. M., Klimovich N. M. (2012). Optimization of sowing times in the Right-Bank Forest-Steppe. Collection of scientific works of Uman National University of Horticulture. Vol. 78 (1): Agronomy, pp. 69–75. *(In Ukraine).*

10. Scherbakov V.Ya. (1983). Grain sorghum. Kiev. Vyshha shkola. 191 p. *(In Ukraine).*

11. Goncharov N. M. (2003). Substantiation of terms and norms for sowing seeds of new varieties of grain sorghum in the southern zone of the Rostov region: the dissertation author's abstract on competition of a scientific degree of the PhD in Agriculture. Don zonal NIISH. 23 p. *(In Russian).*

12. Ieshchenko V. O., Kopytko P. G., Opryshko V. P., Kostogryz P. V. (2005). Basic research in agronomy. K. Diya. 288 p. *(In Ukraine).*

13. Borovykov V. P., Borovykov I. P. (1997). Statistika. Statistic processing and analysis of data in Windows. M. Filin. 608 p. *(In Russian).*

14. Malinovsky B. N. (1992). Sorghum in the North Caucasus. Rostov-na-Donu. 208 p. *(In Russian).*