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Інститут овочівництва і баштанництва НААН

National Academy of Agricultural Science of Ukraine
Institute of Vegetable and Melon Growing

Овочівництво і баштанництво

Vegetable and melon growing

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ОВОЧІВНИЦТВО І БАШТАННИЦТВО

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GARDEN PEA YIELD DEPENDS ON SOWING TIME AND APPLICATION OF WATER-RETAINING GRANULES IN THE RIGHT-BANK FOREST-STEPPE

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Abstract. The article describes a study of effects of different timeframes of garden pea sowing by standard technology and with water-retaining granules. It was proven that sowing within the second 10 days of March ensured the best conditions for garden pea yield. Water-retaining granules optimized the moisture profile to a greater extent and allowed harvesting a higher yield. **Purpose**. To evaluate garden pea yield depending on sowing timeframes and application of water-retaining granules in the Right-Bank Forest-Steppe. **Methods.** The experiments were carried out in the Right-Bank Forest-Steppe in 2020–2022. In the experiments, field, statistical, and laboratory methods were used. The following timeframes of sowing were studied: the second ten days of March, the third ten days of March, the first ten days of April, and the second ten days of April. **Results**. It was shown that the sowing within the second ten days of March created the best conditions for the growth, development, and yielding capacity of pea plants. Application of water-retaining granules combined with the 'second ten days of March' sowing ensured a yield of 8.1 t/ha. **Conclusions.** When pea was sown within the second ten days of March, the number of leaves per plant and plant height increased, in particular by 2.0 leaves/plant and 7.6 cm, respectively, during the grain filling phase. In the experiment with water-retaining granules, the 'second ten days of March' sowing raised these parameters by 2.2 leaves/plant and 7.8 cm, respectively. The 'second ten days of March' sowing by standard technology extended the growing period by 3 days in comparison with the control; the 'second ten days of March' sowing combined with application of water-retaining granules extended it by 4 days. Early (the second ten days of March) garden pea sowing increased the yield by 1.1 t/ha and 1.3 t/ha without and with granules, respectively.

***Keywords**:* garden pea, biometric parameters, interphase periods, reproductive organs, yield.

Introduction. Today's challenge is to provide the population with sufficient amounts of protein, including plant protein, as its amino acid composition is quite similar to that of animal protein and therefore can supplement it. Pea is a crop that contains a lot of protein in its fruits. Garden pea is a cold-resistant and rather hydrophilic plant. Seeds need a lot of moisture to germinate. Therefore, early sowing of seeds, when there are still sufficient reserves of moisture in the soil, is vital. Pea is also very demanding of light and soil, so it often does not fulfill its genetic potential of performance under unfavorable conditions (*Yeremenko O. A., Kapinos M. V.*, 2020). Recently, peas have been grown much less and are increasingly replaced by soybeans. This is attributed to low yields harvested from peas. Varietal characteristics, growing conditions, and cultivation technologies affect the yield. Under climatic changes, one has to improve cultivation technologies constantly, namely, to select the best cultivars and hybrids, optimize sowing time, arrangement, and fertilization, to provide plants with water (*Andrushko M., Lykhochvor V., Andrushko O.*, 2019).

The provision of agricultural plants with water is one of the most important tasks in zones with unstable wetting. Taking into account precipitation amounts in recent years, the largest part of the forest-steppe can be referred to such zones. There are no sufficient amounts of precipitation during the growing period. Water deficit hinders plant growth processes, lowering yields and marketability. Therefore, to harvest a high yield of one or another crop, with high quality and biometric parameters, almost all farms switched to technologies that involve different irrigation methods. However, given the lack of water resources and water quality, irrigation is not always possible. Water-retaining granules are an alternative to irrigation. Absorbents are able to absorb large amounts of free water during periods of its abundance and provide it to plants when they need it. In agriculture, natural and artificial absorbents are used; they help to use water more efficiently (*Palamarchuk I.I.,* 2021, *Sanmay Kumar Patra, Ratneswar Poddar, Marian Brestic, et al.,* 2022).

Review of Recent Studies and Publications. Today, the issue of increasing the production of maximally healthy protein-containing foods has arisen in agriculture. Members of the Leguminous family, including garden pea, are the most effective plants in this aspect. Leguminous plants, in addition to being valued as food, are also able to fix nitrogen from the air, using nitrogen-fixing bacteria and producing biologically pure nitrogen (*Didur I., Bakhmat M., Shynchyk O., Pantsyreva H. et al.,* 2020).

Pea (*Pisum sativum* L.) is an economically important leguminous vegetable. It is of great food, fodder, and agrotechnical value; it is rich in many nutrients. Snap and sugar cultivars are grown in Ukraine. Snap cultivars are used to produce green peas and sugar cultivars are used as edible pods. The latter do not have a parchment layer, without which pod valves shrivel after ripening. Garden pea is the most common in Ukraine, and sugar cultivars are only grown by gardeners. Garden (snap) cultivars are used to manufacture canned green peas, to eat fresh, to dry, and to freeze. The garden pea production does not satisfy the internal needs of Ukraine, even without taking into account the value and distribution of leguminous plants as a source of vegetable protein (*Yeremenko O. A., Kapinos M. V.,* 2020).

Peas are cultivated in 84 countries worldwide. The widespread use of peas is attributed to their high yield capacity, excellent biological properties, and nutritional value for the human body. Pea seeds are of high nutritional value, they are rich in protein, carbohydrates, phosphorus, vitamins A and B, iron, and calcium, and are easily absorbed (*Janusauskaite D.,* 2023).

To optimize growing conditions, it is possible to use water-retaining granules. Sanmay Kumar Patra et al. pointed out that, in arid and semi-arid regions under rainfed conditions, water availability was one of the main environmental limitations that hindered the sustainability of agriculture. Superabsorbents are able to absorb water from the soil. Thus, owing to the absorbent properties of granules, one can manage a moisture regimen, that is, to keep water in the root area by reducing evaporation, deep seepage, and drain loss. Granules absorb water during rainfall or irrigation and release it into the soil when the rhizospheric area dries out during a drought. Water-retaining granules perform different functions, viz. retain water in the soil, carry nutrients and pesticides, cover seeds, and reduce soil erosion. Absorbents improve physicochemical, hydrophysical, and biological properties of the soil, while reducing the frequency of irrigation, improving the use of water and nutrients, and ultimately augmenting yields. These biodegradable materials are non-toxic to soil, crops, or the environment. Therefore, hydrogel polymers will be a workable and promising technological approach to increase the performance of agricultural crops under insufficient wetting (*Sanmay Kumar Patra et al.,* 2022).

Studies of different absorbents were conducted on outdoor-grown celery plants. Absorbents were demonstrated to affect biometric parameters of plants during the seedling and growing periods (*Ulianych O.I., Kovtuniuk Z.I., Vorobiova N.V., et al.,* 2019).

A.H. Ternavskyi et al. showed that an absorbent in combination with soil mulching accelerated the phenological phases in cucumber plants. In particular, mulching with a black film and application of hydrogel accelerated the first fruit formation. The largest early yield of 35.9 t/ha was harvested with black film mulching and gel using (*Ternavskyi A.H., Shchetyna S.V., Slobodianyk G. Ya., et al.,* 2021).

Optimization of water resource use can boost agricultural food production. Given these properties, superabsorbents are widely used in agriculture and horticulture to retain water, to increase the efficiency of irrigation of crops, and to improve physical properties of soils. Better efficiency of water use is a reasonable way, as it is one of the main limiting factors in agricultural production (*Weishuai Wang et al.,* 2021).

Superabsorbent polymers (SAP) and modified natural polymer hydrogels are widely and increasingly used in agriculture (*Venkatachalam Dhanapal, Kaliappa Subramanian, Superabsorbent Polymers,* 2021). Superabsorbent polymers are a class of polymer materials that are able to absorb and retain large amounts of water and aqueous solutions. Agriculture is a sector that develops due to the food needs to satisfy the growing demands of the increasing global population. Superabsorbent-based cultivation technologies for agricultural plants are a boon for the agricultural sector (*Behera, S., Mahanwar, P. A,* 2019).

The largest pea-growing areas are concentrated in Asia, accounting for 68% of the total acreage. India is the top producer of peas, producing 2.34 million tons, and is the second top producer of garden pea in the world after China (*FAOSTAT,* 2019, *Janusauskaite D.,* 2023).

Haq M.T. and Ahmed M.S. studied sowing timeframes and showed that the optimal time of sowing was an important factor in augmenting vegetative growth and yield of pea (*Pisum sativum* L.). It was demonstrated that the optimal date of sowing significantly increased the number of pods per plant, the number of seeds per pod, the thousand seed weight, the dry matter content in the plant, the yield of green seeds, etc. (*Haq M. T., Ahmed M. S.,* 2021).

Early sowing of agricultural plants, including vegetables, has a positive effect on yields. Due to moisture reserves in the soil, plants grow, develop, and yield better (*Palamarchuk I.I.,* 2022).

Precipitation, in particular during anthesis, including the 20 days before and the 10 days after anthesis, played an important role for the garden pea yield (*Telekalo N.V.,* 2019). That is why it is important to sow pea seeds when the soil is sufficiently wetted (*Didur I. M., Mostovenko V. V.,* 2019).

Materials and Methods. The garden pea yield was evaluated depending on sowing time and application of water-retaining granules in the Right-Bank Forest-Steppe. The field experiments were designed in randomized blocks. The study was conducted in accordance with methodological guidelines (*Rozhkov A.O., Puzik V.K., Kalenska S.M., et al.,* 2016). The soil of the experimental field was uniform. Marrow squash was a forecrop. The study was conducted on cv. Avola.

The experimental plot area was 10 m^2 in four replications. Ten plants were marked and monitored on each record plot. The field, static, and laboratory methods were used in the experiments.

The experimental variants were the sowing timeframes: the second ten days of March, the third ten days of March, the first ten days of April, and the second ten days of April. The 'third ten days of March' sowing served as a control. In addition, garden pea was sown within the specified timeframes with water-retaining granules. Aquod water-retaining granules were used as a synthetic superabsorbent. Granules were applied at a dose of 20 kg/ha during the pre-sowing plowing with subsequent enveloping in soil. The phenological observations were carried out, in particular, the lengths of interphase periods, biometric parameters, and yield were measured (*Rozhkov A.O., Puzik V.K., Kalenska S.M., et al.,* 2016). During the growing period, the dates of the onset and mass-scale sprouting, the onset and mass-scale anthesis, mass technical ripeness, and harvesting were documented. The point when 15% of the plants entered a phenological phase was considered as the onset of this phase; the point when 75% were in the phase was considered as the mass-scale phase.

The following biometric parameters were measured during the vegetation: plant height, the total numbers of pods and seeds per plant, the number of seeds per pod, and the thousand seed weight. The performance of one plant was assessed by counting and weighing seeds. Pea was sown in solid rows, with an interrow spacing of 15 cm and a seeding rate of 1.2 million germinable seeds. The yield data were processed by analysis of variance (*Rozhkov A. O., Puzik V. K., Kalenska S. M., et al.,* 2016).

My purpose was to evaluate the garden pea yield depending on the sowing timeframes and application of water-retaining granules in the Right-Bank Forest-Steppe.

Results. I demonstrated that the sowing time and water-retaining granules affected the biometric parameters of pea plants. Across the no-granule experimental variants, the greatest number of leaves and the tallest plants were noted when pea was sown within the second ten days of March. In the budding phase, these parameters increased by 0.8 leaves/plant and 3.0 cm, respectively, compared to the control (Table 1).

In the experiments with water-retaining granules, the parameters increased by 0.7 leaves/plant and 3.9 cm in the 'second ten days of March sowing' variant, respectively, compared to the control. In the control sowing (third ten days of March), they increased by 1.0 leaves/plant and 4.1 cm, respectively, due to water-retaining granules compared to no granule variant.

Similar patterns were observed in the phases of anthesis and seed filling. A clear increase in the number of leaves and plant height was observed depending on the sowing time and application of water-retaining granules. The highest values of the parameters were recorded when pea was sown within the second ten days of March. Without granules, the number of leaves increased by 2.0 leaves/plant and the plant height - by 7.6 cm. With water-retaining granules, sowing within the second ten days of March ensured an increase in these parameters by 2.2 leaves/plant and 7.8 cm, respectively. More active plant growth is attributed to the positive effect of water-retaining granules, in particular, their ability to provide plants with moisture, which is very important.

Table 1. Biometric parameters of pea plants depending on the sowing timeframes and application water-retaining granules, 2020-2022

Sowing timeframe	Developmental phase					
	Budding		Anthesis		Seed filling	
	Leaf number/plant	Plant height, cm	Leaf number/plant	Plant height, cm	Leaf number/plant	Plant height, cm
Without granules						
Second 10 days of March	12.8	49.2	17.3	59.7	19.1	73.9
Third 10 days of March (control)	12.0	46.2	16.8	56.3	17.1	66.3
First 10 days of April	11.7	43.0	16.2	53.1	16.9	63.5
Second 10 days of April	10.6	45.3	14.7	49.3	15.3	55.8
With granules						
Second 10 days of March	13.0	51.3	19.0	62.1	19.9	74.6
Third 10 days of March (control)	12.3	47.4	17.3	58.2	17.7	66.8
First 10 days of April	11.9	43.2	16.5	53.6	17.0	63.8
Second 10 days of April	10.5	45.2	14.9	49.7	15.2	55.6

The lowest values of the biometric parameters of pea plants were recorded in plants sown within the second ten days of April. Suppression of plant growth and development because of late sowing is associated with insufficient amounts of water in the soil. The lengths of the interphase periods were directly influenced by garden pea sowing time, in particular, it was related to different temperature profiles during the specified periods (Table 2).

Table 2. Lengths of the interphase periods in pea plants depending on the sowing timeframes and application of water-retaining granules, days, 2020-2022

Sowing time frame	Interphase period	
	Emergence-anthesis	Growing period
Without granules		
Second 10 days of March	40	51
Third 10 days of March (control)	38	48
First 10 days of April	33	45
Second 10 days of April	29	42
With granules		
Second 10 days of March	42	53
Third 10 days of March (control)	39	49
First 10 days of April	34	45
Second 10 days of April	29	42

Thus, the "emergence - anthesis" interphase period was shorter when pea was sown within the second ten days of April with or without granules (29 days, or by 11 and 13 days shorter, respectively, than in the 'third 10 days of March' sowing variant (control). This period lasted longest when pea was sown within the second ten days of March: without granules, it was 40 days (or by 2 days longer than in the 'third 10 days of March' sowing experiment); with granules, it was 42 days (or by 3 days longer than in the 'third 10 days of March' sowing experiment).

The growing period of garden pea plants lasted 42-53 days in all experiments. The early sowing was associated with longer vegetation and the later pea was sown, the shorter vegetation became. The shortest vegetation was noted when pea was sown within the second ten days of April; regardless of application of granules, it was 42 days (or by 6 and 7 days shorter, respectively, than in the 'third 10 days of March' sowing variant (control). In general, the effect of water-retaining granules on the growing period length was only visible when pea was sown within the second or third ten days of March: granules extended this period.

Parameters of the reproductive organs of plants are important indicators for the yield capacity of garden pea. They changed depending on application of water-retaining granules and sowing time. Comparing no granule variants, I noted the largest numbers of pods and seeds per plant when pea was sown within the second ten days of March: 8.5 pods and 64.5 seeds, respectively, or by 0.5 pods and 7 seeds more, respectively, compared to the 'third 10 days of March' sowing variant (control) (Table 3).

Table 3. Formation of reproductive organs of garden pea depending on the sowing timeframes and application of water-retaining granules, 2020-2022

Sowing timeframe	**Number per plant**		**Seed weight, g**	
	pods	**seeds**	**per plant**	**1000 seeds**
Without granules				
Second 10 days of March	8.5	64.5	11.5	176
Third 10 days of March (control)	8.0	57.5	9.8	169
First 10 days of April	7.8	53.7	8.8	164
Second 10 days of April	7.5	49.5	8.1	161
With granules				
Second 10 days of March березня	9.6	72.5	13.8	184
Third 10 days of March (control)	9.0	62.3	10.7	173
First 10 days of April	7.9	54.1	10.0	167
Second 10 days of April	7.6	49.8	8.4	160

With water-retaining granules, sowing within the second ten days of March increased the numbers of pods and seeds per plant by 6.7 and 16.4%, respectively, compared to the control. It was noted that there were fewer pods and seeds after later sowing.

The seed weight per plant was 8.1 - 13.8 g in all experiments. Water-retaining granules increased the seed weight per plant. In addition, earlier sowing was associated with higher weights of seeds, while late sowing lowered the seed weight. Thus, the greatest weight of seeds was recorded when pea was sown with water-retaining granules within the second ten days of March: 13.8 g or 3.1 g more than in the control.

The largest values of thousand seed weight were recorded when pea was sown within the second ten days of March: 176 g and 184 g without and with water-retaining granules, respectively, or 7 g and 11 g more than in the control. The later pea was sown, the more significant reduction in the thousand seed weight was. The smallest values of this parameter were seen when pea was sown within the second ten days of April: 161 g and 160 g without and with granules, respectively, or 8 g and 13 g less than in the control.

The garden pea yield depended on the sowing time and application of water-retaining granules. The 2020-2022 data showed that the yield was influenced by the studied factors, namely, the sowing time, application of water-retaining granules, and weather. The highest yield of garden pea was harvested in 2022 because there was the most favorable weather then. The least favorable conditions for garden pea growing were in 2020. On average, across the study years, the highest yield was harvested when pea was sown within the second ten days of March: 7.7 t/ha and 8.4 t/ha without and with granules, respectively, or 1.1 t/ha and 1.3 t/ha more than in the control (Table 4). Significance of the differences was statistically confirmed by analysis of variance.

Table 4. Garden pea yield depending on the sowing timeframes and application of water-retaining granules, t/ha, 2020-2022

Sowing timeframe		Yield			Mean	± to the control
		2020	2021	2022		
Without granules						
Second 10 days of March		7.3	7.6	8.3	7.7	+1.1
Third 10 days of March (control)		6.2	6.5	7.1	6.6	0.0
First 10 days of April		5.5	5.8	6.2	5.8	-0.8
Second 10 days of April		5.0	5.3	5.7	5.3	-1.3
With granules						
Second 10 days of March		7.8	8.4	8.9	8.4	+1.3
Third 10 days of March (control)		6.4	6.8	7.5	6.9	0.0
First 10 days of April		5.8	6.3	6.7	6.3	-0.6
Second 10 days of April		5.2	5.4	5.9	5.5	-1.4
$LSD_{0.5\ t/ha}$	A	0.2	0.3	0.4	–	
	B	0.3	0.4	0.5		
	AB	0.5	0.5	0.6		

Later-sown garden pea yielded less compared to early-sown pea. The lowest yield was harvested when pea was sown within the second ten days of April: 5.3 t/ha and 5.5 t/ha without and with granules, respectively, or 1.3 t/ha and 1.4 t/ha less than in the control (sowing within the third ten days of March). The study showed that late-sown plants were not provided with sufficient amounts of water; in addition, less favorable elevated temperatures affected the yield. That is why a significant decrease in the garden pea performance was noted. There was a strong direct correlation between yield and thousand seed weight (r=0.98±0.09). There was also a strong direct correlation between yield and the number of pods per plant (r=0.98±0.10) and a strong direct correlation between yield and weight of seeds per plant (r=0.98±0.11).

Discussion. Today, given the growing need for high-quality foods, it is necessary to constantly improve and adjust agricultural production, in particular vegetable production. According to meteorological observations in recent decades, in particular, in the Forest-Steppe of Ukraine, the average annual temperature has been elevated, the annual precipitation amount has decreased, and summer dry periods have become longer, which are not sufficiently favorable for the growth, development and yields of vegetable plants, including garden pea. Absorbents are used in many countries as an alternative to irrigation or as a supplement to irrigation, or as a method of rational water use.

Superabsorbents can be used as supplements to the soil to improve water retention in sandy soils because they prevent rapid water drainage due to their high capacity to absorb and retain water. Granules are more able to absorb water when irrigation water contains low concentrations of salts (*Masamichi Takahashi, Izumi Kosaka, Seiichi Ohta*, 2023).

According to A.H. Ternavskyi, S.V. Shchetyna, and H.Ya. Slobodianyk, the highest marketable yield of 56.8 t/ha was harvested after black polyethylene film mulching and application of water-retaining granules; without granules, the yield was 54.1 t/ha. The greatest early yield was harvested after film or agrotextile mulching and application of granules: 34.1 t/ha and 32.7 t/ha, respectively. The largest number of fruits per plant was recorded in the experiments with black film mulching and application of granules (26.1; 24.6 fruits were harvested without granules). The highest marketability (99.1%) of cucumbers was achieved under black film and with an absorbent: (*Ternavskyi A.H., Shchetyna S.V., Slobodianyk H.Ya.*, 2019).

Mahrous F. N. and AbdElghany S. H. showed that hydrogel reduced the water consumption by 20% of the total amount of irrigation water in rice fields without a decline in the yield. Every-season application of silica gel was also recommended because it degraded during the inter-season hydration cycle, which reduced its water-retaining capacity (*Mahrous F. N., AbdElghany S. H.*, 2020).

Yang, F.; Cen, R.; Feng, W.; Liu, J.; Qu, Z.; Miao, Q. revealed that superabsorbents elevated the temperature of the soil layer where they were applied, effectively reduced the diurnal fluctuations of the soil surface temperature, and facilitated the stable growth of corn. With various doses of superabsorbents, the surface temperature on corn leaves increased on average by 0.95°C. In particular, at 135 kg/hm^2 of superabsorbents the surface temperature on leaves increased by 1.55°C. Superabsorbents could promote the photosynthetic rate in corn. In addition, plant height, leaf area index, and dry matter accumulation gradually rose in corn with increasing amounts of superabsorbents; superabsorbents not only increased the number of kernel rows per ear and the average weight of 100 kernels but also increased the yield by up to 6% (*Yang F. et al.,* 2020).

In my study, water-retaining granules and sowing time affected the garden pea growth, development, and yield. In particular, when pea was sown within the second ten days of March, the leaf number increased by 2.0 leaves/plant; a combination of this sowing timeframe with granules resulted in an increase in this parameter by 2.2 leaves/plant. Early sowing (the second ten days of March) helped to increase the garden pea yield by 1.1 t/ha and 1.3 t/ha without and with granules, respectively. Hence, given all the cited results, application of water-retaining granules is effective, while it is no less important to sow garden pea within the optimal timeframe.

Conclusions. The garden pea sowing within the second ten days of March contributed to an increase in the number of leaves per plant and plant height; in particular by 2.0 leaves/plant and 7.6 cm, respectively, in the seed filling phase. In the experiments with water-retaining granules, the 'second ten days of March' sowing ensured an increase in these parameters by 2.2 leaves/plant and 7.8 cm, respectively. The 'second ten days of March' sowing extended the growing period by 3 days and 4 days without and with water-retaining granules, respectively, in comparison with the control. Early sowing (the second ten days of March) helped to increase the garden pea yield by 1.1 t/ha and 1.3 t/ha without and with granules, respectively.

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ФОРМУВАННЯ ВРОЖАЮ ГОРОХУ ОВОЧЕВОГО ЗАЛЕЖНО ВІД СТРОКУ СІВБИ ТА ВНЕСЕННЯ ВОДОУТРИМУВАЛЬНИХ ГРАНУЛ В УМОВАХ ЛІСОСТЕПУ ПРАВОБЕРЕЖНОГО

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Анотація. У статті описано дослідження по вивченню впливу різних строків сівби насіння гороху овочевого за стандартної технології та з внесенням водоутримувальних гранул. Доведено, що кращі умови для формування врожаю зеленого горошку забезпечує строк сівби II декада березня. Застосування водоутримувальних гранул в більш повній мірі оптимізує режим вологості і дає можливість отримати більшу врожайність. **Мета**. Метою було вивчення формування врожаю рослин гороху овочевого залежно від строку сівби та водоутримувальних гранул в умовах Лісостепу правобережного. **Методи**. Експериментальні дослідження проводили у 2020–2022 рр. в умовах Лісостепу правобережного. При проведенні експериментальної роботи було використано польовий, статистичний і лабораторний методи. Досліджували строки сівби: II декада березня, III декада березня, I декада квітня, II декада квітня. **Результати.** За результатами проведених досліджень строк сівби II декада березня забезпечувала кращі умови для росту, розвитку та збільшенню врожаю рослин гороху овочевого. Внесення водоутримувальних гранул за строку сівби II декада березня забезпечило отримання врожаю на рівні 8,1 т/га. **Висновки**. Строк сівби гороху овочевого II декада березня сприяв збільшенню кількості листків на рослині та їх висоти, зокрема у фазу наливу зерна на 2,0 шт/рослину та 7,6 см відповідно. На варіанті з внесенням водоутримувальних гранул строк сівби II декада березня забезпечив приріст даних показників на 2,2 шт/рослину та 7,8 см відповідно. Строк сівби II декада березня подовжував вегетаційний період на 3 доби відносно контролю, а за внесення водоутримувальних гранул на 4 доби. Сівба гороху у ранні строки (II декада березня) сприяла збільшенню врожайності зеленого горошку: без гранул на 1,1 т/га, за внесення гранул – 1,3 т/га.

Ключові слова: горох овочевий, біометричні параметри, міжфазні періоди, репродуктивні органи, врожайність.