Effect of Pisum sativum L. seed treatment with the complex of microbiological preparation on the plants’ growth and development under direct sowing

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Abstract. The goal of the research is to study the effect of Pisum sativum L. seeds treatment before sowing with a complex of microbiological preparation, in comparison with a chemical treatment, on the parameters of plants growth, product quality, and yield, against the background of the system of agriculture without soil tillage. The research was conducted in 2016-2018 in the zone of Central Steppe of Crimea. Trial establishment and researches were carried out in accordance with the generally common methods of field experiments in land husbandry and plant growing. In 2016, the symbiosis of Pisum sativum L plants and the microbial community had a significant impact on the number of beans per plant: the control was 7.6 pieces on 1 plant, and under the influence of complex microbial preparation is 8.6 units per 1 plant (LSD₀⁵ – 0.92). The weight of grain from 1 plant was significantly higher by 0.5 g on the variant with inoculation. In 2017 on plant height there is a slight increase in growth by 4.4 cm (LSD₀⁵ – 5.03). The same thing happens with the number of beans of 8.2 and 8.6 units on the same plant that shows at LSD₀⁵ – 1.59, the accuracy increase of this parameter at 0.4 units per plant in the variant with inoculation. Severe weather conditions during the vegetation of Pisum sativum L. in 2018 contributed to the fact that the microbial preparation studied by us practically did not affect the studied indicators of growth and productivity.

1. Introduction

The basis of all life on earth is protein. In parallel with the intensive growth of the population of the planet Earth, the need for high-energy protein foodstuff is also growing [1]. The problem of lack of vegetable protein can be solved by the extension of space and yield under pulse crops [2]. They are composed of several times more protein than in cereals. Legumes also contain a large amount of indispensable amino acids [3].

Among leguminous plants, Pisum sativum L. belongs to one of the first places. In terms of crop acreage in the world, it ranks fifth. In the world, there is an increase in the area occupied by Pisum sativum L., as well as an increase in its yield and grain quality [4-5].
For farmers is *Pisum sativum* L. of interest not only as suppliers of essential foodstuff but also as an indispensable crop rotation culture. *Pisum sativum* L. culture is cold-resistant, early ripe, poor demanding to soils [6]. On its roots, take root nodule nitrogen-fixing microorganisms, thanks to which peas provide themselves with 2/3 of nitrogen from the air and only 1/3 of the soil. Deeply penetrating into the soil taproot system of peas (up to 2 m) with the help of rhizospheric microorganisms and root secretions is able to provide itself not only with nitrogen, but also to convert hard-to-reach phosphates into available soluble forms. Leaving root remains in the soil and stubble residues on its surface, it provides nutrients to following crops, contributing to the stabilization of soil fertility [3, 7-8].

In recent years, more and more farmers pay attention to the system of agriculture of direct seeding (No-till). Direct sowing of seeds in untreated soil, in its essence, is much closer to nature than its long-term multiple processing. The more intensively we cultivate the soil, the more we violate the living conditions of its numerous inhabitants – the soil biota. If we take into account that the living part of the soil is closely intertwined with the inanimate part, it becomes clear that mechanical treatment, its basic agrophysical parameters, including fertility, do not change for the better [9, 10].

It should also be noted that the use of various microbiological preparations can also contribute to the reproduction of our soil fertility [11].

In southern Russia, no academic research work has been carried out to study the effect of seed inoculation of *Pisum sativum* L. on various growth and development parameters on the background of direct sowing. Therefore, the aim of our research was to study the effect of treatment of seeds *Pisum sativum* L. before sowing complex microbiological preparation, in comparison with the chemical treatment on the plant growth parameters, product quality, and yield, against the background of farming systems without tillage.

2. Methodology and research conditions

Experience for investigating the use of complex biological preparation (complex microbial preparation of complex microbiological preparation) was carried out in 2016-2018 at the experimental field of research Institute of agriculture of Crimea, which is located in the village Klepinino, Krasnogvardeisky district (Central plained Crimea) in accordance with the method of B. A. Dospekhova [12].

The soil of the Central plained Crimea is represented by black earth southern mycelial-calcareous, with the presence of humus 2.2-2.3 %. At a depth of 60 meters lie underground water. Mobile phosphates are in a layer of 0-20 centimeters 4.4 mg / 100 g of soil, exchangeable potassium is 39 mg / 100 g of soil, the reaction of soil solution pH 7.5. The agro-climatic conditions of this zone are characterized by unstable and insufficient moisture, with a mean annual rainfall of 428 millimeters and a mean annual air temperature of 12 °C over the past 10 years [13].

The experiments studied the variety of *Pisum sativum* L. Jackpot. The experience is based on three replications, with a plot area of three hundred square meters of plots, with a recorded plot of fifty square meters. Observations and records were carried out by common methods [12, 14].

The experiments studied the use of inoculation complex microbiological preparation (the owner of which is the Research Institute of agriculture of Crimea). On the day of sowing, the seed grain on the variant with the use of the drug was treated with microbial strains by the method of Volkogon V. V. [16]. As a control, the variant with chemical treatment of the seed variant with Vitavax 200 FF, WSC, the norm of 2 liters per ton (active substances of the preparation carboxin 200 g/l + Thiram 200 g/l) was used.

The composition of the studied complex microbiological preparation includes:

1. Microorganisms capable of assimilating nitrogen from the air and after sway death, leave it in the soil. Subsequently, cultivated plants use it for their life activity;
2. Phosphor-mobilizing microorganisms that convert fixed phosphorus in soils into compounds plant-available;
3. The third component is microorganisms that inhibit the growth and development of phytopathogenic bacteria and fungi, that is, work on the principles of chemical treatment.
The quality of the products was determined according to the workshop on agronomical chemistry of Peterburgskiy A.V. [15]. According to Dospekhov B. A. [12], conducted accounting yield.

During the years of the experiments, the weather conditions in the main parameters were ambiguous from optimal (2016) to unfavorable (2018). The amount of precipitation and air temperature per month during the growing season of edible pea are presented in Table 1.

### Table 1. Weather conditions during the experiments with *Pisum sativum* L. (weather station village Klepinino), 2016-2018

| Years         | Precipitation, mm | Amount | Average monthly temperature |
|---------------|-------------------|--------|-----------------------------|
|               | March  | April | May  | June | March | April | May  | June | Medium |
| 2016          | 18.7   | 33.4  | 146  | 209  | 408   | 6.5   | 13.0 | 15.7 | 19.9   | 13.8  |
| 2017          | 22.1   | 39.9  | 23.6 | 20.5 | 106   | 7.0   | 9.3  | 15.7 | 21.4   | 13.4  |
| 2018          | 22.8   | 3.1   | 15.6 | 46.3 | 87.8  | 4.6   | 13.2 | 19.0 | 22.7   | 14.9  |
| Long-time average annual | 31     | 28    | 42   | 59   | 160   | 3.1   | 10.0 | 15.7 | 19.9   | 12.2  |

The main indicators characterizing weather conditions during the years of research are the amount of precipitation in the presowing and growing seasons and the average monthly air temperature. During the period from harvesting the advance crop (doura) to seeding *Pisum sativum* L. precipitation only for 2015-2016, was equal to the long-time average annual rate for the same period and amounted to 168 and 161 mm, respectively. In subsequent years, precipitation at the time of sowing was less than normal by 17.5 mm (2016-2017) and 28.2 mm (2017-2018). The air temperature during this period was close to normal.

The precipitation amount for the growing season of peas in 2016 was 2.5 times higher than the long-time average annual (408 with a long-time average annual value of 160 mm), in the subsequent 2017 precipitation fell by 54 mm less than normal. The temperature regime in the phases of development of *Pisum sativum* L. was close to the optimal parameters and corresponded to its biological requirements.

The most unfavorable turned out to be both presowing and growing seasons in 2018. The precipitation amount for seeding was only 132 mm, and during the growing season of the studied culture, they fell almost 2 times less than normal. During the formation of generative organs, the temperature was above normal and in the daytime reached from 35 to 38 °C. Such weather conditions adversely affected the crop yield, as there was a fall of buds, flowers, and subsequently significantly increased the number of unproductive beans.

### 3. Results of the study

Yield structure analysis is one of the important valuation methods the cultivated plants. The productivity of *Pisum sativum* L. and elements of the structure of its yield, depending on presowing processing of seeds by complex biological preparation, against a system of agriculture of direct sowing are presented in tables by years. The year 2016 was the most favorable not only for *Pisum sativum* L. but also for the microorganisms with which we inoculated the seeds. It is known [16] that optimal environmental factors are important for the active work of microorganisms, that is, in our case, the soil: sufficient moisture, reaction close to neutral, air temperature. All this together led to the fact that the main indicators of the structure of growth and development of *Pisum sativum* L., this year, under the influence of a complex biological preparation, have significantly higher rates in comparison with the control (table 2).

The number of plants in the variant with treated seeds before the harvest of the studied crops was significantly 5 pieces with square meters more in comparison with the control (LSD$_{0.05}$ – 2.48). Plant height was the same and amounted to control of 82.3 cm, in the studied option – 80.7 cm. The symbiosis of *Pisum sativum* L. and the microbial community had a significant influence on the number
of beans per plant: the control was 7.6 pieces on 1 plant, and under the influence of CMP – 8.6 pieces per 1 plant (LSD05 – 0.92). The weight of grain from 1 plant was significantly higher by 0.5 g on the variant with inoculation. The weight of grains in one square meter in the processing of CMP amounted to 639 g and no inoculation 610 g, 29 g significantly less.

Table 2. Influence of inoculation with complex microbiological preparation of seeds *Pisum sativum* L. on growth, development, and structure of the yield, 2016

| Experience variants | Number of plants, pcs / m² | Plant height, cm | Number of beans per 1 plant, pcs | Weight of grain from 1 plant, g. | Grain weight, g / m². |
|---------------------|----------------------------|-----------------|-----------------------------------|----------------------------------|----------------------|
| Control             | 102                        | 80.7            | 7.6                               | 5.8                              | 610                  |
| CMP*                | 107                        | 82.3            | 8.4                               | 6.3                              | 639                  |
| LSD05               | 2.48                       | 9.10            | 0.72                              | 0.38                             | 13.8                 |

* complex microbiological preparation

The research result for 2017 is presented in Table 3.

Table 3. Influence of inoculation with complex microbiological preparation of seeds *Pisum sativum* L. on growth, development, and structure of the yield, 2017

| Variants experience | Number of plants, pcs / m² | Plant height, cm | Number of beans per 1 plant, pcs | Number of grains per 1 plant, pcs | Weight of grain from 1 plant, g. |
|---------------------|----------------------------|-----------------|-----------------------------------|-----------------------------------|----------------------------------|
| Control             | 69                         | 59.3            | 8.2                               | 20.3                              | 5.3                              |
| CMP                 | 68.7                       | 63.7            | 8.6                               | 20.7                              | 5.7                              |
| LSD05               | 3.79                       | 5.03            | 1.59                              | 2.21                              | 0.75                             |

As you can see, seed treatment with a complex microbial preparation did not affect the number of plants per square meter before harvesting *Pisum sativum* L. There was on plant height a slight increase in growth in the processing of CMP 4.4 cm (LSD05 – 5.03). The same thing happens with the number of beans 8.2 and 8.6 pieces on the same plant that shows at LSD05 – 1.59, the accuracy increase of this parameter at 0.4 units per plant in the variant with inoculation. The number of grains per plant and the weight of grain per plant was at the same level. In the variant with the use of CMP, there is a tendency to increase the parameters of the number of grains and weight per plant, compared with the control variant.

Table 4. Influence of inoculation with complex microbiological preparation of seeds *Pisum sativum* L. on growth, development, and structure of the yield, 2018

| Variants experience | Number of plants, pcs / m² | Plant height, cm | Number of beans per 1 plant, pcs | Weight of grain from 1 plant, g. | Grain weight, g / m². |
|---------------------|----------------------------|-----------------|-----------------------------------|----------------------------------|----------------------|
| Control             | 59                         | 34              | 3.2                               | 2.5                              | 145                  |
| CMP                 | 60                         | 36              | 3.3                               | 2.7                              | 143                  |
| LSD05               | 3.11                       | 2.48            | 1.26                              | 0.33                             | 6.2                  |

Severe weather conditions during the vegetation of *Pisum sativum* L. in 2018 contributed to the fact that the microbial preparation studied by us practically did not affect the studied indicators of growth and productivity. The data obtained in 2018 are presented in Table 4.
As a study result, in 2018 it was found that presowing inoculation of seed grain *Pisum sativum* L. had no effect on the studied parameters of growth, development, and structure of the yield. The parameter of the weight of 1000 grains is presented in Table 5.

**Table 5. Influence of inoculation by complex microbiological preparation of seeds *Pisum sativum* L., on the weight of 1000 grains, g.**

| Variants experience | 2016 | 2017 | 2018 | Average for 2016-2018. |
|---------------------|------|------|------|-----------------------|
| Control             | 279  | 263  | 258  | 267                   |
| CMP                 | 290  | 259  | 259  | 269                   |
| Average by variants | 284  | 261  | 258  |                       |
| LSD 0.05            | 7.61 | 5.96 | 2.87 |                       |

In our experiments, the grain size was influenced by both the vegetation conditions in a particular year and the treatment of the seed grain with microbial preparations. The most favorable conditions of vegetation have developed in 2016, which contributed to the formation of the highest weight of 1000 grains on average was 284 g, and the smallest was formed in the high droughty 2018 is 258 g, with a difference of 26 g.

Microbial treatment of seed grain significantly increased the weight of seeds in comparison with control in 2016 to 11 g at LSD 0.05 = 7.61 g. In subsequent years, the mass of 1000 grains was at the same level for the studied variants. On average, for three years, when processing CMP, this parameter is two grams higher.

The protein content of the studied variants in the grain *Pisum sativum* L. is presented in Table 6.

**Table 6. Influence of inoculation by complex microbiological preparation of seeds *Pisum sativum* L., on protein content in grain, %, 2016-2018**

| Variants experience | 2016 | 2017 | 2018 | Average for 2016-2018. |
|---------------------|------|------|------|-----------------------|
| Control             | 22.5 | 22.6 | 24.0 | 23.3                  |
| CMP                 | 24.2 | 21.4 | 24.8 | 23.5                  |
| Average by variants | 23.3 | 22.0 | 24.0 |                       |
| LSD 0.05            | 1.61 | 2.23 | 2.21 |                       |

In 2016, the protein content significantly increased in the variant with inoculation by 1.7 %. In 2017 and 2018, this indicator, in the studied options, was at the same level. If we analyze the impact of the year, we see that in the least favorable 2018, the highest quality grain with 24.0 % protein was obtained.

The yield in the study of the use of inoculum is presented in Table 7.

**Table 7. Influence of inoculation with complex microbiological preparation of seeds *Pisum sativum* L., on yield, t / ha, 2016-2018**

| Variants experience | 2016 | 2017 | 2018 | Average for 2016-2018. |
|---------------------|------|------|------|-----------------------|
| Control             | 6.1  | 3.9  | 1.4  | 3.7                   |
| CMP                 | 6.4  | 3.9  | 1.4  | 3.9                   |
| LSD 0.05 t/ha       | 0.25 | 0.25 | 0.14 |                       |

In 2016, the use processing of seed grains *Pisum sativum* L. contributed to a significant increase in yield by 0.3 t / ha, compared with the variant with a chemical treatment. In 2017 and 2018, this
parameter was at the same level. On average, for 2016-2018 the yield is 0.2 t / ha higher in the inoculated variant. The low yield of Pisum sativum L. in 2018 is due to unfavorable conditions that have developed in the spring period, namely low humidity of air and lack of precipitation.

4. Conclusion

The influence of the complex biological preparation on the studied parameters of growth, development and structural indicators of the yield of Pisum sativum L. had a positive impact in favorable weather conditions in 2016. In little favorable 2018, these indicators were at the same level and under control, and under the action of complex microbiological preparation. Experiments to study the inoculum in the field conditions will be continued, as the work of microbiologists of the Agricultural Research Institute to improve the complex of microbial preparations for the Central plain zone, so that they work effectively regardless of natural and climatic conditions.

References

[1] Sellami M H, Pulvento C and Aria M A 2019 Systematic Review of Field Trials to Synthesize Existing Knowledge and Agronomic Practices on Protein Crops in Europe Agronomy-Basel 6(9) 292 DOI: 10.3390/agronomy9060292

[2] Le Priol L, Dagmey A and Morandat S 2019 Comparative study of plant protein extracts as wall materials for the improvement of the oxidative stability of sunflower oil by microencapsulation Food hydrocolloids 11(95) 105–115 DOI: 10.1016/j.foodhyd.2019.04.026

[3] Parvin S, Uddin S and Tausz-Posch S 2019 Elevated CO2 improves yield and N-2 fixation but not grain N concentration of faba bean (Vicia faba L.) subjected to terminal drought Environmental and Experimental Botany 9(165) 161–173 DOI: 10.1016/j.envexpbot.2019.06.003

[4] Potzsch F, Lux G and Lewandowska S 2019 Sulphur demand, accumulation and fertilization of Pisum sativum L. in pure and mixed stands with Hordeum vulgare L. under field conditions Field Crops Research 6(239) 47–55 DOI: 10.1016/j.fcr.2019.05.005

[5] Sekhon B S, Sharma A and Katoc V 2019 Assessment of genetic diversity in advanced breeding lines derived from intraspecific crosses of garden pea (Pisum sativum L.) Legume Research-An International Journal 2(42) 145–152 DOI: 10.25637/TVAN2018.04.08

[6] Nikolaev E V, Izotov A M and Tarasenko B A 2006 Plant growing of the Crimea (Simferopol: Factor)

[7] ed. E. V. Nikolaev 2004 Scientific justification of the main directions of development of an agroindustrial complex of the Crimea (Simferopol: “Tavria”)

[8] Schneider M, Keiblinger K M and Paumann M 2019 Fungicide application increased copper-bioavailability and impaired nitrogen fixation through reduced root nodule formation on alfalfa Ecotoxicology 6(28) 599–611 DOI: 10.1007/s10646-019-02047-9

[9] Dridiger V K, Godunova E I and Eroshenko E V 2018 Effect of no-till technology on erosion resistance, the population of earthworms and humus content in soil European Journal of Soil Science 2(9) 766–780

[10] Dridiger V K 2016 Practical recommendations for the development of cultivation technology of crops without tillage in the arid zone of the Stavropol Territory (Saratov: Amirit)

[11] Melnichuk T N, Abdurashitov S F, Andronov E E and Brazhnikov I E 2018 Compositional change of the microbiome of southern black earth under the influence of cropping systems and microbial preparations Taurian Journal of Agricultural Science 4 p 76-87 DOI 10.25637/TVAN2018.04.08

[12] Dospekhov B A 2011 Methods of field research (Moscow)

[13] Polovitsky I Ya and Gusev P G 1987 Soils of Crimea and increase of their fertility: Reference edition (Simferopol: Tavria)

[14] Golovachev V I and Kirilovskaya E V eds. 2016 Methods of state variety trial of agricultural crops: The release of the second: cereals, cereals, legumes, corn and forage crops
[15] Petersburgskiy V A 2013 *Workshop on agronomical chemistry* (Moscow)

[16] Volkogon V V, Zaryshnia A S, Grynyk I V and others 2011 *Methodology and practice of using microbial preparations in technologies of crop cultivation* (K.: Agrarian Science)