

## **DROUGHT AND MYCOSES AS A LIMITING BIOPOTENTIAL OF VEGETABLE BEANS (*Phaseolus vulgaris* L.)\***

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### **Abstract**

Field studies of vegetable beans were carried out in small-plot experiments in the climatic conditions and soil of the south of the Chernozem region (Belgorod). Sowing of the "Creolka" variety of vegetable beans and maintenance were carried out manually without the use of fertilizers and pesticides. Used a wide-row sowing method. The area of the accounting plot was 2 m<sup>2</sup> with 2 replicates. To study the symptoms of mycoses in the field, a natural infectious background was used. The prevalence of plant diseases, the intensity and development of the disease were taken into account. Accounting for biological productivity was carried out according to the following indicators: length and weight of one fruit, number and weight of fruits from one plant, number and weight of seeds in one fruit, number and weight of seeds from one plant, weight of 1000 seeds. Determination of taxonomic affiliation was carried out on the basis of a set of cultural and morphological characters isolated in a pure culture of pathogens. A mixed fungal infection (fusariosis and alternariosis) caused by fungi *Fusarium gibbosum* var. *acuminatum* (Ellis and Everh.) Bilai and *Alternaria brassicae* F. *phaseoli* Brunaud was registered on the crops of vegetable beans in the fruiting phase. The prevalence of the disease was 31%, the shortage was 87%, the weight of 1000 seeds in diseased plants decreased by 26%. Vegetative growth kept after the generative organs' formation. till the branching phase's end, the stem growth slowed down, rose with the beginning of bud formation, and stopped with the beginning of flowering. A significant growth of the stem (0.9 cm / day) was noted with the beginning and end of the branching phase. In circumstances of high temperatures and a substantial shortage of precipitation, the beans' growing season was one full month, and the yield was 41.7 c / ha.

**Keywords:** drought, ecology, *Phaseolus vulgaris*, plant resistance, plant diseases, vegetable beans

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## 1. Introduction

Healthy, preventive and curative human nutrition should also include plant proteins (Budovich, 2021; Jalili et al., 2014; Malayer et al., 2019). Crops with a high protein content, “vegetable meats”, are legumes, of which the common beans (*Phaseolus vulgaris* L.) are the most popular worldwide. Bean seeds contain on average: protein – 22.3%, carbohydrates – 54.5%, fat – 1.7%, fiber – 3.9%, ash elements – 3.6%. In addition, beans are rich in vitamins PP and C, contain carotene, vitamins K, B<sub>1</sub> (0.5 mg/100 g), B<sub>2</sub>, B<sub>6</sub> (0.9 mg/100 g), minerals – sodium, potassium, magnesium, calcium, iron, phosphorus, iodine. White beans contain a lot of potassium and phosphorus salts (Erashova et al., 2010; Hamdan et al., 2022; Salih et al., 2022).

Bean fats are composed of unsaturated fatty acids with a predominance of linolenic. In addition, the composition includes lecithin, which makes up 50% of the total fat, choline, methionine, inositol, which are involved in the normalization of lipid metabolism. In terms of energy value, beans surpass beef by more than 2 times, and fish – 7 times. The bean seed protein has all the essential amino acids vital for the human being body, and it combines well with starch, glucose, fructose, sucrose and other seed sugars (Santra and Banerjee, 2020).

Beans began to grow 5000-7000 years ago in Central and South America and South Asia (India, China, and Japan). The ancestor of the cultivated bean is the wild Argentinean species *Ph. aborigineus*. Beans were brought to Europe in the 16th century. Common beans are a polymorphic species consisting of annual, sometimes two- and even perennial vines, climbing or creeping, with thin branching stems, and the branches are intertwined. The main cultivated species *Ph. vulgaris* is a self-pollinator, although there are cases of cross-pollination (in the south). Pollen is carried by bumblebees, sometimes thrips and bees. Seeds and green beans of vegetable varieties are used for food, in which the inner side of the valves is devoid of a parchment layer. But in raw form, beans cannot be used, because they are toxic (Azarian et al., 2019; Bukhari et al., 2022; Mercado-Ruaro et al., 1998).

According to the shape of plants, bean varieties are bushy with a limited (determinant) type of growth (up to 50 cm) or curled tops, semi-curling (up to 2 m) and curly (more than 2 m). The leaves are trifoliate, pointed at the top. The color of flowers, collected in axillary racemose inflorescences, is from white to dark red. Blossoms in June-August; fruits ripen in August-September. The fruit is a straight or slightly curved pod 8-15 cm long with smooth seeds of various colors. The weight of 1000 seeds vary from 150 to 700 grams. Opening of a ripe bean occurs by cracking, which is associated with a special arrangement of mechanical tissue fibers in the walls of the fruit (pericarp). During germination, the seeds carry the cotyledons to the surface of the soil (Santra and Banerjee, 2020).

Vegetable beans are a short-day culture. During an active growing season, beans are demanding for light, as they move to flowering, the demand decreases. Frosts are fatal at all stages of development. The optimum temperature for growth is 20-25 °C. It is noted that the higher the temperature, the greater the rate of development. The average yield of beans is 30 kg / ha. This culture does not grow on acidic soils. Like all legumes, beans are an active nitrogen fixer that contributes to the enrichment of the soil with nitrogen. Bean roots extract phosphorus and potassium from soil minerals ten times more intensively than other vegetable crops, which should be taken into account when compiling crop rotations (Trifonov and Trifonov, 2002). All this testifies to the relevance of studying common beans in the soil and climatic conditions of the south of the Chernozem region (Belgorod) for further breeding improvement of culture

## 2. Material and methods

Field studies were carried out in small-plot experiments on the territory of the Belgorod State University. Sowing of the "Creolka" variety of vegetable beans and care were conducted in a manual manner according to the demands of zonal agricultural technology without the utilization

of pesticides and fertilizers. A wide-row sowing technique was employed, with a seeding rate of nearly 0.3 million/ha. Crop care incorporated post-sowing crust control, inter-row cultivation as the crops grew clogged and after rains. The area of the accounting plot was 2 m<sup>2</sup> with 2 replicates.

To study the symptoms of mycoses in the field, a natural infectious background was used. Determination of plant diseases was carried out using keys Semenov et al. (2003) and Shabgah et al., (2021), and atlas of diseases of agricultural crops by Stanchev (2003). The main elements for recording plant diseases are prevalence (or frequency of occurrence); intensity (or degree of damage); development (or intensity of development of the disease) (Zabihi et al., 2011).

To determine the structure of biological productivity, the following indicators were taken into account: the length and weight of one fruit, the number and weight of fruits from one plant, the number and weight of seeds in one fruit, the number and weight of seeds from one plant, and the weight of 1000 seeds. Quantitative and qualitative analysis of mycobiota was carried out by visual inspection of experimental Petri dishes (on the 3rd-14th day of incubation), followed by microscopy and identification using a Micromed-2 optical microscope with a DCM 310 SCOPE video eyepiece. Determination of taxonomic affiliation by a set of cultural and morphological characters was carried out using keys and mycological atlases (Jalili et al., 2014; Leslie et al., 2006).

### 3. Results and discussion

A mixed fungal infection (fusariosis + alternariosis) in the fruiting phase has been registered on beans crops (Fig. 1). Mushrooms identified *Fusarium gibbosum* var. *acuminatum* (Ellis and Everh.) and *Alternaria brassicae* f. *phaseoli* Brunaud. The mixed mycosis's prevalence was nearly 31%, the development of the disease was 3 points, the index of the development of the disease was 22%, the lack of fruits was 86% and the lack of seeds was 87%. The data on the biological productivity of healthy and diseased (fusariosis + alternariosis) vegetable plants are presented in Table 1.



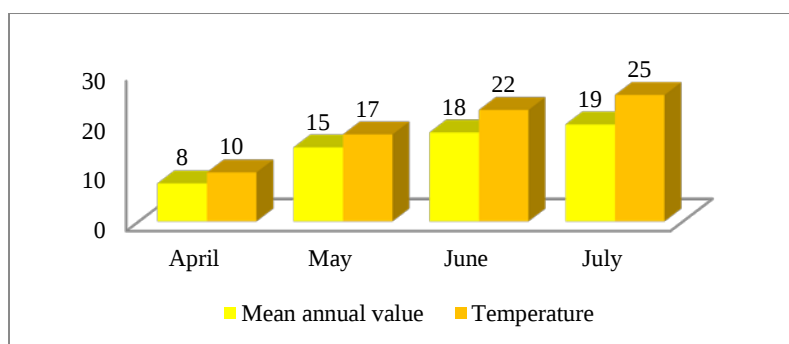
**Fig. 1.** *Phaseolus vulgaris* no signs of mycosis and with signs of mycosis (fusariosis + alternariosis) plants, fruits and seeds (on the left – healthy, on the right – affected by mycosis)

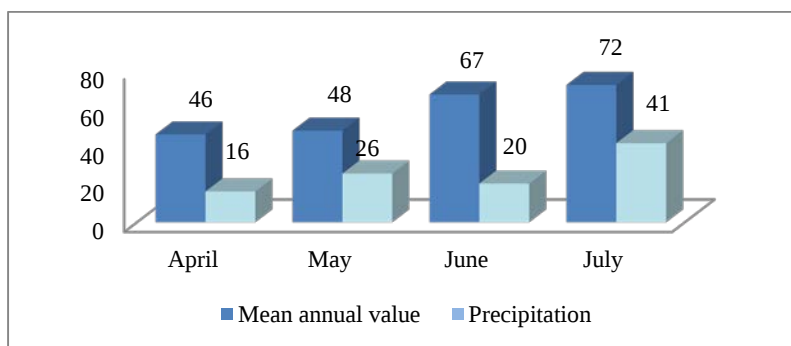
**Table 1.** Average biological productivity of healthy and diseased (fusariosis + alternariosis) plants of *Phaseolus vulgaris* L. (P=0.05)

| Bean growth phases        | Indicators of the structure of productivity | Plants              |                       |
|---------------------------|---------------------------------------------|---------------------|-----------------------|
|                           |                                             | No signs of mycosis | With signs of mycosis |
| Technical ripenes sphase  | Number of fruits per plant, pcs.            | 34.1±6.1            | 11.4±1.1              |
|                           | Fruit weight per plant, g                   | 238.2±4.0           | 38.5±8.9              |
|                           | Length of one fruit, cm                     | 12.3±0.3            | 8.8±0.4               |
|                           | Weight of one fruit, g                      | 5.4±0.4             | 2.7±0.4               |
| Biological ripenes sphase | Number of seeds in one fruit, pcs.          | 5.5±0.3             | 3.3±0.4               |
|                           | Seed weight in one fruit, g                 | 1.6±0.1             | 0.8±0.1               |
|                           | Number of seeds per plant, pcs.             | 78.7±9.0            | 15.8±1.0              |
|                           | Seed weight per plant, g                    | 27.0±2.7            | 4.1±0.3               |
|                           | Weight of 1000 seeds, g                     | 346.0±6.5           | 255.1±10.6            |

In the phase of technical ripeness on diseased bean plants, in comparison with healthy ones, the number and weight of fruits per plant was 67% and 84% lower, respectively. The length and weight of one fruit decreased on average (compared to healthy plants) by 28% and 50%, respectively. In the phase of biological ripeness, the number and weight of seeds in one fruit of a diseased bean plant decreased by 40% and 50%, respectively, compared with healthy ones, and decreased by 80% and 85% from one plant, respectively.

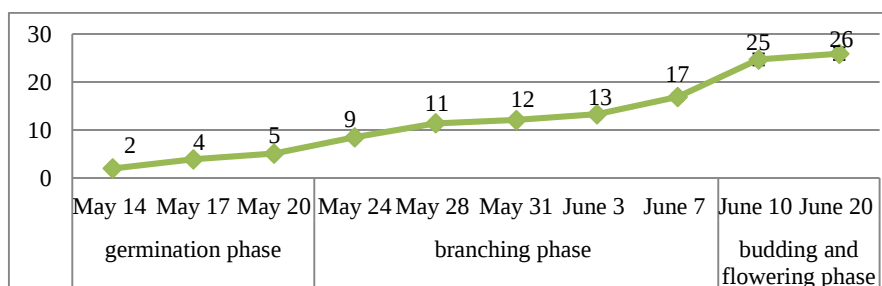
The effective use of the legumes biopotential is essentially confined by undesirable moisture circumstances throughout the growing season. Fluctuations in yields yearly are frequently stemmed from a mismatch between the moisture reserves in the soil and the plants' needs (Kurkina, 2008). We present the data for 2010, which was distinguished by the greatest continentality for the entire ten-year period of field experiments, which was reflected in the excess of the average temperature over long-term values and a significant lack of precipitation (Fig. 2 and Fig. 3). In May, June and July, the amount of precipitation was only 35, 53 and 30% of the average annual values, respectively.

**Fig. 2.** Temperature (°C) during the growing season of *Phaseolus vulgaris*



**Fig. 3.** Amount of precipitation (mm) during the growing season of *Phaseolus vulgaris*

The dynamics of the stem growth in length is reflected in Fig. 4, from which it can be seen that growth of vegetative kept after the generative organs' formation, which is typical for most legumes with indeterminate growth. However the most intense growth was noted in the first month, but by the branching phase's end, growth slowed down and with the bud formation's beginning, vegetative growth increased, and with the beginning of flowering, it stopped.



**Fig. 4.** Average growth of stem of *Phaseolus vulgaris* (P=0.05)

The graph shows, that a significant growth of the stem was noted on May 24 and June 7 (0.85 cm / day) (0.9 cm/day), i.e. with the beginning and end of the branching phase. However on June 7-10, when buds appeared on the plants, the growth of the stem was maximum and amounted to 2.6 cm/day. The growth of the stem stopped with the beginning of the phase of fruit formation, to which nutrients began to flow. The period of formation and ripening of pods is greatly extended, which allows for the season, to collect both ripe seeds and green blades. The growing season of beans in such extreme weather conditions was a full month, the yield was nearly 41.7 c/ha.

#### 4. Conclusion

Thus, in the climatic conditions and soil of the Belgorod region against a natural infectious background, the mixed fungal infection fusariosis + alternariosis became the most common and harmful diseases of beans. A mixed fungal infection caused by fungi *Fusarium gibbosum* var. *acuminatum* Bilai and *Alternaria brassicae* f. *phaseoli* was registered.

The disease prevalence was roughly 31%, the shortage was 87%, the weight of 1000 seeds in diseased plants reduced by approximately 26%. Vegetative continued growing after the generative organs' formation. The high productivity of beans per year with extreme weather conditions with high temperatures and low rainfall indicates that the "Creolca" vegetable beans are

able to widths and drought and make good use of summer precipitation, the growing season of beans was 60 days, and the yield was 42 c/ha.

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