

UDC: 635.652/654: 633/ 635

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EFFECT OF THE SEEDING METHOD AND PLANT DENSITY ON THE DURATION OF INTERPHASE PERIODS AND YIELDS OF COMMON BEAN IN CONDITIONS OF THE RIGHT-BANK FOREST-STEPPE OF UKRAINE

The effect of the seeding method and plant density on the duration of some phonological phases and vegetate on period in general as well as formation of common bean yield capacity in condition of the right-bank Forest-Steppe is examined.

Keywords: *bean common, seeding method, plant density, interphase periods, vegetation period, and yield*

Introduction. Common bean is one of the most important global farming crops grown all over the world under various technologies both industrial ones with maximum application of mechanized operations and those demanding manual labour. The areas under beans in Mexico constitute 1678.5, China – 1.102, the USA - 502.9, Africa - 69.9, Peru - 53.4 [1], India - 885.0, Brazil - 387.0, Kenya and Indonesia - 31.0, Europe - only 21.0 thousand hectares [2, 3]. Ukraine is a traditional region of bean growing. Fertile soils, sufficient moisture, heat, light and rather long frost-free period make it possible to obtain high seed yields of the crop. For this purpose it is necessary to apply appropriate agricultural and technical practices that would ensure optimal plant growth and development based on their morphological and biological characteristics [4, 5,6]. Analysis of the literature sources shows the importance of studying optimal plant density, seeding rates, row width, plant space in a row that is caused by the improvement of cultivation technology. Each plant species, especially a variety, passes phases of ontogenesis differently depending on plant density [7]. For this reason one of the targets of our field trials is to study the duration of vegetation period and some phases of common bean plant development and growth depending on the technological factors.

Furthermore, in conditions of the right-bank Forest-Steppe of Ukraine the effect of the seeding method and plant density on the formation of common bean productivity is still examined insufficiently. Study of the influence of these factors on the individual productivity and formation of seed productivity of bean is an important scientific problem requiring further justification of the technology of crop growing under conditions of the region.

Materials and methods. On the basis of the Department of Breeding and Cultivation of Grain Legume Crops of the Institute of Feeds and Agriculture of Podillia of the NAAS of Ukraine in 2006-2008 there were conducted researches studying the effect and interaction of three factors: A - variety, B –seeding method (wide row with 45 cm row space, and traditional row with 15 cm row space); B –plant density (500, 600, 700, 800 thousand/ha). Ratio of these factors was 2:2:4. Triple replication in the trial was applied. Variants were located systematically in two tiers. Soil of the researched fields was grey forest midloamy in texture with the following parameters of the topsoil, humus content – 2.2-2.4 %, pH (salt) – 5.2-5.4; hydrolysed nitrogen (by Cornfield) – 9.0-11.2, mobile phosphorus (by Chirikov) – 12.1-14.2 and exchange potassium (by Chirikov) – 8.1-11.6 mg per 100 g of soil.

Preceding crop was winter wheat. Preparation and tillage of the soil were traditional for the Forest-Steppe zone of Ukraine. During pre-sowing cultivation mineral fertilizers were applied at the rate of $N_{30}P_{60}K_{60}$. Sowing was conducted in the second decade of May when the soil was well warmed and the threat of spring frosts had passed.

The yield was harvested by combine "Sampo-130" in the phase of full maturity, when the seeds of the lower and middle tiers matured.

Results and discussion. It has been established that the duration of some phenological phases of the vegetation period generally depends on the variety, seeding method and plant density of common bean. In average for the years of researches the duration of the inter-phase period ‘sowing - full maturity’ of Mavka variety was three days longer compared to Nadiia variety (table 1). Thus, in a trial variant, where Mavka variety was sown at plant density of 500 thousand/ha in wide rows with row space of 45 cm, period ‘sowing–shoots’ was 94 days, in Nadia variety - 91 days.

Table 1

Duration of the interphase periods of common bean vegetation depending on the seeding method and plant density, days(average of 2006 – 2008)

| Seeding method | Plant density, thousand/ha | Duration of interphase periods | | | | | | | | Sowing - full maturity | Vegetation period |
|------------------------|----------------------------|--------------------------------|----------------------------|-----------------------------|----------------------------------|---|--|--|--|------------------------|-------------------|
| | | sowing - shoots | shoots - 3d of triple leaf | 3d of triple leaf – budding | budding - beginning of flowering | Beginning of flowering - Formation of green beans | Formation of green beans –seed forming | Grain forming - physiological maturity | Physiological maturity - full maturity | | |
| Mavka variety | | | | | | | | | | | |
| Wide row, 45 cm | 500 | 9 | 14 | 15 | 12 | 4 | 13 | 12 | 14 | 94 | 84 |
| | 600 | 9 | 14 | 15 | 12 | 4 | 13 | 12 | 14 | 94 | 84 |
| | 700 | 9 | 14 | 16 | 12 | 4 | 13 | 12 | 14 | 95 | 85 |
| | 800 | 9 | 14 | 16 | 12 | 4 | 13 | 12 | 14 | 95 | 85 |
| Traditional row, 15 cm | 500 | 9 | 14 | 16 | 12 | 4 | 13 | 12 | 14 | 95 | 85 |
| | 600 | 9 | 14 | 16 | 12 | 4 | 13 | 12 | 14 | 95 | 85 |
| | 700 | 9 | 14 | 17 | 12 | 4 | 13 | 12 | 14 | 96 | 86 |
| | 800 | 9 | 14 | 17 | 12 | 4 | 13 | 12 | 14 | 96 | 86 |
| Nadia variety | | | | | | | | | | | |
| Wide row, 45 cm | 500 | 9 | 14 | 13 | 13 | 4 | 11 | 13 | 13 | 91 | 82 |
| | 600 | 9 | 14 | 13 | 13 | 4 | 11 | 13 | 13 | 91 | 82 |
| | 700 | 9 | 14 | 14 | 13 | 4 | 11 | 13 | 13 | 92 | 83 |
| | 800 | 9 | 14 | 14 | 13 | 4 | 11 | 13 | 13 | 92 | 83 |
| Traditional row, 15 cm | 500 | 9 | 14 | 14 | 13 | 4 | 11 | 13 | 13 | 92 | 83 |
| | 600 | 9 | 14 | 14 | 13 | 4 | 11 | 13 | 13 | 92 | 83 |
| | 700 | 9 | 14 | 15 | 13 | 4 | 11 | 13 | 13 | 93 | 84 |
| | 800 | 9 | 14 | 15 | 13 | 4 | 11 | 13 | 13 | 93 | 84 |

As result of studies it has been established that the increase of plant density of beans under wide row or traditional row seeding method resulted in longer vegetation periods. Thus, vegetation period of Mavka variety was two days longer compared to Nadia variety. When wide row seeding method was applied and plant density was 500 thousand/ha, this index of Mavka variety was 84 days, Nadia variety - 82 days.

Efficacy of application of certain elements of the growing technology is ultimately assessed by their influence on the crop yield.

Spatial and quantitative distribution of plants on the site is one of the most important elements that significantly increases the yield of bean grain that is due to the seeding method and plant density.

As a result of conducted researches there has been established a positive effect of optimization of the seeding method and plant density on the yield of common bean grain. Assessment of grain yield indices enables to establish the most optimal combination of the elements of the technology of common bean growing. In 2006 the high stymied of bean grain of 2.79 t/ha was obtained in the trial variant when plant density was 600 thousand/ha and row width was 45 cm (table 2). Growth of plant density up to 700 and 800 thousand/ha resulted in yield reduction by 0.09 and 0.19 t/ha respectively.

Table 2

Yield of common bean seed depending on the seeding methods and plant density, t/ha (average of 2006 – 2008)

| Seeding method | Plant density thousand / ha | Years | | | | ± before control |
|------------------------|-----------------------------|-------|------|------|-------------|------------------|
| | | 2006 | 2007 | 2008 | 2006 - 2008 | |
| Mavka variety | | | | | | |
| Wide row, 45 cm | 500 | 2,72 | 2,10 | 3,62 | 2,81 | 0,33 |
| | 600 | 2,79 | 2,16 | 3,73 | 2,89 | 0,41 |
| | 700 | 2,70 | 2,09 | 3,59 | 2,79 | 0,31 |
| | 800 | 2,60 | 2,06 | 3,39 | 2,68 | 0,20 |
| Traditional row, 15 cm | 500 | 2,41 | 1,87 | 3,19 | 2,49 | 0,01 |
| | 600 | 2,48 | 1,90 | 3,21 | 2,53 | 0,05 |
| | 700 | 2,40 | 1,85 | 2,97 | 2,41 | -0,07 |
| | 800 | 2,30 | 1,83 | 2,63 | 2,25 | -0,23 |
| Nadia variety | | | | | | |
| Wide row, 45 cm | 500 | 2,37 | 1,86 | 3,21 | 2,48 | - |
| | 600 | 2,45 | 1,92 | 3,24 | 2,54 | 0,06 |
| | 700 | 2,35 | 1,74 | 3,05 | 2,38 | -0,10 |
| | 800 | 2,21 | 1,71 | 2,73 | 2,22 | -0,26 |
| Traditional row, 15 cm | 500 | 2,06 | 1,62 | 2,89 | 2,19 | -0,29 |
| | 600 | 2,15 | 1,67 | 2,92 | 2,25 | -0,23 |
| | 700 | 2,05 | 1,60 | 2,76 | 2,14 | -0,34 |
| | 800 | 1,9 | 1,49 | 2,26 | 1,88 | -0,60 |

Note: A – variety; B – seeding method; C – plant density,

HIP_{0,05}t/ha 2006 A=0,013; B=0,013; C=0,018; AB=0,018; AC=0,026; BC=0,026; ABC=0,037,
 2007 A=0,014; B=0,014; C=0,020; AB=0,020; AC=0,029; BC=0,029; ABC=0,041,
 2008 A=0,024; B=0,024; C=0,035; AB=0,035; AC=0,049; BC=0,049; ABC=0,069,
 2006-2008 A=0,010; B=0,010; C=0,014; AB=0,014; AC=0,020; BC=0,020; ABC=0,028

A similar tendency was observed on the sites where bean of Mavka variety was sown traditionally in rows with 15 cm row space. When plant density was 600 thousand plants/ha the yield was 2.48 t/ha; reduction or increase of this index was caused by the lower productivity of the crop. In trial variants, where plant density was 500 thousand plants per hectare the yield was 0.07 t/ha lower. The increase of plant density to 700 and 800 thousand/ha provides reduction of this index by 0.08 and 0.18 t/ha respectively.

The highest yield of Nadia variety amounted 2.45 t/ha when plant density was 600 thousand/ha and row space was 45 m. Increase of plant density up to 800 thousand plants/ha resulted in yield reduction to 2.21 t/ha. On the sites, where traditional seeding method was applied, the highest yield of 2.15 t/ha was obtained when plant density was 600 thousand plants/ha.

In 2007 the yield of 1.71 – 2.16 t/ha was the lowest compared to the other years studied. Significant influence on yield reduction was made by the lack of rains and high temperatures during critical periods of vegetation of common bean plants, especially in the budding and flowering phases, resulting in abortion of flowers, ovaries and fruits. The highest yield of 2.16 t/ha was obtained in Mavka variety when plant density was 600 thousand/ha and row space was 45 cm. Increase of plant density to 700 and 800 thousand/ha resulted in reduction of the yield by 0.07 and 0.10 t/ha respectively. In areas with row seeding the yield of 1.90 t/ha was recorded when plant density was 600 thousand/ha.

Nadia variety provided the yield of 1.92 t/ha when wide row seeding method was applied and plant density was 600 thousand/ha. When traditional row seeding was applied the yield was 1.49-1.67 t/ha.

In 2008 hydrothermal conditions, compared to previous years, were the most favourable for the growth and development to common bean plants. During vegetation period 361.6 mm of rain fell and the average temperature was 16.8 °C. This resulted in the highest yield of 2.26 - 3.73 t/ha for all years of study.

Sowing of beans of Mavka variety in wide rows with plant density of 600 thousand/ha provided maximum yield of bean grain 3.73 t/ha, that exceeded sowing in traditional rows with 15 cm row space by 0.52 t/ha or 13.9%.

A similar tendency was observed when row seeding with 15 cm row space was applied, but values of the yield were lower. The highest yield of Nadia variety 2.19 t/ha was obtained when plant density was 600 thousand/ha and row space was 45 cm.

Conclusions. Thus, when plant density was increased, both in wide row and traditional row seeding methods, both varieties had prolongation of the vegetation period for one-two days.

In condition of the right-bank Forest-Steppe, common bean gives high and stable grain yield only under favourable weather conditions, optimum plant density and wide row seeding method. Maximum grain yield of beans 2.48 t/ha was recorded in Mavka variety grown in wide rows with row space of 45 cm and plant density of 600 thousand/ha. The increase of plant density up to 800 thousand/ha reduced the yield to 2.33 t/ha.

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Анотація

Мовчан К.І.

Вплив способу сівби та густоти рослин на тривалість міжфазних періодів і урожайність квасолі звичайної в умовах правобережного Лісостепу України

У статті відображені результати досліджень щодо вивчення впливу способів посіву та густоти рослин на тривалість проходження окремих фенологічних фаз і вегетаційного періоду в цілому, а також на формування величини врожайності зерна квасолі звичайної в умовах правобережного Лісостепу України.

Ключові слова: квасоля звичайна, спосіб посіву, густина рослин, міжфазні періоди, вегетаційний період, врожайність

Аннотация

Мовчан К. И.

Влияние способа посева и густоты растений на продолжительность межфазных периодов и на урожайность растений фасоли обыкновенной в условиях правобережной Лесостепи Украины

В статье отражены результаты исследований по изучению влияния способов посева и густоты растений на продолжительность прохождения отдельных фенологических фаз и вегетационного периода в целом, а также на формирование величины урожайности зерна фасоли обыкновенной в условиях правобережной Лесостепи Украины.

Ключевые слова: фасоль обыкновенная, способ посева, густота растений, межфазные периоды, вегетационный период, урожайность