INFLUENCE OF PLANTING DENSITY ON PRODUCTIVITY OF SOYBEAN VARIETIES OF DIFFERENT MATURITY GROUPS IN THE NORTHERN STEPPE ZONE OF THE MYKOLAIV REGION

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Summary. The article is devoted to the study of the peculiarities of productivity formation of soybean varieties of different maturity groups (Annushka - ultra early; Mavka - early ripening; Smuglyanka - mid-ripening), when grown in the Northern Steppe of Mykolaiv region at different planting density (400, 500, 600 and 700 thousand plants per hectare of crop). According to the results of our research, on average for 2020-2021, we found that the biometric parameters of the plants of the studied soybean varieties ranged from 80.8 to 116.1 cm and had an average height of 93.8 cm. The maximum height (104.9 - 116.1 cm) was observed in plants of Smuglyanka variety, and it was found that the highest index was obtained when applying the maximum value of planting density of 700 thousand units/ha. A similar situation was observed for the height of the lower bean on the plant, but it is more due to the biological characteristics of the variety. The thickening of soybean crops affected the reduction of all indicators of the elements of the yield structure. The highest yield of the studied soybean varieties of different maturity groups (2.95 t/ha) was obtained in the variant where the Smuglyanka variety was sown at a plant density of 500 thousand plants per hectare.

Keywords: soybean, varieties, plant density, plant height, lower bean attachment height, elements of yield structure, yield.
Soybeans, the world’s leading high-protein crop, are one of the most common legumes and oilseeds, and play a crucial role in agriculture, the technical industry, and medicine. It is a valuable energy crop, which is of particular importance for the formation of the domestic market of high-protein feed balanced in nutrients and amino acids [1, 2].

At the current stage of development of the agro-industrial complex of Ukraine, soybeans, as a valuable protein and oilseed crop with a wide range of uses in feed production, for food, technical purposes and in medicine, are now gaining exceptional importance [3, 4]. Therefore, it is an urgent problem to increase its production. Stable production of soybean grain can be achieved by increasing the productivity of this crop through further improvement and implementation of elements of adaptive cultivation technologies to fully utilize the potential of intensive varieties. The issue of scientific substantiation of soybean cultivation technologies is currently a relevant and promising area for solving this problem. Expansion of soybean planting areas will change the structure of crops in the crop rotation, solve the problem of good predecessors, improve the nitrogen balance in the soil and increase its fertility [5-11].

A number of measures aimed at realizing the genetic potential of high-yielding intensive soybean varieties include, first of all, the efficient use of the bioclimatic potential of the growing region, and the optimal varietal distribution of soybean production in Ukraine, taking into account hydrothermal resources. Along with this, the introduction of efficient competitive, high energy return, adapted to the environment soybean growing technologies based on the selection of intensive varieties with an appropriate degree of realization of the genetic potential, scientifically based placement in crop rotation, and creation of crops with a rational optical and biological structure, a scientific approach to determining the timing of sowing, systematic tillage, a rational, optimized system of mineral and bacterial nutrition, taking into account the nutrient requirements of plants by stages of organogenesis, as well as effective methods of weed, pest and disease control, will ensure high and sustainable crop yields. This will be an important reserve for the successful development of livestock, increasing soil fertility, strengthening the economy, etc. [12, 13].

Obtaining high yields of field crops involves the formation of crops of optimal density, with plants that are maximally developed and evenly distributed over the feeding area. Such a task can be solved if high rates of field germination, friendly emergence of seedlings and plant survival throughout the growing season are achieved [14, 15, 16].

That is why the productivity of crop plants depending on the density of crops using soybeans of different varietal composition became our task for conducting scientific research in the Northern Steppe of Mykolaiv region.

Agrotechnics of crop cultivation in the experiment was generally accepted for the Northern Steppe zone of Ukraine, except for the agrotechnical methods that were studied. Field and laboratory experiments were carried out during 2020-2021 according to the generally accepted field experiment methodology in crop production [17, 18, 19], accompanied by observations, definitions, records and analyzes.
The soybean fertilization system included pre-sowing fertilization. Pre-sowing fertilization for pre-sowing cultivation was the application of mineral fertilizers (nitroammophoska 16:16:16) at a dose of N32P32K32 [11, 16].

Soybeans were planted after the stubble predecessor, winter wheat. After harvesting the predecessor, in the 2nd decade of July, stubble was peeled, in the 2nd decade of September, plowing was carried out to a depth of 22-24 cm. In the spring, when the soil was physically ripe, the moisture was closed. Prior to sowing soybeans, it was possible to carry out two cultivations, as weeds grew back. Pre-sowing cultivation of the experimental plots was carried out in 1-2 decades of May: cultivation to a depth of 10-12 cm, with harrowing to a depth of 6-8 cm.

The soybean varieties were sown in the first and second decade of May according to the years of research. Before sowing, the seed was treated with rhizotorphin. The seeding rate for each variant was applied according to the experimental scheme.

The experimental design included the following variants: Factor A (soybean varieties): Annushka (ultra-early), Mavka (early maturing), Smuglyanka (mid-season); Factor B (Planting density, thousand units/ha): 400, 500, 600 i 700.

Experimental studies were conducted according to the methods of field experiment and the methods of the State Variety Testing of Crops [17, 19].

The analysis of the elements of the crop structure was carried out according to the methodology of the State Variety Testing of Crops. Harvesting was carried out manually with separate weighing and conversion to 14% moisture content and 100% seed purity. The experiment was repeated three times. The sown area of the elementary plot was 50.0, the accounting area was 25.0 m2 [18].

The research results obtained on the basis of field observations and analysis of the crop structure were processed using statistical methods: analysis of variance [17,20]. Calculations were performed using the applied computer programs "MS Excel" and "STATISTICA 10.0".

The results of the research characterize the norm of reaction of individual plants to changes in the indicators of the feeding area under the conditions of a specific soil and climatic zone. One of the most effective methods of optimizing soybean crops to obtain their consistently maximum productivity in a given region is the selection of seeding density, which results in the formation of the optimal plant nutrition area.

The height of soybean plants was determined in the phase of seed filling. The studies showed that the height of soybean plants of the studied varieties Annushka, Mavka and Smuglyanka of different maturity groups significantly depended on the plant density.

According to the results of the research, it was found that on average, the plants of soybean varieties had a height of 93.8 cm, but the data of plant height in individual varieties differed from the average value. Thus, the height of soybean plants of the Annushka variety of the ultra-early group, on average, ranged from 80.8-91.6 cm (dynamics was 10.8 cm) over two years (dynamics was 11.1 cm), the Mavka variety of the early group - 81.3-92.4 cm (dynamics was 11.1 cm), and the largest among the studied soybean varieties was the Smuglyanka variety of the mid-season group - 104.9-116.1 cm (dynamics was 11.2 cm).
It was found that the height of plants depends more on the biological characteristics of the studied soybean varieties and the conditions of the growing season than on the density of plants. It was found that the highest value of the studied varieties in terms of plant height was observed when using the maximum plant density of 700 thousand units/ha, respectively - Annushka 91.6 cm, Mavka - 92.4 cm and Smuglyanka - 116.1 cm.

The height of the lower bean attachment is a rather important feature that determines the possibility of harvesting soybean crops by mechanical means.

Despite the fact that the suitability for mechanized harvesting is a complex trait that consists primarily of plant resistance to lodging, the height of the lower tier of beans, the resistance of beans to cracking after maturation and seed spillage, one of the main factors that can be influenced by agrotechnical or agroclimatic factors is still the height of Smuglyanka - 116.1 cm. A similar situation was observed for the height of the lower bean on the plant, but here the biological feature of the variety plays an important role, which can differ radically in this indicator.

In contrast to the height of soybean plants, the placement of the lower bean varied and was maximum not in the Smuglyanka variety (14.3 cm), but in the Mavka variety (15.6 cm), which is due to the biology of the crop. The lowest placement of the lower bean (12.7 cm) was observed in the variety Annushka, and the average value in the experiment was 14.2 cm.

Higher placement of the lower bean was formed at a higher plant density. Thus, in the variety Annushka, with thickening from 400 thousand units/ha to 700 thousand units/ha of plants, this indicator increased by 2.5 cm, in the varieties Mavka and Smuglyanka by 3.5 and 3.3 cm, respectively. The maximum placement of the lower beans in the experiment (17.2 cm) was observed when sowing soybean variety Mavka with a planting density of 700 thousand plants/ha.

Thus, the height of soybean plants and the attachment of the lower bean increased with increasing plant density, which is explained by the increased competition of soybean plants for life factors. With the increase of plant illumination in the lower and middle tiers, it improved, which contributed to the formation of a better bush (branching) in the studied soybean varieties.

The level of plant productivity is largely determined by changes in the feeding area and methods of placing them in the crop. In this regard, the study of the effect of the size and shape of the feeding area on the competitive relationships of plants in the agrobiocenosis and the individual productivity of soybean varieties is an important scientific problem.

Plant density is closely related to the formation of productivity elements. With the thickening of soybean crops, a decrease in all indicators of the elements of the yield structure was observed. The most significant decrease in plant productivity occurred at the maximum plant density in our experiments (700 thousand units/ha).

On average, over the years, soybean plants in the experimental variants formed 22.81 beans, while the Annushka variety formed 22.42 beans (from 18.78 to 26.70 beans), Mavka - 20.00 beans (from 15.26 to 25.43 beans), and the Smuglyanka variety - 26.00 beans (from 18.59 to 33.74 beans). Consequently, in the main patterns of formation of the number of beans per plant, the studied varieties were significantly different. This is not surprising, since they all belong to different maturity
groups. The highest value of the number of beans per plant was observed for the minimum planting density of 400 thousand units/ha: Annushka - 26.70, Mavka - 25.43, and Smuglyanka - 33.74.

In the crops of Annushka variety, soybean plants formed the maximum weight of seeds per plant under the condition of sowing with a density of 400 thousand pcs/ha - 5.025 g, Mavka variety - 6.075 g and Smuglyanka variety - 7.100 g at the same density.

Based on the research, it was found that the weight of 1000 seeds depends on the biological characteristics of the studied varieties more than on the factors of agricultural technology presented in the experiment. The main differences between the averaged data between crops with different planting densities were at the level of 0.5-4.2 g.

The largest seeds in the studied soybean varieties were observed in the Mavka variety. Thus, on average, this figure was 178.6 g, varying from 177.2 to 179.6 g, depending on the density of crops. For the variety Annushka, the weight of 1000 seeds was 133.3 g, varying from 130.6 to 134.8 g (for this variety it was the lowest in the experiment), and for the variety Smuglyanka - 162.6 g, respectively, with a difference from 160.2 to 164.4 g.

The final and main indicator of crop plant productivity is yield, which depends on many parameters. These parameters constitute the aggregate interaction of agrotechnical measures of crop cultivation technology and environmental characteristics, such as air temperature, moisture supply, soil nutrient regime, etc.

According to the results of the research, it was found that the average biological yield of soybeans was 2.43 t/ha, in the Annushka variety this figure was 2.14 t/ha (from 2.01 to 2.21 t/ha), in the Mavka variety - 2.41 t/ha (from 2.29 to 3.54 t/ha), and in the Smuglyanka variety - 2.74 t/ha (from 2.46 to 2.95 t/ha). During the two years of research, it was found that planting density significantly affected the yield of soybean seeds. The highest seed yield of soybean variety Annushka was obtained in the variant with a planting density of 600 thousand units/ha - 2.21 t/ha, Mavka variety at a density of 500 thousand units/ha - 2.54 t/ha and Smuglyanka variety also at a density of 500 thousand units/ha - 2.95 t/ha.

Regarding the breakdown of research years, it should be noted that in the more favorable year 2020, soybean varieties had better yields (2.36 - 3.28 t/ha) compared to 2021 (1.66 - 2.62 t/ha), which is due to dry conditions during the growing season in 2021.

Thus, as a result of the research, an increase in planting density, especially of the mid-season soybean variety Smuglyanka from the optimal value, causes a decrease in grain yield compared to low planting density. A similar pattern can be observed in the Mavka variety. The variety Annushka is more responsive to an increase in planting density due to the lower degree of lodging of the variety's plants.

References:


