Peculiarities of Chickpea Growing Technology in the Steppe Zone of Ukraine

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Abstract. Chickpea is a valuable food crop. Among legumes, chickpea (Cicer arietinum) occupies a leading position in both quality and quantity of protein, which makes it a valuable food source. Its grain is widely used in human nutrition, especially in countries such as Turkey, Israel and other Middle Eastern countries. Research on chickpea breeding, seed production and cultivation technologies was carried out at the Odessa State Agricultural Research Station of the Institute of Climate-Oriented Agriculture of the National Academy of Agrarian Sciences of Ukraine from 2019 to 2022. These years provide grounds for highlighting a number of pressing issues in the modern vision of crop development. Growing demand and market prices have necessitated an increase in the cultivation area and promotion of chickpeas in the southern regions of Ukraine. Odessa region is a leader in expanding chickpea cultivation in the south of Ukraine. Several well-known farms, such as OOO AgroSvit (Belgorod-Dnestrovsky district, Petrovpavlovka village), KFH Svetlana (Bolgrad district) and others have been steadily growing chickpeas on areas of 400 to 500 hectares for the past ten years, receiving an average of 2.0–2.2 tons per hectare.

Keywords: chickpea, protein, productivity, crop structure, phenological observations.

1 Introduction

In recent years, leguminous crops such as winter peas, chickpeas, and lentils have become widely adopted in agricultural production practices, which is important for improving the structure of sown areas of agricultural crops, enhancing soil fertility, and addressing the issue of food protein.

Chickpeas (Cicer arietinum L.) hold a leading position among leguminous crops. More than 40 species of chickpeas exist in nature. In terms of nutritional value and vitamin content,

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chickpeas are comparable to other legumes; a distinctive feature of chickpea protein is its high nutritional value.

Chickpea grain contains 20-30% protein, 4-7% fat, 50-60% carbohydrates, 2-5% minerals, and vitamins A, B1, B2, B3, C, B6, PP, and essential amino acids. The vitamin C content in chickpea seeds ranges from 2.2 to 20 mg/100 g. Chickpea protein is easily digestible, and its amino acid composition is similar to that of animal protein [1-3].

Significant climate changes, such as a continuous rise in temperatures, lead to negative consequences like soil and air droughts, which negatively impact the cultivation of traditional agricultural crops. In the search for optimal solutions in the context of agribusiness, agricultural producers are turning to legumes such as peas, chickpeas, and lentils.

Incorporating these crops into crop rotations improves the structure of sown areas for agricultural crops and their ability to fix atmospheric nitrogen from the air through nitrogen-fixing bacteria. The soil can accumulate up to 100-120 kg/ha of nitrogen in active form, which is especially relevant today due to the sharp increase in prices for mineral fertilizers. Farmers are paying particular attention to chickpeas, which are considered one of the best predecessors for key grain crops like winter wheat, winter rapeseed, and others.

India leads global chickpea production, accounting for 30 to 55%, with a sown area of over 7 million hectares. Other major producers include Turkey, Pakistan, and Mexico [4, 5].

In Ukraine, the area under chickpea cultivation has significantly increased over the past 8 years, from 7.1 thousand hectares in 2016 to nearly 20.0 thousand hectares in 2024. Total niche crop production amounts to almost 500 thousand tons, and chickpea production has increased by 7.5 times during this period, with 80-85% of this production concentrated in the steppe regions of Ukraine. While chickpeas account for a relatively small share of total legume production (6-12%), this figure is trending upwards [6-8].

Fig. 1. Comparison of chickpea varieties at the experimental plot, 2024.

Odesa region leads chickpea expansion in southern Ukraine. The total area of chickpea cultivation in the region has grown from 1.5 to 3 thousand hectares, indicating positive growth dynamics. Demand, supply, and pricing are key factors driving the expansion of chickpea cultivation. Leading chickpea-growing farms with the most notable results include AgroSvit L.T.D. (Bilhorod-Dnistrovskyi district, Petropavlivka village), Svetlana Farm (Bolhrad district, Slobidka village), and Michurina LLC (Podilsk district, Pysarivka village), which have consistently cultivated chickpeas on 400-500 hectares with an average yield of 2-2.2 tons/ha in recent years.

These farms are implementing both domestic and global advances in chickpea and lentil cultivation. This year, at the experimental field of the Odesa State Agricultural Research Station of the Institute of Climate-Oriented Agriculture of the National Academy of Agrarian Sciences of Ukraine, seven varieties of chickpeas were tested: Zukhal, Zechovit, Goksu, Aras, Budzhak, Triumph, and Nortenia (Fig. 1).

2 Methods and results

The task of the research includes:

- Comparative evaluation of the productivity and economically valuable traits of chickpea varieties developed by other breeding centers with the aim of selecting the best ones for production.
- Development of technology elements.

Chickpea varieties were sown over a total area of 0.18 ha, with the recorded plot for each variety being 30 m², and each variety was replicated seven times. The sowing method was continuous, with a row spacing of 15 cm and a seeding rate of 300,000 viable seeds per hectare.

The soil was low-humus heavy loam southern black soil, with the arable layer containing 3.02% humus, 105.5 mg/kg of mobile phosphorus, and 165.2 mg/kg of available potassium.

During the growing season, the amount of precipitation was 27% below the average, while temperatures were 15% higher than usual.

The chickpea yield is shown in Table 1. The highest grain yield was obtained from the Goksu variety (2.64 t/ha), which exceeded the yield of the Triumph variety, used as the standard, by 38.2%.

Table 1. Comparative characteristics of chickpea varieties.

Variety	Yield, t/ha	± compared to the Triumph variety		V,%
	n=7	t/ha	%	
Triumph (standart)	1.91	-	-	2.3
Budzhak	2.38	0.47	24.6	2.7
Aras	2.24	0.33	17.3	4.4
Goksu	2.64	0.73	38.2	2.1
Zechavit	1.62	-0.29	-15.2	3.7
Zukhal	1.72	-0.19	-9.9	3.6
Nortenia	1.64	-0.27	-14.1	4.5
$LSD_{0,95}$	0.08	-	4.2	-

In terms of yield, the chickpea varieties are ranked in the following descending order: Goksu > Budzhak > Aras > Triumph > Zukhal > Nortenia > Zechavit. The coefficient of yield variability (V, %) did not exceed the 5% error margin, ranging from 2.1% to 4.5%.

The plant height of all chickpea varieties ranged from 43.4 to 45.7 cm, and there was no significant difference between the varieties in this parameter, as well as in the degree of branching. However, it should be noted that the branching ability of the Zechavit variety significantly exceeded that of Zukhal (Table 2).

Table 2. Yield structure of chickpea varieties.

Variety	Plant height, cm	Per 1 plant				Weight of 1000 seeds
		number of branches	number of pods	number of seeds	weight of seeds	
		quantity			grams	
Triumph	45.7±5.4	3.0±0.9	36.1±13.9	37.3±15.0	14.90±4.78	413.0±56.7
Budzhak	43.1±4.0	3.0±1.1	26.4±11.7	27.1±10.5	11.14±6.81	422.4±39.3
Aras	43.4±4.7	3.1±0.8	20.8±8.3	21.4±9.0	9.56 ±3.02	482.7±86.7
Goksu	45.9±4.9	2.6±1.0	25.2±12.0	29.5±14.4	12.14±5.38	464.2±48.8
Zechavit	45.0±6.6	3.1±1.7	31.9±15.8	32.3±19.9	16.67±9.4	420.0±27.2
Zukhal	45.2±5.9	2.5±0.9	28.9±15.8	33.1±17.9	15.29±7.96	468.0±55.8
Nortenia	44.2±4.3	3.0±0.9	28.4±14.9	30.2±16.2	13.49±6.67	459.4±63.7
$LSD_{0,95}$	3.2	0.6	8.3	9.3	3.65	31.6

The plants of the Budzhak, Aras, and Goksu varieties produced a significantly lower number of pods compared to Triumph, with the difference being 15.3-9.7 pods ($LSD_{0.95}$ = 8.3). At the same time, the ratio between the number of seeds and pods in the Goksu and Zukhal varieties was the best (1.20-1.15), while in other varieties, it did not exceed 1.01-1.06.

In terms of grain yield per plant, the Zechavit and Zukhal varieties stood out, with 16.67 and 15.29 grams, respectively, whereas the individual productivity of Budzhak and Aras plants was significantly lower (11.14 and 9.56 g). The maximum weight of 100 seeds (482.7 g) was recorded in the Aras variety, while the minimum was in the Triumph variety (413.0 g).

There was significant variability in such indicators as the number of pods (38.4-54.6%) and grain weight per plant (31.6-52.1%), while the variability in the weight of 1000 seeds (10.5-18%) and plant height (9.8-11.8%) was much lower (Fig. 2).

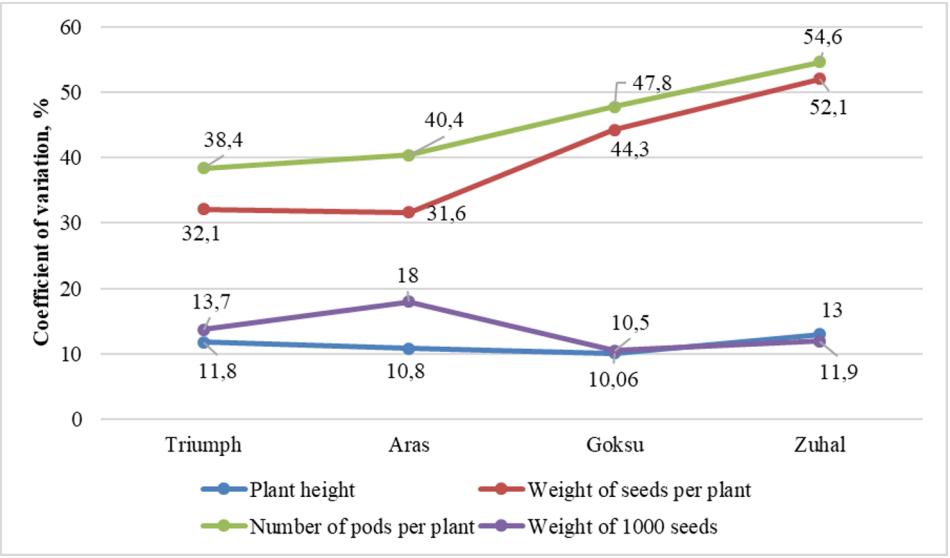

Fig. 2. Variability of yield structure indicators of chickpea varieties.

Correlation analysis of yield structure indicators revealed a strong positive relationship between the number of pods, seeds formed, and the individual productivity of plants, with correlation coefficients of 0.96 and 0.86, respectively (Table 3). On the other hand, the more pods and seeds produced, and the higher the grain yield per plant, the lower the weight of 1000 seeds, with r = - (0.62-0.93).

Table 3. Pairwise correlation coefficients.

Indicators	Correlation coefficient
Plant height - number of stems	-0.63
Number of pods - number of seeds	0.96
Number of pods - weight of seeds per plant	0.86
Number of pods - weight of 1000 seeds	-0.93
Number of seeds - weight of 1000 seeds	-0.83
Weight of seeds per plant - weight of 1000 seeds	-0.62

Alongside phenological observations on plant growth and development, work was conducted on the elements of chickpea cultivation technology, including sowing times, seeding rates, and agrochemical and mechanical methods for controlling pests, diseases, and weeds. Our research showed that the best sowing period is after the early grain crops, from the third decade of March to the first decade of April, with an optimal seeding rate of 300,000 viable seeds per hectare. The best sowing method remains wide-row spacing (50-60 cm), which allows for the use of mechanical weed control tools, such as spring-tine and rotary harrows.

Chickpeas, like all legumes, require clean and level fields, which is why one of the best preceding crops for chickpeas is winter grain, as the fields are relatively weed-free after them.

Soil preparation is classic, using strip-till. The field for chickpeas should be well-leveled, as the crop tends to be relatively low-growing. For keeping the fields weed-free, most farmers use chemical weed control methods, including soil-applied herbicides such as Prometrin, Zenkor, Dual Gold, Merlin, and other insurance herbicides. Glyphosate can also be used for pre-sowing soil treatment.

Pre-emergence harrowing is done when annual weeds are in the white thread stage, while chickpea and lentil seeds are just beginning to germinate, no more than 0.5-0.7 cm. Harrowing is also permissible after sprouting, when plants reach 6-7 cm in height, with an equipment speed of 5-6 km/h on a sunny day [9-11].

During the trial years, chickpeas were affected by pests and diseases. The most common were grain moths and powdery mildew. The methods of control are well-known and readily available. The most effective method is a mixture of insecticides and fungicides. Pest control is performed reactively, while diseases are controlled preventively.

Harvesting is a crucial period in chickpea cultivation. Harvesting begins when 70% of the lower pods have turned brown, typically in the second or third decade of July, depending on the weather conditions. Before harvesting, desiccation is usually performed using Diquat at a rate of 5 L/ha [9-12].

Chickpeas are harvested using direct combine harvesting. To minimize yield losses, it is advisable to use wide-cutting “Flexi” grain headers. The combine speed should not exceed 6 km/h, with the threshing drum speed set to 350-400 rpm. These combine operation conditions are essential to minimize seed loss and damage. After threshing, seeds are cleaned of weeds, plant debris, and other residues using pea-cleaning machines [12].

3 Conclusion

1. Research has shown that chickpeas exhibit favorable phenological traits and significant yield potential in southern Ukraine, but the cultivation technology of chickpeas remains insufficiently studied, making this issue still highly relevant.
2. In southern Ukraine, among the large-seeded chickpea varieties, the Goksu, Aras, and Budjak varieties stand out in terms of yield, while the Zuhal, Goksu, Aras, and Nortenia varieties are notable for their 1000-seed weight.
3. Special attention should be paid not only to crop protection systems but also to the proper harvesting of chickpeas.

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