The productivity of chickpeas varieties planted at different times and sowing schemes

Zarif Bobokulov[1 1], *Pirnazar* Bobomirzaev[1], and *Shermuhammad* Tursunov[2]

[1]Samarkand Agroinnovations and Research University, A.Temur str.7, 191200 Samarkand, Uzbekistan
[2] Samarkand Research Institute of Cereal Legume Crops Scientific Research Station, 140708 Samarkand, Uzbekistan

Abstract. This study analyzes the influence of various sowing times and planting patterns on crop performance the productivity of chickpeas varieties on irrigated lands of the Zarafshon valley. It was found that the autumn and spring sowing dates and sowing schemes affected the yield indicators. According to the sowing scheme options, the higher number of seedlings in the 60x6x1 cm scheme planted in the autumn sowing period compared to the 60x9x1 cm and 60x12x1 cm schemes affected the yield, while in the spring sowing period, the number of pods, the number of grains in the pod, and the mass of 1000 grains in the 60x9x1 cm scheme planted in the spring sowing period compared to the 60x6x1 cm and 60x12x1 cm schemes increased the yield by 1-3 centners compared to the other sowing scheme options in the experiment.

1 Introduction

Among leguminous crops, chickpea is one of the oldest food crops, and currently, chickpea is planted in more than 50 countries of the world on an area of about 21 million hectares per year, with a total yield of 15-18 million tons of grain. The main chickpea-producing countries are India, Australia, Pakistan, Argentina, African countries and Mexico, with India leading the way in chickpea production (10,984 thousand tons), with a share of 73%. Australia (661 thousand tons) and Pakistan (601 thousand tons) are in third place.

In these countries, as a result of the correct application of optimal sowing period, method and standards, high and quality grain harvest is achieved. Determining the optimal planting period and standards of peas in different soil and climate conditions and improving the important agrotechnological elements of cultivation are urgent issues.

Today, considerable attention is given in many pea-producing, exporting, and importing countries to research on developing varieties of peas resistant to different extreme conditions. Such studies focus on exploring their biological, morphophysiological, biochemical, and medicinal properties, as well as enhancing their nutritional value. In addition, the dependence of growth, development, yield formation, and grain quality on cultivation agrotechnology is being actively examined. Equally important are investigations aimed at optimizing the timing

1 Corresponding author: zarif.2024@bk.ru

and rates of sowing, along with saving the amount of organic and mineral fertilizers in subsequent crops by enriching the soil with biological nitrogen through chickpea cultivation.

In our republic, the cultivation of legumes and grains is being widely promoted to fully meet the population's demand for food and livestock feed, as well as to improve soil fertility. The Decree of the President of the Republic of Uzbekistan No. PF-60 dated January 28, 2022 "On the Development Strategy of New Uzbekistan for 2022-2026" sets out important priority tasks for increasing the effectiveness of reforms in the agricultural sector and developing this area in the near future, such as developing the agrarian sector, processing agricultural products on a cluster basis and ensuring food security, creating the necessary conditions for doubling the income of farmers and peasants, and increasing the annual growth rate of agriculture to 5 percent. Therefore, in order to at least partially satisfy the needs of our country's population for food products that are currently imported, scientific research is urgently needed to create new varieties of chickpeas, develop agricultural technologies for their cultivation, and improve existing ones.

Meeting the global population's demand for chickpeas requires the development of new-generation varieties and the creation of high-yield agro-technologies, which is one of the most pressing issues in agriculture today [1].

Its rich nutritional composition is defined by a high content of seed protein, significant levels of non-starch polysaccharides, low energy value, minimal allergenicity, and excellent digestibility. The inherent gluten-free nature of chickpea further positions it as an excellent dietary choice for individuals with gluten intolerance [2-3].

Considering the growing global population, it is essential to develop resource-efficient agro-technologies that take into account the morphological and biological characteristics and potential capabilities of new varieties to ensure high and quality grain yields. In this regard, research aimed at optimizing sowing periods and norms, as well as reducing the use of organic and mineral fertilizers in subsequent crops by leveraging chickpea's ability to enrich the soil with biological nitrogen, is of great importance [4].

Research findings from [5] highlight a substantial divergence in yield responses to sowing time across these regions. In the northern and central production zones, an early-May sowing date resulted in a seed yield of 1625 kg/ha, representing a near doubling of the yield achieved from a late-June sowing (754 kg/ha). Conversely, in southern regions, a late-June sowing strategy proved more effective, producing a higher yield of 865 kg/ha compared to a mid-May sowing, which yielded 610 kg/ha.

Chickpea cultivation in Uzbekistan predominantly employs winter planting, a strategic approach that capitalizes on cold-tolerant varieties. Optimal autumn sowing dates typically fall within October and November. Experimental research has also explored later sowings, such as December 20, 2022, demonstrating the adaptability of winter chickpea genotypes to varied planting windows [3].

The yield of leguminous grain crops is recognized as one of the most complex quantitative traits and represents a key criterion in variety evaluation, breeding, and the development of agronomic practices. Its complexity arises from its dependence on soil fertility, sowing pattern, sowing time, irrigation regime, nutrient management, and the biological characteristics of the variety [6].

The more favorable the growing conditions for a chickpea variety, the better the formation of pods and seeds, which ultimately ensures higher productivity [7,8]

Findings from dissertation research on sowing times and planting patterns revealed that the yield structure of chickpea varieties varied according to regional soil and climatic conditions as well as sowing time and pattern.

For the autumn-sown variety *Polvon*, the average number of pods per plant in the 60×12×1 sowing scheme was 56.8. However, as planting density increased (with higher seeding rates), this value declined by 13.5 to 23.0 pods. In the variety *Zumrad*, a similar trend was observed, where the number of pods averaged 56.0 and decreased by 11.5 to 23.0 pods under denser sowing conditions.

2 Material and research methodology

Field experiments were carried out during 2018–2020 on irrigated lands in the Khatirchi district of the Navoi region, Zarafshan Valley. The study involved chickpea (*Cicer arietinum L.*) varieties Polvan and Zumrad, which are listed in the State Register. These varieties were planted in both autumn and spring, using sowing schemes of 60x6x1 cm, 60x9x1 cm, and 60x12x1 cm**.**

The seeds used for sowing met the Class I seed standard**,** with a germination rate of at least 95%**,** moisture content not exceeding 14%**,** and 100% varietal purity. In autumn, seeds were sown at a depth of 9 cm, whereas in spring, the sowing depth was 5 cm**.**

Before planting, the soil was plowed to a depth of 25–30 cm. To conserve soil moisture, the plowed field was harrowed, after which it was loosened and divided into plots by chiseling in preparation for sowing.

The experimental variants planted in autumn and spring were placed separately in 4 rows, in 2 tiers. The field experiment variants consisted of 4 rows, of which observation and counting were carried out in the middle 2 rows, and the remaining 2 rows were considered protective rows. Each variant was 25 m long, 2.4 m wide, and had an area of 60 m^2.

Chickpea cultivation in the experiment was carried out in accordance with the agrotechnological practices adopted for the region.

The agrochemical and agrophysical properties of the experimental field soils were studied using the following methods:

- Soil humus content was determined by the method of I.V. Tyurin.
- Total NPK content was analyzed using the improved methods of I.M. Maltseva and *L.P. Gritsenko*.
- Mobile nutrient forms: nitrate nitrogen was measured by the Grandwald-Lyaju method, mobile phosphorus by the *B.P.* Machigin method, and exchangeable potassium by flame photocolorimetry.
- Soil bulk density and porosity were determined in the 0–30 cm soil layer using the P.V. - Protasov method with cylinders, according to N.A. Kachinsky.

All field experiment observations were carried out in odd-numbered replications. The onset of each growth and development phase of chickpea was recorded when 10% of plants had reached that stage, while full development was observed when 70% of plants had entered the phase.

Pod thickness, germination, seed storage ability, and other biometric traits were measured within 1 m^2 odd-numbered plots. To study the yield structure, 25 plants were sampled from each experimental variant. The obtained yield data were statistically processed using the dispersion analysis method of B.A. Dospehov**.**

3 Results and Discussion

When planted in autumn, the Polvon variety of peas in 2018 experiments yielded 31.5 c/ha when planted in a 60x6x1 cm scheme, 30.7 c/ha in a 60x9 cm scheme, and 29.4 c/ha when planted in a 60x12x1 cm scheme. It was found that the first variant planted in the 60x6x1 scheme had a higher yield of 0.8-2.1 c/ha compared to the variants planted in the 60x9x1 cm and 60x12x1 cm schemes (Table 1).

When the Zumrad variety was planted in a 60x6x1 cm scheme, in the 2018 experiments, a yield of 28.9 c/ha was obtained. 28.2 c/ha grain yield was obtained when planting the 60x9 cm planting pattern, 0.7 c/ha less than the previous 60x6 cm planted option. When the planting pattern was increased to 60x12 cm, the yield was 26.9 c/ha. It was found that it was reduced by 2.0 c/h compared to the first option.

In the 2019 year of experiments, when the Polvon variety of peas was planted in a 60x6 cm scheme, a yield of 34.1 c/ha was obtained. When the sowing pattern was increased to 60x9 cm, 33.3 c/ha grain yield was obtained, compared to the previous option, 0.8 c/ha less yield was obtained. Planting pattern When planted in a 60x12 cm pattern, a yield of 30.8 c/ha was obtained. It was found that it decreased by 3.3 c/h compared to the first option. The Zumrad variety, when planted in these schemes, is 2.5 c/ha compared to the Polvon variety; 2.8 c/ha; It was determined that the yield was less than 2.5 c/ha.

Table 1. Effect of sowing dates and planting schemes on the yield of chickpea varieties (c/ha)

№	Varieties	Planting scheme	2018 year	2019 year	2020 year	Average by years
Autumn term						
1.	Polvon	60x6x1	31,5	34,1	31,9	32,5
2.		60x9x1	30,7	33,3	31,3	31,8
3.		60x12x1	29,4	30,8	27,7	29,3
4.	Zumrad	60x6x1	28,9	31,6	29,8	30,1
5.		60x9x1	28,2	30,5	29,2	29,3
6.		60x12x1	26,9	28,3	26,7	27,3
Spring term						
7.	Polvon	60x6x1	27,3	32,1	29,1	29,5
8.		60x9x1	28,2	31,4	29,7	29,8
9.		60x12x1	26,1	28,3	27	27,1
10.	Zumrad	60x6x1	26,6	29,8	27,5	28,0
11.		60x9x1	27,5	29,9	28,6	28,7
12.		60x12x1	24,6	27,2	25,7	25,8
(A) Sd=			0,43	0,42	0,37	
LSD_{05}=			0,91	0,90	0,78	
(B) Sd=			0,45	0,45	0,39	
LSD_{05}=			0,97	0,96	0,83	
		Sx%=	3,35	3,04	2,79	

In the 2020 year of experiments, when the Polvon variety of peas was planted in a 60x6x1 cm scheme, a yield of 31.9 c/ha was obtained. 31.3 c/ha when planted in the 60x9x1 cm scheme, 27.7 c/ha when planted in 60x12 cm, and 0.6 c/ha and 4.2 c/ha decrease in yield compared to the 60x6x1 cm scheme was found.

When the Zumrad variety was sown using the 60x6x1 cm planting scheme, the yield reached 29.8 c/ha, which was 0.6 c/ha higher compared to the 60x9x1 cm scheme, and 3.1 c/ha higher than the 60x12x1 cm scheme.

In the experiments of 2018, when the Polvon variety of peas was planted in a 60x6x1 cm scheme when it was planted in spring, 27.3 c/ha was obtained. It was found that 28.2 c/ha was obtained when planting in the 60x9x1 cm scheme, 0.7 c/ha compared to the previous 60x6x1 cm scheme, and 2.1 c/ha higher than the 60x12x1 cm scheme.

When the Zumrad variety was planted in a 60x6x1 cm scheme, in 2018 experiments, a yield of 26.6 c/ha was obtained. 27.5 c/ha was obtained when planting in the 60x9x1 cm scheme, and 2.9 c/ha higher yield compared to the next 60x12x1 cm scheme.

In the 2019 experiments, when the Polvon variety of chickpea was planted using the 60x6x1 cm scheme, a yield of 32.1 c/ha was obtained. In comparison, the yields were 31.4 c/ha under the 60x9x1 cm scheme and 29.8 c/ha under the 60x12x1 cm scheme. For the

Zumrad variety under the same conditions, the yields were 29.9 c/ha (60x6x1 cm), 27.2 c/ha (60x9x1 cm), and less by 2.3, 1.6, and 1.1 c/ha respectively compared to the Polvon variety.

In the 2020 experiments (spring sowing), the Polvon variety yielded 29.1 c/ha under the 60x6x1 cm planting scheme. When planted in the 60x9x1 cm scheme, the yield increased to 29.7 c/ha, which was 2.7 c/ha higher than in the 60x12x1 cm scheme. For the Zumrad variety, the yields were 27.5 c/ha (60x6x1 cm), 28.6 c/ha (60x9x1 cm), and 25.7 c/ha (60x12x1 cm). Compared with the first option (60x6x1 m), the yield in the 60x12x1 cm scheme was 1.8 c/ha lower, and compared with the second option (60x9x1 cm), it was 2.9 c/ha lower.

When pea varieties are planted in the spring, it was observed that the yield decreased compared to the autumn period. During the experimental years, the average grain yield of the Palvon variety decreased by 2.0-3.0 c/ha, depending on the planting scheme, and the Zumrad variety decreased by 0.6-2.1 c/ha. This difference between the varieties is associated with the characteristics and biology of the variety. This When varieties are planted in autumn, their yield is significantly higher than when planted in spring, and it is advisable to plant these varieties in autumn than in spring.

In the experiment, when analyzing the relationship between the yield of pea varieties planted in autumn and spring, the relationship between both varieties was linear and positive.

4 Conclusion

In the years of the experiment conducted in the conditions of the irrigated lands of the Khatirchi district of the Navoi region of the Zarafshan valley, it was found that the autumn and spring sowing dates and sowing schemes affected the yield indicators. According to the sowing scheme options, the higher number of seedlings in the 60x6x1 cm scheme planted in the autumn sowing period compared to the 60x9x1 cm and 60x12x1 cm schemes affected the yield, while in the spring sowing period, the number of pods, the number of grains in the pod, and the mass of 1000 grains in the 60x9x1 cm scheme planted in the spring sowing period compared to the 60x6x1 cm and 60x12x1 cm schemes increased the yield by 1-3 centners compared to the other sowing scheme options in the experiment. It was found that sowing peas in the autumn in November in the 60x6x1 cm scheme is optimal, and this it is recommended to widely use planting in agriculture.

References

1. S. Samineni, M. Thudi, S.B. Sajja, R.K. Varshney, P.M. Gaur, P.M. Impact of Genomics on Chickpea Breeding. In: Varshney, R., Thudi, M., Muehlbauer, F. (eds) The Chickpea Genome. Compendium of Plant Genomes. Springer, Cham (2017). https://doi.org/10.1007/978-3-319-66117-9_11
2. U. C. Jha, H. Nayyar, M. Thudi, R. Beena, P. V. Vara Prasad, K. H. M. Siddique, Unlocking the nutritional potential of chickpea: strategies for biofortification and enhanced multinutrient quality. Front. Plant. Sci. 7, 15, 1391496 (2024). https://doi.org/10.3389/fpls.2024.1391496
3. R. Kaur, K. Prasad, Technological, processing and nutritional aspects of chickpea (Cicer arietinum) - A review. Trends Food Sci. Technol. **109**, 448–463 (2021), https://doi.org/10.1016/j.tifs.2021.01.044
4. I. Adu Oparah et al., Symbiotic Effectiveness, Rhizosphere Competence and Nodule Occupancy of Chickpea Root Nodule Bacteria from Soils in Kununurra Western Australia and Narrabri New South Wales Australia. Plants **14**, 5, 809 (2025). https://doi.org/10.3390/plants14050809

5. R. K. Mahto et al., Uncovering potentials of an association panel subset for nitrogen fixation and sustainable chickpea productivity. BMC Plant Biol. **25**, 693 (2025). https://doi.org/10.1186/s12870-025-06244-z
6. K. L. Regan, K. H. M. Siddique, N. J. Brandon, M. Seymour, S. P. Loss, Response of chickpea (Cicer arietinum L.) varieties to time of sowing in Mediterranean-type environments of south-western Australia. Aust. J. Exp. Agric. **46**, 3, 395-404 (2006). https://doi.org/10.1071/EA05091
7. S. D. Dilmurodov et al., Breeding of winter chickpea genotypes with high photosynthetic productivity, adapted to mechanization, high yield and high protein content in the southern regions of Uzbekistan. E3S Web of Conferences **618**, 03014 (2025). https://doi.org/10.1051/e3sconf/202561803014
8. Atif Hassan Naim, Abdelkarim Hassan Awadelkarim, Naidoo Sershen, Faisal El Gasim Ahmed, Effect of Irrigation Regime and Plant Density on Chickpea (Cicer arietinum L.) Yield in the Semi-Arid Environment of Sudan. Asian Journal of Plant Science and Research **7(6),** 142-151 (2021)