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The Effect of Sowing Dates and Seeding Rates on Root Nodule Formation in Chickpea Varieties

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Abstract

The study revealed that early sowing of chickpea seeds at a relatively low seeding rate of 80 kg/ha resulted in greater root nodule formation compared with delayed sowing and increased seeding rates. It was scientifically established that the Polvon variety formed more root nodules than the Iftikhor and Yulduz control varieties across all three sowing dates and three seeding rates.

Keywords: Chickpea, sowing date, seeding rate, yield, sowing, root nodules.

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1. Introduction

Today, the rapid growth of the global population has led to an increasing demand for food products rich in protein and other essential nutrients. Currently, approximately 70% of the protein consumed by humans is derived from plant-based products. In recent years, India has remained one of the world's leading chickpea-producing countries, accounting for approximately 60% of global chickpea production, with a reported production volume of 9.94 million tons. Other major chickpea-producing countries include Turkey (6.1 thousand tons), the Russian Federation (5.2 thousand tons), Myanmar (4.4 thousand tons), Pakistan (4.5 thousand tons), Ethiopia (4.2 thousand tons), and the United States (2.1 thousand tons) [3].

According to researchers, chickpea (Cicer arietinum L.) is an annual crop widely cultivated worldwide as a food crop. Archaeological remains of ancient cultivated chickpea varieties have been discovered in the Middle East, dating back to approximately 7500–6800 BCE [4, 5].

Chickpea is an annual leguminous plant characterized by its high protein content and nutritional value. Its seeds contain approximately 19–30% protein, 4–7% fat, 47–60% nitrogen-free extractive substances, 2.4–12.8% crude fiber, and 0.2–4.0% ash, as well as vitamin B1 and mineral salts [1].

According to Kh. N. Atabaeva and I. V. Massino, chickpea protein is of high nutritional quality and

contains essential amino acids, including 20.7 g/kg lysine, 5.2 g/kg methionine, 4.8 g/kg cysteine, 11.3 g/kg phenylalanine, and 10.5 g/kg threonine [2].

2. Literature Review

According to N. Atabaeva and other researchers, light-colored chickpea varieties are primarily used for human consumption. Adding 10–12% chickpea flour to wheat flour can improve the nutritional value of bread. Global chickpea production reached 8.34 million tons in 1997 and increased to 14.78 million tons by 2017 [6].

O. G. Saipov noted that as chickpea seed size increases, germination energy also improves, which plays an important role in enhancing field germination, particularly under the relatively cool conditions of spring [7].

The germination process of chickpea seeds is significantly influenced by environmental temperature. Seed germination rates vary in response to temperature fluctuations, and germination may decline when temperatures fall below or rise above the optimal range. Studies have demonstrated that chickpea seeds exhibit higher germination rates under favorable temperature conditions, whereas unfavorable temperatures can substantially reduce germination percentages [8].

Based on experiments conducted under irrigated conditions, Z. K. Yuldasheva reported that the height of the lowest pod attachment in early-sown chickpea plants was lower than that observed in plants sown at later dates. Similarly, plants grown at lower sowing densities exhibited a lower height of the first pod attachment compared with those grown at higher densities [9].

To fully utilize the productive potential of chickpea varieties, it is essential to determine scientifically justified optimal sowing dates and planting arrangements. Furthermore, investigating the influence of these agronomic practices on grain yield in relation to leaf formation and development in different chickpea varieties is of considerable importance [10].

3. Results and Discussion

Root nodule bacteria associated with chickpea varieties play an important role in improving soil fertility. Under the environmental conditions of Nukus, chickpea seeds were treated with a locally developed rhizobial bacterial preparation known as Psevdorizobin, containing Mesorhizobium ciceri-4 and Pseudomonas chlororaphis-66 (local bacterial strains).

The preparation was applied at a rate of 200 g per hectare to treat chickpea seeds before sowing (Table 1).

In our experiment, it was observed that very few root nodules formed on chickpea plants during the first year, while their number gradually increased in the second and third years. An average of 8.0–20.6 nodules of varying sizes formed near the root collar of chickpea plants; however, no nodules developed on the lateral roots. It was found that early sowing at a seeding rate of 80 kg/ha resulted in a greater number of root nodules and relatively higher nodule weight. Among the studied varieties, Polvon formed slightly more nodules than the Iftikhor and Yulduz control varieties. During the first year of the experiment (2024), nodule formation was very limited, whereas both the number and mass of nodules increased in the second and third years. Under the climatic and soil conditions of Nukus, the formation of root nodules through the activity of Rhizobium bacteria and the gradual increase in their number over successive years represent important findings with potential implications for improving soil fertility.

In the Polvon variety, when seeds were sown early (March 25–30) at a rate of 80 kg/ha, an average of 13.6 nodules with a total mass of 0.69 g formed near the root collar in 2024. In 2025, the number of nodules increased to 16.6, with a mass of 0.91 g, while in 2026, it reached 20.6 nodules with a total mass of 1.24 g. When the seeding rate was increased to 90 kg/ha, the number of nodules decreased by 0.9, 0.8, and 0.8 over the respective years, while their mass was lower by 0.08, 0.07, and 0.09 g. At a seeding rate of 100 kg/ha, the number of nodules decreased by 1.4, 1.2, and 1.2, with corresponding reductions in nodule mass of 0.14, 0.14, and 0.17 g, respectively. At the optimal sowing date (April 5–10), the treatment with a seeding rate of 80 kg/ha showed 0.2, 0.3, and 0.3 fewer nodules over the study years, with their mass being 0.04, 0.06, and 0.07 g lower, respectively, compared with the treatment with an increased seeding rate. Compared with the treatment with a further increased seeding rate, the number of nodules was lower by 0.8, 0.9, and 0.8, while their mass was lower by 0.09, 0.12, and 0.15 g, respectively. Delaying sowing until April 15–20 resulted in a substantial reduction in root nodule formation. Nevertheless, the treatment sown at 80 kg/ha maintained a relatively greater number of nodules. Compared with the treatments with increased seeding

rates, the number of nodules differed by 0.3, 0.5, and 0.5, with corresponding differences in mass of 0.04, 0.04, and 0.06 g, while further comparisons showed differences of 0.8, 1.0, and 0.9 nodules and 0.09, 0.10, and 0.13 g in mass, respectively.

In the Iftikhor variety, early sowing (March 25–30) at a seeding rate of 80 kg/ha resulted in an average of 12.3 nodules with a total mass of 0.55 g in 2024. In 2025, the number increased to 15.1 nodules with a mass of 0.79 g, while in 2026, it reached 19.1 nodules with a total mass of 1.05 g. When the seeding rate was increased to 90 kg/ha, the number of nodules decreased by 0.7, 0.6, and 0.7 over the respective years, with corresponding reductions in mass of 0.05, 0.07, and 0.07 g. At a seeding rate of 100 kg/ha, the number of nodules decreased by 1.1, 1.3, and 1.1, while their mass was lower by 0.10, 0.20, and 0.14 g, respectively. At the optimal sowing date (April 5–10), the treatment with a seeding rate of 80 kg/ha had 0.3, 0.4, and 0.3 fewer nodules over the study years, with their mass being 0.03, 0.05, and 0.05 g lower, respectively, compared with the treatment with an increased seeding rate. Compared with the treatment with a further increased seeding rate, the number of nodules was lower by 0.8, 0.7, and 0.7, while their mass was lower by 0.07, 0.09, and 0.12 g, respectively. When sowing was delayed until April 15–20, the treatment with a seeding rate of 80 kg/ha showed reductions of 0.6, 0.3, and 0.1 nodules over the respective years, with corresponding decreases in mass of 0.04, 0.04, and 0.03 g. In comparison with the treatment with a further increased seeding rate, the number of nodules was lower by 0.9, 0.6, and 0.6, while their mass was lower by 0.07, 0.09, and 0.10 g, respectively.

In the Yulduz control variety, early sowing (March 25–30) at a seeding rate of 80 kg/ha resulted in an average of 11.0 nodules with a total mass of 0.42 g in 2024. In 2025, the number of nodules increased to 15.0, with a mass of 0.60 g, while in 2026, it reached 19.0 nodules with a total mass of 0.86 g. When the seeding rate was increased to 90 kg/ha, the number of nodules decreased by 0.7, 0.8, and 0.8 over the respective years, while their mass was lower by 0.06, 0.06, and 0.08 g. At a seeding rate of 100 kg/ha, the number of nodules decreased by 1.3, 1.2, and 1.2, with corresponding reductions in mass of 0.10, 0.12, and 0.15 g, respectively.

1-table

The Effect of Sowing Dates and Seeding Rates on Root Nodule Formation in Chickpea Varieties (2024–2026).

Var	Sowing Dates	Seeding Rate, kg/ha	Number of Root Nodules per Plant at the Flowering Stage, pcs.					
			2024 y		2025 y		2026 y	
			Number, pcs.	Weight, g	Number, pcs.	Weight, g	Number, pcs.	Weight, g
	Yulduz (Control)							
1	25-30 march	80	11,0	0,42	15,0	0,60	19,0	0,86
2		90	10,3	0,36	14,2	0,54	18,2	0,78
3		100	9,7	0,32	13,8	0,48	17,8	0,71
4	5-10 april	80	8,8	0,31	13,9	0,56	17,9	0,72
5		90	8,4	0,28	13,5	0,51	17,5	0,67
6		100	8,0	0,24	13,0	0,46	17,0	0,60
7	15-20 april	80	8,3	0,25	13,6	0,48	17,6	0,62
8		90	7,8	0,22	13,1	0,43	17,1	0,56
9		100	7,5	0,19	12,6	0,38	16,6	0,50
	Polvon							
10	25-30 march	80	13,6	0,69	16,6	0,91	20,6	1,24

11		90	12,7	0,61	15,8	0,84	19,8	1,15
12		100	12,2	0,55	15,4	0,77	19,4	1,07
13	5-10 april	80	13,0	0,58	15,1	0,84	19,1	1,07
14		90	12,8	0,54	14,8	0,78	18,8	1,00
15		100	12,2	0,49	14,2	0,72	18,3	0,92
16	15-20 april	80	12,1	0,49	15,0	0,67	19,0	0,95
17		90	11,8	0,45	14,5	0,63	18,5	0,89
18		100	11,3	0,40	14,0	0,57	18,1	0,82
	Iftixor							
19	25-30 march	80	12,3	0,55	15,1	0,76	19,1	1,05
20		90	11,6	0,50	14,5	0,69	18,4	0,98
21		100	11,2	0,45	13,8	0,56	18,0	0,91
22	5-10 april	80	10,8	0,43	13,7	0,52	17,7	0,89
23		90	10,5	0,40	13,3	0,47	17,4	0,84
24		100	10,0	0,36	13,0	0,43	17,0	0,77
25	15-20 april	80	10,4	0,36	13,5	0,48	17,0	0,76
26		90	9,8	0,32	13,2	0,44	16,9	0,73
27		100	9,5	0,29	12,9	0,39	16,4	0,66

At the optimal sowing date (April 5–10), the treatment sown at a seeding rate of 80 kg/ha had 0.4, 0.5, and 0.4 fewer root nodules over the study years, with their weight being 0.03, 0.05, and 0.05 g lower, respectively, compared with the treatment with a higher seeding rate. Compared with another treatment with an increased seeding rate, the number of nodules was lower by 0.8, 0.9, and 0.9, while their weight was lower by 0.07, 0.10, and 0.12 g, respectively. When sowing was delayed (April 15–20), the treatment sown at a rate of 80 kg/ha produced 0.5, 0.4, and 0.6 fewer nodules over the study years, with their weight being 0.03, 0.05, and 0.06 g lower, respectively. Compared with the treatment with a further increased seeding rate, the number of nodules was lower by 0.8, 1.0, and 1.0, while their weight was lower by 0.06, 0.10, and 0.10 g, respectively.

The number of root nodules formed in the Polvon chickpea variety increased over the study years compared with the Iftikhor variety. In 2026, under early sowing conditions, the Polvon variety formed 1.5, 1.4, and 1.4 more nodules across the three seeding rates, with nodule weights exceeding those of the Iftikhor variety by 0.19, 0.17, and 0.16 g, respectively. At the optimal sowing date, the number of nodules was higher by 1.4, 1.5, and 1.3, while their weight was greater by 0.18, 0.16, and 1.5 g, respectively. Under late sowing conditions, the Polvon variety produced 2.0, 1.6, and 1.7 more nodules, with their weight exceeding that of the Iftikhor variety by 0.19, 0.16, and 0.15 g, respectively.

Compared with the Yulduz control variety, the Polvon variety produced 1.6, 1.5, and 1.7 more root nodules under early sowing conditions across the three seeding rates, with their weight being 0.38, 0.37, and 0.36 g greater, respectively. At the optimal sowing date, the number of nodules was higher by 1.2, 1.3, and 1.3, while their weight was greater by 0.35, 0.33, and 0.32 g, respectively. Under late sowing conditions, the Polvon variety formed 1.4, 1.6, and 1.5 more nodules, with their weight exceeding that of the Yulduz control variety by 0.33, 0.34, and 0.32 g, respectively.

Based on the findings, it can be concluded that early sowing of chickpea seeds at a relatively low seeding rate of 80 kg/ha promotes greater root nodule formation compared with delayed sowing and increased seeding rates. Furthermore, the results provide scientific evidence that the Polvon chickpea variety demonstrates a greater capacity for root nodule formation than the Iftikhor and Yulduz control varieties across all three sowing dates and seeding rates.

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