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EFFECT OF PLANTING GEOMETRY, MINERAL FERTILIZATION AND
BIOSTIMULANT TREATMENTS ON FLOWERING DYNAMICS OF
GROUNDNUT (*ARACHIS HYPOGAEA* L.) cv. SALOMAT

Nurmatova Dildoraxon Erkinjon qizi

PhD Student, Andijan Institute of Agriculture and Agrotechnologies, Andijan,
Uzbekistan

Abstract. *The study investigated flowering dynamics of groundnut (*Arachis hypogaea* L.) cv. Salomat under different planting geometries, mineral fertilizer rates and biostimulant treatment variants under irrigated conditions of the Andijan region, Uzbekistan. Two planting patterns, 70 × 10 cm and 70 × 20 cm with one plant per hill, two mineral fertilizer backgrounds, N60P110K40 and N90P165K65 kg ha⁻¹, and foliar treatments with Oksigumat Ekstra and Rokogumin at 1, 2 and 3 L ha⁻¹ were evaluated. The number of flowers per plant was recorded on 7, 10, 13 and 16 July 2021. Foliar application of the biostimulants was carried out on 8 July; therefore, the 7 July observation represented the pretreatment status. Averaged across 14 treatment combinations, flower number under the 70 × 10 cm planting pattern increased from 2.49 flowers plant⁻¹ on 7 July to 26.52 flowers plant⁻¹ on 16 July. Under the 70 × 20 cm pattern, the corresponding values were 2.87 and 30.54 flowers plant⁻¹. The wider spacing produced approximately 15% more flowers throughout the observation period. On 16 July, the mean flower number under N90P165K65 exceeded that under N60P110K40 by approximately 7.2% at 70 × 10 cm and 7.1% at 70 × 20 cm. The highest value, 33.3 flowers plant⁻¹, was recorded under the combination of 70 × 20 cm, N90P165K65 and Rokogumin at 3 L ha⁻¹. However, because differences among treatments were already present before biostimulant application and no analysis of variance was available for the presented dataset, treatment effects are interpreted as descriptive trends rather than statistically confirmed responses. The results indicate that planting geometry and mineral nutrition were consistently associated with flowering intensity of groundnut cv. Salomat.*

Keywords: *groundnut, *Arachis hypogaea* L., Salomat cultivar, flowering dynamics, planting geometry, mineral nutrition, Oksigumat Ekstra, Rokogumin, flower number, reproductive development.*

INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is one of the important oilseed and grain legume crops cultivated in tropical and subtropical regions. Its productivity is closely related to the successful formation and development of reproductive organs, particularly flowers, gynophores and pods.

Flowers of groundnut develop in the axils of leaves. The number of flowers produced by an inflorescence is influenced both by the botanical characteristics of the cultivar and by environmental conditions. Temperature and moisture are especially important during the



Date: 25th September-2026

reproductive period. Warm conditions around 25–30 °C combined with adequate moisture are generally favourable for flowering and gynophore formation.

Under the climatic conditions of Uzbekistan, the first groundnut flowers may appear approximately 20–35 days after emergence [1]. Individual groundnut flowers are short-lived, usually remaining open for about one day. Following fertilization, the ovary develops into a gynophore, which elongates and penetrates the soil before pod development.

The timing of flowering is important for final yield formation. Nurmatov et al. [2] reported that groundnut plants may continue flowering until the end of the growing period, but flowers formed relatively late in the season may have insufficient time to produce fully mature pods. Therefore, intensive flowering and gynophore formation during June and July are particularly important under the environmental conditions of Central Asia.

Plant population density strongly affects the architecture of individual plants. Wider spacing increases the feeding area per plant and may reduce competition for light, water and mineral nutrients. This can influence branching, vegetative growth and the number of reproductive organs formed by each individual plant.

Mineral nutrition is another important factor affecting reproductive development. Nitrogen, phosphorus and potassium participate in processes related to photosynthesis, assimilate transport, root growth, flowering and pod formation. The response of groundnut to mineral fertilizer, however, may vary with planting density and environmental conditions.

Biostimulants are increasingly used in crop production to support plant metabolic activity and stress tolerance. Their effect on reproductive development can depend on the composition of the preparation, application rate and timing. For this reason, measurements taken before treatment should be separated from observations made after application.

The aim of the present study was to evaluate flowering dynamics of groundnut cv. Salomat under different planting geometries and mineral fertilizer backgrounds and to describe the subsequent flowering patterns in variants treated with different rates of Oksigumat Ekstra and Rokogumin.

Materials and Methods

The field experiment was conducted in 2021 at the experimental farm of the Andijan Institute of Agriculture and Agrotechnologies, Andijan region, Uzbekistan.

The soil of the experimental field was irrigated meadow-serozem, heavy loam in texture and slightly saline. Groundwater occurred at a depth of approximately 1.5–2.0 m.

Groundnut cultivar Salomat was grown under two planting geometries: 70 × 10 cm and 70 × 20 cm, one plant per hill. The corresponding theoretical feeding areas were approximately 700 and 1400 cm² per plant.

Two mineral fertilizer backgrounds were evaluated: N60P110K40 kg ha⁻¹ and N90P165K65 kg ha⁻¹.

Within each fertilizer background, seven variants were included: no biostimulant; Oksigumat Ekstra at 1, 2 and 3 L ha⁻¹; and Rokogumin at 1, 2 and 3 L ha⁻¹. Fourteen variants were therefore evaluated within each planting geometry, resulting in a total of 28 treatment combinations. The experiment was conducted in four replications.



Date: 25th September-2026

The number of flowers per plant was recorded on 7, 10, 13 and 16 July 2021. Foliar application of the biostimulant treatments was performed on 8 July 2021. Therefore, flower counts recorded on 7 July represented pretreatment conditions, whereas observations on 10, 13 and 16 July characterized flowering after the treatment date.

The data were evaluated descriptively. Mean values were calculated for planting geometries and mineral fertilizer backgrounds. Because analysis of variance and least significant difference values were not available for the dataset presented here, numerical differences were not interpreted as statistically significant.

Results and Discussion

General flowering dynamics

Flower formation increased rapidly during the observation period in all experimental variants.

Under the 70 × 10 cm planting geometry, the average number of flowers increased from 2.49 flowers plant⁻¹ on 7 July to 6.11 on 10 July, 12.99 on 13 July and 26.52 flowers plant⁻¹ on 16 July.

Under the 70 × 20 cm planting geometry, the corresponding mean values were 2.87, 7.04, 14.94 and 30.54 flowers plant⁻¹.

Thus, the wider spacing produced consistently greater flower numbers per individual plant. The difference between the planting geometries increased from 0.38 flowers plant⁻¹ on 7 July to 0.93 on 10 July, 1.96 on 13 July and 4.01 flowers plant⁻¹ on 16 July.

In relative terms, the average flower number under 70 × 20 cm was approximately 15% higher than under 70 × 10 cm at each observation date.

This remarkably stable proportional difference suggests that feeding area per plant was strongly associated with reproductive development of individual groundnut plants.

Table 1. Flowering dynamics of groundnut cv. Salomat under the 70 × 10 cm planting geometry, flowers plant⁻¹, 2021

No.	Mineral fertilizer, kg ha ⁻¹	Treatment	7 July	10 July	13 July	16 July
1	N60P110K40	Control	1.7	4.7	10.7	24.3
2	N60P110K40	Oksigumat Ekstra, 1 L ha ⁻¹	2.0	5.6	11.7	24.8
3	N60P110K40	Oksigumat Ekstra, 2 L ha ⁻¹	2.2	5.7	12.1	25.6
4	N60P110K40	Oksigumat Ekstra, 3 L ha ⁻¹	2.4	6.1	12.5	26.8
5	N60P110K40	Rokogumin, 1 L ha ⁻¹	1.9	5.0	11.7	24.9
6	N60P110K40	Rokogumin, 2 L ha ⁻¹	2.3	5.9	12.5	26.0
7	N60P110K40	Rokogumin, 3 L ha ⁻¹	2.4	6.1	13.6	26.8
8	N90P165K65	Control	2.7	6.3	14.9	27.5
9	N90P165K65	Oksigumat Ekstra, 1 L ha ⁻¹	2.5	6.3	12.5	25.8
10	N90P165K65	Oksigumat Ekstra, 2 L ha ⁻¹	2.7	6.4	12.9	26.8
11	N90P165K65	Oksigumat Ekstra, 3 L ha ⁻¹	3.0	6.8	13.4	27.8



Date: 25th September-2026

No.	Mineral fertilizer, kg ha ⁻¹	Treatment	7 July	10 July	13 July	16 July
12	N90P165K65	Rokogumin, 1 L ha ⁻¹	2.8	6.7	13.2	27.2
13	N90P165K65	Rokogumin, 2 L ha ⁻¹	3.0	6.9	14.3	28.1
14	N90P165K65	Rokogumin, 3 L ha ⁻¹	3.3	7.1	15.8	28.9

Flowering under the 70 × 10 cm planting geometry

At the N60P110K40 fertilizer background, the untreated control produced 24.3 flowers plant⁻¹ by 16 July.

The Oksigumat Ekstra treatments reached 24.8, 25.6 and 26.8 flowers plant⁻¹ at application rates of 1, 2 and 3 L ha⁻¹, respectively. The highest value in this group was therefore 2.5 flowers plant⁻¹ higher than the untreated control.

The Rokogumin treatments produced 24.9, 26.0 and 26.8 flowers plant⁻¹ at 1, 2 and 3 L ha⁻¹, respectively.

On the N90P165K65 background, the untreated control reached 27.5 flowers plant⁻¹ by 16 July. Oksigumat Ekstra treatments resulted in 25.8–27.8 flowers plant⁻¹, while Rokogumin treatments produced 27.2–28.9 flowers plant⁻¹.

The highest flower count under the 70 × 10 cm geometry, 28.9 flowers plant⁻¹, was observed in the N90P165K65 + Rokogumin 3 L ha⁻¹ treatment. However, this treatment already had the highest pretreatment flower count on 7 July, at 3.3 flowers plant⁻¹. Therefore, its final superiority cannot be attributed entirely to the foliar treatment.

From 7 to 16 July, flower number increased by 22.6 flowers plant⁻¹ in the N60P110K40 untreated control. The corresponding increase was 24.4 flowers plant⁻¹ with both Oksigumat Ekstra 3 L ha⁻¹ and Rokogumin 3 L ha⁻¹.

Under N90P165K65, the control increased by 24.8 flowers plant⁻¹, while Rokogumin 3 L ha⁻¹ increased by 25.6 flowers plant⁻¹. These results indicate relatively small differences in flowering increment compared with the large overall increase associated with plant development during the observation period.

Table 2. Flowering dynamics of groundnut cv. Salomat under the 70 × 20 cm planting geometry, flowers plant⁻¹, 2021

No.	Mineral fertilizer, kg ha ⁻¹	Treatment	7 July	10 July	13 July	16 July
1	N60P110K40	Control	1.9	5.4	12.3	28.0
2	N60P110K40	Oksigumat Ekstra, 1 L ha ⁻¹	2.3	6.5	13.5	28.6
3	N60P110K40	Oksigumat Ekstra, 2 L ha ⁻¹	2.5	6.6	13.9	29.5
4	N60P110K40	Oksigumat Ekstra, 3 L ha ⁻¹	2.8	7.0	14.4	30.8
5	N60P110K40	Rokogumin, 1 L ha ⁻¹	2.2	5.7	13.5	28.7
6	N60P110K40	Rokogumin, 2 L ha ⁻¹	2.6	6.8	14.4	29.9

Date: 25th September-2026

No.	Mineral fertilizer, kg ha ⁻¹	Treatment	7 July	10 July	13 July	16 July
7	N60P110K40	Rokogumin, 3 L ha ⁻¹	2.8	7.0	15.6	30.9
8	N90P165K65	Control	3.1	7.3	17.1	31.7
9	N90P165K65	Oksigumat Ekstra, 1 L ha ⁻¹	2.9	7.3	14.4	29.7
10	N90P165K65	Oksigumat Ekstra, 2 L ha ⁻¹	3.1	7.4	14.8	30.8
11	N90P165K65	Oksigumat Ekstra, 3 L ha ⁻¹	3.5	7.8	15.4	32.0
12	N90P165K65	Rokogumin, 1 L ha ⁻¹	3.2	7.7	15.2	31.3
13	N90P165K65	Rokogumin, 2 L ha ⁻¹	3.5	7.9	16.5	32.3
14	N90P165K65	Rokogumin, 3 L ha ⁻¹	3.8	8.2	18.2	33.3

Flowering under the 70 × 20 cm planting geometry

The wider planting geometry produced higher flower numbers in every treatment when compared with the corresponding 70 × 10 cm variant.

Under N60P110K40, the untreated control reached 28.0 flowers plant⁻¹ by 16 July. The Oksigumat Ekstra treatments produced 28.6, 29.5 and 30.8 flowers plant⁻¹, whereas Rokogumin treatments produced 28.7, 29.9 and 30.9 flowers plant⁻¹.

At the higher N90P165K65 background, the control reached 31.7 flowers plant⁻¹. Oksigumat Ekstra treatments produced 29.7, 30.8 and 32.0 flowers plant⁻¹ at 1, 2 and 3 L ha⁻¹, respectively. Rokogumin treatments produced 31.3, 32.3 and 33.3 flowers plant⁻¹.

The maximum value recorded in the entire experiment was therefore 33.3 flowers plant⁻¹ in the N90P165K65 + Rokogumin 3 L ha⁻¹ treatment under the 70 × 20 cm planting pattern.

Again, this treatment had the highest pretreatment flower count, 3.8 flowers plant⁻¹, on 7 July. Its net increase from 7 to 16 July was 29.5 flowers plant⁻¹, compared with 28.6 flowers plant⁻¹ in the corresponding untreated control. The difference in net increase was therefore substantially smaller than the difference between final absolute values.

Averaged across seven treatments, flower number on 16 July under 70 × 10 cm was 25.60 flowers plant⁻¹ with N60P110K40 and 27.44 flowers plant⁻¹ with N90P165K65. The difference was 1.84 flowers plant⁻¹, corresponding to approximately 7.2%.

Under 70 × 20 cm, the mean flower number was 29.49 flowers plant⁻¹ with N60P110K40 and 31.59 flowers plant⁻¹ with N90P165K65. The increase associated with the higher fertilizer background was 2.10 flowers plant⁻¹, or approximately 7.1%.

Correct interpretation of the biostimulant treatments requires special attention to application timing.

The preparations were applied on 8 July, while the first flower count was made on 7 July. Therefore, differences among experimental variants on 7 July cannot represent responses to Oksigumat Ekstra or Rokogumin.

Date: 25th September-2026

Pretreatment differences were apparent in both planting geometries and fertilizer backgrounds.

For example, under N60P110K40 and 70×20 cm, the untreated control had 1.9 flowers plant⁻¹ on 7 July, whereas the treatments assigned to Oksigumat Ekstra 3 L ha⁻¹ and Rokogumin 3 L ha⁻¹ already had 2.8 flowers plant⁻¹ before application.

By 16 July, these treatments reached 30.8 and 30.9 flowers plant⁻¹, respectively, compared with 28.0 in the control.

When the pretreatment values are considered, the increase from 7 to 16 July was 26.1 flowers plant⁻¹ in the control, 28.0 with Oksigumat Ekstra 3 L ha⁻¹ and 28.1 with Rokogumin 3 L ha⁻¹.

Under N90P165K65 and 70×20 cm, the corresponding increase was 28.6 flowers plant⁻¹ in the control, 28.5 with Oksigumat Ekstra 3 L ha⁻¹ and 29.5 with Rokogumin 3 L ha⁻¹.

Thus, the final absolute values alone may overstate the apparent treatment response because the experimental variants did not start from identical flowering levels.

Nevertheless, a tendency toward higher flower numbers with increasing treatment rates was observed in several groups, particularly for Rokogumin at 2–3 L ha⁻¹.

For example, under N90P165K65 and 70×20 cm, Rokogumin at 1, 2 and 3 L ha⁻¹ resulted in 31.3, 32.3 and 33.3 flowers plant⁻¹ on 16 July. A similar numerical pattern was observed under N60P110K40, where Rokogumin at 1, 2 and 3 L ha⁻¹ produced 28.7, 29.9 and 30.9 flowers plant⁻¹.

Oksigumat Ekstra also showed increasing values with higher application rates within several treatment groups. However, not all biostimulant treatments exceeded the untreated control. Under N90P165K65, for example, Oksigumat Ekstra at 1 L ha⁻¹ produced fewer flowers than the untreated control at both planting geometries.

Therefore, the dataset does not justify a general conclusion that any application of a biostimulant automatically increased flowering. The most consistent responses observed in the experiment were associated with planting geometry and mineral fertilizer background.

Flowering intensity is important for groundnut because only a proportion of flowers ultimately develop into gynophores and mature pods.

Early and intensive flowering during the period with favourable temperature and moisture conditions may increase the potential number of reproductive structures that have sufficient time to complete pod filling before harvest.

Previous recommendations for groundnut cultivation under Uzbekistan conditions emphasize that late flowers and gynophores formed in August frequently fail to produce fully mature pods [2]. Therefore, crop management practices that favour active reproductive development during June and July may have practical importance.

The results of the present experiment indicate that providing a larger feeding area per individual plant increased flower formation during this critical period.

However, greater flower number per plant does not necessarily mean greater yield per unit area because wider spacing simultaneously reduces plant population density.



Date: 25th September-2026

Consequently, the optimum planting geometry should be determined by integrating flower formation with plant density, pod number, seed weight, final yield and economic efficiency.

CONCLUSION

1. Flower formation increased rapidly between 7 and 16 July under all experimental treatments.
2. Planting geometry had a consistent association with flower number per individual plant.
3. Mean flower number under 70×10 cm increased from 2.49 flowers plant⁻¹ on 7 July to 26.52 flowers plant⁻¹ on 16 July.
4. Under 70×20 cm, flower number increased from 2.87 to 30.54 flowers plant⁻¹ during the same period.
5. On 16 July, plants grown at 70×20 cm produced on average 4.01 more flowers plant⁻¹ than plants grown at 70×10 cm, corresponding to approximately 15.1%.
6. The mean increase between 7 and 16 July reached 24.03 flowers plant⁻¹ at 70×10 cm and 27.66 flowers plant⁻¹ at 70×20 cm.
7. The higher mineral fertilizer background, N90P165K65, was associated with approximately 7% more flowers per plant on 16 July than N60P110K40 under both planting geometries.
8. The highest absolute value in the experiment, 33.3 flowers plant⁻¹, was recorded under 70×20 cm + N90P165K65 + Rokogumin 3 L ha⁻¹.
9. A tendency toward increasing flower number with increasing biostimulant rate was observed in several treatment groups, particularly with Rokogumin.
10. Because pretreatment differences were already present on 7 July and statistical significance parameters were not available, these differences should be interpreted as descriptive tendencies rather than statistically proven treatment effects.
11. Overall, increasing the feeding area from 700 to 1400 cm² per plant was the most consistent agronomic factor associated with enhanced flowering of individual groundnut plants.

REFERENCES:

1. Amanova, M., Bo'riev, X., & Rustamov, A. (2011). Methodological Guide for Studying Morphological Characteristics of Groundnut. Tashkent, 26 p.
2. Nurmatov, Sh.N., Azizov, T.B., et al. (2010). Recommendations on Groundnut Cultivation Technology under Irrigated Conditions. Tashkent: Uzbekistan Scientific Production Centre, Experimental Station of Oil and Fibre Crops.
3. Atabaeva, X.N., Umarov, Z.U., Bo'riev, H.Ch., et al. (2000). Plant Science. Tashkent: Mehnat, pp. 241–243.
4. Amanova, M., Rustamov, A. (2010). Guide for Studying the World Collection of Oilseed Crops. Tashkent, pp. 4–9.



Date: 25th September-2026

5. Abdullaev, A.A. (1997). Effect of Plant Density and Fertilizer Rates on Groundnut Productivity under Grey-Brown Soil Conditions of the Fergana Region. Abstract of Candidate of Agricultural Sciences Dissertation. Tashkent, 20 p.

6. Nabiev, T.N., Kurbanova, B.A., & Shotemur, Sh. (2016). Effects of plant density on groundnut growth and development. Kishovarz: Agricultural Sciences, 4, 4–7.

7. Methods of Conducting Field Experiments. (2007). Tashkent: UzPITI, 131 p.

8. Nichiporovich, A.A. (1963). On ways of increasing photosynthetic productivity of plants in crop stands. In: Photosynthesis and Problems of Plant Productivity. Moscow: Nauka, pp. 5–53.

