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Effect of Planting Patterns on the Growth, Development, and Productivity of Vegetable Bean

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Annotation: The article presents experimental data on the growth and development of vegetable bean (Phaseolus vulgaris L.) cultivars Ravot and Mahsuldor grown under different planting patterns (plant densities). The study reports variations in plant height (50.4–68.8 cm), number of lateral branches (3.2–6.7), number of leaves (36.1–69.3), shoot biomass (170.1–356.2 g), leaf biomass (54.2–74.5 g), root biomass (7.3–13.8 g), and green pod yield (8.4–14.9 t/ha).

Keywords: vegetable crops; food legumes; vegetable bean; nutrition area; planting pattern; plant height; lateral branching; leaf number; shoot biomass; root biomass; pod formation; milk ripeness; productivity; yield.

Introduction

Vegetable bean (common bean) is one of the twelve most important vegetable crops cultivated worldwide. Due to its superior taste quality and nutritional value, it surpasses many other leguminous crops [1, 9]. One hundred grams of fresh (technically mature) green pods contain 2.4 g protein, 0.2 g fat, 5.1 g carbohydrates, 250 mg potassium, 55 mg calcium, 40 mg phosphorus, 0.8 mg iron, 20 mg vitamin C, 0.33 mg vitamin A, and 0.12 mg vitamin B1. The energetic value of cooked bean seeds reaches 297.4 kcal (1236 kJ), while green pods contain 33 kcal (138 kJ) per 100 g [3, 6].

One of the most important characteristics of vegetable bean is its low nitrate accumulation; freshly harvested green pods contain approximately 500 mg/kg nitrates [7]. The proteins in bean

seeds include all essential amino acids. Due to their high solubility, the amino acids are readily digestible and efficiently absorbed by the human body [8, 10].

Materials and Methods

Field experiments were conducted during 2023–2025 at the experimental fields of the Information and Advisory Center of the Samarkand Institute of Agroinnovations and Research. During the trials, phenological observations and biometric measurements were performed based on the methodological manuals **"Methods of Conducting Experiments in Vegetable, Melon and Potato Crops"** [5] and **"Methodology of Field Experiments"** [2].

In the experiment, seeds of two vegetable bean (*Phaseolus vulgaris* L.) cultivars — **Ravot** and **Mahsuldor** — were sown at different planting patterns (plant densities):

70×5 cm (285.7 thousand plants/ha), 70×10 cm (142.8 thousand), 70×15 cm (95.2 thousand – control), 70×20 cm (71.4 thousand), and 70×25 cm (57.1 thousand).

The number of replications was four. The area of each experimental plot was **56 m²**, and the total experimental area was **2240 m²**.

Analysis and Results

One of the most critical agro-technological elements in vegetable crop cultivation is the **optimal spatial arrangement of plants**, i.e., selecting an appropriate planting pattern or plant nutrition area [4]. To determine the most suitable planting scheme for vegetable bean grown as a main crop, the Ravot and Mahsuldor cultivars were compared under different plant densities.

In our experiments, when the Ravot cultivar was grown under planting patterns of **70×5, 70×10, 70×15 (control), 70×20, and 70×25 cm**, the average biometric indicators per plant were as follows: **plant height – 50.4–59.9 cm, number of lateral branches – 3.2–5.2, number of leaves – 36.1–66.3, shoot biomass – 170.1–340.7 g, leaf biomass – 54.2–70.2 g, and root biomass – 7.3–12.1 g.**

Before harvest, the proportion of surviving plants per unit area varied depending on plant density and ranged between **80.7–87.4%**, equivalent to **49.9–230.5 thousand plants/ha**. With increasing plant nutrition area (70×20 and 70×25 cm), the Ravot cultivar showed the highest values for several biometric indicators before harvest:

survival rate – 86.1–87.4%, number of lateral branches – 4.9–5.2, number of leaves – 58.1–66.3, leaf biomass – 64.5–70.2 g, shoot biomass – 268.3–340.7 g, and root biomass – 10.4–12.1 g. Compared with the control (70×15 cm), these treatments exceeded it by: **1.2–2.5% in survival rate, 0.4–0.7 branches, 8.4–16.6 leaves, 4.8–10.5 g leaf biomass, 40.8–113.2 g shoot biomass, and 1.2–2.9 g root biomass.**

Thus, widening the plant nutrition area generally improved vegetative and productive organ formation in the Ravot cultivar. The only exception was plant height, where a reverse trend was observed — narrower spacing produced taller plants due to increased intra-specific competition.

In the Ravot cultivar, depending on planting pattern, the number of pods per plant ranged from **13.7–25.6**, and pod biomass from **56.2–168.9 g**. The increase in both pod number and pod biomass was directly associated with increasing plant nutrition area. A similar trend was observed in the Mahsuldor cultivar. Under different planting densities, biometric indicators were higher than Ravot and varied as follows: **plant height – 58.7–68.8 cm, number of lateral branches – 4.3–6.7, number of leaves – 43.1–69.3, shoot biomass – 177.2–356.2 g, leaf biomass – 58.1–74.5 g, and root biomass – 8.1–13.8 g.** The proportion of surviving plants per unit area ranged from **81.7–88.1%**, equivalent to **50.3–233.4 thousand plants/ha**.

In this cultivar, productivity indicators were also higher:

the number of pods per plant ranged from 15.1–30.3, and pod biomass from 60.4–184.8 g, depending on planting pattern.

Figure 1. General view of the experimental field and the formation of yield components in a single plant of vegetable bean.

Productivity and Yield Dynamics

When the Ravot and Mahsuldor cultivars of vegetable bean were grown under different planting patterns, the expansion of plant spacing and nutrition area led to an **increase in per-plant productivity**. However, due to the **reduction in the number of plants per hectare**, the **overall yield per hectare decreased**. Depending on the cultivar and planting pattern, the green pod yield varied between **8.4–13.6 t/ha** for Ravot and **9.3–14.9 t/ha** for Mahsuldor.

Conclusion

When the Ravot and Mahsuldor cultivars of vegetable bean were cultivated as a main crop using the **70×10 cm planting pattern**, the proportion of surviving plants per hectare reached **83.5–84.2%**, corresponding to **119.2–120.2 thousand plants per hectare**. Under this spacing, the **per-plant productivity** reached **114.3–124.0 g**, while the **green pod yield** amounted to **13.6–14.9 t/ha**, ensuring optimal productivity and efficient use of the nutrition area.

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