The characteristics of hill-drop and potting techniques for growing different bean varieties in the protected ground

Gohar Kirakosyan, *Gayane* Sargsyan, *Iryna* Vardanian*, *Alvina* Avagyan, *Irina* Tsereteli and *Anna* Hakobyan

Scientific Center of Vegetable and Industrial Crops, Ministry of Economy of the Republic of Armenia, 38, st. D.Ladoyan, com. Darakert, Ararat region, Republic of Armenia

Abstract. The research has been conducted in the experimental greenhouses of Scientific Center of Vegetable and Industrial Crops, RA in 2020-2021. Bean varieties were grown without heating during the spring vegetation period. It has been empirically established that per all growing and development indices the best results have been recorded in the local bean varieties of Zepyur (control), Gohar, Ghapan variety-population and in the foreign variety White Ruler cultivated through potting and hill-drop technique. Throughout research activities it has been disclosed that in unheated greenhouse conditions (in the spring vegetation period) the application of pot planting method has been more feasible and effective than hill-drop planting (direct-seeded plants) technique, since the former technique promotes long-lasting fruiting of plants, development of a powerful root system, foliage improvement and, ultimately, a higher yield capacity (the yield surplus was 0.9-1.2 kg/m^2).

1 Introduction

Plant cultivation through pot planting method has been practiced in our republic since 1954. In the initial period the pot planting method was applied mainly for the development of tomato, cucumber and cabbage seedlings for the cultivation thereof in the open field. Anyhow, in the recent years, the range of the mentioned crops have considerably expanded and they are grown not only for the cultivation in the open field but also for that of in the protected ground. Growing seedlings through pot planting method has a number of advantages. The plants are relatively more nutrient-demanding at the younger age than later. The nutrient mixture of humus and turf slightly spread out in the greenhouse suffice only for the first two weeks, thereafter the soil mixture gets poor in the salts required for plants nutrition. The situation is different for the seedlings grown in the pots. Pots have favorable medium for plants nutrition not only throughout the seedling period but also after transplanting them in the ground.

Growing the plants via pot planting method enables to harvest the vegetable yield 10-15 days earlier as compared to the results recorded in case of traditional growing method. Besides, the mentioned method significantly increases the crops yield capacity [1-2].

* Corresponding author: irinvardanian@gmail.com

Considering the above stated and the growing demand for bean worldwide, an objective has been set up to study the growing of bean crops upon the pot planting and hill-drop planting methods in unheated greenhouse conditions [3].

2 Materials and methods

Bean varieties having demonstrated the best results, namely Zepyur (control), Gohar, Ghapan and White Ruler variety-population, have served as study objects.

The experiments were carried out in the glass greenhouse of the Scientific Center of Vegetable and Industrial Crops, RA in 2020-2021. The bean variety samples were grown with spring rotation (without heating).The seeding was implemented through two methods: hill-drop and pot planting.

To evaluate the characteristics of the plants grown via plot planting and hill-drop methods, phenological observations, bio-morphological descriptions, yield calculation through weighing method were carried out during the vegetation period. The total and marketable yield was calculated. The mathematical processing of yield numerical data was conducted through the method of dispersion analysis [4].

3 Results and Discussion

Significant morphological variations have been recorded in the studied variety samples depending on the growing method. The studies have revealed that the pot seedlings have developed denser root systems rich in hair roots than those grown with hill-drop method.

A number of authors have reported that a well-developed rhizosystem increases the plants feeding area, therefore improves growing, development and yield capacity indices [5-7].

The investigations have shown that if the shoots of pot seedlings were thicker and shorter, then those grown through hill-drop method were thinner and longer. The stems of mature plants haven't considerably varied regarding the branching coefficient. All variety samples have shown the same results except from the White ruler, the branching index of which has been higher in case of pot plant growing method than in case of hill-drop growing method.

After transplanting in the ground, the plants grown via pot planting method have developed faster, the leaf formation intensity has been higher than in the plants grown through hill-drop planting method and the mentioned indices are of much significance for high yield capacity [8-10]. In all variety samples under study high foliation index has been recorded in case of pot planting method.

During the investigation years, no significant difference was observed regarding the pulse forms; the main variations were recorded in the pulse color and average mass. The pulses of the plants grown via pot planting method were distinguished with darker color and higher mass from those grown via hill-drop method (tables1-2).

The main significant difference in case of pot planting and hill-drop planting methods was related to the transition periods of phenophases and the duration of vegetation and fruiting periods. The first essential difference was recorded within the seeding-sprouting period. Unlike hill-drop sowings, where the sprouting/germination phase fluctuated within 5-7 days, in case of pot sowing it lasted 4-5 days. After sprouting phase in the pot plants the real first and second leaves got intensively developed. The sprouting-blossoming inter-phasal period lasted 27-33 days in the pot plants, while in those grown via hill-drop method it amounted to 30-36 days.

The difference of the sprouting-technical maturity phases in the plants grown through the two mentioned methods fluctuated within 7-9 days, which is very important for getting

early yield in greenhouse conditions. The duration of the mentioned phase made 48-52 days in the pot plants, while in case of direct-seeded plants it amounted to 55-59 days.

Table 1. Phenological and morphological characteristics of the been variety samples grown via pot planting and hill-drop planting methods (average for 2020-2021)

Growing method	No	Variety	Leaf formation	Seeding-sprouting, day	From sprouting to, day		Yielding duration of the green pulses, day
					blossoming	ripening	
Pot planting	1	Zepyur (control)	Intense	4	30	50	115
	2	Gohar	Intense	4	27	48	120
	3	Ghapan	Intense	5	33	52	105
	4	White ruler	Intense	5	32	50	110
Hill-drop planting	1	Zepyur (control)	Average	5	35	59	105
	2	Gohar	Intense	5	30	55	109
	3	Ghapan	Intense	6	36	59	98
	4	White ruler	Intense	7	36	57	103

Apart from early harvest the duration of fruiting period is also significant. The studies have disclosed that the earlier bean indeterminate varieties pass to fruiting phase, the longer their fruiting period lasts. In the plants grown through pot planting method the mentioned period lasted 105-120 days, which exceeds the direct-seeded plants by 7-11 days. In both variants the longest fruiting period was recorded in Gohar bean variety, which in case of hill-drop seeding made 109 days, while in pot plants it lasted 120 days. The shortest yielding period in case of hill-drop and pot planting methods was recorded in Ghapan variety-population, which made 98 and 105 days, respectively.

The yield capacity of green pulse per unit area fluctuated within 9.1-15.7kg in case of direct-seeded plants, while in case of pot planting it was within 11.4-16.6kg. Per the investigated variety samples, the yield surplus of the plants grown through pot planting method compared to those grown via hill-drop method has amounted to 5.73-25.3% (table2).

The high yield capacity of green bean varieties is related to the yield elements such as number of pulses per plant, their mass, number of pods per pulse, as well as the weight of 1000 pods. These features are mainly determined by the genetic characteristics of the variety. Anyhow, their efficiency is greatly dependent on the soil and climatic conditions of that specific zone and the applied agro-technical measures. Hence an objective has been set up to investigate the impact of hill-drop (direct-seeded) planting and pot planting techniques on the yielding elements of variety samples.

The productivity of vegetable bean varieties is determined by the yield of green pulses, which is determined not only by the number of pods, but also by their mass. In the selection works carried out to increase the productivity of plants, individual study of yielding elements and the identification of the most important ones are important.

The results of the research carried out in this direction have revealed that there is an inversely proportional relation between the number and mass of the plant pulses grown via hill-drop and pot planting methods. The variety White Ruler stands out for the highest number of pulses per plant (101.2 and 105.6 items) in conditions of both hill-drop and pot planting methods, which is respectively 79.4% and 84.9% higher as compared to those grown on the Zepyur control variety. As to the indexes of pulses mass, among the

researched varieties, only the variety of Gohar has demonstrated the highest mass under the conditions of both cultivation methods. Regarding the average pulses mass it has exceeded the Zepyur control variety by 16.5 and 14.4%, respectively (table 3).

Table 2. Bio-economic characteristics of the bean green pulses in case of pot planting and hill-drop planting methods (average for 2020-2021)

Grow. method	No	Variety	Green pulse				*Yield capacity of the green pulse, kg/m^2	Yield surplus kg/m^2	Yield surplus %
			Length cm	Width cm	Weight g	Form/ color			
Pot planting	1	Zepyur (control)	20.5	1.85	19.1	Flat/ dark green	13.7	0.9	7.03
	2	Gohar	25.5	2.49	25.8	Flat wide/ intense green	16.6	0.9	5.73
	3	Ghapan	14.5	1.36	15.2	Sabre-shape/ dark green	11.6	1.0	9.43
	4	White ruler	8.9	0.55	6.1	Round longish/ dark green	11.4	2.3	25.3
							*$LSD_{0.95}$-0.32 kg, S_x- 0.7%		
Hill-drop planting	1	Zepyur (control)	20.4	1.8	18.9	Flat, green	12,8	-	-
	2	Gohar	25.2	2.4	25.5	Lat wide/ green	15,7	-	-
	3	Ghapan	14.2	1.3	14.6	Sabre-shaped/ dark green	10.6	-	-
	4	White ruler	8.6	0.5	5.6	Round-longish/ dark green	9.1	-	-
							*$LSD_{0.95}$-0.32kg, S_x-0.8%		

The analysis of the table data describing the elements of yield capacity makes it obvious that the number of pods per pulse is one of the least fluctuating indices. Moreover, during the investigation years it was the least changeable index in each variety grown through hill-drop (direct-seeded) and pot planting method.

Among the investigated varieties the highest pod number has been observed in the Gohar variety (8.9 items) cultivated via pot planting method, which has exceeded the Zepyur control variety by 14.1 % and in conditions of hill-drop cultivation method again only the variety of Gohar has exceeded the control option in the pod number, which amounts to 15.5%. The least pod number has been developed in the variety of White Ruler (7.1 and 7.2) in conditions of hill-drop and pot planting methods, which conceded the control variant by 7.7 and 7.6% respectively.

Table 3. The description of yielding elements in the researched variety samples.

Growing conditions	N	Name of variety	Average number of pulses per plant, n	Average pulse mass, g	Average number of pods in a pulse, n	Mass of 1000 pods, g
Pot planting	1	Zepyur (control)	57.1	12.5	7.8	456.1
	2	Gohar	56.8	14.3	8.9	489.2
	3	Ghapan	50.9	8.6	7.5	401.5
	4	White ruler	105.6	5.7	7.2	351.4
Hill-drop (direct-seeded)	1	Zepyur (control)	56.4	11.5	7.7	446.8
	2	Gohar	52.1	13.4	8.9	480.5
	3	Ghapan	49.5	8.3	7.4	400.5
	4	White ruler	101.2	4.6	7.1	325.6

4 Conclusion

The research results show that under greenhouse conditions in the spring rotation (without heating) it is more relevant and feasible to implement pot planting method for bean cultivation, since in case of applying the mentioned method the yielding period gets extended, more developed root/ rhyzosystem is formed, the foliation coefficient gets higher and the last but not least improved yield quality and yield capacity is ensured as compared to the same indices observed in the direct-seeded plants

References

1. Grigoryan G., *Growing pot seedlings in collective farms.* (Armstatepub, Yerevan) 46 (1955)
2. Kirakosyan G. V., Bio-morphological features and selective assessment of bean cultivars in conditions of Ararat Valley. *Plant breeding*, Yerevan, 31-40 (2015)
3. Zotikov V. I., Sidorenko V. S., Gryadunova N. V., Development of the production of leguminous crops in the Russian Federation . *Leguminous and cereal crops*. **2 (26).** 2-10 (2018)
4. Khachatryan A. R., *Agronomic research methods* (Yerevan) 231 (2002)
5. Vashchenko S. F., Chekunova Z. I., Savinova N. I. et al. *Vegetable growing in protected ground, 2nd ed., revisedand updated* (Moscow, Kolos) 272 (1984)
6. Yakubenko O. E., Parkina O. V., Technology of organizing a green bean conveyor. *Young scientists in solving urgent problems of science*. Troitsk: South Ural State Agrarian University, 318-322 (2015)
7. Debely G. A. , Leguminous crops in the world and the Russian Federation. *Leguminous and cereal crops* **2** 31-35 (2012)
8. Budanova V. et all., International CMEA classifier of cultivated species of the genus Phaseolus L. Comp.: USSR. 45 (1985)

9. Pletneva M. M., Evaluation of common bean samples per economically valuable traits and grain quality for breeding in the southern forest-steppe of Western Siberia: dis. ... cand. Sciences. Tyumen 216 (2019)
10. Yakubenko O. E., Development of elements of varietal technology and assessment of the collection of vegetable beans in the forest-steppe conditions of thePriobye region. *General agronomy, plant breeding*. 75-80 (2021)