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Plant density of semi-deterninate common bean

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Abstract

Restudying of some technological elements of dry bean is necessary because of climatic changes at last years. In this aspect, since the optimal density of bean plants depends principally by the soil, climatic conditions and genotype, studying the influence of plant density in two new varieties, created by artificial hybridization, has been motivated. There were three plants density levels 150, 250 and 350 thousand of plants/ha and two varieties, L3221 and L232. The experiment was conducted at the experimental fields of ATTC Fushë Krujë, during 2007 and 2008 growing seasons. It must be accentuated that the climatic conditions, in two years of study, especially during the reproductive period, haven't been convenient for dry bean production. The data obtained, indicated that increasing of plants density is followed by the reduction of the plant cycle in 2-3 days. Furthermore, increasing three times the number of plants leads to linear decrease of production elements values. On the other hand, the increase of plants density, from 150 to 350 thousand plants/ha, has increased significantly the yield about 5 quintal/ha. Among the varieties in the study, there are no significant differences on yield, because they belong to the same growing type, but they have different characteristics, that aren't the target of this study.

Keywords: dry bean, haevest index, biological production, competition ability.

1. Introduction

During the last two decades the plant productions at the national level have been unstable. The main reason could be related with the disagreement between biological requirements of plants and climatic conditions. The implementation of a modern technology aims at mitigating most of these disagreements. Besides other elements of technology, depending mainly by farmers, such as renovation of varieties structure, the optimal time of planting, the supply of water balance, etc, ensuring the optimal number of plants/ha, is the most dynamic element of this technology. Often in the practice, our farmers use low rates of seeds, providing a reduction of plant density (from 150 to 200 thousand plants/ha). This number, combined with the current climate conditions, is a limitative factor on the growth and stability of yield. Knowing the biological requirements of bean, its compensating ability, competition between and within plants in different density of dry bean plant, would assist us to better clarify, why the application of this element of technology is more than necessarily[4,6]. The aim of this study was to investigate the effects of plant density on yield and some other characteristics of dry bean

2. Materials and methods

The study was conducted at the experimental field of ATTC- Fushe-Kruje, during the 2007 and 2008 growing seasons. The varieties used in the experiment were two dry bean lines, L-3221 and L-232 (bush indeterminate biological types), created by artificial hybridization, which currently occupies a modest area in the structure of planting. Three plant densities used in the experiment were respectively 150, 250, and 350 thousand plants/ha. The size of each variant was 15 m^2 (5x3). For each variant, 5 rows were planted. The spacing between rows was 60 cm. A randomized complete block design with four replications was used.

Planting time was between 20/04/07 and 22/04/08, almost at the optimal time, because weather conditions did not allow earlier planting. The number of plants, counting after germination, varied in differences ± 500-1000 plant/ha

Nitrogen fertilization, at the dose of 49 kg/ha was applied in the 2-3 true leaves stage (when the plants reached 10-12 cm height). During the growing season were taken notes about the phenological stages, were conducted all the managing practices, except the irrigation because of lack of water supply. At the maturation stage, 10 plants for each plot were analysed for yield components.

3. Results and discussion

The data of Table 1 showed the influence of different plant densities on entire biological cycle and on separate stages.

Table 1: The influence of plants density on plant cycle

Nr	*Varieties*	*Sowing- Germination*		*Vegetative cycle*		*Reproductive period*		**Plant cycle**	
		2007	2008	2007	2008	2007	2008	2007	2008
1	L3221+150 000	13	12	34	35	44	42	78	77
2	L 232+ 150 000	13	12	34	35	44	40	78	75
3	L 3221+250 000	13	12	33	34	43	40	76	74
4	L 232 + 250 000	13	12	33	35	44	40	77	78
5	L 3221+350 000	13	12	33	34	42	41	75	75
6	L 232 + 350 000	13	12	33	34	42	40	75	74

It is known the fact, that increasing number of plants, their biological cycle tends to shorten. Dry bean lines in our study are more or less in the same growth type, so they have similar biological and architectural structure. Therefore, the rate of shortening of entire biological cycle and its separate stages are almost the same. This reduction is mainly due to the reduction of the reproduction stage, which is more responsible for the yield. Comparing the result of two years, noted that reproductive stage was longer in 2007 than in 2008, for two lines and three respective densities. Because of this evidence, the yield obtained in 2007 should have been higher than in 2008 year. But this has no happened, because of prolongation tendency of reproductive stage, was result of the non-productive re-vegetation, caused by sporadic rainfall during the ripening stage. On the other hand, we noted an abbreviation of entire dry bean plant cycle, comparing with normally growth conditions (7-10 days), indicating that climatic conditions during the study years were stressful for the yield of dry bean. In table 2 are presented the data of production components in different plant density for both lines used in the study.

Table2: Production elements in different plants' densities ()

Nr	*Varieties*	**Production elements**								
		Pods/plant			grain/plant			g/plant		
		07	08	avg.	07	08	avg.	07	08	avg.
1	L 3221+150 000	26.5	27.6	27.5	84.1	119.1	101.6	23.4	35.4	29.4
2	L 232 + 150 000	25.8	24.0	24.9	78.6	102.3	90.5	25.3	30.4	27.8
3	L 3221+250 000	24.3	21.1	22.7	70.1	85.1	77.6	18.7	24.6	21.6
4	L 232+ 250 000	24.0	19.1	21.5	72.3	87.9	80.1	20.4	26.0	23.2
5	L 3221+350 000	18.5	16.9	17.7	60.5	60.3	60.4	16.1	19.7	17.9
6	L 232+ 350 000	17.6	15.8	16.7	61.8	58.5	60.1	16.5	18.2	17.3

These data showed that increasing the plant number leads to reducing linearly the production elements. Two cultivars in the study do not differ much for the production elements in the respective densities of plants. During optimal conditions of year, in the dry bean development verified that with increasing three times the number of plants per ha, the production elements reduced almost three times. This progressive reduction is related primarily with the compensating ability of dry bean, which except to other factors, largely depends on weather conditions and genotype. Small reduction of production elements values with increasing three times of plants number, indicates that the compensating ability of dry bean in the years of study, was small. This suggests that climatic conditions during the study years have been unsuitable for the production of beans. However, comparing the values of production elements in two years we observed significant differences. The values of pod/beans trait, fore two lines and the for three respective densities, were higher in 2007 than 2008. But the situation was different for two other production elements, grains/plant and g/plant, which resulted lower in 2007, both for densities and two varieties used in the study. This is related with climatic conditions during the stage of pod formation witch have been more tolerable by plants in 2007 than 2008. Temperatures at the stage of grain formation and maturation, which varies from 32 to 35^{0}C, have been over the thresholds of stress tolerance,. Under these conditions, the competition between grains in the pod for assimilates, was increased. This effect was reflected not only on reducing of their number but also on their weight in general. On the other hand, the re-vegetation has made that a part of assimilates, which should be allocated in the grains, be addressed into the formation of new leaves, which at this stage have played the parasite role in plants.

Case is to make a brief theoretical argumentation, both plant cycle and production elements. Achievement of a high biological production per unit area is only one component of the equation for productivity increase[3,8]. More important is the proportion between economic

(harvest index) and biological production Theoretically, it is recognized that many plants before achieve the optimal plant density, by means of which realize the maximum biological production, the separation efficiency of economic production decreases. There is a reverse relationship between competition and harvest index. Genotypes relatively not competitive, as varieties included in our study, are more suitable in high density, because the harvest index remains the same. Competitiveness of an individual into plant population, is expression of requirements for investment in such organs that grow rapidly[2,7.10]. The model of an ideal population should be a compromise between the ability of an individual, which uses the environmental components in such rates that not to prevented neighbors, investments in plant development and not to exceed the available resources. [4,5].When the competition between plants is high (high density) the investments resources of plant decrease. This fact increases the competition between the vegetative and reproductive parts of plant. This is the main reason why increasing plant density (high competition) leads to a linear reduction of production elements[1,4,9]. In the competitive genotypes (Shijaku) are favoured the vegetative parts, which leads to reduce productivity due to the reduce of harvest index. In the non-competitive genotypes (as are the variety Kallmet and those included in the study), the balance will be in favor of reproductive parts, where also the harvest index will be higher But, even in these genotypes, if the requirements are greater than the investment opportunities of plant, the growth will be shorten before the environmental resources are fully utilized. Only in this way we can explain the shortening of plant cycle when investment resources (unsuitable climatic conditions) aren’t in accordance with the requirements of the plant. In this case, the production will be low due to the insufficient biological production. An ideal plant variety should have the ability of high biological production and harvest index, even at high densities. When plants grow under strong competition, small improvements in the efficiency of of assimilates separation, are very important in determining of the final yield. As the fruit constitutes a significant proportion of the plant weight, the examination of its structures and functions can play an important role in further improving of assimilates efficiency. The pods of beans seem to be store and cumulative organs, but not knowing if this is a temporary storage for the later distribution or it acts as a competitive in the distribution of assimilates. Finally, we should emphasize that is the number and weight of individual seeds that survive which determines production. As it is important for the genotypic ability to tolerate competition, so it is for seeds to tolerate competition within the plant.

The above argumentation on competition within a plant population shows the great importance of investing resources, environmental factors and inputs, in the relationships between the particular elements of production and the final production. In table 3 is showed the yield quintal/ha according to the years yield.

Table3: The yield (Quintal / ha) according to the interations ().

Nr	*Varieties*	*Study years*		
		2007	2008	**Average**
1	L 3221 + 150 000 plants/ha	15.7	19.3	17.5
2	L 232 + 150 000 plants/ha	16.5	18.7	17.6
3	L 3221 + 250 000 plants/ha	17.6	22.4	20.0
4	L 232 + 250 000 plants/ha	17.9	22.8	20.3
5	L 3221 + 350 000 plants/ha	20.5	25.1	22.7
6	L 232 + 350 000 plants/ha	20.8	24.2	22.5
	D001	3.54	3.90	
	D005	2.69	2.72	

In present study yield were significantly affected by density of plants. In our investigation (Table 3) increased the number of plants, increase significantly and linearly the yield of the two varieties. Higher yield was obtained at the density of 350 000 plants/ha for both varieties Yield obtained in this density, was 5 quintals/ha higher than at density of 150 000 plants/ha. On the other hand, the data showed that the yield obtained in 2008 was higher than in 2007, a consequence of the higher number and weight of grains per plant in this year, compared to this elements of 2007 year, a phenomenon that was analyzed above. A such argumentation show that the plant density, in stressing conditions for the bean plant is crucial for obtaining high and stable productions. This fact showed that compensating ability through the yield elements during the two years of study, was small, because of disagreement of biological requirements of beans with these climatic conditions.

Consequently we can conclude that until we are not able to predict the development of climatic conditions the way to obtain high and stabilized yield, may be providing about 350 000 dry bean plants per ha. This number is more necessarily especially for genotypes with small competitive ability, such as varieties in the study.

Conclusions

1. The environmental conditions of study years not allow the full genetic expression of each component, fact which is reflected on the shortening of plant cycle. So the influence of studied factors on the final yield was not high.
2. However, increasing three times the number of bean plants caused a linear reduction of production elements, but this reduction did not justify the compensating ability.
3. Density of dry bean plants per hectare is determinant on the final production. Higher productivity is obtained when providing 350 000 plants/ha. This density is very important, especially for varieties with low competitive and compensatory ability.

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