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RESEARCH ON THE PRODUCTIVITY OF MAIZE INTERCROPPED WITH COMMON BEAN IN TWO SPATIAL ARRANGEMENTS, IN THE ORGANIC AGRICULTURE SYSTEM

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Abstract

Research was oriented towards studying the productivity and land equivalent ratio of maize and common bean in intercropping, in two spatial arrangements, in the organic agriculture conditions.The experiment was carried out in Moara Domneasca Experimental Field, on reddish preluvosoil, in randomised variants in 4 replications. The seed used in the experiment was obtained from ecological, material. It was sown a simple, early maize hybrid (Zea mays-DK 391) and common bean cultivar (Phaseolus vulgaris–Diva cultivar). Maize was sown at 70 cm between rows and 28.6 cm between plants per row, at a density of 5 plants/m^2. Bean was sown between maize plants at a density of 2 plants/m^2 or between maize rows at a density of 12 plants/m^2.

It was determined the productivity components, yields and land equivalent ratio, both for maize and for common bean.

INTRODUCTION

The consumers' interest in food security, respectively healthy food with high nutritional value and in the environment protection led to the development in the last decades of some concepts regarding the agricultural systems, especially the organic agriculture. One of the specific agricultural practices would be introducing of intercropping in the organic agriculture system. The main objective of intercropping is to have an additional crop without affecting the basic crop yield, or to obtain higher total economic returns.

Intercropping involves competition for light, water and nutrients. However, intercropping usually benefits from increased light interception, root contact with more soil, increased microbial activity and can act as a deterrent to pests and weeds of the other crop. In intercropping with a leguminous, a non-leguminous which needs nitrogen may benefit, since legumes will fix nitrogen in the soil (Portes, 1984; Carruthers K., 2000).

Intercropping maize with leguminous plants is an alternative to monoculture of maize (for example, maize-bean mixture represents an important production system

for the organic agriculture due to the reduction of the cultivated land area, the increase of human population and the high protein content of the bean seeds.

MATERIAL AND METHODS

The experiment was conducted in the year 2008 in Moara Domnească Experimental Field, on redish preluvosoil, in randomised variants in 4 replications. The seeds used in the experiment were obtained from ecological materials. A simple, early maize hybrid (*Zea mays* - DK 391) was sown together with common bean cultivar (*Phaseolus vulgaris* – Diva cultivar). The maize was sown at 70 cm between rows and 28.6 cm between plants per row, at a density of 5 plants/m^2. The bean was sown between the maize plants at a density of 2 plants/m^2 or between the maize rows (one row of maize and two rows of bean) at 12 plants/m^2 and 40 cm distance between rows. The spatial arrangement was as shown below (figure 1).

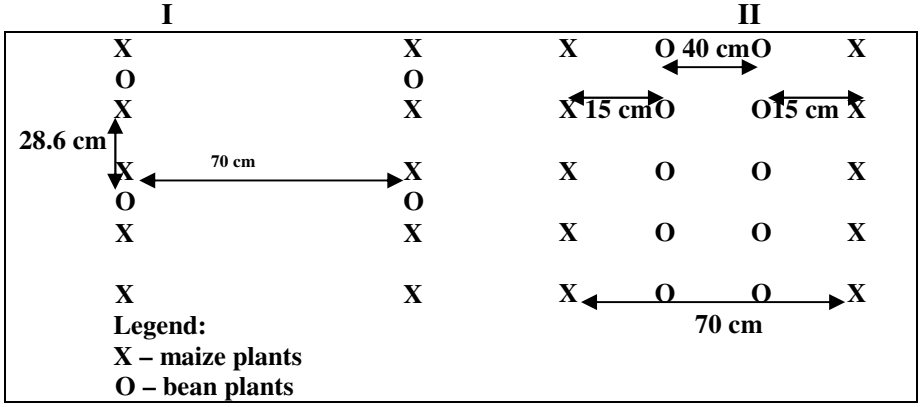

Fig. 1. The spatial arrangements for maize – common bean intercropping (I – first spatial arrangement; II – second spatial arrangement)

The observations determined the productivity components, the yield and the land equivalent ratio, both for maize and for common bean.

RESULTS AND DISCUSSION

A. Results for maize. The analysis of the productivity components of maize grown in monoculture and intercropped with bean in two spatial arrangements showed that, in monoculture, the cobs had an average length of 20 cm, with 14-16 rows of grain and 489.5 grains/cob. In monoculture, maize had a grain efficiency of approximately 82.1% and the TGW was 297.2 g. When the maize was intercropped with beans, in the first spatial arrangement, the cob was shorter, respectively 17 cm; the maize formed 14 rows of grains and their number was lower - 450 grains/cob. The grain efficiency was 81.7%, and TGW was of 290.7 g (table 1).

Compared to the first spatial arrangement, in the second arrangement the maize formed smaller cobs of 16 cm long and the number of grains rows on the cob was the same - 14. The maize cobs showed a smaller number of grains per cob, respectively 437.5, with fewer grains per row. The maize grains weight per cob was 124 g in this spatial arrangement, and the TGW was calculated to 283.4 g.

Table 1

Productivity components of maize grown in monoculture and intercropped with bean

Productivity components	*Zea mays* – maize (cobs)		
	Monoculture	Maize-bean intercropping (1st spatial arrangement)	Maize–bean intercropping (2nd spatial arrangement)
Cob length (cm)	20	17	16
Number of grain rows/cob	14-16	14	14
Number of grains/cob	489.5	450	437.5
Number of grains/row	32.6	32.1	31.25
Cob weight (g)	165	155.4	152.2
Grain weight/cob (g)	135.5	127.1	124
Grain efficiency (%)	82.1	81.7	81.4
1000-grain weight (TGW) (g)	297.2	290.7	283.4

Based on the productivity components and the sowing density, there were determined the yields, both for maize grown in monoculture and intercropped with bean, in the two spatial arrangements. The average grain yield of maize grown in monoculture was of 5044.22 kg/ha, higher than the yield of maize intercropped with bean from the first spatial arrangement, respectively 4537.8 kg/ha. In the second spatial arrangement there was obtained a lower yield, namely 4353.7 kg/ha (figure 2). Thus, in the first spatial arrangement, there was no growth of yield for the maize grown in monoculture, but the yield was 184.1 kg/ha higher compared to the maize yield from the second arrangement.

B. Results for bean. The analysis of the productivity components of bean grown in monoculture and intercropped with maize in two spatial arrangements showed that, in monoculture, the bean had an average height of 39 cm, i.e. 5 cm less than the bean intercropped with maize, in the first spatial arrangement and 1 cm less than the bean from the second arrangement.

In monoculture, the bean stems formed an average 7 fertile levels and around 12 pods per plant. On the contrary, in the first spatial arrangement of intercropping, the bean plants formed 8 levels with pods and 15 pods/plant, with 1.84 pods/level.

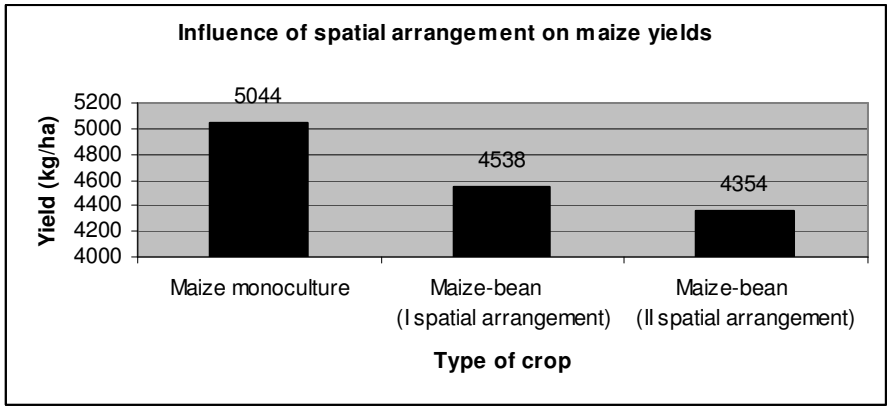

Fig. 2. The influence of intercropping on maize yields

As far as the number of seeds per plant is concerned, the bean plants formed 65 seeds when grown in monoculture, i.e. 15 fewer than when intercropped with maize, in the first spatial arrangement and 2 seeds more than in the second spatial arrangement. The number of seeds/pod at the bean plants grown in monoculture was of 5.4, with the seed weight per plant of 10.5 g. In the first spatial arrangement, the number of seeds/pod was 5.2, with the seed weight per plant of 14.25 g. In the second arrangement, the bean plants formed the same number of seeds per pod, the seed weight per plant being slightly smaller - 10.1 g. TGW in monoculture was of 161.53 g, in the first special arrangement, 182.69 g and in the second arrangement, of 160.31 g (table 2).

Table 2

Productivity components of bean grown in monoculture and intercropped with maize

Productivity components	***Phaseolus vulgaris* – common bean**		
	Monoculture	**Maize-bean intercropping (1st spatial arrangement)**	**Maize–bean intercropping (2nd spatial arrangement)**
Plant height (cm)	39	44	40
Number of pod levels/plant	7	8	6.5
Number of pods/plant	12	15	12
Number of pods/level	1.71	1.87	1.84
Number of seeds/plant	65	78	63
Number of seeds/pod	5.4	5.2	5.25
Seed weight/plant (g)	10.5	14.25	10.1
1000 – seed weight (TGW) (g)	161.53	182.69	160.31

When grown in monoculture, the bean plants had an average yield of 1361 kg/ha; when intercropped with maize, in the first spatial arrangement they had a yield of 570 kg/ha and in the second spatial arrangement (one row of maize and two rows of bean), a yield of 1212 kg/ha (figure 3).

Thus, the bean plants from the first spatial arrangement had a yield lower by 791 kg than those grown in monoculture, due to the lower density of the crop, which were intercropped through maize plants. In the second spatial arrangement of maize-bean intercropping, the yield slightly decreased by 149 kg.

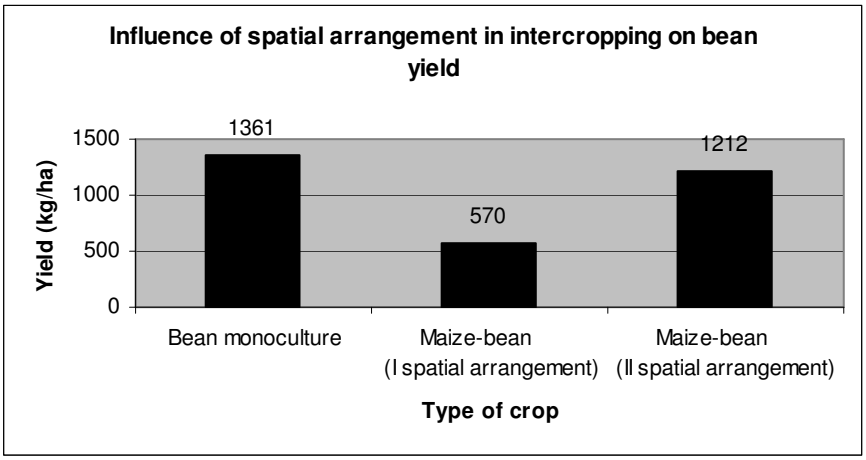

Fig. 3. The influence of intercropping on bean yields

The partial and total land equivalent ratio (LER) was also determined during the research. Thus, LER ranged between 1.3 for the first spatial arrangement of maize-bean intercropping and 1.75 for the second arrangement. These values show that there is a real advantage of intercropping beans with maize as compared to monoculture. For these two values, 30% respectively 75% extras land would be necessary to produce the combined yields of all crops if they were to be grown as pure stands (table 3).

CONCLUSIONS

1. When intercropped, the maize plants from the first spatial arrangement developed better than those from the second arrangement. This is due to the lower density of the bean crop and the lower competition for soil water and nutrients.
2. The average grain yield for maize grown in monoculture was 5044.2 kg/ha. In the first spatial arrangement, there was no growth of maize yield

compared to monoculture. Nevertheless, the yield was 184.1 kg/ha higher than in the second spatial arrangement.

3. The beans plants from the first spatial arrangement developed better than those from the other spatial arrangement and those grown in monoculture. This means that, although the bean plants were intercropped through the maize plants, they did not compete for water and nutrients.
4. When grown in monoculture, the beans plants had a yield of 1361 kg/ha. When intercropped with maize, in the first spatial arrangement, their yield was 791 kg lower than in monoculture, due to the lower density of crop and the maize shading. In the second spatial arrangement of maize-bean intercropping, the yield decreased by only 149 kg, which means that a higher crop density may result in higher yields.
5. The value of the land equivalent ratio (LER) ranged between 1.3 for the first spatial arrangement of the maize-bean intercropping and 1.75 for the second arrangement. Thus, intercropping lead to overall higher LER values, the land being better exploited when maize is mixed with bean.

Table 3

Land equivalent ratio for maize intercropped with common bean in two spatial arrangements

	Type of crop	**Intercrop yield (kg/ha)**	**Monoculture yield (kg/ha)**	**Partial LER**
(1st spatial arrangement)	**Maize**	4537.8	5044.22	0.89
	Bean	570	1361	0.41
Total LER	**-**	-	-	**1.3**
(2nd spatial arrangement)	**Maize**	4353.7	5044.22	0.86
	Bean	1212	1361	0.89
Total LER	-	-	-	**1.75**

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