International Journal of Agriculture and Environmental Research

ISSN: 2455-6939

Volume:04, Issue:06 "November-December 2018"

ANALYSIS OF SOME GROWTH AND PRODUCTION TRAITS IN COMMON BEAN AS MONOCROP AND IN ASSOCIATION WITH MAIZE IN KOSOVO

Avni Behluli[1], Agim Canko[2] and Shukri Fetahu[1]

[1]University of Prishtina "Hasan Prishtina", Faculty of Agriculture and Veterinary, Department of Plant Production, Prishtina, Kosovo

[2]Agricultural University of Tirana, Department of Plant Production, Tirana. Albania.

ABSTRACT

Two common bean landraces (*Phaseolus vulgaris* L.), "Trenaria" and "Peja" representing the indeterminate growth habit were tested in two cultivation systems: monoculture and in association with maize hybrid NS444 (*Zea mays* L.). The aim of the research was to find the advantages of the cultivation system of the common bean populations of indeterminate growth habit based on performance of physiological growth traits and production elements. The experiment was conducted during the cultivation season of 2016 and 2017 in the agro-ecological conditions of Prishtina. Experimental design was random complete block with three replications, with genotype respectively population, cultivation system and year as main factors and other sub-factors. The studied parameters were growth traits: Leaf area index (LAI), crop growth rate (CGR) and net assimilation rate (NAR), as well as yield components: pods number per plants ($PNplant^{-1}$), grain number per plant ($GNplant^{-1}$), grain weight per plant ($GWplant^{-1}$) and grain weight per unit area (GWm^{-2}). Research data were subject of ANOVA variance analysis. The results of the study showed significant differences between common bean landraces in both systems and years of cultivation. Landraces in the monoculture system showed better performance for all studied parameters. Therefore, based on the obtained data, could be concluded and recommended the cultivation of common bean in Kosovo in the monoculture cultivation system, because of its advantage in terms of production compared to the system in association with maize.

Keywords: Common bean, maize, cultivation system, growth traits, yield

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1. INTRODUCTION

In Kosovo the cultivation of common bean in association with maize is almost widespread and is become a traditional cultivation system. It was conditioned firstly by the limited areas and the lack of beans cultivar suitable for monocropping production system. As consequence, farmers for a long time and now days continue to cultivate the seed of the common bean landraces created by own cultivation traditions and practices (Fetahu, 2012).

The intercropped cultivation system is a method of cultivation of more than one crop simultaneously in alternate rows of the same field (Beets, 1990). It means cultivation of two or more species or crops in the same field during the growing season (Ofori and Stern, 1987). The common characteristics of different forms of association is their advantage of using environmental resources more efficiently (Francis, 1989; Li et al., 2003; Zhangand Li, 2003; Li et al., 2006); (Javanmard et al., 2009; Dahmardeh et al., 2010), and increasing the yield and quality of crop (Shenand Chu, 2004; Dahmardeh et al., 2010).

Different competition indices have calculated the advantage of the association and the effect of competition between the two species. The effectiveness of intercropping based on use of the environmental resources in comparison to sole cropping was indicated by Land Equivalent Ratio (LER) (Willey 1985).

Improving the production of common bean by analyzing the production components has continued for a long time and without underestimating the positive results, it is often noticed that the increase in the value of a component is counter-balanced by the low values of the other elements. This indicates that a particular individual, but the population as well, is a well-integrated system (Olivieri et al, 1989).

Various studies on the effect of the association of maize with common bean found that maize yield is not affected by the effect of association with common bean, while the yield of common bean in other side was reduced (Tsubo et al., 2005). Crop growth traits such as leaf area index (LAI), net assimilation rate (NAR), relative growth rate (RGR) and leaf area ratio (LAR) are important traits in the physiology of the crop. These parameters may relate to the growth and competition of crop in association (Olasantan et al., 1996). Ozalkan et al. (2010) showed that LAI and CGR in the flowering stage have been identified as the main yield determinants. Addo-Quaye et al. (2011) found higher LAI values in the soybean as a sole crop than in association with maize. According to the authors, the low LAI performance of soybean in association with maize was due to the shading effect caused by the taller maize plants that reduce the light intensity.

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Plant morphology, as well as the particular components of production, being a manifestation of the genotype may vary depending on the environment and the cultivation technique. Achieving a high biological yield per unit area is only one component in the performance yield equation (Donald, 1976). It is equally important the ratio of distribution of biological production to economic yield. Based on these processes lies the photosynthesis and transpiration, which in turn depend on the leaf area, the rate of dry matter accumulation, the plant architecture of genotype and other environmental and technological factors (Canko et al., 2013; Behluli et al., 2018).

Therefore, this study may serve to better know the physiological bases of common bean production in different cultivation systems with a particular focus on the analysis of leaf area index, crop growth rate and the net assimilation rate, and production elements as well.

2. MATERIAL AND METHODS

2.1. Description of the experimental site

The experiments were conducted at the Experimental Didactic Farm of the Faculty of Agriculture and Veterinary in Prishtina, which is located at the geographical location 42°38'97"N and 21°08'45'E, with an altitude of 570 m.a.s.l.

2.2 Plant material

In the study, two common bean landraces were set up, representing the indeterminate growth habit. One was originating from Albania ("Trenaria"), while the other landrace from Kosovo ("Peja"). Both landraces had white seeds and adaptability in wide range of agro-climatic conditions in the country. In the experiment was also used a maize hybrid "NS444", which was used as association crop.

2.3. Experimental design

The experiment was set up during 2016 and 2017, according to the randomized block scheme with three replications, with the genotype i.e. landrace, cultivation system and year as the main factors, as well as the parameters as sub factors. For each landraces were planted 6 rows of 3 m length and 60cm x 30cm distance, to ensure the number of plants 5.5 plants per m2. Planting was done in two separate plots. In the first experimental plot were sown common bean and maize seeds, where 2 seeds of each crop were threw in the same hill. Whereas, in the next plot, were planted only common bean seeds without maize (Table 1). In order to avoid the lodging and to ensure the normal growth of the common bean plants was applied the supporting system with strings and wooden stakes, trellis supporting system.

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Table 1: Plant spacing and expected population density for common bean and maize.

Plant	Cultivar	Spacing	Plant/ Hill	Expected number of plants	
				m^2	Ha
Common bean	"Trenaria-S"	60cm x 30 cm	2	5.55	55.555
	"Trenaria-M"				
	"Peja-S"				
	"Peja-M"				
Maize	"NS444"	60cm x 30 cm	2	5.55	

–S and –M represent the cultivation system: S-sole (monocrop) and M-in maize association

2.4. Planting and cultivation practices

The field was ploughed and harrowed just before planting. Planting was done on 11.05.2016 and 13.05.2017. In the same hill were thrown simultaneously 2 common bean and maize seeds to provide at least one plant for each hill. Prior to planting, doses of mineral fertilizers NPK 15-15-15 were applied at the rate of 250 kg per hectare. During the first year of the study (2016) the amount of precipitation was sufficient, as well as the temperatures were optimal for the development of beans and maize plants. Whereas, in the second year of study (2017), the amount of rainfall was very small and at the same time in the flowering and reproduction stage extreme temperatures for common bean ranging up to 35°C were recorded (Table 2). To ensure the sufficient amount of moisture and to avoid the drought stress the drip irrigation was applied at certain growing stages according to the plant needs.

Table 2: Temperatures and rainfalls during the plant cycle for the two years of study (2016 and 2017) (HMIK*)

Years	2016						2017					
Months	IV	V	VI	VII	VIII	IX	IV	V	VI	VII	VIII	IX
Tmax.(°C)	20.5	19.1	26.8	28.4	26.8	22.8	16.3	21.3	26.3	29.1	30.1	23
Tmin.(°C)	6.1	7.7	12.6	14.4	13	9.8	3.3	8.1	13.1	14.2	12.6	9.6
Tavg.(°C)	13.1	13.5	19.9	21.7	20	16.1	9.6	14.8	20.9	22.2	21.9	16.2
Prec. (mm)	39.5	106.2	53.7	94.9	51,1	65.7	57.3	84.8	72.2	34.2	45	35.9

**HMIK- Hydrometeorology Institute of Kosovo*

2.5. Parameters measured

Leaf area was measured using the portable digital area-meter AM300, where for each plant the individual leaf area was measured separately, then the leaf area of the plant was calculated based on the number of leaves per plant.

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Based on the leaf area of the plant and the number of plants per square meter is calculated the leaf area index according to the formula (Radford, 1967; Buttery, 1970) shown below:

$$\mathrm{LAI} = \frac{\mathrm{LA}}{\mathrm{P}}\left(\frac{\mathrm{m}^2}{\mathrm{m}^2}\right)$$

Whereas, based on the rate of dry matter accumulation per leaf unit area over time, the crop growth rate (CGR) and the net assimilation rate (NAR) are calculated according to the following formulas:

$$\mathrm{CGR} = \frac{(\mathrm{Wt}_2 - \mathrm{Wt}_1)}{(\mathrm{T}_2 - \mathrm{T}_1)}\left(\frac{\mathrm{g} \cdot \mathrm{m}^2}{\text{ditë}}\right)$$

$$\mathrm{NAR} = \frac{(\mathrm{Wt}_2 - \mathrm{Wt}_1) \cdot (\ln\mathrm{L}_2 - \ln\mathrm{L}_1)}{(\mathrm{L}_2 - \mathrm{L}_1) \cdot (\mathrm{T}_2 - \mathrm{T}_1)}\left(\frac{\mathrm{g}}{\mathrm{m}^2 \cdot \text{ditë}}\right)$$

Where LA - the leaf area of the plant, P - the ground cultivation area, Wt - the plant dry weight, T_2 - T_1 the time interval between two successive measurements, lnL_2 - lnL_1 the natural logarithm of the leaf area index between the two consecutive measurements, L-leaf area index.

The measurements of the studied parameters were done in 5 periods (PI - PV) of growth, starting from flowering to full maturation. The interval between each measurement period was 10-12 days. For each population, 5 plants were harvested at each replication. Plants were divided according to their different organs (fully open leaves, new leaves, stem and pods). Statistical data processing was conducted in Microsoft Excel and statistical software NSCC12, where variance analysis was performed at LSD0.05 and LSD0.01 levels.

3. RESULTS AND DISCUSSION

3.1. Leaf area Index (LAI)

In the first year of the study (2016) LAI gradually increased in both treatments, while the maximum reached in the third period (66-78 DAE) and thereafter it declined. The highest LAI values for the two years of study were recorded in landraces in monoculture cropping system and they were significantly higher compared to system in association with maize (Table 3). Within this treatment "Trenaria-S" had higher values of LAI in all periods, with the exception of the third period where "Peja-S" had higher values.

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Table 3: The effect of the cultivation system in the leaf area index (LAI) ($m^2 \cdot m^{-2} \cdot day^{-1}$) for two research years (2016 and 2017), in common bean landraces.

Landrace	PI		PII		PIII		PIV		PV	
	Days after emergence (DAE)									
	29-41		53-65		66-78		79-91		92-104	
	Years									
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Trenaria - M	3.55	2.72	4.22	4.44	4.88	5.16	2.61	2.83	0.33	0.22
Peja - M	3.33	2.89	3.89	4.05	4.38	4.5	2.83	3	1.28	1.05
Trenaria - S	**5.49****	**5.33****	**6.94**	6.55	8.44	8.71	**5.61****	**5.77**	**2.78****	**2.44****
Peja - S	5	4.5	6.66	**6.83****	**8.82***	**8.99**	5.33	5.61	2.33	2.11
LSD 0.05	*0.43*	*0.34*	*1.28*	*1.65*	*2.55*	*2.49*	*1.16*	*1.99*	*0.74*	*0.14*
LSD 0.01	*0.64*	*0.51*	*1.94*	*2.5*	*3.86*	*3.77*	*1.75*	*3.01*	*1.12*	*0.21*

Differences in LAI were found also between the years of study but with minor changes. Thus, in the two years of the study (2016 and 2017), the highest values of LAI were recorded to the "Peja-S" in PIII (8.82 and 8.89), while the lowest in “Peja-M” (4.38 and 4.50). The difference between them was 4.44 and 4.49, which means that "Peja-S" had 50.34%, respectively 49.38% grater LAI than "Peja-M" at this period. While in all other periods "Trenaria-S" had higher LAI values compared to "Peja-S" and "Peja-M" and its own variant with maize. From the data obtained could be seen that "Trenaria-S" in the PI, at the beginning of flowering (29-41 dae) reaches and exceeds the critical value of LAI for common bean which is estimated to be 4 (Jones, 1967).

In the maize association treatment, in the first three growth periods and the two years of study the highest values of LAI were found at “Trenaria”, while in the last two periods the greater LAI values had "Peja". Therefore based on this, "Trenaria" in the first three growth periods had also better competing ability for LAI than "Peja", while in the last two periods "Peja" had better competitiveness. In this treatment the maximum LAI values were also recorded in "Trenaria-M" in the PIII for the two years (4.88 and 5.16), while "Peja-M" had lower values for this period (4.38 and 4.5), whereas the differences between them were 0.50 and 0.66, respectively 10.24% and 12.79%. In the last two periods these values fall drastically to "Trenaria" but remain stable in "Peja".

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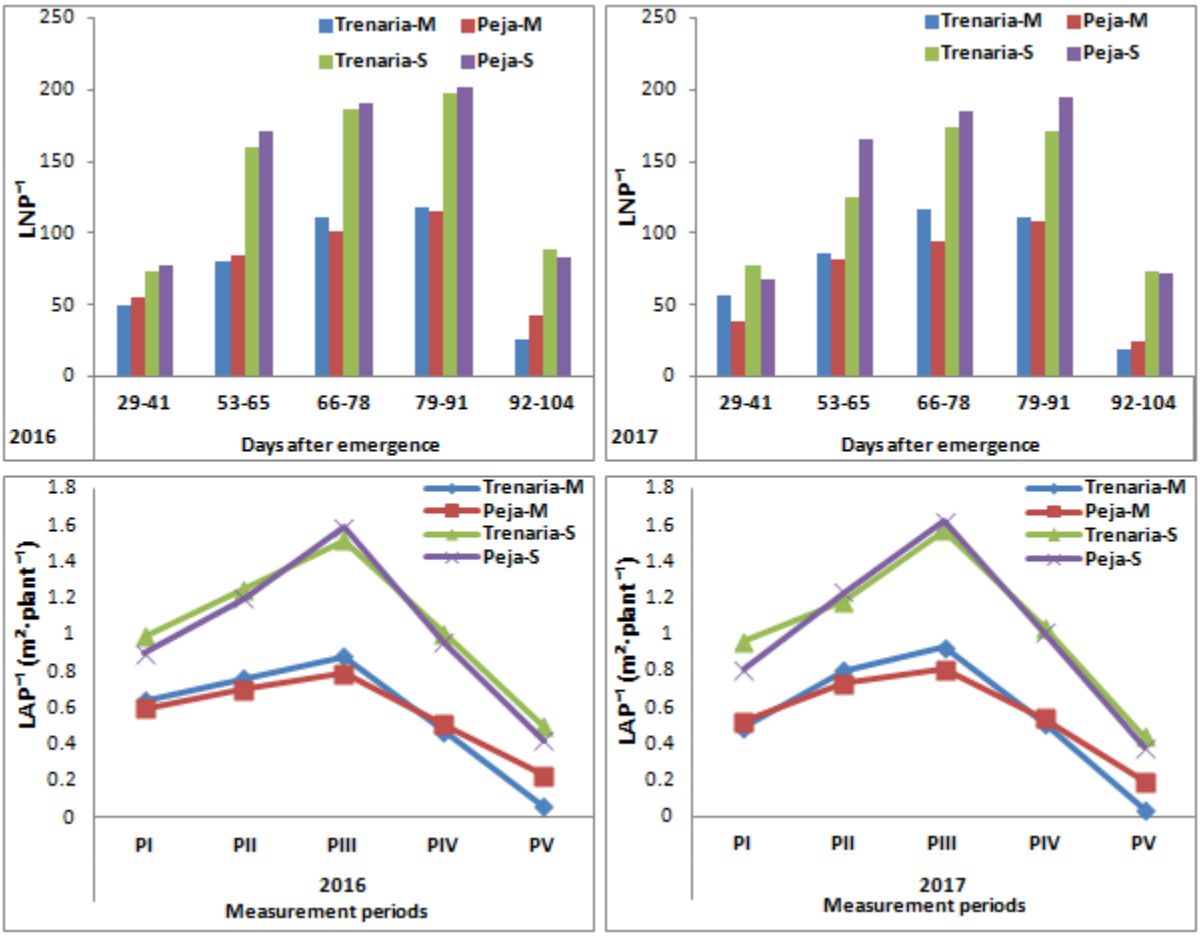

Fig. 1: Number of leaves per plant (LNP) and leaf area per plant (LAP) in common bean landraces for two treatments (S-monocrop and M-in association with maize) for two research years (2016 and 2017).

Reduction of LAI in the common bean in association with maize may be due to the shading effect of taller maize plants which affect the growth limitation of bean plants as a result of reduction of the light intensity. In this context, our data are consistent with the findings of Addo-Quaye et al. (2011) who found higher LAI values to soybean as a monocrop than in association with maize. Similar results were obtained by Shibles and Weber (1965) and Gardiner and Craker (1981). The low performance of LAI in the common bean association with maize compared to the monocropping system may be also due to the lower number of leaves per plant, respectively the leaf area of the plant (Fig. 1). This is consistent with the finding by Enyi (1973), according to which the increasing of LAI in common bean as monocrop compared to association with maize could be due to the increase in the leaf number per plant because of better leaves irradiance.

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On the other hand, the LAI values in the maize as association crop, in our study range from 0.1 to 5.12 $m^2 \cdot m^{-2} \cdot day^{-1}$, depending on the growth period (Table 4). Even in this case LAI values are increasing from the PI and the maximum reaches in the PIII (5.12 in 2016, respectively 4.46 in 2017), and then continue to decline in the last two periods corresponding to leaf senescence and crop maturation. Similar LAI results were reported by Osafo (1976), which recorded a LAI of 1.5-6.2 in maize in association with the soybean. According to other authors, the association of leguminous plants, namely the soybean, does not affect the LAI of maize because the maize plant architecture cannot be influenced by leguminous plants (Addo-Quaye et al., 2011). These results were also confirmed by Yavas and Unay (2016) who found the same LAI values (4 to 5) of maize as a sole crop and in association with pea and soybean.

Table 4: Comparative values of growth traits in maize association with common bean

Maize hybrid NS444	PI		PII		PIII		PIV		PV	
	Days after emergence (DAE)									
	29-41		53-65		66-78		79-91		92-104	
	Vitet e e studimit									
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
LAP (m2)	0.67	0.55	0.8	0.65	0.92	0.8	0.46	0.35	0.035	0.023
LAI (m2/m2)	3.7	3.04	4.41	3.61	5.12	4.46	2.56	1.95	0.194	0.128
CGR (g/m2/ditë)	7.72	7.93	26.68	23.7	31.64	26.25	16.95	14.31	2.267	1.519
NAR (g/m2/ditë)	3.63	2.82	7.43	5.26	7.62	6.58	3.97	3.41	0.709	0.88

3.2. Crop Growth Rate (CGR)

The CGR values were different in the two years of the study. These values increased gradually and the maximum reached in PIII (66-78 dae), then declined. The highest CGR values at this period was reached to "Trenaria-S" and for the two years of study (22.35, respectively 21.85 $g \cdot m^{-2} \cdot plant^{-1}$), while the lowest CGR values for this period were recorded to "Peja-M" in the first year (14.64 $g \cdot m^{-2} \cdot plant^{-1}$) and "Trenaria-M" in the second year of study (12.44 $g \cdot m^{-2} \cdot plant^{-1}$). The difference between them was 7.71 in 2016 and 9.41 in 2017, or in percentage in the first year "Trenaria-S" had 34.49%, respectively 43.06% higher CGR values than "Peja-M" and "Trenaria-M" (Fig. 2).

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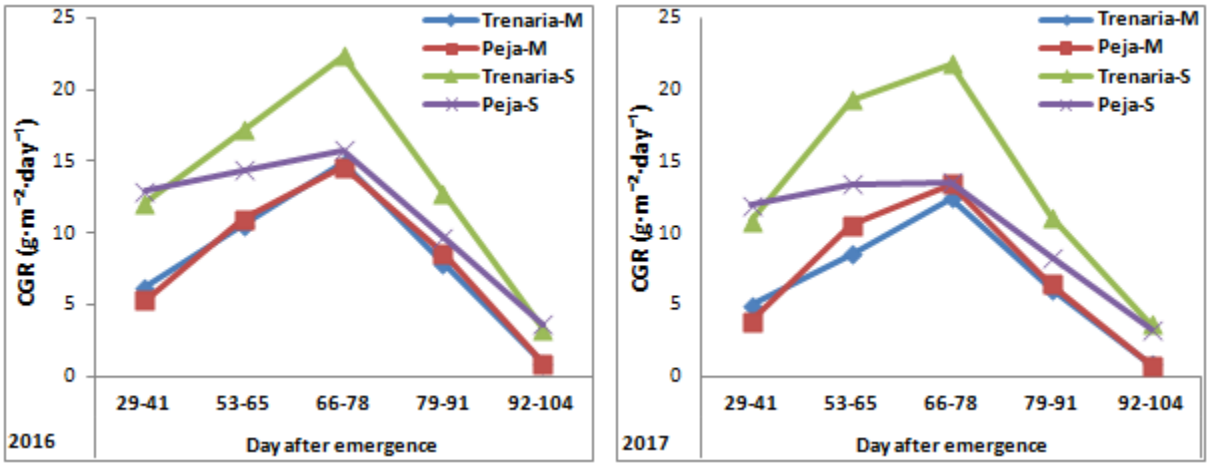

Fig. 2: The effect of cultivation system in the crop growth rate (CGR) of common bean landraces as monocrop and in association with maize during 2016 and 2017

It should be mentioned the low values of CGR in "Peja-S" compared to "Trenaria-S" in the first period were probably due to the growth habit of the “Trenaria”, which at the flowering stage is characterized by a higher intensity of growth, which then gradually stabilizes. The higher CGR values in common bean in monocrop can be related with the highest LAI of this treatment, because the leaves intercept greater amounts of light, due to the greater LAI and is more exposed to PAR than the variant in association with maize. This affects the growth of dry matter production which is in proportion to the increasing of CGR (Enyi, 1973 and Addo-Quaye et al., 2011).

In the other hand, the CGR values of common bean in the treatment in association with maize were lower and there was no significant difference between the landraces in terms of this parameter, although “Trenaria” had a better performance in almost all periods. This shows that "Tenaria-M" had better competing abilities for both CGR and LAI than “Peja-M”. The causing of the reduction of CGR of common bean in association with maize is also the lowest rate of LAI which affects the reduction of photosynthesis, as consequence the CGR is also reduced. The effect of crop association on the reduction of CGR has been confirmed by other authors as well. According to Egli (1988) this is a consequence of the shading of common bean plants by the taller maize plants which cause reduction of LAI and thus CGR as well. Shibles and Weber (1965) also observed that CGR is a linear function of intercepted radiation, which means that in our study the common bean plants in association with maize suffer from excessive shading caused by taller maize plants.

ISSN: 2455-6939

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On the other hand, the analysis of maize growth traits indicates that CGR as well as LAI is unlikely to be affected by the association (Table 4). This may be due to the type of maize hybrid which is used as association crop. Rather, in our study, extremely high CGR values were recorded (31.64, respectively 26.25 $g \cdot m^{-2} \cdot plant^{-1}$), especially in the third period of measurement corresponding to the reproductive growth stage of the plant. This is consistent with the findings of other authors who found that the effect of association of maize with beans does not affect the yield in maize but yes in beans (Tsubo et al., 2005). The results of our study for this trait are higher than the findings of other authors who reached the maximum CGR values up to 16 -17 g / m2 / day (Osafo, 1976).

3.3. Net Assimilation Rate (NAR)

The effect of association with maize had a significant effect on NAR decrease in common bean. In the two years of study, lower NAR values were found in association treatment compared to the monocrop. Although the monocrop treatment had higher NAR values, these values were different at different measurement periods. Within this treatment, in the PI of 2016, the highest NAR values were recorded in "Peja" and in 2017 at “Trenari”. Similar was the PII. Meanwhile, in the PIII, which implies the pod setting and grain filling, as well as the continuation of the flowering of indeterminate types, the highest values of NAR were recorded in "Peja-S" (7.15, respectively 7.32 $g \cdot m^{-2} \cdot plant^{-1}$), while the lowest values for this period were recorded in "Trenaria-M" (3.61 and 3.78 $g \cdot m^{-2} \cdot plant^{-1}$) (Fig. 3.). The differences between them were 3.54 but with different percentages, respectively 49.51% and 48.36%.

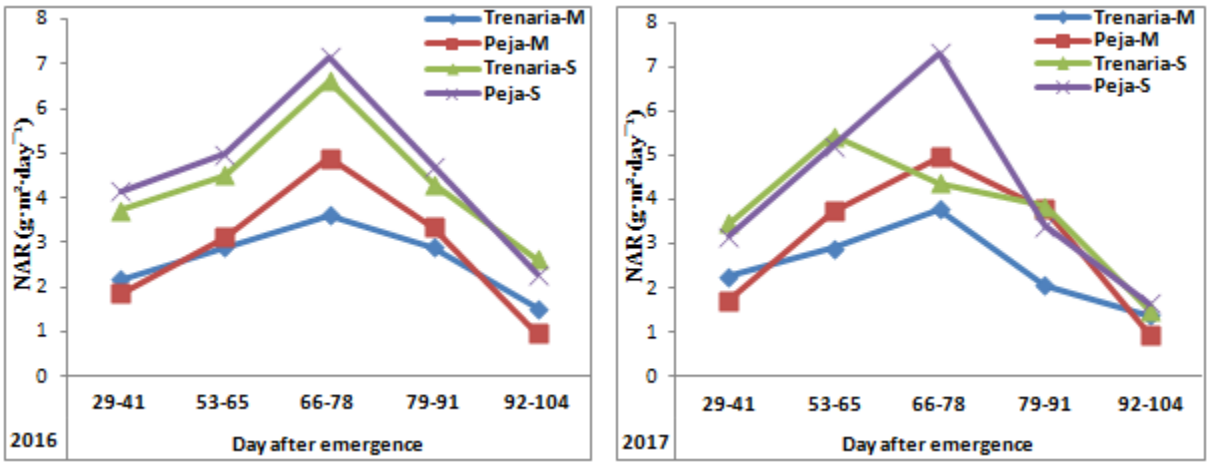

Fig. 3: Comparative values of net assimilation rate (NAR) in common bean landraces grown in different cultivation system for two research years (2016 and 2017).

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Whereas, in the treatment in association with maize "Peja-M" had a better performance for NAR. This means that "Trenaria-M" had lower competing abilities than "Peja-M" in terms of NAR compared to other traits.

Although “Trenaria-S" had a higher LAI in almost all measurement periods, on the other hand there was a lower NAR. According to Watson (1958), as LAI increased, the mutual shading of leaves while will affect the reduction of photosynthesis in a part of the lower leaves, and thus the NAR decreases.

Our study data show that NAR values decrease as the season progressed. Buttery (1970) also noted a decline of NAR in soybean with the season progress and attributed this mainly to the increased LAI of maize. While, according to Watson (1958), with increasing of plant height, self-shading is enhanced and there may be an exceedingly steep light gradient between the top and bottom of the plant which affects the reduction of the photosynthesis intensity and this also reduces NAR.

Based on the data of our study may be concluded that the main causes for the decrease of NAR and other growth traits in common bean is the cultivation in association with maize. However, the common bean cultivation system in association with maize has its own benefits, especially in the eco-physiological aspect of the plant. Various studies have shown that the taller maize plant covers the bean plant, at least partially, and so the common bean production in association with maize may not be affected by the drought stress rather than being sole. Hence, the growth of common bean plants in association with maize may not equally suffer from the constant drought stress as they in sole cultivation. A similar finding was reported by Abate and Alemayehu (2018), who studied the biological benefits of leguminous cultivation in association with maize. On the other hand, the beneficial effect of association may be avoiding of heat stress from direct radiation by maize plants. Direct radiation on the leaves may affect the immediate closure of the stoma by reducing the photosynthesis process to a high degree, and thus the NAR decrease (Tardieu, 2013).

The NAR of maize, as well as the other traits, was not affected by the effect of the association with common bean, as the maize plant has architectural advantage in comparison to the bean plant. Our study data for NAR values of maize (3.6 to 7.6 $g \cdot m^{-2} \cdot plant^{-1}$) at 66-78 dae is similar, even slightly higher than the findings of other authors Osafo (1976) that recorded NAR values of maize in association with the soybean from 3.6 to 5.0 $g \cdot m^{-2} \cdot plant^{-1}$) at 76-90 dae.

3.4. Yield components in Common bean

From the data analysis of yield per plant and its elements could be drawn that studied landraces had differences depending on the cultivation system, monocrop or in association (Table 5).

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The higher number of pods per plant had "Peja-S" in the two years of study (PNplant^{-1} = 77 and 51.67), while the lowest number had "Peja-M" (45.67 and 35.67). These differences were significant for the treatments and years. Expressed in percentage "Peja-S" had 40.68% higher PNP than its treatment in association with maize and 32.89% higher PNplant^{-1} in 2016 compared to 2017 within its treatment. "Peja-S" also had the highest GNplant^{-1} in the two study years (GNplant^{-1} = 234.32, respectively 111.33), while the lowest number had "Peja-M" (130.65 and 78). Differences between treatments were 103.67 and 33.33, or 44.24% and 29.93%, while differences between years 52.20% and 40.30%.

Table 5: Variance analysis for elements of production (yield components) in common bean landraces cultivated in two different cropping systems (monocrop and in association with maize) for two research years (2016 and 2017).

Population	NPplant^{-1}		GNplant^{-1}		GWplant^{-1}		GWm^{-2}	
	2016	**2017**	**2016**	**2017**	**2016**	**2017**	**2016**	**2017**
Peja-S	**77.00***	**51.67***	**234.32***	**111.33**	100.79	45.97	559.03	255.15
Peja-M	45.67	35.67	130.65	78	61.73	35.97	342.6	199.63
Trenaria-S	64	43	142.51	100.95	**102.47***	**92.28***	**568.70***	**512.15****
Trenaria-M	52.67	41.33	133.98	**110.21**	67.94	52.66	378.77	292.26
LSD0.05	*24.77*	*24.96*	*79.66*	*52.82*	*29.63*	*23.98*	*197.86*	*119.89*
LSD0.01	*37.53*	*38.87*	*120.66*	*80.02*	*57.18*	*34.66*	*299.74*	*181.63*

Meanwhile, regarding the grain weight per plant, the highest values were recorded at "Trenaria-S" (102.47, respectively 92.28g·plant^{-1}), while the lowest values of "Peja-M" (61.73 and 35.97g·plant^{-1}). Differences were significant, both within treatments and years of study. Differences between treatments for this parameter at “Trenaria” were 34.53 for 2016 and 39.62 for 2017, which means that in 2016 "Trenaria-S" had 33.69% higher GWplant^{-1} compared to its treatment in association with maize, while in 2017 for 42.93%. Whereas, in "Peja" the differences for GWP were 39.06 and 10.0, so "Peja-S" in 2016 had 38.75% higher GWplant^{-1} than “Peja-M”, while in 2017 this percentage declined to 21.75%.

Even for the grain weight per unit area, the highest values were recorded in "Trenaria-S" and in the two years of study (568.70 and 512.15gm^{-2}), while the lowest values were found in "Peja-M "(342.6 and 199.63gm^{-2}). The differences were highly significant at LSD = 0.05 and 0.01. While within treatments "Trenaria" had better performances than "Peja" for this parameter. From our research data can be noticed that the differences between treatments for GWm^{-2} of “Trenaria” were 189gm^{-2} in 2016 and 219 gm^{-2}in 2017, whereas in "Peja" these values were 216.43 gm^{-2} and 55.52 gm^{-2}. In the percentile ratio, "Treneria-S" in 2016 had 1.70% higher GWm^{-2} than "Peja-S" and 39.75% than “Peja-M", while for 2017 also "Trenaria-S" had higher values of GWm^{-2} and 50.19% higher than "Peja-S" and 61.02% higher than "Peja-M". Whereas,

ISSN: 2455-6939

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differences within treatment for "Trenaria" were 189.93 (33.39%) in 2016 and 219.89 (42.93%) in 2017. In “Peja”, differences within treatment were 38.71% in 2016 and 21.75% in 2017. This also confirms the fact that "Trenaria", in addition to the better performance of the growth traits in the monocrop system, also had better competitive abilities against maize in the association cropping system.

In the context of the effect of association in decreasing of production elements, our data are consistent with the findings of Worku (2008), who found a significant decrease in grain yield of common bean in association with maize compared to sole production and this was related with low number of pods per plant. Significant reductions in common bean production elements were reported in various studies. Fininsa (1997) and Gebeyelru et al. (2006) reported 67 and 75-91% reduction in yield of cultivated beans in association with maize, while Hauggaard-Nielsen and Jensen (2001) reported a 35-64% decrease in yield of pea cultivated in the intercrop system with barley .

Reduction of crop yields of common bean as a climbed plant can be caused by shading of associated crop such as maize, depending on plant density. According to Gardiner and Craker (1981), in 55,000 maize plants per hectare, the associated beans may intercept only 20% of light and thus yields decreased by 70% compared to sole cropped beans.

The high values of the production elements of the monocrop treatment compared to the treatment in association may be attributed to the higher values of the physiological growth traits in the studied landraces (Nambiar et al., 1983).

4. CONCLUSIONS

From the results of our study the following conclusions could be drawn:

- Cultivation of common bean in association with maize affects the LAI, CGR and NAR of both crops.
- The common bean cultivated in the monocrop system had higher values of all growth traits and yield components, compared to treatment in association with maize.
- The maximal values of growth traits were reached at 66-78 dae, corresponding to massive flowering, pods setting and grain filling stages.
- Better performance for growth and production traits was achieved in the first year of study (2016) compared to the second year (2017) for both treatments.
- Within the monocrop system "Peja-S" had better LAI performance in the main period of reproductive development, but in the other periods is dominated by "Trenaria-S". Meanwhile, for CGR the highest values were achieved in "Trenaria-S" in all periods,

ISSN: 2455-6939

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except in the PI, whereas in terms of NAR the results were approximate for the two landraces, alternating from period to period.

- In the association cropping system, "Trenaria-M" had a better performance than "Peja-M" for LAI and CGR, while for NAR "Peja-M" was in the advantage compared to "Trenaria-M".
- The common bean cultivated in the monocropping system also had higher values for yield components, production elements respectively. Between landraces, "Peja-S" had 16.88% higher PNplant^{-1} than "Trenaria-S", while between treatments "Peja-S" had 40.68% higher PNplant^{-1} than "Peja-M".
- Regarding the GWplant^{-1} as the main component of the yield, "Trenaria-S" had 1.63% higher GWplant^{-1} than "Peja-S" and 33.69% higher than "Trenaria-M".
- Differences within landraces for PNplant^{-1} in “Peja” were 40.68% for 2016 and 30.96% in 2017, while "Trenaria" 22.39% for 2016 and 3.88% for 2017. While for the GWplant^{-1}, differences within the landraces were in “Peja"38.75% for 2016 and 21.75% in 2017, while" Trenaria "33.69% in 2016 and 42.93% in 2017.
- Based on the values of the physiological growth traits and the main yield components in the common bean landraces in the monocropping system and in association with maize, could be concluded and recommended the application of the monocroping compared to the association cropping system, because it has an advantage in the yield and its elements, especially at “Trenaria”, which at the same time has the better competitive abilities in association with maize compared to "Peja".

5. ACKNOWLEDGEMENTS

We would like to thanks the farmers for seed donation and Gene Bank of Kosovo for Plant Genetic Resources for offering seed storage and material resources capacities in realization of this study.

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