UDC (UDK) 633.35(497.115)

Shukri FETAHU, Sali ALIU,
Imer RUSINOVCI, Besa KELMENDI, Nevzad MALIQI [1]

ACCUMULATION AND DISTRIBUTION OF DRY MATTER IN SOME COMMON BEAN LANDRACE SEEDLINGS AT THE PHASE OF THE COTYLEDONS

SUMMARY

The landraces of common bean are cultivated all over Kosovo, along with maize or as a monoculture in small gardens. Planting area with common beans is 7,505 ha, with average yield 0.9 t ha^{-1}, while the annual consumption per capita is 11.53 kg. The level of genetic and phenotype diversity of common bean landraces *(Phaseolus vulgaris* L.), in Kosovo is still unknown and not enough explored. The allocation of dry matter in seedling of the common bean depends on the nutrient content in the cotyledons on principle of germination. The importance of these structures for the growth of the seedling ranges from the time of germination to the emergence of the seedling and the time when the simple leaves can realize photosynthesis.

The research aim was to evaluate the diversity and variability among some common beans landraces according the accumulation and distribution of dry mater in different organs of seedling in early stage of development. The dry mater in root, cotyledon, epicotyl, hypocotyl and leaves, was analysed. For this purpose the experiment was conducted in the laboratory, random complete block design in three replications (RCBD) during 2011. The experimental model was: 10 landraces x 3 replication x 5 parameters =150 combinations. The obtained results showed a highly significant value for diversity and variability of different common beans landraces in Kosovo and the differences were highly significant on the level $P_{0.01}$ and $P_{0.05}$.

To determine the dry weight of the structures seedling was carried out in ages of senescence of cotyledons and development simple leaves. The distribution of dry matter in the seedlings organs structures was in the following order: simple leaves 33.18%, hypocotyl 22.84%, epicotyl 8.55% and root 14.75%.

Key words: Common bean, landraces, accumulation, diversity, dry mater.

INTRODUCTION

The common bean (*Phaseolus vulgaris* L.) is one of 10 most important crops in the world, with a production of 20,394,893 tons / year dry beans, ranking directly after soybean in the world production of grain legumes (FAOSTAT,

[1] Shukri Fetahu, (corresponding author: shfetahu@hotmail.com), Sali Aliu, Imer Rusinovci, Besa Kelmendi, Nevzad Maliqi, and Veterinary, Departamnment of Crop Production. Boulevard “Bill Clinton” nn. 10 000 Prishtina.

2010). In Kosovo, common beans are sown in 7,505ha, with average yield 0.9 tha^{-1}, with annual production of 6,755 tonnes / year, annual consumption is 11.53 kg per capita, while in 2009, are imported 2,258 tons / year, mainly from Turkey (MAFRD, 2010). The common bean is a highly variable species with a long history of cultivation and great value for nutrition in Kosovo. Cultivation for a long time of the common beans in different agro ecological conditions has created high diversity and variability some of them are linked to the traditional cultivation (Fetahu et al., 2012).

Characterisation of landraces basically means to identify and describe differences between the accessions, besides the information on the origin and differences related to the agricultural performance of the landraces are normally also considered: yield, growth, flowering, habit, pathogen and pest responses.

Genetic diversity of landraces is thought to be the most economic valuable part of global biodiversity and is considered of paramount importance for future world production (Gómez et al., 2004)**.** The long tradition of common bean cultivation in Italy has allowed the evolution of many landraces adapted to restricted areas (Lioi et al., 2005).

Characterization of landraces, allows quantification and structuring of the genetic variability in the germ plasma which is highly important for pre breeding improvement of program and for the conservation of genetic diversity and variability (Pereira et al., 2009).

Phase of growth and development of common bean landraces are different for physiological, phenotypic and genotypic traits. These phases of growth and development are: embryo, seedling, juvenile state, reproductive state and senescence (Salisbury and Ross, 1994, citied by Diaz et al., 2008).

In each phase occurs nutrition and translocation of nutrients among structures of the different seedlings organs. Thus during plant growth accumulates and assigns to their structures different proportions of dry matter. During the process of germination begins mobilization of nutrients from seed cotyledons to the embryonic axis. This process is maintained until seedling state, in which the first sources (cotyledons) are exhausted and seedling becomes autotrophic. The translocation of reserves is reflected in dry weight, which decreases in the cotyledons, yet increases in hypocotyls and subsequently increases in epicotyls, plumule and roots (Mayer and Poljakof -Mayber, 1989; Diaz et al., 1999). The translocation of assimilate starts from seed germination and continues during all the development stages of the plant (Ho et al., 1989).

The supply of nutrients from imbibitions until it triggers photosynthesis depends on the nutrient content stored in the cotyledons. These structures are the first ones that come to the senescence in the state of seedling which coincides with the depletion of its stored reserves (Diaz et. al., 2008).

Thus a nutrient concentration gradient is established between source and sink and the nutrients are moved through the vascular system (Ho et al., 1989). Under normal conditions, seedlings rapidly initiate the synthesis of photosynthesis passing into the autotrophic phase, thus ensuring its establishment

(Mayer and Poljakof-Mayer, 1989). At this stage the cotyledons are indispensable for supplying of nutrients that are used for the growth of the different structures of the seedling in common bean.

The objective of this study was to evaluation genotype diversity and variability for dry matter among common bean landraces, and determination for accumulation and distribution the dry matter among the structures of the seedling developed during the phase of senescence of cotyledons: dry matter in roots (DMR), dry matter in hypocotyl (DMH), dry matter in epicotyl (DME) and leaf dry matter (LDM).

MATERIALS AND METHODS

The research material included 10 landraces of common beans, collected in different rural areas of Kosova: FAGB-01, FAGB-02, FAGB-05, FAGB-09, FAGB-10, FAGB-19, FAGB-20, FAGB-23, FAGB-50 and FAGB-51**.** Dry matter in different organs of common bean seedling is calculated according to the formula specified in this case.

Research was conducted in laboratory of Gene Bank of Kosovo. The seeds are sowed on Petri dishes, in substrate of sand, then seedling for growing were transferred at the vegetable modules.

Design was according to the Random Complete Block with three replication (RCDB), or Landraces (L-10) x Repetition (R- 3) x Seeds (S - 20). For genotype evaluation were estimated 10 plants, in each replication.

Dry matter is determined at a temperature 105^0C until constant weight of various organs. Data analysis and interpretation were performed by: MINITAB-16, Microsoft Excel, and various statistical tests for level P0.01 and P0.05 and LSD test. For estimation differences among landraces, is used grouping Fisher's Method-Hsu's MCB. Distances among landraces are presented by Dendogram, Cluster Analysis of Observations, Standardized Variables, Pearson Distance, and Complete Linkage Amalgamation Steps. The obtained results were compared with average experimental genes value of landraces (μ). Variability among common bean landraces is calculated, according formula for each parameter:

$$DM = \frac{DMS}{SOj}\ (P/g)$$

DMS= Dry matter
TDM= Total dry matter
SOj=Different seedling organs
P/g= parameter / gram

Diversity among landraces is calculated, according formula for each parameter:

$$D = (XG \pm \mu)\ x\, 100$$

D= diversity, XG= genotype value, μ= average gene values effect.

D= diversity, XG= genotype value, μ= average gene values effect.

RESULTS AND DISCUSSION

Environment and genotypes of common bean, at all stages of development and growth, from germination to the realization of the ultimate goal of yield, are in constant interaction, and from of their ratio defined especially quantitative and production traits. The results of our research are presented in Table1 and Table 2. Diversity among landraces of common bean was estimated for accumulation and distribution of dry matter in different organs of seedlings at the phase of senescent of cotyledons.

Dry matter in root (DMR), had an average of experimental gene value μ=0.0597g seedlings^{-1}. Diversity between landraces FAGB-51 and FAGB-21 was 0.038g seedlings^{-1} or 63.65%. Difference for these landraces, compared with μ, was 0.0186g seedlings^{-1} or 31, 15% and – 0.0194g seedlings^{-1} or - 32.49%. Total range of variability was 63.65%, differences was high significant for dry matter accumulation in roots, for the level of LSDpo.o1= 0.0025.

The total amount of dry matter accumulated in seedlings, distribution in the root was 12.71 to 17.94%, with average value 14.75%. Variability among landraces was only 5.18%, therefore the distribution of dry matter in roots is more conservative traits.

Dry matter accumulation is genotype characteristic with high variability, while the distribution of dry matter it is characteristic of structural and functional characteristics of plants. Diversity of dry matter accumulation was with maximal variability, whereas its distribution was with minimum variability.

Quantity of dry matter accumulation and distribution in leaf and hypocotyl, had similar values of variability 52.047 and 53.94%, compared with all investigated parameters and variability was lower.

Maximum and minimum values for accumulation of dry matter in leaves were found in landraces FAGB-02 and FAGB-09, while the accumulation in hypocotyl such value were observed in different landraces: FAGB-51 and FAGB -20.

While the variability of dry matter accumulation was similar distribution of dry matter had different relations for landraces to leaf and hypocotyl. Landraces FAGB-02, had distributed 41.30% of dry matter in leaves, other side FAGB-19, only 27.26%, the differences among them were 14.4%. Compared to the value of μ, the difference between landraces was 42.31%. Regarding the distribution of dry matter in hypocotyl maximum values were found to FAGB-02 and the minimum FAGB-50, the differences between them were 6.64%.

From total quantity of dry matter accumulation and distribution in hypocotyl was almost double percentages then amount of root, in simple leaf stage of seedlings of common beans. All those difference among different landraces, for dry mater accumulation and distribution were high significant on level of LSDp o.o1.

Our research results for different landraces and parameters, regarding accumulation and distribution of dry matter, showed diversity among landraces, but also between organs which are developed from common bean seedlings.

Table1. Dry matter accumulation in different organs of seedlings phase g seedlings^{-1}

No	Accessions	Root	Hypocotyl	Epicotyl	Cotyledons	Leaves
1	FAGB-01	0.0629^{AB}	0.1022 ^{AB}	0.0379^{AB}	0.1069 ^{AB}	0.1212 ^{AB}
2	FAGB-02	0.0537 ^{AB}	0.1053 ^{AB}	0.0403 ^{AB}	0.0376 ^{B}	0.1667 ^{A}
3	FAGB-05	0.0438 ^{B}	0.0972 ^{AB}	0.0446 ^{AB}	0.0391 ^{B}	0.1389 ^{AB}
4	FAGB-09	0.0466 ^{AB}	0.0764 ^{AB}	0.0264 ^{AB}	0.0527 ^{B}	0.0968^{B}
5	FAGB-10	0.0673 ^{AB}	0.0909 ^{AB}	0.0368 ^{AB}	0.1168 ^{B}	0.1338 ^{AB}
6	FAGB-19	0.0772 ^{AB}	0.1013 ^{AB}	0.0337 ^{AB}	0.1171 ^{AB}	0.1234 ^{AB}
7	FAGB-20	0.0403^{AB}	0.064 ^{B}	0.0219 ^{AB}	0.0693 ^{B}	0.1198 ^{AB}
8	FAGB-23	0.0694 ^{AB}	0.0842 ^{AB}	0.0344 ^{AB}	0.0424 ^{A}	0.1564 ^{AB}
9	FAGB-50	0.0577 ^{AB}	0.0883 ^{AB}	0.0211 ^{B}	0.1613 ^{AB}	0.1257 ^{AB}
10	FAGB-51	0.0783 ^{A}	0.1143 ^{A}	0.0492 ^{A}	0.0938 ^{AB}	0.1604 ^{AB}
	μ	0.0597 ^{AB}	0.0925 ^{AB}	0.0346 ^{AB}	0.0837 ^{AB}	0.1343 ^{AB}
	LSD 0.05	0.0018	0.0014	0.0016	0.0037	0.0022
	LSD 0.01	0.0025	0.0019	0.0021	0.0051	0.0030

Means that do not share a letter are significantly different.

The value of the average effects of genes in epicotyl of seedlings was μ = 0.0346 g seedling^{-1}, differences among landraces; FAGB-51 and FAGB -50, were 0.0211g seedling^{-1} or 81.21% high significant.

Genotype of landraces, had difference for maximum and minimum values, diversity have been in the two opposite direction: +0.0146 g seedling^{-1} or +42,196 % and -0.0135 g seedling^{-1} or -39,017 % compared with the μ value.

Distribution of dry matter in epicotyl, average value was about 2 to 4 times less, compared with the results of the root and leaves. Diversity among landraces for dry mater distribution in epicotyl were from 4.65 to 12, 27%.

Characteristics of cotyledons for surveyed landraces, regarding dry matter accumulation were with maximum diversity and variability to 147%, it is to be considered an important indicator for identification of differences among genotype landraces.

The average value of genes effects was μ = 0.0837 g plant^{-1}, with a maximum genotype value were FAGB-50 or Xg = 0.1613 g plant^{-1}, in opposite position were landrace FAGB-02, which was set apart with minimal value or Xg = 0.0376 g plant^{-1}.

Genotype differences among these landraces were distinctive maximum values, which were found among FAGB FAGB-50-02, or d=0.1613 - 0.0376 = 0.1237 g plant^{-1}, which differences of dry matter accumulation were higher significant in cotyledon on level of LSDpo.o1 = 0.0051.

Such difference was upper and lower position, always compared with the value of μ, FAGB-50 landraces, had the genotype variability to +0.0776 g plant^{-1} or +92.71%. Another genotype FAGB-02 had the genotype variability lower values from μ, or - 0.0461 g plant^{-1} or -55.07%.

Their variability was with wide range from 9.32% for FAGB-02 up 35.52% for FAGB-50. The average distribution of dry matter, had similarities results to the hypocotyl distribution values of common bean seedlings in the senesce of cotyledon.

Genetic distances and similarities regarding the bean landraces diversity were analyzed by Cluster Analysis of Standardized Variables for the five evaluated traits, landraces were with significant differences among them and they were grouped in major groups, subgroups, but also individual genotypes, which are presented in Figure 1.

Table 2. The genotypes diversity for different traits in common bean landraces in Kosovo

	Diversity	XG	μ	d	V
DMR	FAGB-51	0.078	0.0597	0.0186	31.15
	FAGB-20	0.040	0.0597	0.0194	32.49
	D	0.038	0.0		63.65
DMH	FAGB-51	0.114	0.0925	0.0281	23.56
	FAGB-20	0.064	0.0925	0.0281	30.37
	D	0.049	0.0	0.0	53.94
DME	FAGB-	0.049	0.0346	0.0146	42.196
	FAGB-50	0.021	0.0346	0.0135	39.017
	D	0.028	0.0	0.0011	81.21
DML	FAGB-02	0.166	0.1343	0.0324	24.12
	FAGB-09	0.096	0.1343	0.0375	27.92
	D	0.069	0.0		52.047
DMC	FAGB-50	0.161	0.0837	0.0776	92.71
	FAGB-02	0.037	0.0837	0.0461	55.07
	D	0.123	0.0	0.0315	147.78

DMR= Dry matter in root, DMH= dry matter in hypocotyl, DME= dry matter in leave, DMC= dry matter in cotyledons. D= diversity, XG= mean genotype value, μ= average gene value for landraces, d= difference and V= variability (%).

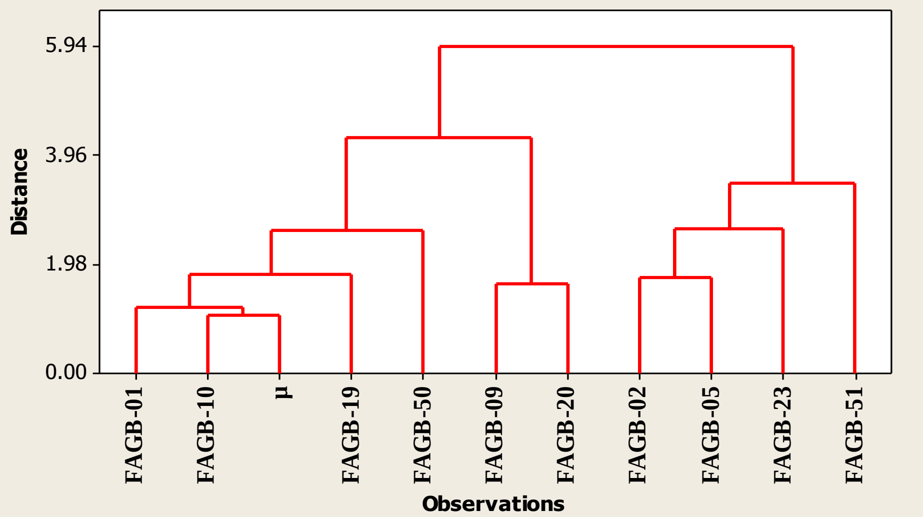
The common bean reacts to environmental conditions and its adaptation, depending on the genotype structure and variability of altitude and their adaptation to different environments (White and Laing, 2003). Although all bean landraces depend of the collecting locality, they were cultivated in the same agro-ecological and agro-technical conditions, such results and differences represent real values of landraces, but also the diversity for researched traits, and in particular for the genetic production capacity per plant (Fetahu et al, 2010).

Seedling during its establishment passes through three stages: the heterotrophic, transition and autotrophic phase, in this case, the cotyledons are exhausted in the transition phase. The loss of dry weight in the cotyledons due to the use of its reserves led to a decline of 92.7% of their total dry weight that could correspond to the mobilization of the reserves and more nutritious consumption by respiration (Barloy, 1984).

The stability of the dry weight of cotyledons indicates that the seedling uses the nutrients contained in the cotyledons as a source of food in the early days of its development the rest belongs to the cell walls of cotyledons that consisted soluble solution. The shoot accumulated more dry matter than the root, which is typical for annual plants (Shiga and Lajolo, 2006).

In the seedling stage the shoot is the most developed and it requires an increase of nutrients, however roots are starting their development so demand is lower. The blade of the simple leaves become the main source of nutrients from the moment that the cotyledons do not provide nutrients. In this way, the seedling demand the highest proportion of nutrients from the cotyledons during the early phase of germination and development until the simple leaves production enough nutrients for export to the structures that are sink.

Fig1. Dendrogram Complete Linkage, Pearson Distance



The transitions of the simple leaves, as sink organ to source organ is associated with their ability to production nutrients and maintain a balance between their syntheses and use. After the death of cotyledons, simple leaves begin the senescence as a first organ with its maximum growth and are the main organ where photosynthesis occur. Under these conditions, the dry matter production of the seedling is a function of the nutrients generated in the simple leaves (Diaz et al 2008).

CONCLUSION

From the results obtained in the experiments over the course of two years, we can conclude that not all imported fruit products can meet the consumption criteria. As it can be seen from the tables and charts above, residues such as Cypermethrin, Malathion, Methomyl, Endosulfane, Fenithrotion etc. have exceeded the permitted limit of MRL, as foreseen by the European Union. From the results obtained during this study it is evident that producers have harvested these agriculture products before the carenza phase of these insecticides was over and they were imported and consumed in Kosovo in this condition. Therefore, based on these data, we recommend that such imported goods should be initially sent to the quarantine until the MRL laboratory report is obtained. We also recommend closer and better cooperation of the phitosanitary service of Kosovo with all states exporting their vegetable products in order for us to have a better review about the list of pesticides which are used for such products entering the state of Kosovo. Such prerequisites would bring forth a better safety of imported products that are consumed by our local markets.

ACKNOWLEDGEMENTS

The authors would like to thank the Gene Bank of Kosovo, for seed accessions and financial support.

REFERENCES

Barloy J. (1984): Phase germination, levée et implantation. In: Physiologie du Mais. INRA, París, France, 13-48.

Díaz-Ruiz R., Kohashi S. J., Yanez J. P., Escalante E. A. (2008): Growth and allocation of dry matter in bean seedlings developed up to the senesce of the cotyledons. Agriculturae Conspecpectus Scientificus. Vol. 73. No. 4. 203-210.

FAOSTA (2010): Year book.

Fetahu Sh., Aliu S., Rusinovci I., Kelmendi B., Caka H., Maliqi N. (2012): Diversity of seeds size and weight of common beans landraces (Phaseolus vulgaris L.) in Kosovo. Proceedings. 47th Croatian and 7th International Symposium on Agriculture. Opatija. Croatia (270–274).

Fetahu Sh., Bürstmayr H., Aliu S., Shala- Mayrhofer V., Cakaj H. and Haxholli I. (2010): Genotype characterization and evaluation of diversity and variability for common bean (Phaseolus vulgaris L.) Landraces in Kosova. Edition Scientific Research. ISBN: 978-3-900962-92-0. 8-22.

Gómez, O., J. Blair, Matthew W.,Frankow-Lindberg, Bodil E. Gullberg, U. (2004): Molecular and Phenotypic Diversity of Common Bean Landraces from Nicaragua Crop Sci. 2004 44: 1412–1418.

Ho L. C., Grande R. I., Shaw A. F. (1989): Source/sink regulation. In: Transport of Photoassimilates. (D A Baker, J A Milburn, eds). Longman Scientific & Technical.Great Britain, 306-343.

Lioi, L., A. R. Piergiovanni, D. Pignone, S. Puglisi, M. Santantonio, and G. Sonnante, (2005): Genetic diversity of some surviving on-farm Italian Common Bean (Phaseolus vulgaris L.) landraces. Plant Breeding 124, 576-581.

MAFRD (2010): Ministry of Agriculture, Forestry and Rural Development, Prishtina, Kosova.

Mayer A. M., Poljakoff -Mayber. (1989): The germination of seeds. Fourth edition. Pargamon Press. Great Britain, 270.

Periera T., Coelho C.M.M., Bogo A., Guidolin A.F., Miquelluti, D.J. (2009): Diversity in common bean landraces from south Brazil. Acta Bot. Croat. 68 (1): 79–92.

Shiga T. M., Lajolo F. M. (2006): Cell wall polysaccharides of common beans (Phaseolus vulgaris L.) composition and structure. Carbohydrate Polymers 63 (1): 1-12.

W. White and D. R. Laing. (2003): Photoperiod response of flowering in diverse genotypes of common bean (Phaseolus vulgaris). Field Crops Research. Volume 22, Issue 2, September 1989, Pages 113-128.

Shukri FETAHU, Sali ALIU,
Imer RUSINOVCI, Besa KELMENDI, Nevzad MALIQI

AKUMULACIJA I DISTRIBUCIJA SUVE MATERIJE U NEKIM DOMACIH POPULACIJA PASULJA SADNICA U FAZI KOTILEDONA

SAŽETAK

Domaće populacije pasulja se gaje širom Kosova, kao združena kultura sa kukuruzom ili kao čist usjev - monokultura u malim baštama. Pasulj se gaji na površini 7 505 hektara, uz prosječan prinos 0,9 t ha^{-1}, dok godišnja potrošnja po glavi stanovnika iznosi 11.53 kg. Nivo genetičke i fenotipske raznokolitosti kod domaćih populacija pasulja (*Phaseolus vulgaris* L.) na Kosovu su još uvijek nepoznate, tj. nedovoljno istražene. Raspodjela suve materije u sadnicama pasulja zavisi od sadržaja hranljivih materija u kotiledonima i uslovimia klijanja semena. Uloga ovih struktura za rast sadnice je značajna od vremena nicanja sjemena do pojave sadnice, i od vremena kada prosto lišće moze ostvarati fotosintezu. Cilj istraživanja je bio procjena raznolikost i varijabilnost nekih domaćih populacija pasulja u odnosu na akumulaciju i distribuciju suve materije u različitim djelovima sadnica pasulja u ranoj fazi razvoja. Suva materija analizirana je u korjenu, kotiledonima, epikotilu, hipokotilu i lišću. U tu svrhu, tokom 2011. godine, ogled je izveden u laboratoriji, prema slučajnom blok sistemu u tri ponavljanja (PSBS). Model ogleda:10 domaćih populacija pasulja x 3 ponavljana x 5 parametara = 150 kombinacije.

Dobijeni rezultati su sa visoko značajnim vrijednostima, za različitosti i varibilnost različitih domaćih populacija pasulja na Kosovu, a razlike su bile veoma značajne na nivou verovatnoće P0.01 i P0.05.

Suva masa strukture sadnice odredjena je u fazi rasta sadnica i razvoja do prostog lišća, u sadnicama do faze starenja kotiledona.

Distribucija suve materije u strukturama organa sadnice predstavljena je u sledećem redosledu: prosto lišće 33,18 %, hipokotil 22,84 %, epikotil 8,55 % i korena 14,75 %.

Ključne riječi: Pasulj, domaće populacije, akumulacija, različitost, suva materija.