Prelimenary results on a comparative study evaluating landraces of common bean *(Phaseolus vulgaris* L.) under organic agriculture in a protected area in Greece.

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Key words: local landraces, dry beans, organic growing conditions, yield characteristics, cooking time

Abstract

Organic farming requires cultivars or landraces that are specifically adapted to this low input cropping system. Six landraces of Greek common dry bean (Phaseolus vulgaris L.*) and one from the neighbouring Former Yugoslav Republic of Macedonia (FYROM) were evaluated for different agronomic and physicochemical characteristics under organic conditions in the National Park of the lake Prespes, on the borders of Greece, FYROM and Albania. Significant differences among landraces were found in yield characteristics such as yield plant^{-1}, pod plant^{-1} and seeds pod^{-1} with two of the landraces performing the best. The cooking time was estimated by measuring seed hardness using a penetrometer. There was a considerable variation between the landraces tested with cooking times between 25-45 minutes. Some of the landraces could be a useful resource for the development of organic farming systems in this protected area.*

Introduction

Organic farming is increasingly gaining interest in Greece with organic farmers especially in the North part of the country to have tripled in the past few years. However, the research on organically grown land is limited with organic farming relying on the improvements achieved by conventional methods. The use of modern cultivars in the organic context does not imply that these are the best cultivars for the organic cropping system. Indeed, the lack of specifically adapted cultivars or landraces is one of the most important problems (Desclaux, 2005). A major intention of organic farming is to use local varieties or populations that are best adapted to the needs of these forms of agriculture (Lange et al., 2006, N.A.G.R.E.F., 2005). The long-term cultivation of dry bean at distinct microenvironments in Greece, combined with the extensive genetic heterogeneity, led to various landraces with particular genetic and morphological traits (Papoutsi-Costopoulou and Gouli-Vavdinoudi, 2001). In some regions of Greece and FYROM dry bean local landraces are still cultivated, mainly with traditional methods (e.g., harvesting by hands). Compared to commercial varieties, these landraces are less productive and more variable, but better adapted to the specific pedoclimatic conditions of these restricted areas. Moreover, their product has market desirable quality traits (i.e., easy cooking, tasteful, thin peel). Organic farmers can profit from the physiological and qualitative characteristics of such genetic

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material adapted to local conditions with possible tolerance to diseases and weed competition. Consumer preferences of high quality product with good physicochemical characteristics are also an important factor when selecting cultivars adapted to organic farming. It is therefore a fundamental concern of an organic management system to evaluate and choose varieties or locally adapted landraces that have constantly high yields with low input (Ghaouti et al., 2008). The objective of this study was to evaluate locally adapted landraces of common dry bean and determine the most adequate type of dry bean fitting the requirements of organic farming in the region of Lake Prespes. The results will contribute to the better exploitation of local plant material and give us important information about the use of particular local landraces of beans concerning their agronomic behaviour, yield and qualitative characteristics of the final dry product.

Materials and methods

Seven landraces of common bean, *Phaseolus vulgaris* L., collected in the last five years (Papadopoulos et al., 2004) in traditional areas of common cultivation in Northern Greece and FYROM were studied (Table 1). Each landrace, cultivated for over 30 years from each farmer avoiding seed mixing, was originally collected (500 g sample) from farmer's stocks. The populations numbered 1, 2 and 3 were collected around Prespa lakes (1:Agios Germanos, 2:Plati, 3:Laimos), population number 4 from neighbouring FYROM (4:Nakolets) and numbers 5, 6, and 7 also from Northern Greece (5:Chrisoupoli, 6:Kastoria, 7:Florina). The experiment was established during the summer of 2008 to the village Pili situated in the traditional area of common bean cultivation close to Lake small Prespa, Greece (40º 50´ 1N, 21º 07´ 2E, 856 m altitude and soil developed during Neogene by lacustrine deposits). The agronomic practices followed those of organic agriculture recommended for the crop in this region. The field was fertilized 2 years earlier with 50 tn per hectare of dry cattle manure. The landraces were planted in a randomized complete block design with four replications. Each replication consisted of seven plots (one for each landrace) and each plot of 4 three meter rows, with plant to plant distance of 60 cm and row to row distance of 70 cm. During the growing period, data related to phenology, yield and yield components and seed characteristics were collected (IBPGR, 1982). Beginning of flowering, end of flowering, physiological maturity, yield and yield components such as pods plant^{-1}, seeds pod^{-1} (determined on twenty pods per plot) and yield (g plant^{-1}). Seeds length, width, and thickness were determined on 20 seed per plot, seed weight (g 100 seeds^{-1}), water absorption by 12 and 24 hours and hydration coefficient (Bishnoi and Khetarpaul, 1993). Seed coat proportion was determined on 10 seeds per plot, as the ratio in weight between coat and cotyledon expressed in percentage, after removing the seed coat from the cotyledons, both after soaking and keeping them for 24h at 105 ^{o}C. Cooking time was determined according to the method described in Illiadis (2001). Sixty seeds from each plot soaked for 12h were placed in a 500 ml conical flask with 350 ml of distilled water. The flasks were placed in a water bath kept at 100 ^{o}C. After 15 min of initial cooking, samples of 10 seeds were taken from each flask at 5 min intervals. Using a penetrometer (Sur PNR-6, Berlin, Germany) with loading of 50 g and gravity of 0,5s needle intrusion depth was measured. The seeds were considered cooked when they reached the value of 6 mm. The criterion of 6 mm needle penetration representing fully cooked seeds was derived with a method described in Iliadis (2001). Comparison of means was conducted by Least Significance Test (LSD) after Analysis of Variance (ANOVA), for one-factor randomized complete block design.

Table 1 Collecting place, growth habit and seed colour of the 7 landraces evaluated. Altitude, long term average temperature and rainfall of the collecting places

Land race	Collecting place	Growth habit*	Seed Colour	Altitude (m)	Mean T °C	Average rainfall
1	Agios Germanos	IV	white	856	11.3	680
2	Plati	IV	white	883	11.5	680
3	Laimos	IV	white	871	11.0	700
4	Nakolets	IV	white	870	11.3	685
5	Chrisoupoli	IV	white	8	15.8	590
6	Kastoria	IV	white	623	12.8	610
7	Florina	IV	white	1010	11.9	580

* IV indeterminate climbing type

Results

In general, the studied populations showed limited variation in the morphological characteristics measured in the present study and no serious disease and pest problems occurred. Hence, we focus here on the yield component results (Table 2). The yield varied considerably with two of the dry bean landraces deserving particular attention since their values were better than the others in two or more yield traits. The landraces from Kastoria and Nakolets had higher yield (g plant^{-1}) with 149,7 and 153,8 g plant^{-1} and also the highest number of pods plant^{-1} with 101,1 and 75,2 respectively. Similarly higher was the number of seeds per pod with 5,01 for Kastoria and 4,96 for Nakolets landraces.

Table 2 Mean of the most important seed and yield characteristics of seven dry bean landraces grown under organic conditions in 2008.

Landrace	**Pods plant^{-1}**	**Seeds pod^{-1}**	**g plant^{-1}**	**g 100 seeds^{-1}**
1	49,6 b	4,04 c	90,2 b	82,5 a
2	55,8 b	4,38 bc	115,5 ab	73,5 bc
3	58,5 b	5,03 a	121,2 ab	68,3 bc
4	75,2 ab	4,96 ab	153,8 a	66,5 cd
5	51,8 b	4,35 bc	91,5 b	68,8 bc
6	101,1 a	5,01 a	149,7 a	58,4 d
7	73,7 ab	4,29 c	132,8 ab	73,9 b
LSD (P<0,05)	39.3	0.61	53.4	7.34

*a-d= means within the same column with different letters are significantly different (P<0.05)

However, both showed the lowest weight in g 100 seeds^{-1}. Generally there was a strong correlation between yield per plant and number of pods plant^{-1} r=0.87

(P<0,01) and the number of seeds pod^{-1} r= 0.56 (P<0,05). In contrast a negative correlation (r= -0,35) was observed between the seed yield plant^{-1} and the seed weight. Most of the tested landraces had a hydration index close to 100% in 24 h, which indicates that the seeds absorbed as much weight as their dry weight (data not shown). Coat percentages observed in this study were between 7,48-9,01 with the landraces from Laimos and Florina having the lowest and highest means respectively (Table 3). Differences on the cooking time were more prominent. The lowest cooking time of 25 minutes was observed in the landrace from Chrisoupoli and the highest values of 40 and 45 minutes in the landraces from Laimos and Agios Germanos respectively.

Table 3 Percentage of coat to sperm of the bean seeds and time of cooking

Landrace	Coat (%dm)	Time of cooking (min)
1	8,38 ab	45 d
2	8,02 b	32 b
3	7,48 b	40 cd
4	8,65 ab	37 bc
5	8,89 a	25 a
6	8,37 ab	33 b
7	9,01 a	35 bc
LSD (P<0,05)	0.85	6.7

*a-d= means within the same column with different letters are significantly different (P<0.05)

Discussion - Conclusions

Results show limited variation within landraces. The lack of exchange of genetic material between farmers, the traditional way of cultivation (e.g., no mechanical harvesting), and the consecutive inbreeding and selection carried out over the years by each farmer, might have led to increased genetic homogeneity within populations. However, there was a considerable variation between the tested landraces in yield component characteristics, with the landraces from Kastoria and Nakolets having much higher yield plant^{-1}, seeds pod^{-1} and pods plant^{-1}. The positive correlation of yield per plant with the number of pods and the number of seed per pod is in accordance with other reports (Abebe and Brick, 2003) and well explains the higher yields of these two landraces. However, the negative correlation between the size of the seeds and the yield is a fact that has to be kept in mind when choosing the best performing landraces since large-seeded cultivars (more than 70 g per 100 seeds) are preferred by consumers and industry (Piergiovanni et al. 2000). Both the high yielding landraces had seed weights below this level, and especially number 6 had very small seeds. Cooking time is also important for consumers, and should be short to save time and energy. The cooking time varied significantly, with the shortest time obtained for the land race from Chrisoupoli (25 minutes). However, this landrace had a low yield performance. This population had the highest hydration coefficient and this could explain the lower cooking time. Dry bean with high hydration coefficient require generally less cooking time (Castillo et al. 2008).

This preliminary report of agronomic and physicochemical properties of several landraces revealed variability that could lead to the selection of cultivars best suited for organic growing. Nevertheless evaluation in a single environment may not result in high and stable performance in a range of environments due to Genotype x Environment interactions. That induces the need for multi-environment evaluation in different locations or/and years. Well-adapted landraces may be used as source material in breeding programs under low-input conditions.

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