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ASSESSMENT OF MUNG BEAN YIELD POTENTIAL PRODUCTION IN THE NORTH EASTERN REGION OF ROMANIA

Teodor ROBU[1], Creola BREZEANU[1,2], Petre Marian BREZEANU[2], Silvica AMBARUS[2]

[1]University of Agronomic Sciences and Veterinary Medicine of Iasi
Aleea Sadoveanu, No. 3, Iaşi, 700490, România
[2]Vegetable Research and Development Station Bacau
Calea Birladului Street, No 220, Bacau, Romania

Corresponding author email: creola.brezeanu@yahoo.com

Abstract

The significant climate changes observed and registered throughout the entire world over the past few years demonstrate the vital importance of finding workable solutions allowing us to preserve our natural resources (especially vegetal genetic resources, land, and water) and ensure a steady and nutritious food supply to all people. The use of genotypes with drought and salinity tolerance, which are resistant to pathogens and have minimum inputs, might represent an alternative solution to the current challenges. The aim of this study was to test a species – the mung bean -- that has all the above characteristics, and to recommend its use to farmers. The mung bean is distinguished by its high protein content, and it is appropriate for human consumption. The study was accomplished using a number of 96 genotypes. The paper presents data for 22 representative genotypes of (Vigna radiata (L.) Wilczek). The vegetation period for the genotypes involved in the study varied from 85 to 110 days. Our study revealed the fact that variety influenced: germination, emergence duration, interval to appearance of first true leaves, flowers and pods, plant height, number of fertile shoots, number of pods per plant, pod length, number of seeds in pods, and weight of 100 seeds production of grain. The mean value per hectare in relation to the mung bean's productive potential was 1.88 t ha^{-1}. The sprouting capacity highlighted a full germination process in 2-3 days, and a necessary minimum of 4-5 days to develop sprouts 5 cm in length. During our investigation, we discovered that the genotypes with the highest seed weight value had a faster rate of sprouting. Our TLC investigation concluded that the mung bean can be considered a food-drug due to its chemical composition. Correlation and path coefficient analyses indicated that high yielding mung bean genotypes could be obtained by selecting plants with a high number of pods per plant. The cultivation of Vigna radiata (L.) Wilczek species can contribute to the development and diversification of agricultural production through diversification of food in general and the development of sustainable agriculture in the context of European and world agriculture.

Key words: *Vigna radiata, cultivation, germination, pods.*

INTRODUCTION

In recent years, society as a whole has begun paying increasing attention to the health of the environment. This shift demonstrates a growing interest in finding sustainable solutions that would reduce the negative effects of human activity upon the environment, particularly those caused by agriculture.

Intensive agriculture, established after the World War II, completely ignored the need for biodiversity and for preserving the environment. Over the course of the last few years, the use and development of adapted genotypes with minimum impact (genotypes requiring only low doses of fertilizers and pesticides) that are also resistant to drought, salinity, and pathogens has become increasingly important. In our research, we sought to introduce a relatively new and little-known species to our area, one which is distinguished by its unique quantitative and qualitative potential. Towards this purpose, the evaluation and characterization of the germplasm are necessary to identify qualitative and quantitative characters useful for the cultivation program.

The main international objective of mung bean cultivation is to develop new varieties of the species, some with short vegetation periods (55 and 65 days), with mass maturation phases (for a single harvest) MMB high value (> 5 g per 100 seeds) with high and stable yield (2.5 t ha^{-1}), with reduced sensitivity to photoperiod and temperature, and with resistance / tolerance to biotic and abiotic stress. This species is particularly valuable due to its ability to improve soil quality through its cultivation by using symbiotic nitrogen fixation – a factor particularly important for farmers with limited resources. Input requirements for mung bean cultivation are low, making the species extremely valuable in the current economic crisis. The mung bean can be easily grown in newly reclaimed sandy soil and can be irrigated with saltwater, because it can tolerate drought and soil salinity (Mohamed, 2005). The species is one of the best to use for winter grains (Pierce and Rice, 1988; Sharma, 1996). Mung bean can be grown in a variety of cropping systems; wheat-mungbean-wheat was the dominant cropping rotation in Pakistan. The mung bean is widely cultivated for human consumption (consumed as fresh pods, fresh and dry beans, sprouts, and flour). Is it regarded as a quality nutrient for its rich protein content and excellent digestibility, especially when combined with other grains (Rachie and Roberts, 1974; Thirumaran and Seralathan, 1988). Rich in easily digestible protein (24%), the mung bean adds much-needed diversity to the grain-based diet of the poor (Thirumaran and Seralathan, 1988). Mung beans contain vitamin A (94 mg), iron (7.3 mg), calcium (124 mg), zinc (3 mg) and folate (549 mg) per 100 g dry seed. It is consumed as dhal in South Asia, and is used in food products such as fried snacks, desserts, and bean sprouts. Mung bean sprouts, which are a good source of vitamin C (8 mg per 100 g), can be produced year-round at home or commercially (Calloway et al., 1994; Gopalan et al., 1989). Each kilogram of mung bean seeds produces 6-10 kg of sprouts. The mung bean is the most important grain legume in Thailand and the Philippines, and it ranks second in importance in Sri Lanka, and third in India, Burma, Bangladesh, and Indonesia (Lawn and Ahn, 1985).

Considering the species' potential to perform in drought condition with minimum input, our study investigates some yield compounds, as well as the quality (antioxidant compounds) of seeds. The study's findings should be useful to the diversification of the assortment of cultivated species and to the establishment of selection criteria in the mung bean breeding program for high seed yield.

MATERIALS AND METHODS

Place and experimental conditions

The research was carried out over the course of two experimental years. The experiments were conducted at the Vegetable Research and Development Station in Bacau, Romania, at an elevation of 91 m, latitude 46.521946 N, longitude 26.910278 E.

Average annual temperatures during the experimental period averaged between 8 to 9 degrees Celsius. During the winter, temperatures dropped as low as -29º C, while during the summer, they reached as high as +39º C. Average annual rainfall exceed 500-550 mm per m^2. Precipitation ranged between 500 and 1100 mm per year. The predominant wind direction is north and northwest.

Given the strength of the species specified in the literature, the experimental culture was placed into a certified polygon of biological agriculture. No fertilizers or chemical treatments for diseases or pests were applied. The experiment used no inoculated seeds. No desiccation treatments were applied before harvesting.

Experimental variants were placed in a plot of land subdivided into four partitions.

The seeds were sowed into moisture at a depth of 2-4 cm, without the use of press wheels that exert heavy pressure directly over row, at a density of 40 plants per m^2.

Biological material

The study was carried out using 96 genotypes. The paper presents data for 22 representative genotypes of (*Vigna radiata* (L.) Wilczek).

Observations

Regarding growth, we made the following phenologycal observations*:* the number of days required for germinating, the appearance of the first true leaves, the number of days to flowering and to set pods.

Regarding yield potential, we took into account*:* plant height, number of fertile shoots, number of pods per plant, number of seeds in pods, MMB, production of grain per hectare.

Statistical analysis

Statistical calculations were performed to highlight differences between experimental variants.

RESULTS AND DISCUSSIONS

Even though this species has an important potential for cultivation, in many European countries, it is still little known and rarely cultivated. Our results, obtained during a post-doctoral research project and continued over other the two years, in the northeast of Romania, establish the suitability of mung bean cultivation, and also promote its use (*Vigna radiata* (L.) Wilczek) species.

According to our results, mung bean has a high potential for cultivation in the climatic conditions of northeast Romania (confirming the recommended area of cultivation longitude 26°55 and latitude 46°34', as stated in the literature).

We registered differences between genotypes, but generally, species of mung beans requires 90-120 days of no frost for development of production.

One of the challenges that cultivators of mung beans face is obtaining short vegetation period genotypes.

In our experimental conditions, we planted the seeds on May 2nd into moisture at a depth of 2-4 cm, at a density of 40 plants per m^2.

The lowest level of germination was registered at genotype PA17, with only 20% germinated seeds. The genotype PA5 registered 80% germinated seeds; seven genotypes accomplished 90% germinated seeds (PA1, PA2, PA, PA10, PA19, PA21, PA22). The rest of the 10 genotypes registered the optimum level of germination of 100%. Eight genotypes required 9 DAS for germination. Even when the time period was longer, this was not an impediment, as all these genotypes experienced a germination level of 100%. In our study, we analyzed the dynamic of germination and as a result, we observed the genotypes at 7, 9 and 10 days after sowing (DAS).

83% germinated seeds in 7 DAS was the fastest rhythm of germination, at PA 14. Six genotypes registered up to 50% germination in 7 DAS. Although 11 genotypes required a minimum of 9 DAS for germination, final germination percentage was not influenced, as nine of those genotypes registered 100% germination at 9 DAS, and two genotypes germinated 90%.

The appearance of the first true leaves requires a number of 17 to 21 DAS. The total number of DAS to flowering varied from 66 for genotypes PA11, PA12 and PA19 to 71 for genotypes PA14, PA18, PA 21 and PA 22, with a mean value of 68.27.

We observed that the process of setting pods started after a mean interval of 70.63 DAS. The process of set up pods occurs after a minimum of 68 DAS and a maximum of 74 DAS.

Our study revealed the fact that variety influenced: germination, emergence duration, interval to appearance of first true leaves, flowers, and pods.

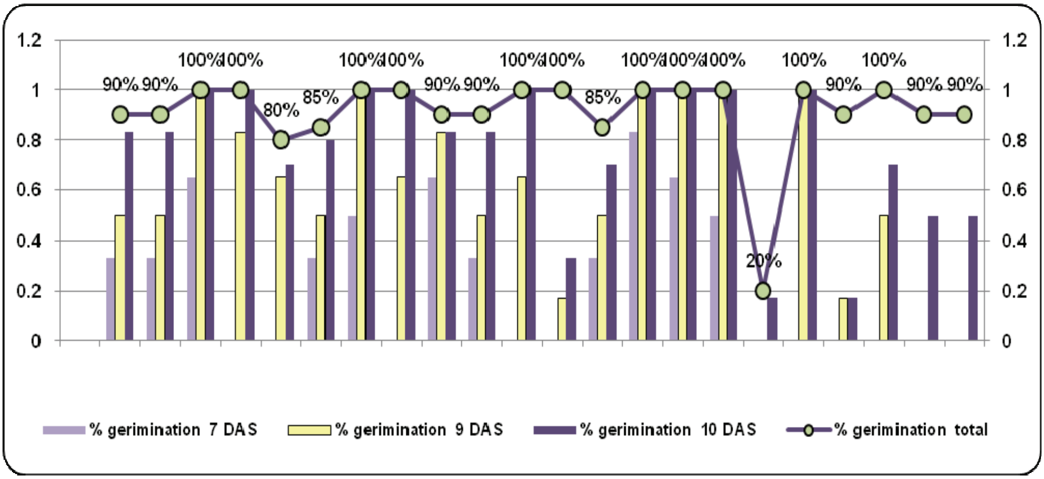

Figure 1. Influence of mung bean variety on germination capacity

Table 1 Phenological observation accomplished at genotypes

Genotype cod	Data of sowing	% germination				number of days to first true leaves appearance	number of days to flowering	number of days from sowing to set up pods
		7	9	10	total			
		Days After Sowing (DAS)						
PA1	2.05	33%	50%	83%	90%	20	68	70
PA2	02.05.	33%	50%	83%	90%	20	67	68
PA3	02.05.	65%	100%	100%	100%	19	67	69
PA4	02.05.	0%	83%	100%	100%	19	67	69
PA5	02.05.	0%	65%	70%	80%	21	69	71
PA6	02.05.	33%	50%	80%	85%	20	67	70
PA7	02.05.	50%	100%	100%	100%	19	67	69
PA8	02.05.	0%	65%	100%	100%	19	68	70
PA9	02.05.	65%	83%	83%	90%	20	68	70
PA10	02.05.	33%	50%	83%	90%	20	68	70
PA12	02.05.	0%	65%	100%	100%	20	66	70
PA11	02.05.	0%	17%	33%	100%	20	66	71
PA13	02.05.	33%	50%	70%	85%	20	67	70
PA14	02.05.	83%	100%	100%	100%	17	71	73
PA15	02.05.	65%	100%	100%	100%	19	69	71
PA16	02.05.	50%	100%	100%	100%	29	69	71
PA17	02.05.	0%	0%	17%	20%	22	70	73
PA18	02.05.	0%	100%	100%	100%	18	71	73
PA19	02.05.	0%	17%	17%	90%	19	66	69
PA20	02.05.	0%	50%	70%	100%	19	69	71
PA21	02.05.	0%	0%	50%	90%	19	71	74
PA22	02.05.	0%	0%	50%	90%	19	71	74
Mean		**25%**	**59%**	**77%**	**91%**	**19.91**	**68.27**	**70.73**

In determining the yield capacity of mung beans in our research, we investigated the next quantitative characters: plant height, number of fertile shoots, number of pods per plant, pod lenght, number of seeds in pods, weight of 100 seeds, and production of grain (t ha^{-1}). Phenotypic and genotypic correlations between seven quantitative characters studied showed that plant height has a positive correlation to the number of fertile branches and the number of pods per plant. These results are in agreement with previous results obtained in research conducted by Malhorta (1974) and Malik (1983). Variety influenced: emergence duration, plant height, number of branches per plant, plant port, and productivity. There were differences of: plant height, number of branches, number of pods per plant, number of viable seeds in pods.

All studied genotypes registered very significant differences in terms of plant height when compared to the control variant. The plants' height varied from 43.10 cm for genopype PA2 to 52.30 for genotype PA5. Significant diffrences were registred based on the number of fertile shoots and the number of pods per plant.

The yield is determined by the number of pods, which is a product of the number of flowers and pod-set-ratio. Since pod-set-ratio is strongly affected by pollen fertility under high temperature conditions, pod yield deterioration in the summer might be due to the decrease of pollen fertility.

Heat stress in particular affects the development of reproductive organs (Hall, 1992).

The pod yield of mung beans was severely depressed under high temperature conditions (especially in the second year of experimentation). High temperatures, combined with high solar radiation led to excessive transpiration. The decline in the water potential of the vegetative and reproductive organs in mung bean plants was considerably larger under high temperatures, compared to the results obtained under optimal temperature conditions (Tsukaguchi et al., 2003).

Table 2 Mean values and standard deviation for seven quantitative characters of 22 mung bean genotypes

Genotype	Plant height (cm)	Number of fertile shoots	Number of pods per plant	Pod lenght (cm)	Number of seeds in pods	Weight of 100 seeds	Production of grain (t ha^{-1})
VR 75 control	39.13	4.23	54.23	5.94	11.03	3.85	1.26
PA1	46.90 **	7.28 **	59.59 **	6.15	11.38 *	4.43 **	1.68 **
PA2	43.10 **	6.87 **	63.03 **	6.41	11.44 *	4.46 **	1.79 **
PA3	48.47 **	9.41 **	73.88 **	6.99 **	11.52 *	4.41 **	2.59 **
PA4	44.71 **	6.95 **	62.46 **	6.75 **	11.49 *	4.41 **	1.69 **
PA5	52.30 **	7.39 **	55.04 **	6.56 **	11.20	4.37 **	1.42
PA6	46.95 **	8.57 **	64.45 **	6.44 *	11.26	4.53 **	1.64 *
PA7	45.80 **	7.52 **	55.92 **	6.61 **	11.41 *	4.55 **	1.48 *
PA8	50.73 **	8.82 **	55.33 **	6.62 **	11.37 *	4.51 **	1.47 *
PA9	49.52 **	7.25 **	73.28 **	6.63 **	12.10 **	4.66 **	2.12 **
PA10	48.34 **	7.44 **	70.12 **	6.72 **	12.20 **	4.68 **	2.10 **
PA11	48.55 **	6.98 **	71.55 **	7.12 **	11.98 **	4.55 **	1.99 **
PA12	47.82 **	6.46 **	70.42 **	7.10 **	13.02 **	4.98 **	1.96 **
PA13	46.59 **	6.86 **	71.44 **	6.95 **	12.62 **	4.96 **	1.87 **
PA14	46.56 **	8.45 **	69.55 **	6.45 **	12.45 **	4.69 **	1.75 **
PA15	47.88 **	8.22 **	68.88 **	7.22 **	11.98 **	4.85 **	1.73 **
PA16	50.22 **	7.53 **	62.59 **	7.29 **	11.82 **	4.76 **	1.89 **
PA17	50.31 **	7.45 **	64.45 **	6.88 **	11.96 **	4.88 **	1.95 **
PA18	51.24 **	7.12 **	65.65 **	7.33 **	12.23 **	4.91 **	2.12 **
PA18	51.62 **	6.55 **	66.44 **	7.04 **	12.23 **	4.75 **	2.13 **
PA20	49.88 **	6.59 **	67.56 **	7.23 **	12.02 **	4.82 **	2.15 **
PA21	49.66 **	6.98 **	70.23 **	7.33 **	11.88 **	4.69 **	1.98 **
PA22	48.75 **	7.51 **	70.11 **	7.98 **	11.86 **	4.90 **	1.86 **

The mean of pods per plant was 70.11, with a variation from 55.04 at PA4 to 73.88 at PA3. As is the case with plant port, the total number of pods per plant is strongly influenced by variety. In our research, the genotypes with red seeds registered a higher number of pods per plant (up to 70 pods per plant) when compared to the genotypes with green seeds.
The total number of seeds in pod varies from 11.20 to 13.03.

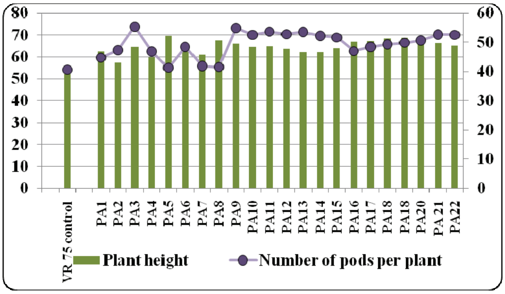

Figure 2. Variation of plant height and total number of pods per plant

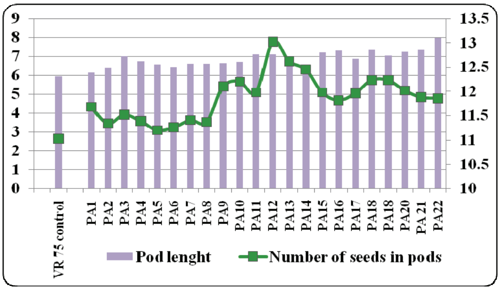

Figure 3. Variation of pod length and the number of seeds in pods

From a farmer's point of view, the most important factors are obviously the weight of the seeds and the total yield of each genotype. We obtained outstanding yield results during our study, especially considering the fact that the experimental culture was placed in a certified polygon of biological agriculture and received no fertilizer or chemical treatments for diseases or pests. The experiments used no inoculated seeds. No desiccation treatments were applied before harvesting. In order to avoid losses, the harvesting process was carried out early in the morning.
The data presented in table-2 noted that yield ranged from 1.42 t/ha for PA5 genotype to 2.59 at PA3.

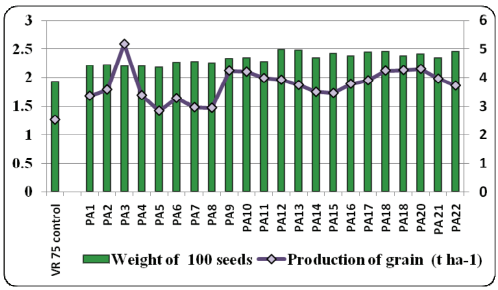

Figure 4. Variation of weight of 100 seeds and yield

CONCLUSIONS

The assessment of the 22 mung bean genotypes tested in the climatic conditions of Romania, in an ecological culture system, led us to some interesting conclusions.

Variety influenced: emergence duration, plant height, number of branches per plants, plant port, and productivity.

The appearance of the first true leaves requires a number of 17 to 21 DAS.

The total number of DAS to flowering varied from 66 to 71, with a mean value of 68.27. Upon collection, the process of setting pods started after a mean interval of 70.63 DAS. The process of set up pods occurs after a minimum of 68 DAS and a maximum of 74 DAS. These results can be extremely important to the selection of genotypes with the fastest rate of growth and development for cultivation programs, in order to obtain new genotypes with short vegetation periods.

The number of pods per plant represents an important yield component, and should be useful as selection criteria.

Correlation and path coefficient analyses indicated that high yielding mung bean genotypes could be obtained by selecting plants with high number of pods per plant.

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REFERENCES

Calloway D.H., Murphy S.P., 1994. User’s guide to the international minilist nutrient database. Department of Nutritional Sciences, University of California, Berkeley, CA.

Gopalan C., Rama Sastri B.V., Balasubramnaian C.V., Narasinga Rao B.S., Deosthale Y.G., Pant K.C., 1989. Nutritive value of Indian foods. Indian Council of Medical Research, Hyderabad, India. 156 p.

Hall A.E., 1992. Breeding for heat tolerance, Plant Breed. Rev. 10:129-168.

Lawn R.J., Ahn C.S., 1985. Mung bean (*Vigna radiata* (L.) Wilczek. In: R.J. Summerfield and E.H. Roberts (eds.), Grain legume crops. William Collins Sons & Co. Ltd, London, p. 584-623

Malhotra V.V., Singh S., Singh K.B., 1974. Yield components in greengram (*Phaseolus aureus* Roxb.). Indian J. Agric. Sci. 44:136-141.

Malik B.P.S., Singh V.P., Singh M., 1983. Correlation and correlated response and relative selection efficiency in green gram. Indian J. Agric. Sci. 53 (2), p. 101-105.

Mohamed M.H., Kramany E., 2005 Salinity tolerance of some mung bean varieties. J. Applied Sci. Res., 1, p. 78-84.

Pierce F., Rice C., 1988. Crop Rotation and its impact on efficiency of water and nitrogen use. ASA Special Publication-American Society of Agronomy USA., 51:21-42.

Rachie K.O., Roberts L.M., 1974. Grain legumes of the lowland tropics. Adv. Agron. 26:1-132.

Shanmugasundaram S., McLean B.T., (eds.). Proceedings of the Second International Symposium on Mung bean. AVRDC, Shanhua, Taiwan. AVRDC Publication No. 88-304, p. 470-485.

Sharma S.N., Prasad R., Singh S., 1996. Residual effect of growing mung bean and uridbean onthe yield and nitrogen uptake of succeeding wheat crop. Fertilizer Research, 44:163-166.

Thirumaran A.S., Seralathan M.A., 1988. Utilization of mung bean. In: Shanmugasundaram S, McClean BT (eds) Proceedings of the second international mungbean symposium, Shanhua, Taiwan: The World Vegetable Center (AVRDC).

Tsukaguchi T., Kawamitsu Y., Takeda H., Suzuki K., Egawa Y., 2003. Water status of flower buds and leaves as affected by high temperature in heat-tolerant and heat-sensitive cultivars of snap bean (*Phaseolus vulgaris* L.). Plant Prod. Sci. 6:24-27.