SIGNIFICANT PROGRESS ACHIEVED IN COWPEA BREEDING IN ROMANIA

Dr. Reta Draghici[1]
Dr. Iulian Draghici[2]
Dr. Aurelia Diaconu[3]
Dr. Mihaela Croitoru[4]
Dr. Milica Dima[5]
[1, 2, 3, 4, 5]Research & Development Station for Plant Culture on Sands Dabuleni, Romania

ABSTRACT

Climate change has led to drought, the expansion of desertification, loss of wetlands, loss of biodiversity, declining agricultural output and productivity. In the area of sandy soils in the southwest of Romania, where, compared to the multiannual average, the average air temperature in the May-August period increased by 1.01^{0}C and the precipitations recorded insignificant increases (5.97 mm), being very low (227. 82 mm) and unevenly distributed in relation to plant requirements. In these conditions, it is necessary to cultivate some species of plants resistant to drought and to preserve and improve some genetic resources adapted to the arid climate. For the efficient use of the microclimate in the sandy soils areas at the Dabuleni Research & Development Station for Plant Culture on Sands, three genotypes of Aura 26, Ofelia, Doljana were developed, which were studied in a comparison comparative culture with Jiana variety. The production potential of the new varieties (2120-2706 kg / ha) was clearly superior to the control variety, the production differences being significant and very significant.

Keywords: *Vigna unguiculata L. Walp, sandy soil, biology, productivity, quality*

INTRODUCTION

In Romania, the phenomenon of drought is a specific characteristic, due to the fact that our country is located in a temperate climate zone with very high deviations from the normal values of the climatic, agroclimatic, hydrological and pedological parameters. The accentuation of this phenomenon from the last period and the specific microclimate, which is created especially in the southern part of Romania, required extensive studies at the Dabuleni Research & Development Station for Plant Culture on Sands (R & DSPCS Dabuleni), which led to the promotion of some plant species, including cowpea (Vigna unguiculata L. Walp), a plant that capitalizes with good results the ecopedological potential of sandy soils. Originally from Central Africa, the cowpea is considered to be one of the oldest legume crops for beans on the three continents of the "Old World" [5], [14], being an important vegetable for East, South, Central and Western African agriculture [6]. Through plant physiology, cowpea is a drought-resistant plant with wide ecological plasticity that can be cultivated widely in both high and low rainfall areas in South Africa.

Considering that ensuring genetic progression in agriculture starts from the evaluation of existing germplasm resources and their specificity for a particular area [1], [2], [3], many studies have been made on the improvement of cowpea plants in various parts of the world. The research conducted by the Institute for Agricultural Research, Ahmadu Bello University Zaria, Nigeria, highlights drought-resistant cowpea genotypes and resistantce to Striga gesnerioides (Willd.) [9]. The results obtained in Romania regarding the behavior of 144 genotypes of cowpea revealed the variability of the species in terms of plant biology, morphology and productivity [11]. Of the 144 studied cowpea genotypes, 38% allowed selection for the production of grain varieties for beans, 26% allowed selection of fetal genotypes for fodder, and 36% allowed the selection of genotypes for green fertilizer.

MATERIAL AND METHODS

In order to promote a sustainable agriculture system in areas with sandy soils subject to aridisation, the choice of species and variety with high adaptability to the climatic and soil conditions is a necessity in obtaining high and safe production. In this regard, 3 cowpea genotypes created at R & DSPCS Dabuleni (Aura 26, Ofelia, Doljana) were studied in a comparative competition culture, compared to the control variety, Jiana (the first Romanian variety of cowpea). The study was conducted on a low fertility psamosol, poorly supplied in nitrogen (0.039%), medium supplied in phosphorus of 30.5 parts per million ("ppm") and low in potassium (129 ppm). Experience has been placed under irrigation conditions in a 3 year crop: cowpea - rye - sorghum. The cowpea genotypes were sown in the period of May 1-10, when in the soil the average temperature was 10-12^{0}C, being fertilized with 60 kg/ha of nitrogen, 60 kg/ha of phosphorus and 60 kg/ha of potassium. During vegetation, soil moisture was maintained above the minimum 30% of the active humidity range, on a depth of 50 cm, in the phase of floral organs formation, flowering, and the formation of pods, by application of 2 - 3 watering with a norm of 150-200 m^3 water per hectare. They were carried out observations and observations of biology, morphology, productivity, and quality of the cowpea genotypes, and the results obtained were interpreted by variance analysis and mathematical functions.

RESULTS AND DISCUSSIONS

The analysis of climatic conditions recorded during the vegetation period of the cowpea (May to August) (Figure 1) shows an increased temperature in the last decade, compared to the annual average, which combined with rainfall records, they have resulted in increased droughts. Thus, compared to the multiannual average, average air temperature on rose by 1.01^{0}C and rainfall increased insignificantly (5.97 mm). The 227.82 mm rainfall, registered in the period 2008-2017, was unevenly distributed in relation to the requirements of most plants. The meteorological conditions recorded during the study period of the cowpea genotypes (2015-2017) highlight the increase of the drought phenomenon in the vegetation period, by increasing the air temperature by 1.41 ^{0}C, compared to the multiannual average. Through the plant's biological attributes, regarding increased drought resistance and reduced requirements for soil fertility, the cowpea may be a

good alternative for bean culture and for soybean culture, plants are very sensitive to stress factors in areas with excessive drought [4], [13].

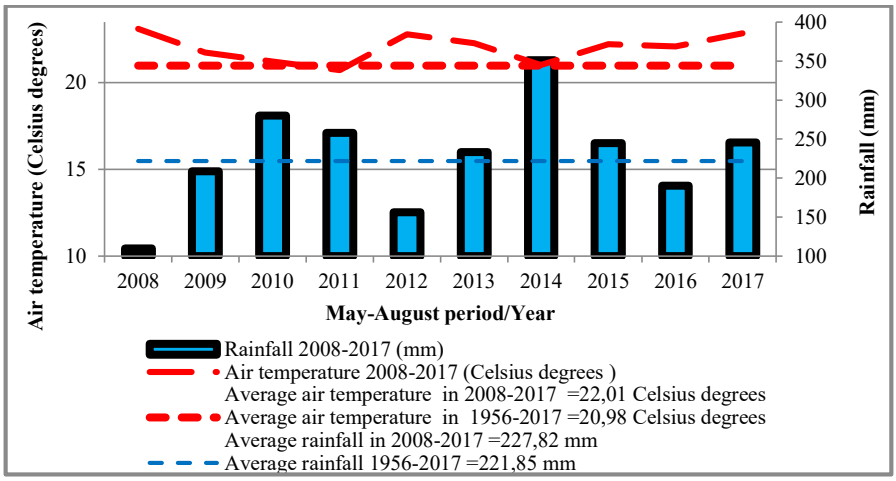

Fig. 1. *Climatic conditions recorded at the meteorological station of R&DSPCS Dabuleni during the cowpea vegetation period (Mai-August)*

Compared to beans, the cowpea has a very strong root system with a high absorption power, a waxy layer on the leaves, which gives it greater resistance to the climatic conditions that occur in the sandy soil area. Often, elevated soil temperatures (+ 60 °C), accompanied by low atmospheric humidity, lead to bean flower abortions, partially or totally compromising culture [3], [10]. From germination to the end of the vegetation period, all the vital processes of the cowpea plant were carried out under high-temperature conditions above 10^0C. Under the study conditions, the vegetation period of cowpea genotypes ranged over 91-103 days, with a thermal demand of 2096 - 2353.9 °C (Table 1). Compared to the Jiana variety, which is very late, the Aura 26 and Doljana genotypes have been highlighted through an early 11-12 days, when maturing the pods. Early plant life is an objective of creating varieties in areas subject to aridisation, in order to avoid drought periods from the moment the plants flourish. Being a leguminous plant, the fascia forms on its roots numerous nodosites in which the bacterium develops and fixes atmospheric nitrogen. Nitrogen, biologically fixed by the leguminous plants, compared to mineral nitrogen, has advantages because it does not consume fossil energy and is environmentally non-polluting. The results obtained in Nigeria, by K.O.Awonaike, on treatment the seeds of three cowpea varieties (Ife Brown, Ife BPC and AFB 1757) with Bradyrhizobium cowpea, revealed the biological fixation of about 74-116.87 kg / ha of atmospheric nitrogen [8]. The determinations carried out on the four cowpea genotypes, emphasize intense symbiotic activity in the blooming phase of the plant (111.6-129.5 nodules / root), which confirms the plant's role in fixing the biological atmospheric nitrogen (Table 1). Statistical analysis of the functional connections of the leaf area index (L.A.I.) and the vegetative growth of the plant, reveals positive correlations with the height of the plant and significantly positive with the weight of the plant biomass. Type of plant growth

allows selection and use biotypes of cowpea in the plant breeding process, according to the desired variety (grains, feed or green fertilizer).

Table 1. *Biological characteristics of some cowpea varieties studied under the conditions of sandy soils in Romania*

Genotypes	Vegetation period of the cowpea plant		The height of the plant (cm)	Plant weight (g)	L.A.I.	Plant growth type	No. nodules / root at flowering
	No. days	Amount degrees of temperature in air (^{0}C)					
Jiana	103	2353.9	111.33	173.75	7.265	erect, undetermin-ed	129.5
Aura 26	91	2096	82.33	147	5.13	erect, determined	114.8
Ofelia	95	2187.8	91.87	136.55	5.495	erect, undetermin-ed	136.2
Doljana	92	2115.4	81.4	151.65	6.58	erect, undetermin-ed	111.6
Correlation between L.A.I. and plant weight			$Y = 15.728x^2 - 181.04x + 659.75$; $R^2 = 0.972$; $r = 0.985$*				
Correlation between L.A.I. and plant height			$Y = 14.646x^2 - 171.95x + 584.93$; $R^2 = 0.7027$; $r = 0.838$				
Correlation between the height and weight of the plant			$Y = 0.1093x^2 - 20.288x + 1077.7$; $R^2 = 0.996$; $r= 0.998$**				

The plant productivity determines a number of pods in the range of 8.4-20.6 pods/plant, with a podshell length of 12.73-14.22 cm and a number of grains in the pod with values between 10.12-10.45 grains, depending on the genotype (Table 2). The genotypes Aura 26 and Ofelia were highlighted by higher percentages of grains/pods and grain weights. Similar results have been obtained in Brazil by Salvador B. Torres, which shows that the number of grains / pods per 10 cowpea genotypes ranged from 12 to 16 and the best results were obtained in the Amapá variety, which is the earliest [12],. An important role in the production of grain is represented by the percentage of grains / pods and the thousand weight grains (TWG). In this respect, all three varieties created in Dabuleni registered a percentage of grains in the pod net superior to the witness variety, Jiana. In terms of grain weights (TWG), this indicator is a varietal character and has a range of 182.2 g (Aura 26) and 130.5 g (Doljana).

Table 2. *Productivity characteristics of some cowpea genotypes studied under the conditions of sandy soils in Romania*

Genotypes	No. pods/plant	No. grains/pods	Length pods cm	% of grains in the pod	TWG g
Jiana	8.4	10.12	14.22	76.3	174.7
Aura 26	14.23	10.6	14.0	82.6	182.2
Ofelia	17.27	10.37	12.73	82	175.5
Doljana	20.6	10.45	13.77	81	130.5

Under the conditions of 2015-2017, cowpea recorded between 1522-2706 kg/ha of grain, depending on the variety (Table 3). High yields revealed the Aura 26 and Ofelia varieties, which recorded very significant production differences from the control variant (Jiana). The color of the grain is an aspect of the cowpea breeding process, depending on the requirements of the consumers, and in this respect, the researches carried out at Dabuleni aimed at obtaining the cowpea genotypes with white color of the grains. Thus, the Doljana variety, although having a lower production, due to its pleasant commercial appearance (the white color of the grain) is increasingly used in human nutrition. As a result of high protein content in both plant and bean, cowpea is considered to be the queen of psamosol areas, having multiple uses: in man's diet as pods or grains, in improving soil fertility, by cultivating the plant in crops from the sands or by incorporation into the soil as a green fertilizer [7], in animal nutrition, by participating with sorghum or rye in the formation of dried and silage feed. Analyzing the quality of grain production in fascia genotypes, is highlighted a crude protein content of 21.8-22.9%, a fat content between 2.2-2.7%, and a boiling shell content ranging from 7.23-11.36%. The three genotypes created in Dabuleni showed superior nutritional values to the control Jiana variety, both chemically and physically.

Table 3. *Level and quality of production obtained from some cowpea genotypes studied under the conditions of sandy soils in Romania*

Genotypes	Grai yield			Quality of grain			
	Kg/ha	The difference compared to the control Kg/ha	Significance	Color of the grain	Crude protein %	Fats %	Shell %
Jiana	1522	control	control	reddish brown	21.8	2.2	11.36
Aura 26	2706	1184	***	white with reddish brown hill	22.9	2.6	7.23
Ofelia	2530	1008	***	white with black hill	22.5	2.3	8.12
Doljana	2120	598	*	white	22.2	2.7	7.52

LSD 5% = 546.66
LSD 1% = 978.665
LSD 0.1% = 735.99

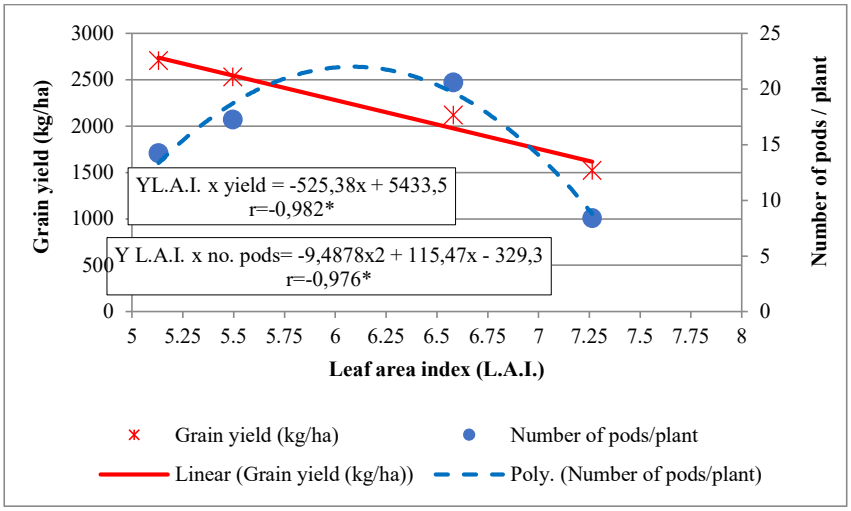

Fig. 2. *Correlations between Leaf area index and cowpea plant productivity*

The intraspecific competition between plants is carried out during the development of the foliar system and the root system, and the results show that higher increases of energy biomass are achieved as the plant is cultivated in an area more similar to that of origin [10]. The results obtained in cowpea varieties show that they developed a rich vegetative mass, with an index of foliar surface in the blooming phase ranging from 5.13-7.265, which correlates negatively with the number of pods/plant and the grains yield obtained (Figure 2). From this point of view, the genotypes of cowpea with high-value foliar surface index can be an important source of bioenergy for sandy soils.

CONCLUSIONS

Due to the plant's biological features, increased drought resistance and reduced soil fertility requirements, the cowpea may be a good alternative for bean culture and soybean culture, plants that are very sensitive to stress factors in areas with excessive drought.

The vegetation period of the cowpea genotypes experimented to R&DSPCS Dabuleni was carried out during 91-103 days with a thermal demand of 2096 - 2353.9 ° C.

The results obtained in the four genotypes of cowpea show that they developed a rich vegetative mass with a leaf aria index, in the blooming phase, between 5.13-7.265, which correlates positively with the height and weight of the plant and negative with the number of pods/plant and grain yields.

They were revealed by high yields (2530-2706 kg/ha) Aura 26 and Ofelia varieties, which have been very significant differences compared to the Jiana control production.

The cowpea genotypes created at Dabuleni (Aura 26, Ofelia and Doljana) showed superior nutritional values to the control Jiana, both chemically (crude protein = 22.2-22.9%, fats = 2.3-2.7%) as well as physically (percentage of boiling shells = 7.23-8.12%).

REFERENCES

[1] Abe S Gerrano, Patrick O Adebola, Willem S Jansen van Rensburg & Sunette M Laurie. Genetic variability in cowpea (Vigna unguiculata (L.)Walp.) genotypes. South African Journal of Plant and Soil, Volume 32, 2015 - Issue 3, DOI: 10.1080/02571862.2015.1014435, Online ISSN: 2167-034X, South Africa, 2015, pp. 165-174;

[2] B.B. Singh, D.R. Mohan Raj, K.E. Dashiell, and L.E.N. Jackai. Advances in Cowpea Research. International Institute of Tropical Agriculture, Ibadan, Nigeria and Japan International Research Center for Agricultural Sciences Tsukuba, Ibaraki. ISBN 978131 110 X, Japan, 1997, pp. 30-50;

[3] Baudoin J.P., Marechal R. Wide crosses and taxonomy of pulse crops, with special emphasis on Phaseolus and Vigna. In: Ng NP, Perrino P, Attere F, Zedan H (eds) Proceedings of an African plant genetic resources Workshop, International Institute of Tropical Agriculture, 17–20 October 1988, Nigeria,1991, pp 287–302;

[4] Boukar O, F. Massawe, S. Muranaka, J. Franco, B. Maziya-Dixon, and C. Fatokun. Evaluation of cowpea germplasm lines for minerals and protein content in grains. 5th World Cowpea Research Conference, 27 September–1 October 2010, Palm Beach Hotel, Saly, Senegal, 2010, pp.18;

[5] Draghci Reta. "Contributions to the growing technology cowpea (Vigna unguiculata (L.) Walp) on irrigated sands in southern Oltenia", PhD thesis, Unversity Craiova, Romania, 1999, pp 89-105;

[6] Emongor V. Gibberellic acid (GA3) influence on vegetative growth, nodulation and yield of cowpea (Vigna unguiculata (L.) Walp.). Journal of Agronomy Volume 6; Issue; eISSN: 1812-5417; p ISSN: 1812-5379, Botswana, 2007, pp. 509–517;

[7] Ion Petre. Dynamics of organic matter in soil and its influence on production capacity with special regard to soils with coarse texture. PhD thesis, ASAS Bucharest, Romania, 1981, pp.82-84;

[8] K.O. Awonaike, K.S.Kumarasinghe, S.K.A.Danso. Nitrogen fixation and yield of cowpea (Vigna unguiculata) as influenced by cultivar and Bradyrhizobium strain, Field Crops Research. ISSN: 0378-4290, Volume 24, Issues 3–4, October, Nigeria, 1990, pp.163-171;

[9] M.F. Ishiyaku and H. Aliyu. Field Evaluation of Cowpea Genotypes for Drought Tolerance and Striga Resistance in the Dry Savanna of the North-West Nigeria. International Journal of Plant Breeding and Genetics, Volume 7 (1): eISSN: 2152-3347 pISSN: 1819-3595, Nigeria, 2013, pp. 47-56;

[10] R.B. Dadson, F.M. Hashem, I Javaid, J. Joshi, A.L.Allen, T.E. Devine. Effect of Water Stress on the Yield of Cowpea (Vigna unguiculata L. Walp.) Genotypes in the Delmarva Region of the United States. Journal of Agronomy and Crop Science. Online ISSN:1439-037X. Volume 191, Issue 3, USA, 2005, pp. 210-217;

[11] Reta Draghici, Iulian Draghici, Aurelia Diaconu, Milica Dima. Variability of genetic resources of cowpea (Vigna unguiculata L. Walp) studied in the sandy soil conditions from Romania. Annals of the University of Craiova-Agriculture, Montanology, Cadastre Series. Vol. XLVI. ISSN: 1841-8317, Romania, 2016, pp. 147-153;

[12] Salvador B Torres, Fabrícia N de Oliveira, Regina C de Oliveira, João B Fernandes. Yield and morphology of cowpea accessions in Mossoró, Rio Grande do Norte State, Brazil. Horticultura Brasileira, Print version ISSN 0102-0536; On-line version ISSN 1806 - 9991, vol.26 no.4, Brasília, 2008, pp. 537-539;

[13] Thomas R. Sinclair, Anju Manandhar, Ouhoun Belko, Mandeep Riar, Vincent Vadez and Philip A. Roberts. Variation among Cowpea Genotypes in Sensitivity of Transpiration Rate and Symbiotic Nitrogen Fixation to Soil Drying. Crop Science Society of America, Vol. 55 No. 5, ISSN: 1435-0653 Print ISSN: 0011-183X, USA, 2015, pp. 2270-2275;

[14] Zavoi A. Contributions related to biology, improvement and agrotechnology of cowpea. Vigna sinensis (Torn) Endl – PhD thesis, University of Cluj Napoca, Romania,1967, pp 122-200.