ASSESSMENT OF THE BIOLOGICAL POTENTIAL OF LEGUMINOUS PLANTS OF THE SPECIES *Vigna unguiculata* (L.) WALPERS AND *Vigna radiata* (L.) WILCZEK IN THE CONDITIONS OF THE SANDY SOILS IN ROMANIA

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Abstract. The research was carried out at SCDCPN Dăbuleni, between 2016-2018 and dealt with the behaviour of 6 genotypes of cowpea (*Vigna unguiculata* L. Walpers) and 5 genotypes of mung beans (*Vigna radiata* L. Wilczek), of Chinese origin, in comparison with the indigenous cowpea genotype, Aura 26 in the conditions of the sandy soils. The following genotypes stood out with a large number of pods/plants (15.9-24 pods): China B1, China G1, China B2, China T4, China G2, China G3. In terms of grain weight, the TGW varied in the range 115-190.3 grams, for the genotypes of the species *Vigna unguiculata* (L.) Walpers and in the range 59.1-63.7 grams, for the genotypes of the species *Vigna radiata* (L.) Wilczek. The determinations of the physiology of the plant revealed a better adaptability of the genotypes of cowpea compared to mung beans. The results obtained at the harvest showed the production of grains in the range of 670-2511.9 kg/ha in the cowpea genotypes and 1861,9-2209,5 kg/ha at the genotypes in the mung beans.

Keywords: cowpea, mung beans, biometrics, physiology, productivity.

Rezumat. Evaluarea potențialului biologic al unor plante leguminoase din speciile *Vigna unguiculata* (L.) Walpers și *Vigna radiata* (L.) Wilczek, în condițiile solurilor nisipoase din România. Cercetările s-au efectuat la SCDCPN Dăbuleni, în perioada 2016-2018 și au vizat comportarea în condițiile solurilor nisipoase a 6 genotipuri de fasoliță (*Vigna unguiculata* L. Walpers) și 5 genotipuri fasole mung (*Vigna radiata* (L.) Wilczek), de origine chineză, comparativ cu gentipul autohton de fasoliță, Aura 26. S-au detașat printr-un un număr mare de păstăi/plantă (15,9-24 păstăi) genotipurile: China B1, China G1, China B2, China T4, China G2, China G3. Sub aspectul greutății boabelor, MMB-ul a variat în intervalul 115-190,3 grame, la genotipurile din specia *Vigna unguiculata* (L.) Walpers și în intervalul 59,1-63,7 grame, la genotipurile din specia *Vigna radiata* (L.) Wilczek. Determinările de fiziologie a plantei au evidențiat o adaptabilitate mai bună a genotipurilor de fasoliță, comparativ cu fasolea mung. Rezultatele obținute la recoltare, au evidențiat producții de boabe cuprinse în intervalul 670-2511,9 kg/ha la genotipurile de fasoliță și de 1861,9-2209,5 kg/ha, la genotipurile din fasolea mung.

Cuvinte cheie: fasoliță, fasole mung, biometrie, fiziologie, productivitate.

INTRODUCTION

Vigna is a genus of flowering plants from the leguminous Fabaceae family, with a very large distribution in the tropical area (BISHT et al., 2005; KUMAR et al., 2012). It includes several species, among which *Vigna unguiculata* L. Walpers, but also many types of beans, which are cultivated on quite large surfaces in India, under the name of mung beans (*Vigna radiata* (L.) R. Wilczek). Cowpea *(Vigna unguiculata* L. Walp*)*, through the biological attributes of the plant, for its increased drought resistance and reduced requirements of soil fertility, can be a good alternative for the cultivation of beans for grains and for the culture of soybean, plants which are very susceptible to stressful factors in areas with excessive drought (SINCLAIR et al., 2015; DRĂGHICI et al., 2018).

In Romania, cowpea was known as *Vigna sinensis* (Torn) Endl, a name adopted by Flora of R.P.R., Vol. V (ZĂVOI, 1967), and currently, for a wider coverage of the species, the name *Vigna unguiculata* (L.) Walpers was adopted (Official List of Varieties and hybrids of culture plants in Romania, 1991). BRYSSINE (1962) mentioned that the genus *Vigna savi* is very polymorphic. He quotes Wilezek (1954) and Hepper (1956), who introduced the edible bean species of Asian origin, such as *Phaseolus aureus* Roxb, *Ph. radiatus* L*., Ph. mungo* and *Ph. hirtus* L., in the genus *Vigna*, and who considered that by their characters these species are better framed to the genus *Vigna* than *Phaseolus*. The Beans mung [*Vigna radiata* (L.) Wilczek], has small seeds of different colours, being rich in digestible proteins (about 25-28%) and with a higher capacity of nitrogen fixation in the atmosphere than the cowpea (SENARATNE et al., 1995; KUMAR et al., 2012). The research carried out by R. Senaratne at al., 1995 at the University of Ruhuna Kamburupitiya in Sri Lanka, with the help of the isotopic nitrogen, revealed the fixing of a quantity of 161 and 197 mg N/plant, by cultivating the cowpea and the mung beans intercropped with maize. The mung bean has a shorter period of vegetation than the cowpea, is relatively resistant to drought and harnesses with good results the sandy soils of the tropical area (ANDRE et al., 2018).

Harnessing the sandy soils of southern Oltenia assumes a specific, rational and integrated agriculture system with less demanding plants at soil fertility and tolerating the stressful factors, which ensures profitability and environmental protection (MARINICĂ, 1994; DRĂGHICI, 2018). To this end, germoplasm of the genus *Vigna*, existing at SCDCPN Dăbuleni, was collected, by testing some genotypes from China, belonging to the species *Vigna unguiculata* (L.) Walpers and *Vigna radiata* (L.) Wilczek, for the purpose of assessing the adaptability of Chinese genotypes to Romania conditions.

MATERIALS AND METHODS

The research was carried out at SCDCPN Dăbuleni in the period 2016-2018 and dealt with the behaviour of genotypes in the genus *Vigna* in the conditions of the sandy soils. Tests were made for 7 genotypes of cowpea (*Vigna unguiculata* (L.) Walp): Aura 26, China Dazhi, China T1, China T2, China T3, China T4, China T5 and 5 genotypes mung beans (*Vigna radiata* (L.) Wilczek): China B1, China B2, China G1, China G2, China G2. The tested beans were collected from China (from the Agro-Resources and Environment Institute in Shijiazhaung, belonging to the Academy of Agricultural and Forestry Sciences in Hebei) and were studied compared to the Aura 26 variety, created at SCDCPN Dăbuleni in Romania.

The experiment was established on a sandy soil, with a poor supply of nitrogen and a good supply of phosphorus, low to average supply of potassium, with low organic carbon and slightly acid to neutral pH. Thus, extractable phosphorus presented values between 73 ppm and 103 ppm, the content in the replaceable potassium was between 59 ppm and 94 ppm, organic carbon presented values in the range 0.12%-0.48%, and the pH of the soil on which it has oscillated between 5.6 and 6.93 values showed a moderately acidic to neutral reaction. The experiment was placed in irrigation conditions, in a 3-year rotation: cowpea – rye – sorghum. The genotypes of cowpea were seeded from 1.10 to May, when the average temperature in the soil was 10-12^{0}C, being fertilized by 60 kg/ha N, 60 kg/ha P_2O_5 and 60 kg/ha K_2O. During the vegetation soil humidity was maintained above the minimum ceiling of 30% of the active humidity range, at the depth of 50 cm, in the formation phase of the floral organs, flowering and formation of pods, by applying 1-2 irrigations with a norm of 300 m^3 water/ Ha. Observations and determinations of biology, physiology, morphology, and productivity were made. The determinations of the physiology of the plant (photosynthesis rate, the rate of the foliar transpiration, the stomatic conductance, the active radiation in the photosynthesis, the temperature at leaf level) were performed in the growth phenofase of the fruit using the LC Pro + device. The results were calculated and analyzed in statistical terms by the variance analysis method.

RESULTS AND DISCUSSIONS

The analysis of the climatic conditions from 2016-2018, during may-august (calendar period for the growing cycle of species studied) highlights the recording of an average air temperature of 22.66 ^{0}C, 1.65 ^{0}C higher than the multiannual average (Table 1). These results underline the importance of drought in the summer period, which can cause many plants to fail. In this context, in order to promote sustainable agriculture in drought conditions, plant species should be found that adapt more easily to existing hydro-thermic stress conditions and ensure good stability of the obtained productions. Originating in Central Africa, the cowpea (*Vigna unguiculata* L. Walp), is considered as "the Queen of the areals with psamosoils", because of the biological qualities of the plant, the increased resistance to drought and reduced requirements of the soils fertility, can promote a system of sustainable agriculture in areas affected by drought and with poorly productive land (MARINICĂ, 1994; EGASHIRA et al., 2016; DRĂGHICI, 2018). In terms of the rainfall regime, compared with the multiannual average, when 222.45 mm were registered in May=August, during the period 2016-2018 the rainfall during the same period totalled 305.42 mm, exceeding the multi-annual average by 82.97 mm. Because, the amount of water provided by precipitation was insufficient in the maximum consumption phases of the plant, the soil humidity regime was completed by applying 1-2 irrigations at around 300 m^3 water/ha.

Table 1. Analysis of climatic conditions recorded at the ADCON Telemetry Weather Station located in SCDCPN Dăbuleni.

Climatic elements	May	June	July	August	Average (^{0}C)	$\sum$ ^{0}C / mm
Average temperature (2016-2018) (^{0}C)	18.43	23.36	24.4	24.46	22. 66	2787.18
Multiannual Temperature (2056-2018) (^{0}C)	16.86	21.61	23.11	22.44	21.01	2584.23
Deviation from the multi-annual average (^{0}C)	1.57	1.75	1.29	2.02	1.65	
Rainfall 2016-2018 (mm)	96.53	88.6	100.36	19.93		305.42
Rainfall precipitation (mm)	63.09	70.47	55.74	33.15		222.45
Deviation from the multi-annual average (mm)	33.44	18.13	44.62	-13.22		82.97

The analysis of the resistance of the plant to the virosis in the flowering phase underlines the good behaviour of most of the studied genotypes, (Photos 1, 2, 3, 4) (Table 2). The only variety that did not adapt to the Dăbuleni conditions was China Dazhi.

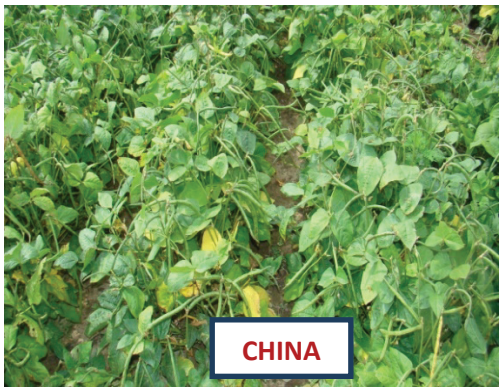
For growth and development, plants underwent the vegetation cycle for 82-101.5 days, needing about 1808.9-2300^{0}C, to reach technical maturity. Compared to the Aura 26 cowpea variety, with the exception of China Dazhi variety, all other Chinese varieties were 4.3 to 12 days earlier.

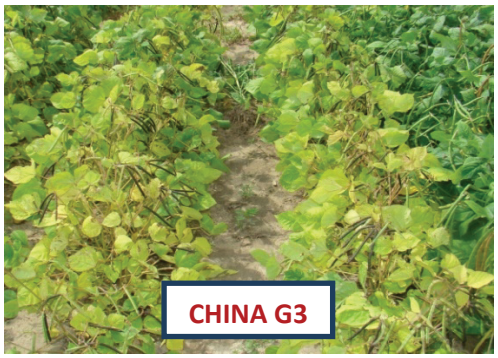
The biometric and productivity determinations of the plant (number of pods/plants, number of grains in the pods, the thousand grains weight (TGW), have highlighted significant differences between the genotypes studied (Table 2). Thus, the height of the plant was comprised in the range 3.4-97.5 cm, with an average of 46.27 cm. The following

genotypes stood out in terms of the number of pods/plants (15.9-24 pods): China B1, China G1, China B2, China T4, China G2, China G3. The number of grains in the pods was, on average, 9.17 grains, with limits in the range 6.7-11.6 grains/pods. Under TGW, it varied in the range of 115-190.3 grams, for genotypes of the species *Vigna unguiculata* (L.) Walpers and in the range of 59,1-63,7 grams, for genotypes of the species *Vigna radiata* (L.) Wilczek (Table 2).

Table 2. The value of the elements of biometrics and of productivity in the genotypes in *Vigna* ssp., studied on sandy soils in Romania.

Species	Genotype	Resistance to diseases (Notes 1-9)	Vegetation period (days)	The plants height cm	No pods/ plant	No. Grains/ pod	TGW g
Vigna unguiculata (L.) Walpers	Aura 26	1	94	86.9***	13.3	11.0	180.5***
	China Dazhi	4.5	101.5	97.5***	7.9^{0}	6.7^{0}	190.3***
	China T1	2.3	86	33.7^{0}	10.9	11.6*	160.4***
	China T2	2.3	89.7	33.7^{0}	10.2	9.2	158.1***
	China T3	2	89.7	36.4	13.6	8.5	172***
	China T4	1	88.3	35.2	16.8	8.6	115.0
	China T5	1	87.3	33.4^{0}	14.1	9.5	130.8*
Vigna radiata (L.) Wilczek)	China B1	2	89	34.7	24.0*	9.0	59.1^{000}
	China B2	1.7	85.3	40.6	18.3	8.3	63.7^{000}
	China G1	2	82	37.8	19.9	10.0	66.8^{000}
	China G2	2	89.7	38.6	15.9	9.3	74.2^{000}
	China G3	2	89	35.2	17.3	8.3	68.9^{000}
Average		1.98	89.21	41.52	15.18	9.17	119.98
Minimum		1	82	33.4	7.9	6.7	59.1
Maximum		4.5	101.5	97.5	24	11.6	190.3
LSD 5%				7.54	7.16	2.11	10.73
LSD 1%				10.56	9.76	2.89	14.62
LSD 0,1%				14.2	13.11	3.88	19.64





Photos 1, 2, 3, 4. *Vigna* ssp. (original).

A global analysis of the average daily value of the photosynthesis rate (Table 2) shows that Chinese genotypes

The analysis of the physiological processes of the plant highlighted a diurnal variation of photosynthesis, transpiration and stomatologic conductance (Table 3), being influenced by environmental factors (temperature, the amount of radiation active in photosynthesis) and genotype.

Table 3. The diurnal variance of physiological processes in some cowpea genotypes in flowering stage.

Time of determinations	Genotypes	RAF µmol/m²/s	T °C	Photosynthesis µmol CO_2/m²/s	Foliar transpiration mmol H_2O/m²/s	Stomatal Conductance mol/m²/s
9 o'clock	Aura 26	1300	26.5	20.66	4.14	0,85
	China Dazhi	1300	25.8	14.79	3.82	0,91
	China T1	1335	26.3	15.59	2.36	0,38
	China T2	1328	26.5	23.28	3.56	0,86
	China T3	1338	26.4	21.90	2.94	0,54
	China T4	1346	26.5	19.71	3.40	0,69
	China T5	1330	26.5	13.15	2.65	0,36
	China B1	1312	26.0	19.64	3.39	0,66
	China B2	1322	26.0	28.30	3.66	0,95
	China G1	1322	26.0	19.18	3.79	1,11
	China G2	1328	26.1	25.76	2.96	0,48
	China G3	1328	26.4	22.36	3.55	0,76
Average at9 o'clock		1890.4	31.8	25.71	4.92	0.97
12 o'clock	Aura 26	1892	32.5	29.09	4.52	1,95
	China Dazhi	1913	30.0	30.16	4.87	2,21
	China T1	1880	32.6	36.77	3.56	1,07
	China T2	1903	32.7	13.10	5.58	0,65
	China T3	1880	33.0	19.83	6.37	1,18
	China T4	1900	32.7	33.65	6.03	0,67
	China T5	1880	32.8	24.29	5.27	0,53
	China B1	1895	30.1	24.99	4.49	0,79
	China B2	1895	30.5	20.18	4.02	0,54
	China G1	1870	31.2	24.32	5.51	0,91
	China G2	1890	31.7	22.26	4.12	0,67
	China G3	1887	32.2	29.89	4.73	0,46
Average at 12 o'clock		1890.4	31.83	25.71	4.92	0.97
15 o'clock	Aura 26	1828	34.3	28.88	7.27	1,14
	China Dazhi	1849	30.0	25.71	3.92	0,78
	China T1	1820	33.5	33.41	6.74	0,90
	China T2	1812	34.0	38.91	7.03	0,86
	China T3	1817	34.5	27.65	7.39	0,84
	China T4	1820	35.3	28.86	7.76	0,72
	China T5	1820	35.5	24.99	8.03	0,71
	China B1	1805	30.0	24.34	3.84	0,87
	China B2	1817	30.5	8.39	3.91	0,48
	China G1	1817	31.3	19.37	4.30	0,74
	China G2	1815	32.3	24.95	3.32	0,22
	China G3	1817	32.8	23.17	5.22	0,47
Average at 15o'clock		1819.7	32.83	25.72	5.73	0.73
Daily average	Aura 26	1673	31.1	26.21	5.31	1,31
	China Dazhi	1687	28.6	23.55	4.20	1,30
	China T1	1678	30.8	28.59	4.22	0,78
	China T2	1681	31.0	25.09	5.39	0,79
	China T3	1678	31.3	23.12	5.56	0,85
	China T4	1688	31.5	27.40	5.73	0,69
	China T5	1676	31.6	20.81	5.31	0,53
	China B1	1670	28.7	22.99	3.90	0,77
	China B2	1678	29.0	18.95	3.86	0,65
	China G1	1669	29.5	20.95	4.53	0,92
	China G2	1677	30.0	24.32	3.46	0,45
	China G3	1677	30.4	25.14	4.50	0,56
The average of the cowpea genotypes		1680.1	30.8	24.98	5.108	0.9
The average of the mung bean genotypes		1674.2	29.5	22.47	4.05	0.67

The determinations made at 9 o'clock showed an average of the photosynthesis rate of 20.36 µmolCO_2/m²/s, with a minimum value of 13.15 µmol CO_2/m²/s (in the China T5 genotype) and a maximum of 28.3 µmol CO_2/m²/s (in the China B2 genotype) at an active radiation between 1300-1346 µmol/m²/s. At 12 o'clock, as the temperature increased (33.2 °C), the amount of active radiation in photosynthesis also increased, registering an average value of 1890.4 µmol/ m²/s. In these circumstances, most of the tested genotypes intensified the photosynthesis process, because both the cowpea and the mung beans being species that love light and heat. At this time of the day, 4 of these genotypes recorded a photosynthesis rate of over 30 µmol CO_2/m²/s (Dazhi, China T4, China T1). For the China T2 genotype, although the air temperature had optimum values for conducting physiological processes, the large amount of active radiation (1903 µmols/m²/s) resulted in partial closure of the stoms (the value of the stomatal conductance being of 0.65 mol/m²/s), with repercussions on photosynthesis (13.10 µmols CO_2/m²/s). The same genotype (China T2) returned

spectacularly from a photosynthetic point of view at 15 o'clock, reaching the maximum diurnal of photosynthesis (38.91 µmols $CO_2/m^2/s$) at an active radiation of 1812 µmols $CO_2/m^2/s$ and a temperature of 34 °C. With a low photosynthetic yield, the genotype of China B2 was revealed at this time, the photosynthesis rate being only 8.39 µmols $CO_2/m^2/s$, at a stomatal conductance of 0.48 µmols $CO_2/m^2/s$.

Compared to other species cultivated on the sands, the cowpea generally loses reduced amounts of water through foliar transpiration, being a drought-resistant species (SINGH et al., 2013; RIVAS et al., 2016). The genotypes studied in this experiment presented an average foliar transpiration between 3.46 mmol $H_2O/m^2/s$, China G2 and 5.73 mmol $H_2O/m^2/s$, to China T4, with evaporated water being efficiently exploited. The intensity of this process was influenced on one side by the temperature, as the values of the foliar transpiration increase directly proportionally with it, and on the other hand the number of stomata and the degree of openness cause differentiation between genotypes in terms of photosynthesis productivity. If we compare the two studied species of legumes, it is noted that the genotypes of cowpea have recorded higher average values of both photosynthesis and foliar transpiration compared to mung bean genotypes.

A global analysis of the average daily value of the photosynthesis rate (Table 2) shows that Chinese genotypes have adapted to the pedoclimatic conditions of Dăbuleni, obtaining values ranging between 18.95-28.59 µmols $CO_2/m^2/s$. The cowpea genotype, China T1, stands out as very resistant to the stressful action of environmental factors, which is explained by the high photosynthetic yield at 12-15 hours. At the opposite pole, the mung bean genotype, China B2, proved to be slightly more sensitive, where the photosynthetic yield decreased as the stressful action of external factors intensified, also in order to cope with the heat phenomenon of the afternoons.

The analysis of the dimensions of length and width of the pods and the grain emphasizes differentiations according to variety and species, with the genotypes of the species *Vigna unguiculata* L. Walpers obtaining the highest values (Table 4).

Table 4. The characters of the pods and the grain at the genotypes in *Vigna* ssp., studied on sandy soils.

Species	**Genotype**	**Length of the pods cm**	**Width of the pods cm**	**Length of the grain mm**	**Width of the grain mm**	**% grains/pod**	**Grains colour**
Vigna unguiculata (L.) Walpers	Aura 26	14.63**	0.85*	8.14***	4.68	79,8***	White with red brown hill
	China Dazhi	10.82	1***	8.9***	6.3***	75***	beige + red brown
	China T1	15.8***	0.98***	8***	5.5***	73,3**	red brown
	China T2	12.23	0.98***	9.4***	5.4**	69,1	red
	China T3	11.31	0.8	9.2***	5.5**	72,3*	red brown
	China T4	12.2	0.9**	9.1***	5.9***	69	beige + red brown
	China T5	12.57	0.85*	6.9	3.7^{00}	$66,7^{0}$	beige + red brown
Average*Vigna unguiculata* (L.) Walpers		12.79	0.91	8.52	5.23	72.17	
Vigna radiata (L.) Wilczek)	China B1	8^{00}	0.35^{000}	4.5^{000}	3^{000}	$57,1^{000}$	Black
	China B2	7.92^{00}	0.4^{000}	5.4^{000}	3.8^{00}	68,2	Black
	China G1	9.9	0.6	5.2^{000}	3.7^{00}	$65,4^{00}$	Green Khaki Matte
	China G2	8.53^{0}	0.5^{00}	5.2^{000}	3.7^{00}	68,2	Green Khaki Glossy
	China G3	8.43^{0}	0.48^{000}	4.8^{000}	3.6^{000}	$65,2^{00}$	Green Khaki Glossy
Average *Vigna radiata*		8,56	0.47	5.02	3.56	64.82	
Average Vigna (Witness)		11.03	0.71	7.06	4.56	69,46	
LSD 5%		2.14	0.13	0.28	0.49	2.38	
LSD 1%		2.91	0.17	0.38	0.67	3.24	
LSD 0,1%		3,92	0.23	0.51	0.9	4.36	

Also, the percentage of grains in the pods was differentiated, with an average value of 72.17%, to cowpea genotypes and 64.82%, to mung bean genotypes. In the appearance of the colour of the coil, which is a variety character, a wide range of colours was noted: white, black, green, white, brown, reddened, with different shades and intensity of colours.

The results obtained at the harvest showed the production of grains in the range 670-2511.9 kg/ha, to the genotypes of cowpea and 1861.9-2209.5 kg/ha, to genotypes in mung beans (Fig. 1). Statistically analysing the results obtained for the species *Vigna unguiculate*, it was seen that the native variety Aura 26 detached from all others by a production yield of 742.2 kg/ha, significantly distinct compared to the average of 1737.7 kg/ha of the 7 genotypes. The 5 genotypes of the species *Vigna radiata* were not statistically differentiated.

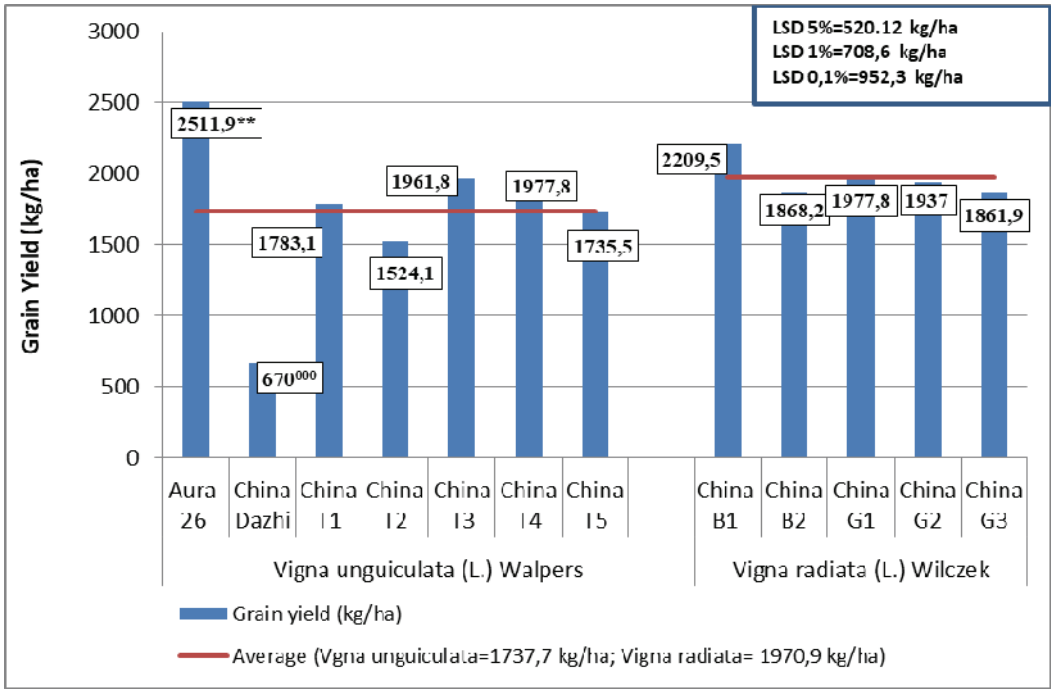


Figure 1. Production of grains obtained from cowpea genotypes and Mung beans, under the conditions of the sandy soils.

CONCLUSIONS

Analysis of the resistance of the plant to the virosis in the flowering phase, underlines the good behaviour of most of the genotypes tested (Photos 1, 2, 3, 4).

The following genotypes stood out in terms of number of pods/plants (15.9-24 pods): China B1, China G1, China B2, China T4, China G2, China G3.

The weight of 1000 grains varied in the range 115-190.3 g, to genotypes of the species *Vigna unguiculata* (L.) Walpersand in the range 59.1-63.7 g, to genotypes of the species *Vigna radiata* (L.) Wilczek.

The physiology determinations of the plant have shown a better adaptability of the cowpea genotypes compared to mung beans.

The results obtained at the harvesting showed the production of grains in the range of 670-2511.9 kg/ha for the genotypes of cowpea and 1861.9-2209.5 kg/ha for the genotypes of mung beans.

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