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RESEARCH REGARDING THE INFLUENCE OF GENOTYPE AND EPOCH OF SOWING ON SEEDS YIELD AT CHICKPEAS (*CICER ARIETINUM* L.) IN THE PEDO–CLIMATIC CONDITIONS OF CENTRAL MOLDOVA

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Abstract: The agronomic importance of the chickpea crop is given by the improvement of soil fertility by fixing atmospheric nitrogen, the resistance to drought and high temperatures, the resistance to falling and the fact that the pods do not burst at maturity. These advantageous features reduce losses during harvesting. The present paper presents data on the influence of genotype and epoch of sowing at Cicer arietinum L. (chickpeas). The researches were organized in 2021–2022 at the Agricultural Research and Developement Station Secuieni, Neamt County. The genotypes tested in the first year of experimentation showed a high adaptability to the pedoclimatic conditions of the area, thus obtaining productions around 2100 kg/ha. Compared to the first year of experimentation, in 2022 the productions were lower, noting that the lowest production was recorded in the Kaffe variety (1796 kg/ha), and the highest in the Burnas variety (2031 kg/ha). This paper presents new data on the improvement the optimal epoch of sowing in a particular zone for optimising the seeds production obtained at chickpeas.
Keywords: chickpeas, seed, genotype, epoch of sowing, yield

INTRODUCTION

Chickpea (*Cicer arietinum* L.) ranks third among the most cultivated legumes in the world, after beans and peas (*Ohri D., 2016*). It is cultivated worldwide in about 57 countries under varying environmental conditions (*MoEF&CC 2016,*). In South and Southeast Asia chickpea production dominates with 80% of the regional contribution. Although developed countries do not contribute much to chickpea production, the yield is particularly high in some Eastern European countries.

Chickpeas is traditionally cultivated in semi–arid tropical (Asia, Australia and India) and Mediterranean regions and has recently expanded its cultivation area to higher latitudes (*Yartsev G. F. et al., 2021*). It is a microthermic plant, which grows and develops well in the conditions of a warm and semi–arid climate. In the regions of the world where chickpea grows, the average maximum temperature ranges from 21 to 29 °C during the day and from 15 to 25 °C at night (*Daba K. et al., 2016,*). In our country, this culture meets favorable conditions for growth and development and could in the future have an even greater extension, because the temperatures during the summer are high and the possibilities of irrigation of the crops are minimal.

Chickpea is a valuable crop that provides nutritious food for an expanding world population and will become increasingly important with climate change (*Muehlbauer and Sarker, 2017*). Chickpea plays a leading role in world food security, covering the protein deficiency in the daily food ration of Indian and African populations without compromising the quality of nutrition (*Malunga L.N. et al., 2014*).

The agronomic importance of the chickpea crop is given by the improvement of soil fertility by fixing atmospheric nitrogen, the resistance to drought and high temperatures, the resistance to falling and the fact that the pods do not burst at maturity. These advantageous features reduce losses during harvesting.

The optimum sowing time for chickpea depends on the interaction between the environment and the genotype used at sowing. Current chickpea genotypes have excellent frost tolerance but average daily temperature below 15 ^{0} C has been shown to cause flower abortion (*Chen Y. et al., 2017*).

In some countries the optimum sowing date results in flowering when the risk of low temperatures is high and it is particularly important to avoid frost during flowering as it can kill chickpea plants (*Kolesnikov A. A. et al., 2022*). Earlier sowing may expose the crop to more rainfall which may increase the risk of *Ascochyta rabies* – chickpea anthracnose which has been reported to be the most destructive disease in 32 countries (*Ramirez M.L. et al. 2018*, *Ryley M. et al., 2015*). It will also increase crop biomass, thus increasing the risk of gray mold (*Botrytis*) and soil moisture deficit during grain filling.

Also, sowing later can result in shorter plants that will be more difficult to harvest but reduce the risk of downy mildew (*Lake L. and Sadras V.O., 2014*). The minimum germination temperature of the chickpea crop is 3–4 ^{0} C in cold areas and in the Mediterranean area the germination temperature is between 20 ° C and 30 ° C and the emergence of seedlings takes place in these conditions, from five to six days after seeding (*Nascimento W.M. et al., 2016*).

Optimal sowing time provides more time for plant growth and development, which is favorable for higher yield. Also, sowing chickpeas at the optimal time ensures a better harmony between the soil, the plant and the atmospheric system, and is also a critical factor influencing production. The highest production depends on the date of sowing (*Merga B. and Haji J., 2020, Verma M.M. et al., 2014*).The season for sowing chickpeas in the conditions of our country is early spring when the soil, at the sowing depth, reaches 3–4 ^{0} C. A delay of 10 days compared to the optimal season can reduce production by 20% *(Nascimento W.M. et al., 2016*).

This paper presents new data on the improvement the optimal epoch of sowing in a particular zone for optimising the seeds production obtained at chickpeas.

MATERIALS AND METHODS

The purpose of the research carried out at the Secuieni Agricultural Research – Development Station was to study the influence of technological factors such as: genotype and epoch of sowing. The experiments aimed to identify the genotype with the highest adaptability to climatic conditions in the area of influence and establish the optimal time to sow.

The placement was performed in the experimental field of the A.R.D.S. Secuieni, on a soil of the faeoziom (chernozem) typical cambic with medium texture, acid: pH H_2O – 5.98, characterized as: well supplied in phosphorus (77.6 ppm PAL), Ca (13.6 meq / 100 g soil Ca) and Mg (1.8 meq / 100 g soil Mg), medium supplied with active humus (1.88%) and nitrogen (16.2 ppm N–NO_3) and poorly supplied with potassium (124.6 ppm K_2O) (*Lupu Cornelia, 2017; Mîrzan Oana, 2020*).

The experiment was placed according to the method of subdivided plots, in three repetitions of type A x B, and the experimental factors studied were: A – genotype (a_1 – Kaffe, a_2 – Burnas, a_3 – Orion) and B – epoch of sowing (b_1 – sown in the second decade of March, b_2 – sown in the third decade of March, b_3 – sown in the first decade – April). The studied biological material included a Romanian chickpeas variety, Burnas and two foreign varieties, Kaffe and Orion.

The obtained results were processed and interpreted statistically according to the method of analysis of variance.

From a climatic point of view, the vegetation period, in the two year of experimentation, was characterized as hot from a thermal point of view and dry from a pluviometric point of view. The year 2021 was characterized as a warm and dry; the annual amount of rainfall that was unevenly distributed during the growing season of chickpeas. The monthly averages of temperatures recorded during the vegetation period were similar to the multiannual average, the deviations being between 0.4^0 C in June and 1.8^0 C in July. From a pluviometric point of view, the precipitations were lower than the multiannual average, registering deviations of – 23.8 mm in April and – 31.4 mm in May (*Table 1 and Table 2*).

Table 1. Temperatures recorded at A.R.D.S. Secuieni meteorological station

Average temperature ºC	Months								Average vegetation period
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	
2021	–0.7	–0.4	2.9	7.5	14.7	19.2	22.2	20.5	10.7
2022	–0.1	2.6	2.7	9.5	16.3	20.7	22.2	22.7	12.1
Multiannual average	–3.9	–2.2	2.8	9.5	15.4	18.8	20.4	19.5	10.03

The year 2022 was characterized by hot weather in terms of temperatures and dry in terms of rainfall. The spring was normal thermally, the monthly temperature deviations were between –0.1°C (March) and 0.9°C (May) (*Table 1*).

Regarding precipitation, the amounts of water that fell were reduced in January (5.4 mm) and February (4.6 mm), these months being characterized as very dry. Rainfall in April (38.4 mm) helped the chickpea crop to sprout, and that in June (56.6 mm) to continue its development. In May, a significant rainfall deficit of – 44.9 mm was recorded (*Table 2*).

Throughout the vegetation period of chickpeas crop, the deviations from the multiannual average were different. The distribution of precipitation was extremely uneven, on the phenophases of growth and development of the plant (*Table 2*).

Table 2. Rainfall recorded at A.R.D.S. Secuieni meteorological station

Rainfall (mm)	Months								Sum for the vegetation period
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	
2021	12.2	10.8	31.8	23.8	31.4	79.4	51.6	76.8	317.8
2022	5.4	4.6	0.8	38.4	20.8	56.6	35.2	15.2	177.0
Multiannual average	20.1	19.5	26.9	46.9	65.7	85.0	82.3	60.2	406.6

RESULTS

The genotypes tested in the first year of experimentation showed a high adaptability to the pedoclimatic conditions of the area, thus obtaining productions around 2100 kg/ha. The influence of the genotype on the yield of seeds obtained from chickpeas, in 2021, materialized by obtaining fluctuating yields, between 2022 kg/ha (Kaffe) and 2249 kg/ha (Burnas) (*Table 3*). Compared the yields obtained with the average experience (control), we notice that the Burnas variety (91 kg/ha) obtained a statistically assured yield increase and interprete positive very significant and Orion variety (45 kg/ha) recorded a production statistically interpreted as distinctly significant. The Kaffe variety achieved a yield difference (–136 kg/ha) ensured statistically and interpreted as very significant negative (*Table 3*).

Table 3. The influence of genotype on seed yield at *Cicer arietinum* L., 2021

Variety	Yield (kg/ha)	% compared to control	Difference (kg/ha)	Significance
Kaffe	2022	93,69	–136	000
Burnas	2249	104,21	91	***
Orion	2203	102,08	45	**
Average	2158	100	Ct.	
LSD 5% =		25,24 kg/ha		
1% =		36,30 kg/ha		
0,1%=		55,72 kg/ha		

Table 4. The influence of genotype on seed yield at *Cicer arietinum* L., 2022

Variety	Yield (kg/ha)	% compared to control	Difference (kg/ha)	Significance
Kaffe	1796	93,10	–133	000
Burnas	2031	105,28	102	***
Orion	1961	101,65	32	*
Average	1929	100	Ct.	
LSD 5% =		26,41 kg/ha		
1% =		38,01 kg/ha		
0,1% =		59,21 kg/ha		

Compared to the first year of experimentation, in 2022 the productions were lower, noting that the lowest production was recorded in the Kaffe variety (1796 kg/ha), and the highest in the Burnas variety (2031 kg/ha). Orion and Burnas varieties stood out with yield increases of 32 kg/ha, respectively 102 kg/ha, significant and very significant compared to the average experience (control) (*Table 4*).

The average of the two years, indicates the fact that the Burnas variety has the greatest adaptability to the conditions of the area. Compared to the control variant (average experience), this variety achieved a very significant increase in yield (96 kg/ha) (*Table 5*).

Table 5. The influence of genotype on seed yield at *Cicer arietinum* L., average years

Variety	Yield (kg/ha)	% compared to control	Difference (kg/ha)	Significance
Kaffe	1909	93,39	–135	000
Burnas	2140	104,69	96	***
Orion	2082	101,85	38	*
Average	2044	100	Ct.	
LSD 5% =		25,82 kg/ha		
1% =		37,15 kg/ha		
0,1% =		57,46 kg/ha		

The second sowing season positively influenced the seed yield, and its level was influenced by the climatic conditions recorded in the analyzed period. In the agricultural year 2021, the yield fluctuations were quite large, the yields obtained varied from 2094 kg/ha (the third epoch of sowing) to 2202 kg/ha (the second epoch of sowing). From a statistical point of view, compared to the control (average of experience) the variant sown in the third epoch achieved a very significant negative production difference (– 64 kg/ha). However, the variants sown in the first and the second epoch obtained distinctly significant and very significant yield increases (20 – 44 kg/ha) compared to the control (*Table 6*).

Table 6. The influence of sowing epoch on seed yield at *Cicer arietinum* L. 2021

Epoch of sowing	Yield (kg/ha)	% compared to control	Difference (kg/ha)	Significance
I[st] epoch	2178	100,92	20	**
II[nd] epoch	2202	102,03	44	***
III[rd] epoch	2094	97,03	–64	000
Average	2158	100	Ct.	
LSD 5% =		14,20 kg/ha		
1% =		22,38 kg/ha		
0,1% =		32,47 kg/ha		

In the second year of experimentation (2022), the yields obtained were smaller and between 1864 kg/ ha (the third epoch of sowing) and 1989 kg/ha (the second epoch of sowing). Compared to the control (average of experience) the variants sown in the third epoch achieved very significant negative production differences (–65 kg/ha), the variant sown in the second epoch achieved a very significant increase in production (60 kg/ha) (*Table 7*).

Table 7. The influence of sowing epoch on seed yield at *Cicer arietinum* L. 2022

Epoch of sowing	Yield (kg/ha)	% compared to control	Difference (kg/ha)	Significance
Ist epoch	1934	100,25	–5	
IInd epoch	1989	103,11	60	***
IIIrd epoch	1864	96,63	–65	000
Average	1929	100	Ct.	
LSD 5% =	13,52 kg/ha			
1% =	21,98 kg/ha			
0,1% =	33,97 kg/ha			

During the experimental period (2021–2022), the highest production increases (52 kg/ha), compared to the control were obtained for the varietie sown in the second epoch, resulting in chickpea responding favorably for sowing by until until the beginning of April.

Table 8. The influence of sowing epoch on seed yield at *Cicer arietinum* L. average years

Epoch of sowing	Yield (kg/ha)	% compared to control	Difference (kg/ha)	Significance
Ist epoch	2056	100,58	12	
IInd epoch	2096	102,54	52	***
IIIrd epoch	1979	96,81	–65	000
Average	2044	100	Ct.	
LSD 5%=	13,86 kg/ha			
1%=	22,18 kg/ha			
0,1%=	33,22 kg/ha			

In the variant sown in the third epoch, a very significant production deficit of 65 kg / ha was obtained, compared to the witness of the experience, which we deduce that it is necessary to sow the chickpea no later than the third decade of March, because the seeds do not reach maturity (*Table 8*).

CONCLUSIONS

The natural environment of the Secuieni Agricultural Research – Development Station is favorable for field crops, where in normal years as temperatures high yields are obtained for all crops established within the company, the future of which is also the chickpea crop.

The average of the two years, indicates the fact that the Burnas variety has the greatest adaptability to the conditions of the area.

During the study period (2020–2021), the highest production increases (52 kg/ha), compared to the control were obtained for the varieties sown in the second epoch, which means that chickpea is favorable for sowing until the first decade of April.

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