

## RESEARCH ON THE INFLUENCE OF TILLAGE AND VARIETY ON CHICKPEA PRODUCTION IN PEDOCLIMATIC CONDITIONS FROM MOARA DOMNEASCĂ, ROMANIA

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### Abstract

*Recently, climatic changes have induced long periods of drought during growing season that caused a high decrease of agricultural yields of classic grain legumes crop. In this circumstances, chickpea crop is considered to be more and more involved in crop rotation in Romania as it withstands drought best and has very good nutritional value. Thus, improving crop technology becomes an important aim for near future. This study aimed at the impact of tillage and chickpea varieties on quantity and quality index under climatic environment of Moara Domneasca in 2022 where at three varieties of chickpea (Burnas, Rodin, Kuky) three types of tillering were performed (plowing at 25 cm, subsoiling at 35 cm and disc harrowing at 12 cm). Finally, it was concluded that type of tillage most influenced yields than varieties, best average yield being 1575 kg/ha when plowing at 25 cm. Also, tillage types positively impacted quantity and quality indexes of chickpea yields in a higher degree than varieties.*

**Key words:** chickpea, varieties, tillage, quality, yield.

### INTRODUCTION

Chickpea (*Cicer arietinum* L.) is the grain legume species most resistant to drought and arid conditions, adapting in arid climates to residual soil moisture, where peas, beans and soybeans do not give satisfactory results. (Devasirvatham & Tan, 2018). In terms of global importance, it is grown in more than 55 countries, with an area of about 15 million ha in 2022 and a global annual volume of about 18 million tonnes (Varshney et al., 2017; <https://www.fao.org/faostat/en/#data>).

The high protein content provides to chickpea a special food value, successfully replacing meat. Where desired it can also be a substitute for other related crops, for example it is proven that chickpea protein is superior to soybean protein in terms of essential amino acid composition and high digestibility (Leterme et al., 1990; Chitra et al., 1995). In addition, it contains very few anti-nutritional factors, 3% on average (Ahmad et al., 2005). Also the crude protein concentration of chickpeas (12.6-30.6%) is higher than that of cereals (5.8-15.0%) (Wang et al., 2017).

Chickpeas contain a low glycemic index which helps prevent diabetes, obesity and cardiovascular disease (Jukanti et al., 2012; Wang et al., 2017).

Geographical conditions of climate, variety used, soil and cultivation technology greatly influence the chemical composition of chickpeas, so the values between minimum and maximum are far: protein substances between 12 and 31%; fat 4 and 8%; carbohydrates 42 and 71%; cellulose 2 and 12%, anti-nutritional factors 2 and 5% (Borcean et al., 2006).

Regarding abiotic factors, drought is the main obstruction to achieving maximum yield potential in chickpea growing regions (Toker et al., 2007). Though chickpea provide a higher tolerance to drought than almost the others legume grains, drought lowers down the yield with 50-60% percent and can lead even to the whole failure of the crop (Talebi et al., 2013). Chickpea is sensitive to drought throughout its growing season, however, its sensitivity increases if drought occurs in the flowering stage (Mondal, 2019).

In The Official Catalogue of Crop Varieties in Romania (2022), four varieties are mentioned

for chickpea cultivation: Burnas (2004), Rodin (2004), Kuki (2020) and Valahia 1 (2020). Burnas and Rodin varieties are obtained at SCDA Teleorman in 2004 and approved in 2006, are top varieties, suitable for cultivation in the arid areas of our country with high resistance to drought and anthracnose [*Ascochyta rabiei* (Pass.) Labr.]. With a high crude protein content of 24.9% for Burnas and 23.8% for Rodin (David et al., 2010). The Kuky variety is created at UASVM Bucharest in 2020, it has drought resistance and anthracnose resistance, it can be sown in all chickpea growing areas in our country, under irrigated and non-irrigated conditions, it is an early variety, vegetation period 85-90 days and production potential 2350-2410 kg/ha.

The research carried out focused on the influence of the soil tillage and the chickpea variety on the production, plant height, productivity elements and quality indices under soil and climatic conditions at the Didactic Research and Agronomic Development Station Moara Domnească, Ilfov County, in 2022. Three tillage options were assessed: plowing at 25 cm depth, subsoiling at 35 cm and disc harrowing at 12 cm and 3 varieties of chickpea: Burnas, Rodin and Kuky.

## MATERIALS AND METHODS

The experiment was laid out according to randomized blocks in 3 replications with 9 variants comprising plowing at 25 cm depth, subsoiling 35 cm and disc harrowing at 12 cm on which Burnas, Rodin and Kuky varieties were sown. The area of an experimental variant was 21 m<sup>2</sup> (3.5 x 6). The location of the experiment was at the Didactic Research and Agronomic Development Station Moara Domnească, Ilfov county, in the year 2022 on the reddish preluviosol soil type belonging to the luvisol class being dominant in the region. Soil profile characterization at 0-20 cm is loamy-clayey with over 32% clay, low humus content around 2.4%, moderately acidic pH around 5.4 and as the soil profile progresses the texture becomes more clayey by over 40% for the 60 cm profile (Mihalache et al., 2010). Immediately after rainfall crusting is easily formed due to the high clay content leading to reduced permeability (Mihalache et al., 2009).

Soil tillage according to the investigated variants was done at the end of November and sowing of chickpea varieties was done on 28 March 2022. Before sowing the field was worked with the cultivator.

The varieties investigated were sown after the oat crop at a density of around 40 plants/m<sup>2</sup> at a row spacing of 50 cm and an average depth of 5 cm.

Protein and lipid determinations were carried out in the Phytotechnics Laboratory of the Faculty of Agriculture, UASVM in Bucharest with an Instalab NIR Product-Analyzer infrared spectrophotometer. With this apparatus it is possible to determine the percentage concentration of constituents in a wide range of agricultural, food and fertilizer products.

In order to determine the protein and lipid content of the grains, the device was calibrated by a specialized company Metron Agri-Lab, Novi Sad, Serbia, comparing the results of the infrared spectroscopy analysis with the Instalab NIR Product-Analyzer with the chemical analysis performed by classical methods. The samples to be analysed are ground uniformly using a laboratory mill and analysed on the same day as all other analyses. The samples to be analysed are grinded uniformly using a laboratory mill and analysed on the same day.

1000 seed weight (TSWG) and hectolitre weight (HW) determinations were carried out in the Agrotechnics laboratory of the Faculty of Agriculture, UASVM Bucharest. Mas per 1000 kernels (TSWG) is an element of productivity but for certain products (e.g. chickpeas where large kernels are desired) it is also a quality index, which is why we have included it in the quality indices.

## RESULTS AND DISCUSSIONS

Regarding the weather data recorded by Moara Domnească Farm at the local station, we can state that 2022 was a dry agricultural year compared to the multi-year average recorded in Romania. The total rainfall recorded during the growing season from February to August for the chickpea crop was 180.6 mm and 324.7 mm for the whole year. In February and March rainfall was extremely low 5.6 mm and 14.0 mm but for the beginning of the growing season April came with a favourable first start

of crop development with 71.5mm. But from the end of May, when 36.7 mm were recorded, the summer drought set in with rainfall in June of 20.2 mm, July of 7.0 mm and August of 31.2 mm (Figure 1). The highest recorded temperatures were in July with an average of 27.8°C, where extremely little precipitation was recorded in the same month. Chickpeas are known to tolerate arid weather, but for a good yield, rainfall must be favourably distributed until the flowers set (Kirnak et al. 2017; Rani et al., 2020).

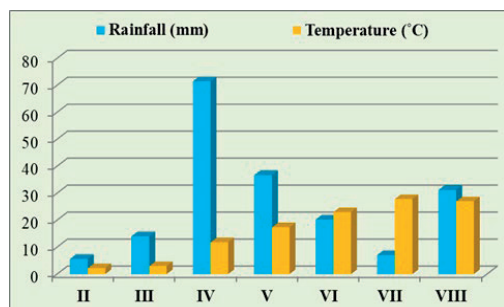


Figure 1. Precipitation and temperature evolution at Moara Domnească, in 2022

Table 1 shows the influence of soil tillage and variety on chickpea production under the soil and climatic conditions at Moara Domnească in 2022. Yields varied greatly according to the soil tillage and much less according to the

variety grown. It should be remembered that the agricultural year 2022 was an extremely dry year and the recorded yields were very low, yet in the variant where the basic work was plowing, the average yield of the cultivated varieties was 1575 kg/ha. Comparing with the variants where the basic tillage was subsoil where the average yield of the varieties was 1255 kg/ha and the disc harrowing tillage 492 kg/ha, we can say that the plowing yield was satisfactory for an extremely dry year.

The data obtained is in accordance with published literature data which estimates that 33% of the world's chickpea production is lost annually due to drought stress (Varshney et al., 2009; Keerthi et al., 2023).

The yield differences between plowing, subsoiling and disc harrowing were 320 kg/ha and 1083 kg/ha respectively, significantly negative and very significantly negative.

The explanation we are trying to reveal for the significant yield decreases is that the remaining plant residues from the previous crop, partially incorporated into the topsoil (in the subsoiling and disc harrowing) favoured the loss of soil water from the topsoil, under conditions of low amount of rainfall, while in the plowing the moisture from low rainfall in winter was better absorbed by the soil and the water reserve at sowing was higher.

Table 1. Influence of tillage and cultivar on chickpea yield, Moara Domnească, 2022

NO.	TILLAGE	VARIETY	YIELD		DIF. kg/ha	MEAN
			kg/ha	%		
1	Plowing	Burnas	1531	100.0	-	-
2		Rodin	1576	102.9	45	-
3		Kuky	1618	105.7	87	*
Average plowing			1575	100.0	-	-
4	Subsoiling	Burnas	1224	100.0	-	-
5		Rodin	1237	101.1	13	-
6		Kuky	1304	106.5	80	-
Average subsoiling			1255	79.7	- 320	oo
7	Disc harrowing	Burnas	453	100.0	-	-
8		Rodin	460	101.5	7	-
9		Kuky	562	124.1	109	*
Average disc harrowing			492	31.2	- 1083	ooo
Average varieties		Burnas	1069	100.0	-	-
		Rodin	1091	102.1	22	-
		Kuky	1161	108.6	92	*

DL 5% = 82.36 kg/ha; DL 1% = 274.35 kg/ha; DL 0,1% = 556.76 kg/ha.

Comparing the yields of the three chickpea varieties, we note that the Kuky variety yielded an average of 1161 kg/ha, which was

significantly higher than Burnas with 1069 kg/ha and Rodin with 1091 kg/ha. This can be explained by the fact that the Kuky variety is

earlier, has a shorter growing season of 7-8 days, flowered and bound earlier and the number of grains/hectare was higher (Table 2) and the climatic conditions of 2022 were favourable for the variety. In all variants with tillage, the Kuky variety, in this extremely dry year, gave the highest yields of 80 and 109 kg/ha more than the control variety, Burnas, the most widely grown variety in the area.

Figure 2 shows the influence of plowing and cultivar on plant height in chickpea. Plant height was strongly influenced by tillage but also by variety. At tillage the average plant

height was 46.3 cm, decreased to 41.2 cm at subsoiling tillage and the lowest 31.3 cm at disc harrowing tillage. The Kuky variety has a lower height (39.2 cm) compared to Burnas (50.0 cm) and Rodin (49.8 cm), we believe that this is a characteristic of the variety that may negatively influence mechanized harvesting. Although the yield of Kuky was the highest (1618 kg/ha) but because the variety is shorter in height compared to Burnas and Rodin and on rough, irregular ground, losses during mechanised harvesting can be higher, which is a disadvantage.

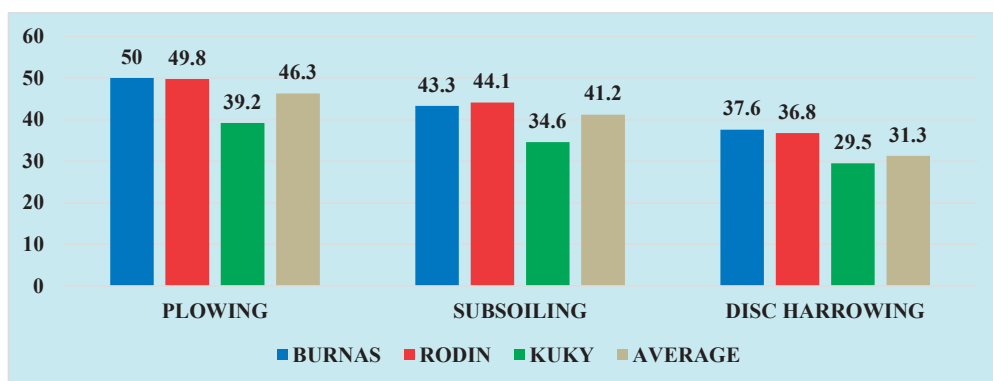


Figure 2. Influence of tillage and cultivar on plant height in chickpea, Moara Domnească

Table 2 shows the productivity elements of chickpea plants under the influence of tillage and cultivar: number of main shoots/plant, total number of pods/plant of which fertile and sterile, number of kernels/plant, number of kernels/pod and mass of kernels/plant.

The average number of main shoots/plant was 3.5 in the plowing and subsoiling operation and 2.4 in the disc harrowing operation. As for the influence of variety on the average number of shoots/plant in Burnas 3.3, Rodin 3.2 and Kuky 3.0 were recorded.

The average number of pods per plant was mostly influenced by the basic tillage performed to establish the chickpea crop. The plowing operation averaged 16.6 pods/plant of which 3.6 sterile pods, i.e. 21.3%. The subsoiling operation decreased the number of pods to 15.9 and the number of sterile pods increased to 4.1, i.e. 25.8%. The lowest number of pods/plant was recorded in the disc harrowing operation with 8.3, of which 3.6 were sterile pods and 43.4% sterile pods. The Kuky variety had the lowest number of sterile

pods 3.3, compared to Rodin 3.9 and Burnas 4.1.

Kernel average number on plant was highly influenced by the main tillage and less by cultivar. At plowing operation it was recorded 18.1 kernels/plant, at subsoiling 15.9 kernels/plant and at disc harrowing 7.0 kernels/plant. The influence of variety on the number of kernels/plant highlights the variety Kuky with 14.3 kernels/plant, followed by Rodin and Burnas (13.3 kernels/plant).

The average number of kernels in the pod, at plowing 1.09, at subsoiling 1.00 and at disk 0.84, and the influence of variety on the number of kernels in the pod highlights the variety Kuky with 1.01 slightly higher compared to Rodin and Burnas with 0.96.

Kernels weight per plant averaged 4.53 g for plowing, 3.62 g for subsoiling and 1.42 g for disc harrowing. The influence of the variety on the kernels weight per plant highlights the variety Kuky with the highest value (3.34 g) followed by the varieties Rodin and Burnas (3.13 g and 3.07 g respectively).

Table 2. Influence of soil tillage and cultivar on productivity elements in chickpea crop, Moara Domnească, 2022

No.	Tillage	Variety	No. main shoots	No. of pods			No. kernels per plant	No. kernels per pods	Kernels weight per plant (g)
				Total	Fertile	Sterile			
1	Plowing	Burnas	3.6	16.5	12.7	3.8	17.7	1.07	4.39
2		Rodin	3.7	16.6	12.8	3.8	18.0	1.08	4.52
3		Kuky	3.4	16.7	13.4	3.3	18.5	1.11	4.64
Average plowing			<b>3.5</b>	<b>16.6</b>	<b>13.0</b>	<b>3.6</b>	<b>18.1</b>	<b>1.09</b>	<b>4.52</b>
4	Subsoiling	Burnas	3.7	15.9	11.3	4.6	15.7	0.99	3.52
5		Rodin	3.6	15.5	11.3	4.2	15.4	0.99	3.55
6		Kuky	3.3	16.2	12.7	3.5	16.6	1.02	3.75
Average subsoiling			<b>3.5</b>	<b>15.9</b>	<b>11.8</b>	<b>4.1</b>	<b>15.9</b>	<b>1.00</b>	<b>3.61</b>
7	Disc harrowing	Burnas	2.5	8.1	4.3	3.8	6.6	0.81	1.31
8		Rodin	2.4	8.0	4.3	3.7	6.5	0.81	1.33
9		Kuky	2.4	8.9	5.7	3.2	7.9	0.89	1.62
Average disc harrowing			<b>2.4</b>	<b>8.3</b>	<b>4.8</b>	<b>3.6</b>	<b>7.0</b>	<b>0.84</b>	<b>1.42</b>
Average varieties		Burnas	<b>3.3</b>	<b>13.5</b>	<b>9.4</b>	<b>4.1</b>	<b>13.3</b>	<b>0.96</b>	<b>3.07</b>
		Rodin	<b>3.2</b>	<b>13.4</b>	<b>9.5</b>	<b>3.9</b>	<b>13.3</b>	<b>0.96</b>	<b>3.13</b>
		Kuky	<b>3.0</b>	<b>13.9</b>	<b>10.6</b>	<b>3.3</b>	<b>14.3</b>	<b>1.01</b>	<b>3.34</b>

Table 3 shows the quality indices of chickpea under the influence of tillage and cultivar: mass per 1000 kernels (TSWG), hectoliter weight (HW), protein and lipid content in kernels. 1000 Seed Weight (TSWG) showed the highest average value in tillage at 260.4 g, followed by subsoiling at 228.8 g and only 206.4 g in disc tillage and between varieties the values were almost equal, ranging from 227.9 - 235.9 g. Hectoliter weight (HW) averaged 75.7 kg for plowing, 76.8 kg for subsoiling and 78.2 kg for

disc harrowing and between varieties values were 76.2 - 76.2 kg.

Protein content in kernels averaged 24.35% in plowing, 24.04% in subsoiling and 21.03% in disc harrowing and between varieties in Burnas 23.45%, followed by Rodin 23.35% and Kuky 22.63%.

The lipid content in kernels had average values of 6.33% in plowing, 6.12% in subsoiling and 5.19% in disc harrowing and 6.02% between varieties in Burnas, followed by Rodin 5.83% and Kuky 5.78%.

Table 3. Influence of tillage and cultivar on chickpea quality indices, Moara Domnească, 2022

No.	Tillage	Variety	TSWG (g)	HW (kg)	Protein (%)	Lipid (%)
1	Plowing	Burnas	252.8	76.3	24.73	6.59
2		Rodin	266.6	75.9	24.57	6.21
3		Kuky	261.8	74.8	23.75	6.18
Average plowing			<b>260.4</b>	<b>75.7</b>	<b>24.35</b>	<b>6.33</b>
4	Subsoiling	Burnas	226.5	76.6	24.17	6.13
5		Rodin	232.3	77.4	24.20	6.21
6		Kuky	227.7	76.3	23.75	6.02
Average subsoiling			<b>228.8</b>	<b>76.8</b>	<b>24.04</b>	<b>6.12</b>
7	Disc harrowing	Burnas	204.3	78.8	21.44	5.35
8		Rodin	208.7	78.1	21.28	5.06
9		Kuky	206.1	77.6	20.38	5.15
Average disc harrowing			<b>206.4</b>	<b>78.2</b>	<b>21.03</b>	<b>5.19</b>
Average varieties		Burnas	<b>227.9</b>	<b>77.2</b>	<b>23.45</b>	<b>6.02</b>
		Rodin	<b>235.9</b>	<b>77.1</b>	<b>23.35</b>	<b>5.83</b>
		Kuky	<b>231.9</b>	<b>76.2</b>	<b>22.63</b>	<b>5.78</b>

## CONCLUSIONS

From climatic point of view, the 2021/2022 crop year was unfavourable, extremely dry and with very high temperatures.

Chickpea yields were strongly influenced by basic tillage and less by the grown variety. The highest yield was recorded in the plowing tillage, averaging 1575 kg/ha, followed by the subsoiling tillage of 1255 kg/ha, a distinctly

significant negative value and the lowest in the disc harrowing tillage of 492 kg/ha, a highly significant negative value.

Varietal yield differences showed that Kuky, compared to Burnas, had a significant difference of 92 kg/ha higher.

Plant height was highly influenced by the basic tillage but also by the variety. Variety Kuky has a lower height compared to Burnas or Rodin, with negative influences on mechanized harvesting.

Productivity elements and yield quality indices of chickpea plants were considerably influenced by tillage and less by variety.

Under pedoclimatic conditions of Moara Domneasca, with a clay content of more than 32% in the 0-20 cm soil profile, tillage with disc harrowing is not an appropriate option for chickpea growing.

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