

**The effect of locality and sowing term on chosen
morphological features of two chickpea
(*Cicer arietinum* L.) cultivars**

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ABSTRACT

Research studies were conducted in 1999 – 2001 in Garlica Murowana near Kraków and Felin near Lublin. They aimed at defining the effect of locality and sowing term on chosen morphological features of two chickpea cultivars belonging to different types. The cultivars used in the study ('Sanford' – *kabuli* type and 'Myles'- *desi* type) differed morphologically. As a warm climate species, the chickpea cultivated in Poland meets a climatic obstacle resulting from low air temperature combined with high total precipitation at flowering and pod setting.

Cultivar, sowing term, and proper localization are main factors influencing vegetative growth. Plants of both chickpea cultivars, cultivated in Lublin, were shorter than plants from Kraków. In the years 2000 and 2001 it might have resulted from higher total precipitation in Kraków in the April – June period. Delaying of sowing term caused inferior vegetative growth of both chickpea cultivars in Kraków. ‘Sanford’ generated more lateral branches on the plant in Lublin (3.7-4.8) in comparison with in Kraków (3.2-4.2). ‘Myles’ generated more branches when sown early. In the year 2001 both chickpea cultivars in Lublin set higher number of pods, as the effect of 58.3 mm higher total of July precipitation on this locality. Neither localization nor sowing term had the influence on number of seeds per pod.

INTRODUCTION

Chickpea is widely grown in USA and Western Europe where it is valued for its nutritive seeds with high protein content (24.9%) as well as all essential amino acids in proportions beneficial for humans, starch (50%), vitamins B and E, cellulose (3%), and various minerals (Champ 2001).

Chickpea cultivars were divided into two broad groups, based on seed size, shape, and colour. The *kabuli* types produce large seeds (weight of 1000 seeds is about 495 g) which are rounded and pale cream. The plants are tall, with white flowers, and no anthocyanin pigmentation. The *desi* types produce small seeds (weight of 1000 seeds is about 245 g), irregularly shaped, of dark brown colour. Compared to *kabuli* types, *desi* plants are shorter, more prostrate, their flowers are white, pink, purple or blue depending on a cultivar (Muehlbauer and Singh 1987, Poniedziałek et al. 1996).

Chickpea is a branched, spreading, annual species that reaches a height of 20-150 cm, depending on a cultivar and vegetation conditions. Roots are robust and 0.6-2.0 m long. The leaves are pinnately compound with 3-8 leaflet pairs. The self-pollinated flowers, usually 0.6-1.3 cm long, are borne singly or sometimes doubly on inflorescences that originate from the stem axes. Forms with two flowers are rare, and are used by breeders as a possible source of yield increase. Pods are acuminate, pubescent, characteristically inflated, up to 3 cm long. They contain 1-2 angular seeds (Cubero 1987).

As a warm climate species, chickpea cultivated in Poland meets a climatic obstacle resulting from low air temperature combined with high total precipitation at flowering and pod setting (Poniedziałek et al. 1999, Poniedziałek et al. 2001). The course of meteorological factors during vegetative period influences the growth, phenology, and productivity of chickpea (Soltani et al. 1999). Features like plant height, number of lateral branches, or number of pods per plant determine the yield. Therefore the cultivar, sowing term, and proper localization are main factors influencing vegetative growth and ensuring high, good quality yield.

The aim of the investigation was to estimate the influence of locality and sowing term on plant height, number of lateral branches, number of pods per plant, and number of seeds per pod of chickpea cultivars belonging to two, morphologically different types.

MATERIAL AND METHODS

The research was conducted between 1999 and 2001 in Garlica Murowana near Kraków, on brown soil formed on loess (pH_{KCl} 4.8, organic C level 2.2%) and in Felin near Lublin on fertile, loamy soil formed on dust (pH_{KCl} 5.6, organic C level 3.5%). The experiment was conducted in four replications, split-plot method. Chickpea cultivars of two different types: *desi* type – ‘Myles’ and *kabuli* type – ‘Sanford’ were the object of the research. Mineral fertilization was conducted in the following amount per hectare: 20 kg N, 40 kg P_2O_5 , 20 kg K_2O . The plants were sown on 9 m² plots (3.6 m x 2.5 m), with 40 x 8 cm spacing (281 plants per plot) at three terms, i.e. 15 April, 30 April, and 15 May. Harvest was carried out after the pods had shriveled. After harvest, 25 plants from each plot were chosen for morphology determination. Plants’ height, number of lateral branches, number of pods per plant, and number of seeds per pod were estimated. The results were evaluated statistically, using the ANOVA method and Student’s test, with $p = 0.05$. During vegetative period at both localities mean daily air temperature and total precipitation were assessed.

RESULTS AND DISCUSSION

The course of meteorological factors during vegetative period influenced the vegetative and generative growth of plants. Average monthly air temperature at both localities was much the same. The differences in chickpea morphology were caused by precipitation, which differed at localities (Fig. 1).

Kabuli types cultivars are usually higher than *desi* ones (Muehlbauer and Singh 1987), which was confirmed in the present investigations. The average height of ‘Sanford’ was 82.5 cm, ‘Myles’ 72.7 cm (Tables 1 and 2). The chickpea height highly depended on environmental conditions, especially moisture, which confirmed the findings of Cubero (1987). Comparing 22 Spanish cultivars, in two consecutive years, he observed considerable differences. In the first year chickpea plants were 52 cm high, whereas in the next they were shorter than 36 cm.

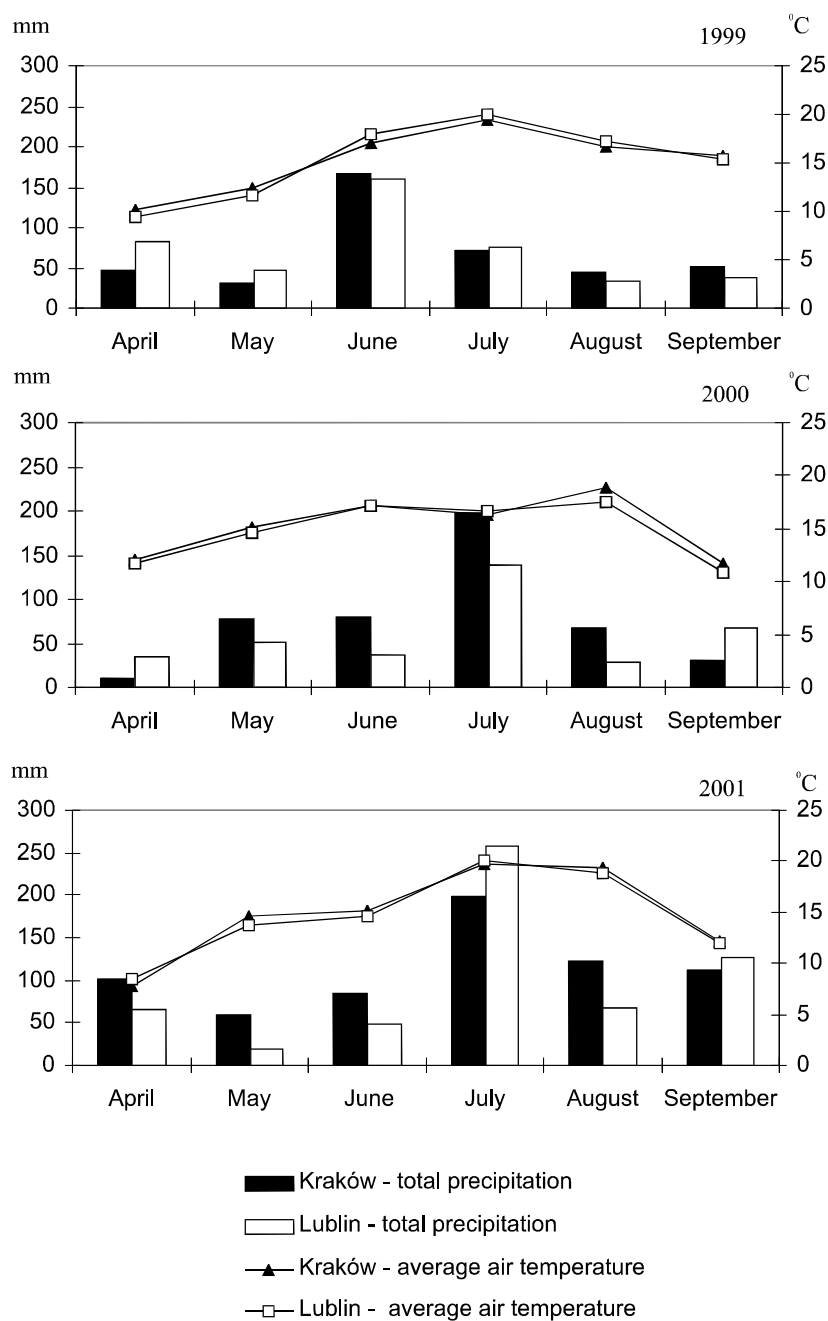


Figure 1. Total precipitation (mm) and average air temperature (°C) during chickpea vegetation period in Kraków and Lublin in 1999 – 2001

Plants of both cultivars in Lublin were shorter than those in Kraków. 'Sanford' height ranged from 50.0 to 99.1 cm in Lublin and from 80.9 to 113.3 cm in Kraków (Table 1). 'Myles' height ranged from 39.7 to 93.3 cm in Lublin and from 70.3 to 93.4 cm in Kraków (Table 2). The most intensive vegetative growth of chickpea ends with flowering and falls in the April – June period (Gan et al. 2001). Differences in height of plants cultivated in years 2000 and 2001 might have resulted from higher total precipitation in Kraków than in Lublin (Fig. 1). In 1999 other than precipitation factors caused the more intensive plant growth on this locality.

Sowing date had a significant effect on biomass production. The delay in sowing caused inferior vegetative growth of both chickpea cultivars in Kraków. Similar results were obtained for 'Sanford' by Gan et al. (2001). Early sown plants (April 30 – May 5) produced 16% more dry matter per hectare than the later sown (May 16 – May 20) ones.

Not only plant height but also the number of branches were intensified by excessive moisture. The number of lateral branches ranged from one to eight. This feature, however, is not apt to describe a cultivar but is largely influenced by cultural practices (Cubero 1987). 'Sanford' plants in Lublin branched more intensively (3.7-4.8 lateral branches) than those in Kraków (3.2-4.7). 'Myles', which generated 2.8-6.0 lateral branches did not confirm this regularity (Tables 1 and 2). Sowing term influenced the number of lateral branches in 'Myles' despite locality. In the case of early sown chickpea, greater number of lateral branches was observed, although the results did not always differ statistically. Gan et al. (2001) observed that earlier sown plants had a longer period of time conducive to vegetative growth.

The number of pods per plant varies between 30 and 150 (Cubero 1987). Liu et al. (2003) cultivated chickpea in density 30 plants per m² and found 44.1 pods per plant for *desi* type and 28.4 pods per plant for *kabuli*. The number of pods highly depends on meteorological factors, locality, and sowing date (Cubero 1987). In the present experiment the locality had an influence on a number of pods, although it differed in succeeding years. In 1999 'Sanford' produced more pods per plant in Kraków than in Lublin, and in 2001 more in Lublin than in Kraków. In 2000 there were no differences between localities in a number of pods per plant. 'Myles' produced more pods in Lublin in 1999 and 2001 and in Kraków in 2000. Pod setting of both chickpea cultivars began in July. In 2001 total July precipitation was 58.3 mm higher in Lublin than in Kraków (Fig. 1), therefore both cultivars grown in Lublin set more pods. Similarly in 2000, total July precipitation was 60.6 mm higher in Kraków than in Lublin, and number of pods set by 'Myles' in Kraków increased by 44%. Poniedziałek et al. (1999) also noted environmental influence on pod setting.

Table 1. Chosen morphological features of 'Sanford' chickpea plants according to sowing term and locality

Locality	Plant height (cm)						Number of lateral branches per plant			Number of pods per plant			Number of seeds per pod					
	sowing term			sowing term			sowing term			sowing term			sowing term					
	15	30	15	15	30	15	mean	April	15	30	15	mean	April	15	30	15	mean	
	April	April	May	April	April	May	mean <td>April</td> <td>April</td> <td>May</td> <td>May</td> <td>mean <td>April</td> <td>April</td> <td>May</td> <td>April</td> <td>May</td> <td>May</td> </td>	April	April	May	May	mean <td>April</td> <td>April</td> <td>May</td> <td>April</td> <td>May</td> <td>May</td>	April	April	May	April	May	May
	1999																	
Kraków	94.9 d	92.4 cd	86.3 c	91.2	3.2 a	3.2 a	3.2 a	3.2 a	36.4 ab	37.0 ab	50.7 b	41.4	1.5 bc	1.6 cd	1.7 d	1.6		
Lublin	61.4 b	58.1 b	50.0 a	56.5	4.2 c	3.7 b	4.3 c	4.1	35.8 ab	29.7 a	30.8 a	32.1	1.3 ab	1.3 ab	1.2 a	1.3		
mean	78.2	75.3	68.2		3.7	3.5	3.8	3.6	36.1	33.4	40.8	1.4		1.5	1.5			
	2000*																	
Kraków	92.4	113.3 c	99.7 b	101.8	4.7	4.2 ab	3.8 a	4.2	29.3	8.5 a	7.2 a	15.0	1.0	1.1 a	1.2 a	1.1		
Lublin	-	82.4 a	99.1 b	90.8	-	4.4 bc	4.8 c	4.6	-	10.1 a	7.5 a	8.8	-	1.5 b	1.2 a	1.4		
mean	-	97.9	99.4		-	4.3	4.3	4.4	-	9.3	7.4	11.9	-	1.3	1.2			
	2001*																	
Kraków	90.5	95.8 c	80.9 b	89.1	3.3	3.3 a	3.5 a	3.4	7.4	6.5 b	3.0 a	5.6	1.0	1.2 c	1.1c	1.1		
Lublin	-	64.3 a	67.0 a	65.7	-	4.1 b	4.2 b	4.2	-	15.9 c	16.3 c	16.1	-	0.8 b	0.6 a	0.7		
mean	-	80.1	74.0		-	3.7	3.9	3.8	-	11.2	9.7	11.9	-	1.0	0.9			

* Owing to the lack of 2000 and 2001 data from Lublin, variation analysis was performed for sowing terms: 30 April and 15 May

Table 2. Chosen morphological features of 'Myles' chickpea plants according to sowing term and locality

Locality	Plant height (cm)		Number of lateral branches per plant				Number of pods per plant				Number of seeds per pod					
	sowing term		sowing term		sowing term		sowing term		sowing term		sowing term		sowing term			
	15	30	15	30	15	30	15	30	15	30	15	30	15	30		
	April	April	mean	April	May	mean	April	May	mean	April	May	mean	April	May		
	mean	mean	mean	mean	mean	mean	mean	mean	mean	mean	mean	mean	mean	mean		
1999																
Kraków	93.4 c	90.1 c	88.0 c	90.5	3.4 b	2.9 a	2.8 a	3.0	47.3 a	45.7 a	79.3 b	57.4	2.0 bc	2.1 c	2.0 bc	2.0
Lublin	50.1 b	49.3 b	40.1 a	46.5	3.2 ab	3.1 ab	2.9 a	3.1	80.6 b	54.4 a	77.7 b	70.9	1.6 ab	2.1 c	1.5 a	1.7
mean	71.8	69.7	64.1	3.3	3.0	2.9	2.9	64.0	50.1	78.5	1.8	2.1	1.8	2.1	1.8	1.8
2000																
Kraków	89.3 ab	83.8 a	82.3 a	85.1	6.0 b	3.6 a	3.5 a	4.4	52.3 d	20.6 bc	16.3 ab	29.7	1.2 a	1.3 ab	1.2 a	1.2
Lublin	87.7 ab	83.3 a	93.3 b	88.1	4.2 a	4.1 a	4.0 a	4.1	26.5 c	13.4 ab	10.3 a	16.7	2.0 d	1.7 c	1.5 bc	1.7
mean	88.5	83.6	87.8	5.1	3.9	3.8	3.8	39.4	17.0	13.3	1.6	1.5	1.6	1.5	1.4	1.4
2001																
Kraków	80.7 e	70.3 d	74.4 d	75.1	4.6 b	4.0 a	4.0 a	4.2	12.6 a	8.9 a	9.4 a	10.3	1.1 b	1.2 b	1.1 b	1.1
Lublin	39.7 a	60.7 c	52.0 b	50.8	4.2 b	4.0 a	3.9 a	4.0	33.4 b	40.9 c	42.0 c	38.8	1.4 c	1.1 b	0.8 a	1.1
mean	60.2	65.5	63.2	4.4	4.0	4.0	4.0	23.0	24.9	25.7	1.3	1.2	1.3	1.2	1.0	1.0

The number of seeds per plant relates closely to the number of pods per plant. Extreme numbers noted were 20 and 240, this giving one to two seeds per pod. The number of seeds per pod is negatively correlated with seed size. It seems that a genetic factor is responsible for the number of seeds formed in a pod. Large-seeded *kabuli* cultivars produce fewer seeds per pod, whereas small-seeded *desi* cultivars - more, usually two seeds (Liu et al. 2003). In the present investigation 'Sanford' produced from 0.6 to 1.7 seeds per pod, whereas 'Myles' from 0.8 to 2.1 (Tables 1 and 2). Neither localization nor sowing term had the influence on the number of seeds per pod.

Chickpea seed yield depends on the number of set pods (Gan et al. 2001). Despite differences between the number of set pods, chickpea yield in Lublin was 1.35 t ha⁻¹ higher than in Kraków. The delay in sowing lowered the yield (Poniedziałek et al. 2004).

CONCLUSIONS

1. Plants of both investigated chickpea cultivars ('Sanford' and 'Myles') were shorter in Lublin than in Kraków. The delay in sowing caused the inferior vegetative growth of both cultivars planted in Kraków.
2. 'Sanford' generated more lateral branches on a plant in Lublin. The effect of sowing term was significant only for 'Myles', which generated more branches when sown early.
3. In 2001 both chickpea cultivars in Lublin set greater number of pods than in Kraków as a result of higher July precipitation.
4. Neither localization nor sowing term had the influence on number of seeds per pod.

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WPŁYW LOKALIZACJI I TERMINU SIEWU NA WYBRANE CECHY
MORFOLOGICZNE DWÓCH ODMIAN CIECIERZYCY POSPOLITEJ
(*CICER ARIETINUM* L.)

Streszczenie: Badania prowadzono w latach 1999 – 2000 w Garlicy Murowanej koło Krakowa i Felinie koło Lublina. Ich celem było określenie wpływu lokalizacji i terminu uprawy na wybrane cechy morfologiczne dwóch odmian ciecierzycy pospolitej należących do różnych typów. Odmiany wykorzystane w badaniach ('Sanford' – typ *kabuli* oraz 'Myles' – typ *desi*) różnią się budową morfologiczną. Jako gatunek ciepłolubny ciecierzycy natrafia w Polsce na niską temperaturę połączoną z wysoką sumą opadów w okresie kwitnienia i zawiązywania strąków. Czynniki takie jak: odmiana, termin siewu, właściwa lokalizacja są odpowiedzialne za rozwój wegetatywny roślin. Rośliny odmian ciecierzycy uprawiane na stanowisku w Lublinie były niższe niż w Krakowie. W latach 2000, 2001 mogło to być spowodowane niższą na tym stanowisku sumą opadów w okresie

intensywnego wzrostu wegetatywnego (kwiecień – czerwiec). Opóźnienie terminu siewu powodowało słabszy wzrost wegetatywny obu odmian ciecierzycy uprawianych w Krakowie. Odmiana ‘Sanford’ tworzyła więcej pędów I rzędu na roślinie na stanowisku w Lublinie (3,7-4,8) niż w Krakowie (3,2-4,2). Termin siewu miał znaczenie tylko w przypadku odmiany ‘Myles’, która wysiewana wcześniej tworzyła większą ilość rozgałęzień. W 2001 roku obie odmiany ciecierzycy uprawiane w Lublinie tworzyły więcej strąków, co mogło być spowodowane wyższą o 58,3 mm sumą opadów lipca na tym stanowisku. Lokalizacja i termin siewu nie wpłynęły na liczbę zawiązanych w strąku nasion.

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