Scientific Papers. Series B, Horticulture. Vol. LXVI, No. 1, 2022
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

INFLUENCE OF THE PLANTING SEASON AND CORMS SIZE ON THE *CROCOSMIA*, IN AGROCLIMATIC CONDITIONS OF IASI (NORTHEASTERN ROMANIA)

Petronica AMIŞCULESEI, Maria APOSTOL, Roberto Renato BERNARDIS, Lucia DRAGHIA

"Ion Ionescu de la Brad" Iasi University of Life Sciences, 3 Mihail Sadoveanu Alley, Iasi, Romania

Corresponding author emails: amisculesei_petronica@yahoo.com, lucia@uaiasi.ro

Abstract

The genus Crocosmia, from the Iridaceae family, includes the plants with obvious potential both for garden decoration and as a cut flowers. This paper evaluated the influence of the planting times and the size of the corms on the some characters of ornamental interest of Crocosmia plants, in the agroecological conditions from northeastern Romania (Iași). The corms of Crocosmia 'Lucifer' from two size categories (3-5.9 g and 6-9 g) were used, which were planted in the experimental field in November and April.The observations and determinations made during 2018-2021 highlighted the fact that from the corms with a mass between 6-8 g, planted in autumn, they ensured the obtaining of plants with the highest number of flower stems and the most flowers on the stem. Regarding the height of the flower stems, the best results were recorded in corms with a mass between 3-5.9 g, planted in autumn. In the case of corms planted in the spring, the results were less significant, except for the number of shoots in plants resulting from large corms (6-8 g). The flowering period was longer to the plants obtained from corms of 3-5.9 g, planted in autumn.

Key words*: corm size, crocosmia, planting time, morphological characters.*

INTRODUCTION

The family *Iridaceae* (Juss.) is one of the largest families in Monocotyledonatae, being found in the most diverse natural habitats due to the high adaptability of its representatives. It includes over 2000 species distributed in 65-75 genera (Goldblatt et al., 2008). Among the genera belonging to the *Iridaceae* family, the best known in Romania are: *Iris, Gladiolus, Crocosmia, Crocus* and *Freesia*. *Crocosmia* is the genera of about seven species of perennials, identified in the pastures of South Africa (Armitaje, 1993).

Crocosmia is grown mainly for its attractive flowers and ornamental fruits (Armitage & Laushman, 2008), but can also be grown in landscaping or as a potted plant (Filios & Miller, 2010).

Crocosmias are perennial plants that have the corm as an underground organ. The tubular flowers, in shades of yellow, orange and red, numbering four to 20, are grouped in large, slightly arched spikes. They bloom from early summer to September (Brickell, 2011). The fruits are trilobate capsules (5-10 mm long), green to brown. Each plant can produce up to 14 new corms each year. They detach from the mother plant and begin to produce their own network of roots, being very easy to multiply.

In areas with cold winters, cormsshould be harvested in the fall (using the same technology as in sunflowers), stored at 4-9^{0}C and replanted in the spring (Armitaje, 1993).

The results of an experiment, organized in England by Brown, in 1967, show that crocosmia no longer has the same ornamental value when left in the same place for more than three years, so it is recommended to plant it annually or replant every 2-3 years (cited by Armitage &Laushman, 1990).

In Europe, research into the crocosmia crops period was conducted in Greece, near Athens, at the 'James Coey' cultivar (Armitage & Laushman, 1990). The results showed that the corms planted in January had a flowering period of 30 days, five and seven days shorter than for the plants in the corms planted in February and March. Armitage and Laushman (1990) also showed that delayed planting time resulted in a smaller number and lower quality of inflorescences. Plants from corms planted in January produced 1.3 inflorescences / plant, with a length of 25.7 cm, and the average for plants resulting from corms planted in February and March had 0.8 inflorescences with a length of 20.1 cm. Contradictory results were obtained by Żurawik et al., (2015), who planted the crocosmia cormson different dates (April 15, May 5, May 25), for staggering flowering period in three cultivars of *Crocosmia* (‘Emily McKenzie’, ‘Lucifer’ and ‘Mars’). The longest flowering period was obtained in the plants resulting from the cormsplanted in March, in all three cultivars, this can be explained by the fact that crocosmia is a thermophilic plant and higher summer temperatures favor its growth (Goldblatt et al., 2004). Regardless of the cultivar, the corms planted on May 5 produced plants with the longest flower stems and the largest number of flowers.

At the *Tritonia crocata*, cultivated in Egypt, the effect of cold storage of corms and zinc foliar fertilization on the growth, flowering, productivity of corms and the composition of some chemical constituents was studied. The results indicated that all cold storage treatments tended to induce a constant and significant growth of flower, leaves and stems, increase in number of flowers, early flowering and increase the vase life of cut flowers, as well as corms production (El-Bably & Mahmoud, 2005).

The results of studies conducted on many species and varieties of geophytes in the family *Iridaceae* indicate that the size and quality of the flower stems and the yield of corms depend on the time of planting and the quality of the material with which the crop is established (Hetman et al., 2007; Ahmad et al., 2011; Zubair et al., 2013).

Thus, in *Gladiolus hybridus*, studies were carried out on varieties grown in different ecological conditions, in order to establish optimal variants of the size of the corms used in the establishment of crops or applied technologies. The authors report that the best results were obtained in the crops established with large corms, materialized by positive effects on early flowering, number of leaves per plant, height of flower stem, number of flowers/stem, flower size, duration of flowering, preservation of cut flowers, quantity and quality of production of new corms and cormels etc. (Alhajhoj, 2017; Amin et al., 2013; Bhat et al., 2009; Farid et al., 2002; Gowda, 1987; Mazzini-Guedes et al., 2017; Memon et al., 2009; Methela & Islam, 2021); Nafees et al., 2021; Pittu et al., 2017; Singh, 2000; Zaharia et al., 2018).

In *G. byzantinus*, observations and determinations performed in 2020 showed that corms with a mass > 10 g yielded plants with the highest number of shoots, flower stems and flowers. In the variants of the smaller corms, respectively, 7-9 g and <7 g, the results were lower, except for the height of the flower stems. From a phenological point of view, the onset of vegetation, the formation of flower stems, the onset and the duration of flowering were to the advantage of cormswith a mass > 10 g (Amișculesei et al., 2020).

Similar results were obtained for saffron (*Crocus sativus*), in terms of the positive correlations between the size of the corms and the number of flowers, the early and the duration of flowering (De Mastro & Ruta, 1993; Renau-Morata et al., 2012; Özel et al., 2017).

The aim of this study was to determine the effect of planting season and corms size on ornamental value in *Crocosmia* ‘Lucifer’.

MATERIALS AND METHODS

This paper evaluates the influence of the planting period and the size of the corms on some ornamental characters of crocosmia plants (*Crocosmia* x *crocosmiiflora*) ‘Lucifer’, in the agroecological conditions in northeastern Romania (Iași).

Crocosmia ‘Lucifer’ is characterized by red-orange flowers, arranged 20-30 on flower stem with a height of approx. 40-60 cm.

Cormsof two size categories (3-5.9 g and 6-9 g) were used to set up the experimental crops, which were planted in the Floriculture field of the “Ion Ionescu de la Brad” University of Life Sciences from Iași, in November (2019 and 2020), respectively April (2019, 2020 and 2021).

The combination of the two experimental factors resulted in four experimental variants: V_1 - corms of 6-9 g, planted in autumn; V_2 -corms of 3-5.9 g, planted in autumn; V_3 -cormsof 6-9 g, planted in spring; V_4 - corms of 3-5.9 g, planted in spring.

The experiments were organized in randomized blocks design with three repetitions(20 plants/each repetition). The corms were planted in rows, at a distance of 15 cm between plants per row and 25 cm between rows. Crops established in the fall overwintered in the field without protection.

The observations and determinations made during 2018-2021 focused on: plant height, number of shoots per plant, number of leaves per shoot, number of stems per plant, stem height, number of flowers per plant, number of new corms. The results were compared to the average of the variants (considered control), and the interpretation was made using the analysis of the variance, with the LSD test (Săulescu & Săulescu, 1967).

The average monthly temperatures and the total monthly precipitations, which characterized the meteorological conditions of the experimental period (2018-2021), are presented in Figure 1 and Figure 2.

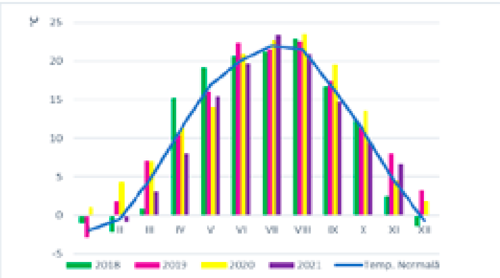

Figure 1. Average monthly temperatures (^{0}C)

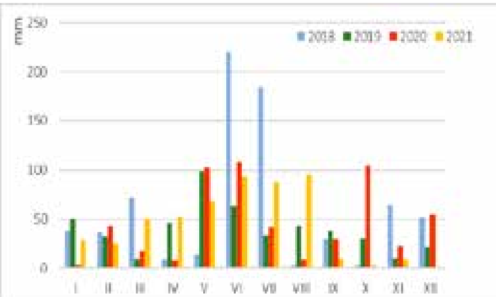

Figure 2. Total monthly rainfall (mm)

The average monthly temperatures recorded were higher in 2020, with large differences in January (1.1^{0}C; 3^{0}C higher than in 2019) and in February (4.3^{0}C; 2.5^{0}C higher than in 2019). The average annual temperature in 2020 was about 1.5^{0}C higher than in 2018 and 0.5^{0}C compared to 2019. Also, the precipitation regime varied during the analyzed period, especially in April and June of 2018 and 2020. The wettest year was 2018 (727.8 mm total annual), and the driest 2019 (478.7 mm total annual).

RESULTS AND DISCUSSIONS

The recording of data on the main phenophases was one of the objectives of the study and aimed to identify how crocosmia plants behave in experimental crops during the growing season. Phenological data refer to the onset of vegetation, the appearance of flowerstems, the beginning and end of flowering (Table 1). Phenology issues are also shown in Figure 4. Table 1 and Figure 4 include phenological data differentiated only by planting time and year of establishment of the crops, without taking into account the size of the corms, given that according to this criterion the differences they were very small and of no practical significance. The onset of vegetation was characterized by differences marked by both the planting season and the size of the corms. From table 1 it can be seen that in the crops established in the spring, the cormsstarted to grow three to six weeks later. The share of corms that started growing in vegetation was dependent not only on the time of planting, but also on the size of the corms (Figure 3). Thus, the corms with a mass of 3-5.9 g, planted in autumn (V_2), started in vegetation in a proportion of 94.57%, substantially surpassing all other variants. However, planted in the spring, the cormsof the same size category (V_4) had the lowest percentage of start in the vegetation (42.11%). The corms with a mass of 6-9 g, regardless of the planting season (V_1 and V_3), had approximately the same starting capacity in the vegetation, with slightly higher values when planted in autumn (V_1).

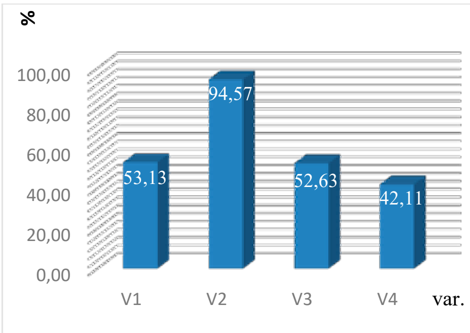

Figure 3. The corms started in vegetation (%)

Table 1. The main phenological data

The time of establishment	Date of establishment of the experiment	Starting in the vegetation	The appearance of flower stems	The beginning of flowering	End of flowering
Autumn	14.11.2020	23.04.2021	22.06.2021	07.07.2021	12 09.2021
	16.11.2019	08.04.2020	02.07.2020	08.07.2020	02.09.2020
Spring	24.04.2021	21.05.2021	21.07.2021	11.08.2021	25.10.2021
	06.04.2020	15.05.2020	11.07.2020	25.07.2020	17.09.2020
	02.04.2019	13.05.2019	07.07.2019	22.07.2019	15.09.2019

Also, from the analysis of the other phenological data (Table 1) we can highlight the differences generated by the planting season.

In spring crops, the late onset of vegetation led to delays in the emergence of flowerstems (with a maximum of 4 weeks in 2021) and the onset of flowering (with variations ranging from 17 days in 2020 to 35 days in 2021).

Flowering ended in the first half of September, about a week later in spring crops (Table 1).

The phenological diagram (Figure 4) better highlights the differences reported between the times to cultivate of the establishment of crocosmia cultures. The stage of full flowering, which characterizes the maximum period of decoration of the plants, had a shorter duration in the crops established in the spring. The exception was the year 2021, when the flowering lasted by approx. one week, probably due to a month's delay in flowering compared to the autumn crops.

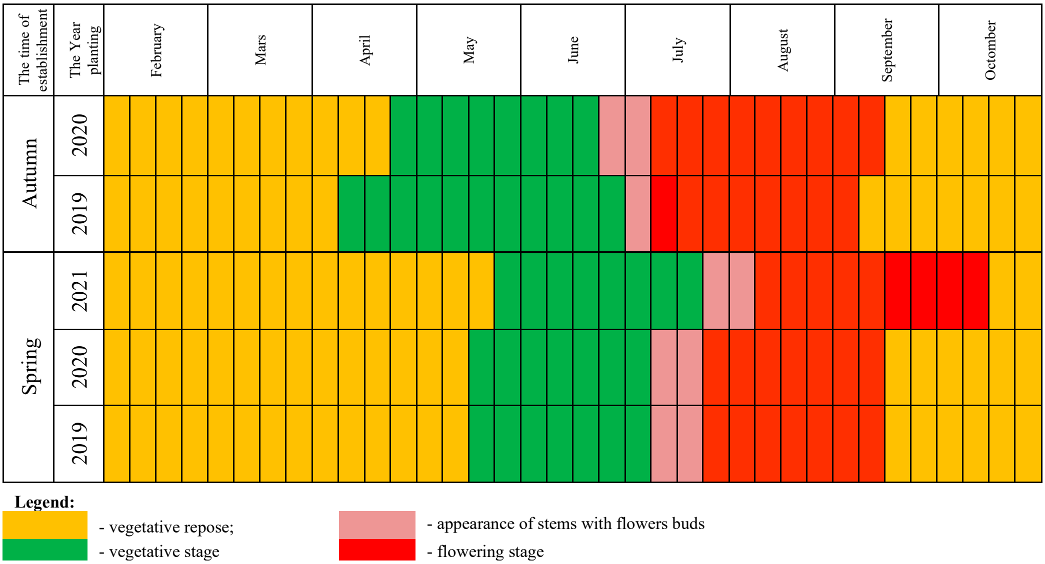

Figure 4. The phenological diagram of *Crocosmia* 'Lucifer'

The passage of each phenophase, from one stage to another, required acertain duration, with differences between the two or three years of vegetation.

In the crops established in autumn (Figure 5), from the start of vegetation until the appearance of flower stems were required 25 days more in 2020 compared to 2021, a difference that can be justified by the start of vegetation 15 days earlier in 2020, against the background of relatively high temperatures from January-March (with 3-4^{0}C above the normal area), followed by less favorable conditions: dry April (8.4 mm total precipitations), and May and June with excess humidity (102-108 mm total rainfall).

The extension of this period led to the shortening of the time until the beginning of flowering by nine days compared to 2021 (Table 1), so that, calendarically, in the two years, the opening of the first flowers took place on the same date (July 7-8). Flowering in autumn crops took place from the beginning of July until the first decade of September, but lasted 10 days longer in 2021 (Table 1, Figure 5), when July and August were characterized by a higher rainfall (88 mm in July and 95 mm in August), as opposed to 2020 (42 mm in July and 9.2 mm in August) (Figure 2).

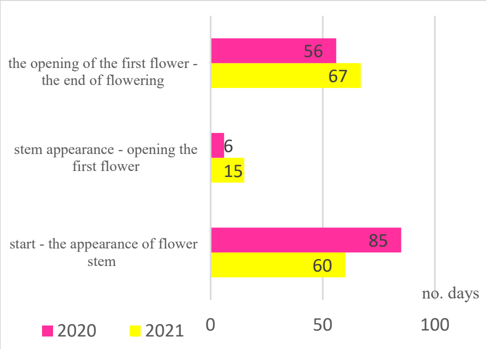

Figure 5. Duration of the main phenophases in the crops established in autumn (no. days)

In the case of plants from crops established in spring (Figure 5), it is found that the year 2021 is characterized by a longer duration of phenophases and a delay in their onset, compared to the other two years analyzed (2019 and 2020).

The gap recorded in 2021, may be the consequence of the establishment of crops with approx. three weeks later than in previous years, due to less favorable weather conditions (cold and rainy spring) (Figure 1, Figure 2).

In 2021, the latest flowering was recorded (August 11), both compared to the crops established in autumn and compared to those in the spring of 2020 and 2019 (Table 1, Figure 6).

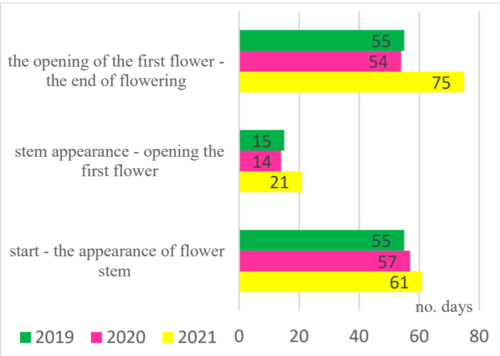

Figure 6. Duration of the main phenophases in the crops established in spring (no. days)

The morphological characteristics of the plants from the four experimental variants highlight both the aspects related to vegetative growth and flowering.

The *length of the leaves* varied from 66.5 cm (V_2) to 31.5 cm (V_4), the higher values being in the variants established in autumn, with very significant positive differences compared to the average (Table 2). Regarding the size of the corms, those of 3-5.9 g favored the growth in height of the leaves only in the conditions of the establishment of the autumn crops; instead, planted in the spring, formed the shortest leaves (31.5 cm).

Table 2. The length of the leaves

Var.	Absolute value (cm)	% from $\bar{x}$	Diff. from $\bar{x}$	Signif.
V_1	54.2	110.16	5	xxx
V_2	66.5	135.16	17.3	xxx
V_3	44.6	90.65	-4.6	000
V_4	31.5	64.02	-17.7	000
$\bar{x}$	49.2	100.0	0	control

LSD 5% =0.6 LSD 1%= 0.9 LSD 0.1%= 1.3

The *number of shoots per plant* had similar values to the variants established in autumn (2.2-2.6 shoots), regardless of the size of the corms, the differences from the average being insignificant (Table 3). In the case of plants planted in the spring, the size of the corms caused greater differences in the ability to germinate. From the corms of 6-9 g, formed three shoots/ plant, 25% more than the control (distinctly significant positive differences). The smaller corms (3-5.9 g) formed plants with the smallest number of shoots (1.8 shoots/plant).

Table 3. Number of shoots/plant

Var.	Absolute value	% from $\bar{x}$	Diff. from $\bar{x}$	Signif.
V_1	2.2	91.67	-0.2	ns
V_2	2.6	108.33	0.2	ns
V_3	3.0	125.0	0.6	xx
V_4	1.8	75.0	-0.6	00
$\bar{x}$	2.4	100.0	0	control

LSD 5% =0.3 LSD 1%= 0.4 LSD 0,1%= 0.6

The *number of leaves per shoot* was another feature analyzed to assess the vegetative growth of the crocosmia plants (Table 4).

Table 4. Number of leaves/shoot

Var.	Absolute value	% from $\bar{x}$	Diff. from $\bar{x}$	Signif.
V_1	6.2	98.41	-0.1	ns
V_2	6.8	107.94	0.5	x
V_3	6.2	98.41	-0.1	ns
V_4	6.0	95.24	-0.3	ns
$\bar{x}$	6.3	100.0	0	control
LSD 5% =0.5	LSD 1%= 0.7	LSD 0.1%= 1.1		

The values of the variants were close to the control (Table 4), andhavingthe non significant differences, except for the variant V_2, established in autumn with corms of 3-5.9 g, which recorded above average values and statistically assured differences (significantly positive).

The ornamental value of the plants was highlighted by the data on the number of flower stems/plant, the height of the flower stems (total and up to the level of the branches) and the number of flowers/stem.

The *number of flower stemsper plant* (Table 5) was favored by the establishment of autumn crops (V_1 and V_2) when, regardless of the size of the corms, the plants formed an equal number of flower stems (2.7), with values above that of the control (4), but with non significant differences. The influence of the corms size used for planting was evident in the variants established in the spring. The small corms, weighing 3-5.9 g, had the lowest capacity to form flower stems (1.8 stems/plant), and the differences from the control were significantly negative. Also, from the observations made, it was found that all the corms, regardless of season and size, formed flower stems.

Table 5. Number of flower stems/plant

Var.	Absolute value	% from $\bar{x}$	Diff. from $\bar{x}$	Signif.
V_1	2.7	112.5	0.3	ns
V_2	2.7	112.5	0.3	ns
V_3	2.4	100.0	0	ns
V_4	1.8	75.0	-0.6	0
$\bar{x}$	2.4	100.0	0	control
LSD 5% =0.4	LSD 1%= 0.6	LSD 0.1%= 0.9		

The *total height of the flower stems* (measured from the ground to the top of the main inflorescence) was strongly influenced by the time of establishment of the crops (Table 6). If the size of the cormsplanted in the autumn(V_1 and V_2) had a small influence on the increase in height of the flower stems, the spring season caused larger differences, to the detriment of the corms of 3-5.9 g (V_4). From the statistical analysis, there were differences compared to the control very significantly positive in the variants which were planted in autumn and negative in those with the planting season in spring (very significant in V_4 and distinctly significant in V_3).

Table 6. Total height of flower stems

Var	Absolute value (cm)	% from $\bar{x}$	Diff. from $\bar{x}$	Signif.
V_1	65.2	112.61	7.3	xxx
V_2	66.6	115.03	8.7	xxx
V_3	56.4	97.41	-1.5	00
V_4	43.4	74.96	-14.5	000
$\bar{x}$	57.9	100.0	0	control
LSD 5% =0.9	LSD 1%= 1.2	LSD 0.1%= 1.9		

The *height of the flower stems*up to the level of the branches (measured from the ground level to the insertion point of each branch) gives indications on the architecture of the flower stem and the possibility of separating the main stem from the branches, for use as a cut flower. In addition, the degree of branching of the flower stems can be highlighted.

The *height up to the first branch* varied from 32 cm (V_2) to 19.2 cm (V_4) and was influenced by both the time of establishment of the crops and the size of the corms(Table 7). Very significant positive differences were obtained in corms with a mass of 3-5.9 g, planted in autumn (V_2) and in corms with a mass of 6-9 g, planted in spring (V_3). In plants resulting from small corms, planted in spring (V_4), the first branch was formed close to the ground, at a height of approx. 19 cm.

The *height of the flower stem up to the second branch* was between 43.6-23.8 cm and registered very significant positive differences in the variants established in autumn and in the one established in spring, with large corms(Table 7). From the small corms, planted in the spring, the flower stemsformed the second branch at a low height (23.8 cm).

Regarding the *third branch*, it is observed that it was formed only in the plants from the variants established in autumn. The high height above ground level (45-50 cm) indicates the proximity to the top of the main stem, respectively at approx. 15-20 cm (Table 7).

Table 7. The height of the flower stems to the level of the branches

Variants	To the branch I			To the branch II			To the branch III		
	Absolute values (cm)	% from $\bar{x}$	Diff./ signif.	Absolute values (cm)	% from $\bar{x}$	Diff./ Signif.	Absolute values (cm)	% from $\bar{x}$	Diff./ signif.
V_1	29.8	103.11	0.9^{x}	39.0	105.12	1.9^{xxx}	44.9	187.08	20.9^{xxx}
V_2	32.0	110.73	3.1^{xxx}	42.0	113.21	4.9^{xxx}	51.1	212.92	27.1^{xxx}
V_3	34.6	119.72	5.7^{xxx}	43.6	117.52	6.5^{xxx}	0	0	-24^{000}
V_4	19.2	66.44	-9.7^{000}	23.8	64.15	-13.3^{000}	0	0	-24^{000}
$\bar{x}$	28.9	100.0	control	37.1	100.0	control	24.0	100.0	control
	$LSD_{5\%}$ = 0.7 $LSD_{1\%}$ = 1.1 $LSD_{0.1\%}$ = 1.6			$LSD_{5\%}$ = 0.8 $LSD_{1\%}$ = 1.1 $LSD_{0.1\%}$ = 1.7			$LSD_{5\%}$ = 0.6 $LSD_{1\%}$ = 0.9 $LSD_{0.1\%}$ = 1.4		

The number of flowers on the stem (Table 8) was influenced by the time of the establishment of the crops. The plants from the corms planted in autumn (V_1 and V_2) formed 36.5 and 36.8 flowers/stem, respectively, with 5.3-5.6more than the control.In the plants resulting from the corms planted in spring, the average number of flowers per stem was 28.5 and 23, respectively, the differences from the control being very significant negative.

Table 8. Number of flowers/stem

Var.	Absolute values	% from $\bar{x}$	Diff. from $\bar{x}$	Signif.
V_1	36.5	116.99	5.3	xxx
V_2	36.8	117.95	5.6	xxx
V_3	28.5	91.35	-2.7	000
V_4	23.0	73.72	-8.2	000
$\bar{x}$	31.2	100.0	0.0	control
LSD 5% =0.5		LSD 1%= 0.7	LSD 0.1%= 1.1	

In the Table 9 was determinated the production of corms obtained from experimental crops. Compared to the time of establishment, it can be seen that the autumn plantings reduced the capacity to form new corms, their number being 1.2-1.4. Depending on the size of the corms used to establish the crops, the highest yield was obtained for large corms, 6-9 g.

Table 9. Number of new corms

Var.	Absolute values	% from $\bar{x}$	Diff. from $\bar{x}$	Signif.
V_1	1.4	82.35	-0.3	ns
V_2	1.2	70.59	-0.5	0
V_3	2.3	135.29	0.6	xx
V_4	1.9	111.76	0.2	ns
$\bar{x}$	1.7	100.0	0	control
LSD 5% =0.4		LSD 1%= 0.5	LSD 0.1%= 0.8	

CONCLUSIONS

The size of the corms and the time of planting influenced most of the characters analyzed in the *Crocosmia* 'Lucifer'.

The highest proportion of corms in the vegetation (94.57%) was recorded in corms of 3-5.9 g, planted in autumn.

In the crops established in autumn, the smaller corms positively influenced especially the vegetative growth of the plants (leaf length and number of leaves, number of shoots). In the characters of flowers and inflorescences (number and height of flower stems, number of flowers), the results were approximately similar to those of plants obtained from corms of 6-9 g.

The establishment of crocosmia crops in the spring is justified only with the use of large corms.

Significant differences between planting seasons were recorded in the number of branches of the flower stems. The plants resulting from the corms planted in spring formed only two branches compared to those resulting from the corms planted in autumn which formed three branches on the stem.

The plants resulting from corms planted in autumn were characterized by the early stages of some phenophases (starting in the vegetation, the appearance of the flowerstems, flowering).

Corms with a mass of 6-9 g planted in the spring favored the production of new corms.

REFERENCES

Alhajhoj, M.R. (2017). Effects of Corm Size, Planting Time and Pot Size on Plant Development and Flowering of Gladiolus × hybrid. *International Journal of Agriculture Innovations and Research,* 5(5), 845-848.

Amin, N.U., Khattak A.M., Ahmad, I., Ara, N., Alam A., Ali, M.& Ali, I. (2013). Corm and cormel size of Gladiolus greatly influenced growth and development of subsequent corm production. *Pak. J. Bot*., 45(4), 1407-1409.

Amişculesei, P., Chelariu, E.L., Apostol, M., Hangan, A.M.R. &Draghia, L. (2020). The influence of corm size on phenology and ornamental value of *Gladiolus byzantinus, Lucrări Ştiinţifice, Seria Horticultură, USAMV Iași,* 63 (1).

Armitage, A. (1993). *Specialty cut flowers*. Varsity Press, Timber Press Portland, Oregon.

Ahmad, I., Khattak, A.M., Ara, N. & Amin, N.U. (2011). Effect of planting dates on the growth of gladiolus corms in Peshawar.*Sarhad J. Agric*., 27(2), 195–199.

Armitage, A.M. &Laushman, J.M**.** (1990). Planting date in-ground time affect cut flowers of Acidanthera, Anemone, Allium, Brodiaea, Crocosmia.*Hort-Science*, 25, 1236–1238.

Armitage, A.M. &Laushman, J.M. (2008). Specialty cut flowers. The production of annulas, perennials,bulbs, and woody plants for fresh and dried cut flowers. *Timber Press, Portland, London*,227–232.

Bhat, Z. A., Paul, T. M. & Mir, M.M. (2009). Effect of corm size and planting geometry on growth, flowering and corm production in *Gladiolus* cv. White Prosperity. J. *Orna. Hort.*, 12(1), 35-38.

Brickell, C., (2011). *Encyclopedia of plants & flowers.* American Horticultural Society.

Cantor, M., Dumitraș, A. & Zaharia, D. (2007). *Bulbous plants used in landscape design*. Cluj-Napoca, RO: Todesco Publishing House.

De Mastro, G. & Ruta, C. (1993). Relation between corm size and saffron (*Crocus sativus* L.) flowering. *Acta Horticulturae*, 344, 512-517

El-Bably, S.M.Z. & Mahmoud, A.M.A. (2005). Effects of corms storage, zinc application and their interaction on vegetative growth, flowering, corms productivity and chemical constituents of Tritonia crocata Ker Gawl. plant. https://www.researchgate.net/publication/324546341.

Farid Uddin, M., Rahman, M.M., Rabbani, M.G. & Mannan, M.A. (2002). Effect of corm size and depth of planting on the growth and flowering of gladiolus. *Pak. J. Biol. Sci*., 5, 553-555.

Filios, C. & Miller, B. W. (2010). Topflor has potential for *Crocosmia* height control. *Res. Newslet*. http://www.flowerbulb.nl/RP/2010%20march.pdf.

Goldblatt, P., Manning, J.C. & Rudall, P. (1998). *Iridaceae. In: KUBITZKI*, K. *The families and genera of vascular plants. Flowering plants. Monocotyledons*. v. 3 Heidelberg/New York: Springer Verlag.

Goldblatt, P., Manning, J.C. & Dunlop, G. (2004). *Crocosmia* and *Chasmanth*e. Timber Press. *Portland. Cambridge*, 17–196.

Gowda, J.V.N. (1987). Interaction effect of corm size and spacing on growth and flower production in gladiolus cv. Snow Prince. *Current Res. Univ. Agril. Sci., Bangalore*, 16(2), 27-28.

Hetman, J., Laskowska, H. & Durlak, W. (2007). The influence of selected factors on the yield of *Allium moly* L. bulbs. *Acta Sci. Pol. Hortorum Cultus*, 6(2), 23–27.

Kalasareddi, P., Reddy, B., Patli, S, Ryagi, Y.Y.&Gangadharappa, P. (1998). Effect of corm size on growth and spike yield of *Gladiolus* cv. Snow White. Karnataka J. *Agric. Sci*. 4, 1133-1135.

Mazzini-Guedes, R.B., Guedes Filho, O., Bonfim-Silva, E.M., Costa Couto, J.C., Pereira, M.T.J. & Da Silva, T.J.A. (2017). Management of corm size and soil water content for gladiolus flower production. *Ornamental Horticulture*, 23(2), 152-59.

Memon, N.N., Qasim, M., Jaskani, M.J., Ahmad, R. &Anwar, R. (2009). Effect of various corm sizes on the vegetative, floral and corm yield attributes of *Gladiolus. Pak. J. Agri. Sci.,* 46(1), 13-19.

Methela, N.J. & Islam, M.S. (2021). Corm and Cormel Production Improvement of *Gladiolus* by Spacing and Size. *Tropical Agricultural Research*, 32(4), 445-452.

Nafees, M., Ahmad, I., Maryam, Qureshi, R., Ashraf, I., Maqsood, A., Aslam, M.N. & Nisa, N. (2021). Memoncultivars and corm size response for gladiolus flower and corms production in arid region of Bahawalpur. *Pak. J. Bot.,* 53(2): DOI: http://dx.doi.org/10.30848/PJB2021-2(1).

Özel, A., Erden, K. & Demirbilek, T. (2017). Determination of optimum corm size for saffron (*Crocus sativus* L.) and corm yield under the Harran Plain conditions. *Journal of Agricultural and Biological Science,* 12(7), 236-240.

Pittu, S., Chopde, N., Patil S. & Lokhande, S. (2016). Effect of planting geometryand corm size on yield and economics of gladiolus. *Plant Archives*, 16(2), 527-530.

Renau-Morata, B., Nebauer, S.G., Sánchez, M. & Molina, R.V. (2012). Effect of corm size, water stress and cultivation conditions on photosynthesis and biomass partitioning during the vegetative growth of saffron (*Crocus sativus* L.). *Industrial Crops and Products* 39, 40–46.

Săulescu, N.A. & Săulescu, N.N. (1967). *Field of experience.* Bucharest, RO: Agro-Forestry Publishing House.

Singh, K.P. (2000). Growth, flowering and multiplication in *Gladiolus* cultivar "Aarti" as affected by grades of mother corm and cormel. *J. Appl. Hort*., 2(2), 127-129.

Zaharia, A., Cantor, M., Borsai, O., Buta, E. & Jucan, D. (2018). Correlation analysis of different morphological characters among cultivars and hybrids of *Gladiolus hybridus* Hort. *Romanian Biotechnological Letters*, 23(4), 13723- 13727.

Zubair, M., Ayub, G., Rab, A., Amin, N.U., Ahmad, M.& Ara, N. (2013). Preflowering growth of gladiolus in response to staggered planting. *Pakistan J. Bot*., 45(4), 1329–1338.

Żurawik, P., Salachna, P., Żurawik, A. & Dobrowolska, A. (2015). Morphological traits, flowering and corm yield of*Crocosmia × crocosmiiflora* (Lemoine) N.E. cultivars are determined by planting time. *Acta Sci. Pol. Hortorum Cultus*, 14(2), 97-108.