Original Research Article

Evaluation of the Ornamental Potential of Safflower (*Carthamus tinctorius* L.)

ABSTRACT

Aims: to evaluate the ornamental potential of two safflower genotypes (*Carthamus tinctorius* L.): ICA 73, ICA 193, grown under protected environment.
Place and Duration of Study: Department of Agronomy of Federal Rural University of Pernambuco, between March and May 2017.
Methodology: The methodology addressed evaluated the performance of the two genotypes, through three experiments. The first experiment was carried out in a completely randomized design, being evaluated: plant height; stem diameter; leaf dentin; spinescent margin of the leaves; number of branches; number of flower buds; spinescent margin of the bracts; flowering, and flower production. The second one was conducted in a randomized complete block design in a factorial scheme, and the following variables were evaluated: plant height; stem diameter; number of branches; number of flower buds; and flower production. Finally, the third experiment used a completely randomized design in a factorial scheme and evaluated the variables: number of flowers; number of flower buds and post-harvest durability. The analysis of variance was performed using the F test at 5% of probability and, afterwards, the regression or comparison analysis of averages by the Tukey test at 5% of probability.
Results: The ICA 73 access showed plants with high flower production and the ICA 193 exhibited plants with weak or moderate spinescent margin of the leaves and bracts, besides good uniformity of the anthesis of the flowers.
Conclusion: Both accesses showed ornamental potential, demonstrating precocity, beauty and durability of the flowers. The density of one plant was the most favorable for pot plant and cut flower. The semi-open flowers harvest point was the best for maintaining the stem quality.

Keywords: Floriculture. Precocity. Flowers. Potted Plant. Cut Flower Stems.

1. INTRODUCTION

Floriculture is a segment that stands out in the world, with significant growth, constituting an important source of income for several countries and promoting the development of productive poles. In this context, production is mainly intended for export to large consumer centers located in the European Union, the United States of America and more recently Asia and the Middle East [1, 2].

In Brazil, in contrast to other developing countries, this sector has grown mainly towards the intern market [3]. With annual growth of around 8% per year, growing exports and significant increase in domestic consumption, the floriculture in the country became one of the most prominent segments in the agribusiness market, moving around R $ 6.7 billion in 2016 [4].

Most of the market is supplied by plants from states in the Southeast of the country [5], while other important Brazilian regions, where new floriculture poles emerge, end up with difficulties to development, despite their natural aptitude for this sector [6].

The production of flowers consists of a dynamic sector with a constant search for new products that meet the new trends. In this sense, safflower has great potential for this market. The safflower (*Carthamus tinctorius*) belongs to the Asteraceae family, it is an herbaceous annual plant, self-pollinated and capable of developing into various edaphoclimatic conditions [7, 8], tolerating low water availability and high temperatures [9].

The use of this herbaceous plant covers many possibilities and extends to practically every part of the plant. Its seeds exploited part in the market, being present in food products [10], cosmetics and in the composition of drugs [11]. Safflower oil may also be intended for biofuel production [12], and the bagasse used in animal feed supplements [13]. The flowers allow the extraction of two dyes from their petals, a soluble and another hydrophilic [14], and have ornamental potential as fresh or dried cut flower [15].

The variability of the color, size and arrangement of the florets that the safflower possesses, make the species very attractive to the floriculture market, being able to be used as ornamental plants, cutting stems and confection of bouquets, with potential for planting in gardens or pots and trade while fresh or when dry [16]. In Europe, the use of this herbaceous plant in the flower market is common with specific cultivars for this purpose [17].

Safflower cultivation in Brazil is still very limited and is restricted to attending to some scientific research; moreover, usually it covers only the production of oil, thus not exploiting the ornamental potential. However, considering the importance that the floriculture is taking in Brazilian agribusiness, the search and insertion of new products to expand and meet market demand becomes a necessity and, in this context, investing in the potential of this specie is a very promising strategy.

The objective of this work was to evaluate the ornamental potential of two safflower genotypes to pot plant and cut flower, cultivated in a protected environment, determining the best density and harvest point.

2. MATERIAL AND METHODS

The safflower accesses (*Carthamus tinctorius*) ICA 73 and 193 used in the study were imported by the Institute of Agricultural Sciences (ICA) in agreement with the Federal University of Minas Gerais (UFMG) from germplasm banks of India and Ethiopia, which were later transferred to the Plant Breeding Program of the Federal Rural University of Pernambuco (UFRPE) to carry out this work.

Three experiments were carried out under greenhouse conditions in the Agronomy Department of the Federal Rural University of Pernambuco - UFRPE, Recife - PE, whose geographical coordinates are 8°10'52''S latitude, 34°54'47'' longitude and 2m altitude.

Sowing was done manually in pots with 5 L capacity, filled with commercial Basaplant™ substrate, the depth of approximately three centimeters [18]. Irrigations were performed manually and daily, approximately 300 ml per vase. No fertilization was applied.

2.1 First Experiment (Characterization of Access)

The experimental design adopted was completely randomized, with twenty repetitions. The treatments were composed of the two safflower genotypes. Twenty vases were used for each access (ICA 73 and ICA 193), where each vase represented an experimental unit, totaling 40 parcels.

The Emergency Velocity Index (EVI) was calculated according to the formula of [19]: $ESI = \Sigma({}^{En}/_{Nn})$; Where: n = the number of normal seedlings recorded in the count "n"; Nn = number of days of sowing until the count "n". For this, the number of emerged plants, with two open cotyledon leaves, was registered until the ninth day after sowing. The percentage of germination was calculated after stabilization of the emergency, considering the final number of emerged plants.

The evaluations was carried out sixty days after sowing (DAS), based on the following characteristics: Plant Height (PH (cm)) - performed with ruler and corresponding to the measurement of the soil to the apex of the plant; Stem Diameter (SD (cm)) - measured with a digital pachymeter in the base of the stem; Leaf Dentin (LD) - classified by scale of notes: absent or weak (0); moderate (5); strong (10) [20] (Figure 1); Spinescent Margin of the Leaves (SML) - graded by note scale: absent or weak (0); moderate (5); strong (10) [20] (Figure 2); Number of Branches per plant (NB) - obtained by counting (Figure 3); Number of Flower Buds (NFB) - obtained by counting the flower buds (*capitulum*); of the Spinescent Margin of the Bracts (SMB) - graded by grading scale: absent or weak (0); moderate (5); strong (10) [20] (Figure 4); Flowering (Fl) - number of days from sowing to beginning of flowering; Flower Production (FP) - obtained by counting open inflorescences.

Figure 1. Leaf Dentin of Safflower: (A) Weak; (B) Moderate e (C) Strong.

Figure 2. Spinescent Margin of the Leaves of Safflower: (A) Weak; (B) Moderate; (C) Strong.

Figure 3. Safflower plants: (A) Little branched; (B) Very branched.

Figure 4. Spinescent Margin of the Bracts of Safflower: (A) Strong; (B) Moderate; (C) Absent.

2.2 Second Experiment (Conduction Pruning)

The experimental design was the one of randomized block, in a 4 x 2 factorial scheme, combining four plant densities per vase and two safflower access, distributed in 4 blocks. Each block was composed of eight vases, each one corresponding to an experimental unit, totalizing 32 experimental plots. The densities were evaluated referring to: four; three; two; and one plant per vase.

After reaching the phase of rosette (30 DAS), the apices of the central stem of the plants were pruned through a single cut. Subsequently, 30 days after the procedure, the following characteristics were evaluated: Plant height (PH (cm)); Stem Diameter (SD (cm)); Number of Branches per plant (NB); Number of Flower Buds (NFB); Flower production (FP).

2.3 Third Experiment: (Post-Harvest Characterization)

The experimental design was a completely randomized design, in a 3 x 2 factorial scheme, combining three cutting points of the stems and two safflower accesses, using four repetitions. Twelve vases were used for each genotype, wherein each vase received two seeds and corresponded to one experimental unit, the cut-off points of the stems were: closed buds, semi-open buds, and open buds. To stimulate the development of lateral buds the apices of the central stem were pruned.

The harvest point of the stems was done according to the respective treatments: open inflorescences, above 70% of the open florets; semi-open, 30 to 40% of open florets; and closed, 5 to 15% of the open florets (Figure 5). The harvest point was determined based on the inflorescences of each stem, and the cut was performed when half of the inflorescences presented the percentage of open florets corresponding to the treatment. The stems were cut in the basal portion, about 3 cm from the base of the plant. At laboratory, the flower stem were evaluated from ornamental characteristics as follows: Number of inflorescences (NI) Number of Close Buds (NCB); Later the flower stems were placed in containers with tap water, leaving about 5 cm from the stem base submerged. The flower stems were discarded when presented an unpleasant visual aspect, with flowers, leaves and stem darkened. The Post-Harvest Durability (PHD) was consider the number of days from stem cutting to discard.

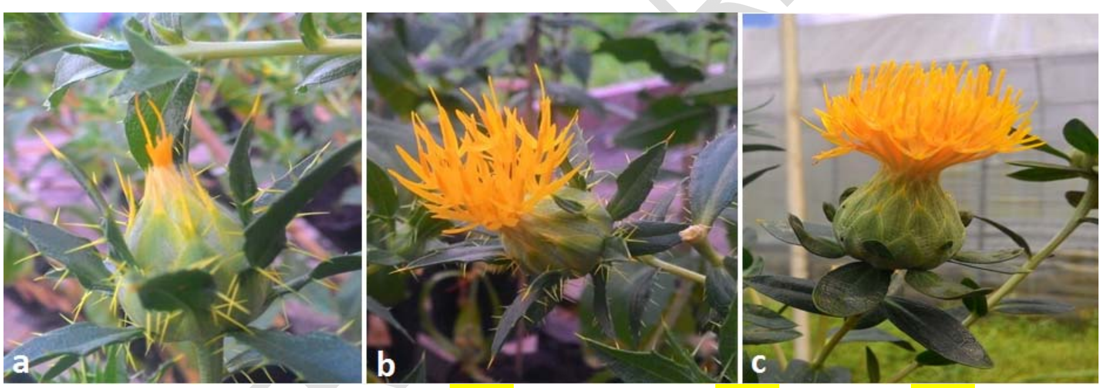

Figure 5. Cut-off points: (a) Closed buds; (b) Semi-open buds; (c) Open buds.

For the analysis of variance, the effects of the treatments and the averages were considered as fixed and treated according to the statistical model for the specific designs of each experiment.

Using the F test at the 5% probability level, were tested the significance of the mean squares and posteriorly the means were submitted to polynomial regression analysis or comparison of means by the Tukey test using the GENES program [21].

Estimates of variance components and genetic parameters were obtained from the following expressions: $\sigma_g^2 = \frac{QMG - QMR}{r}$, $h^2 = \frac{\sigma_g^2}{QMG/r}$, e $CV_g = \frac{100\sqrt{\sigma_g^2}}{\mu_a}$, for the genetic variance among means, heritability coefficient and coefficient of genetic variation, respectively.

3. RESULTS AND DISCUSSION

The emergence of seedlings began 4 days after the sowing and continued for two days. The accesses presented 80% and 90% of germination (% G) and 5.47 and 8.22 of Emergency Velocity Index (EVI) for ICA 193 and ICA 73, respectively.

3.1 First Experiment (Characterization of Access)

Significant differences were observed between the accesses evaluated at the 5% level by the F test for the analyzed characteristics, except for the diameter of the stem, evidencing the existence of genetic variability (Table 1).

According to [22], the plants are classified as ornamental when they present characteristics that arouse attention and interest, from their aesthetic particularities, referring to the color and shape of leaves and flowers, phenological aspects, among others. Taking these characteristics into consideration, the ICA 73 presented plants with the highest number of branches (9.15), a high number of buds (15.9) and, mainly, high flower production (14.3). On the other hand, it exhibited strong spinescent margin of the leaves and bracts (9.25). On the other hand, ICA 193 access presented the most favorable points to the low and moderate spinescent margin of the leaves and bracts (2.39 and 3.36, respectively). However, showed low branching (5.25) and consequently, lower number of buds and flower production (7.65 and 6.95, respectively) (Table 2).

According to [23], the leaves and bracts margins of safflower plants are peculiarly spinescent; however, the vehemence with which this characteristic is expressed in the plant varies according to the different genotypes, thus allowing the selection and development of varieties that exhibit a weak or moderate character expression, offering attractive materials to the floriculture market.

Table 1. Summary of variances analysis and genetic parameters estimates for Plant Height (PH), Stem Diameter (SD), Leaf Dentin (LD), Spinescent Margin of the Leaves (SML), Number of Branches (NB), Number of Flower Buds (NFB), Spinescent Margin of the Bracts (SMB), Flowering (FI), and Flower Production (FP), Recife, 2017.

SV	DF	MS								
		PH (cm)	SD (cm)	LD	SML	NB	NFB	SMB	FI	PF
Acesses	1	2822.4	0.006	30.625	122.5	152.1	680.62	90.0	198.02	540.22
Residual	38	6665.2	0.022	5.62	15.20	8.90	36.75	13.35	22.31	28.18
F		16.09**	0.29^{ns}	5.44*	8.06**	17.08**	18.52**	6.74*	8.87**	19.16**
Mean		68.1	0.98	4.12	7.5	7.2	11.77	7.75	56.52	10.62
CV		19.45	15.06	57.50	51.98	41.44	51,48	47.15	8.36	49.97
σ^2_g		132.35		1.25	5.36	7.16	34.03	3.83	8.78	25.60
H^2		93.78		81.63	87.60	94.15	94.60	85.16	88.73	94.78
CV_g		16.89		27.10	30.88	37.17	48.19	25.26	28.25	47.62
CV_g/CV_e		0.87		0.47	0.59	0.90	0.94	0.53	5.24	0.95

** and ** significant at the 5% and 1% levels, respectively, of the probability by the F test and "ns" not significant by the F test*

Table 2 - Average of Plant Height (PH), Stem Diameter (SD), Leaf Dentin (LD), Spinescent Margin of the Leaves (SML), Number of Branches (NB), Number of Flower Buds (NFB), Spinescent Margin of the Bracts (SMB), Flowering (FI), and Flower Production (FP), Recife, 2017.

Accesses	PH (cm)	SD (cm)	LD	SML	NB	NFB	SMB	FI	FP
ICA 73	59.7b	9.99a	5.0a	9.25a	9.15a	15.9a	9.25a	58.7a	14.3a
ICA 193	76.5a	9.74a	3.25b	2.39b	5.25b	7.65b	3.36b	54.3b	6.95b

**Means followed by the same letter do not differ by Tukey test at 5%.*

Plants with spines have less acceptance in the market, by virtue of limiting the touch, due to the possibility of promoting scratches in the skin [36]. In this context, ICA 193 stands out for having naturally weak or moderate spinescent margins, both in the leaves and in the bracts, presenting viability for insertion in the market of cut flowers without resistance to acceptance. In contrast, access ICA 73 needs to be submitted to breeding programs in order to circumvent this limitation for its use in floriculture.

Both accesses presented precocity of flowering, and ICA 73 presented a subtle highlight in relation to this phenological stage, starting its flowering about 59 DAS, while the ICA 193 access began about 54 DAS. According to [24], this phase starts between 60 and 100 days after sowing and confirms, therefore, the precocity of the materials evaluated in this work (Table 2).

No early commercial material of *Carthamus tinctorius* intended for the ornamental market is reported, in addition, it is possible to notice a certain difficulty in the development of cultivars of this species that present attributes of ornamental interest and initiate this phenological stage early [15]. Less late varieties, commonly used, show beginning of flowering only 80 days after sowing [25, 26]. In this sense, the accesses under study have a scarce and desired characteristic, offering a further differential to include these in commerce, not only facilitating acceptance but demonstrating competitiveness with products already available.

Regarding plant height, ICA 73 showed lower heights than ICA 193, referring to 59.7 cm and 76.5 cm, respectively (Table 2). Considering also the use for cutting stem, according to [15], the stem length of products with superior quality must present between 70 cm and 80 cm, however, there are already commercial safflower varieties specific to the ornamental market with stems from 60 cm [25]. In this way, the values demonstrated by the accesses of this research, fit within the allowed for both sides.

As to leaf dentin, ICA 73 presented moderate intensity (5.0) and weak to moderate ICA 193 (3.25) (Table 2). In order to make arrangements, the margin of the leaf does not have a fixed pattern, since even the most unusual can contribute to creative and decorative combinations, including being something very desired to compose bouquets base [27].

During the experiment, pathogens and pests affected the plants, since no chemical control was performed. From the symptoms and a previous microscopic analysis, the presence of *Cercospora carthami* and aphid (aphis) was observed (Figures 6a and 6b). However, the inflorescences were not directly affected and the characteristics of interest could be effectively evaluated. [12] reported that, safflower is the target of many pathogens, including fungi, bacteria and viruses, but the first group cited is the most prominent. *Cercospora carthami* is one of the fungi that commonly affect the culture, causing foliar damage. Among the pests, aphids cause recurrent damages, however they are less worrisome than diseases [28].

3.2 Second Experiment (Conduction Pruning)

The summary of the analysis of variance for the second experiment and the estimation of the main genetic parameters for the agronomic and ornamental characters evaluated in the two safflower accesses are organized in Table 3. According to the results, it is possible to observe a significant difference between the accesses at the level of 5% by the F test for the characteristics analyzed.

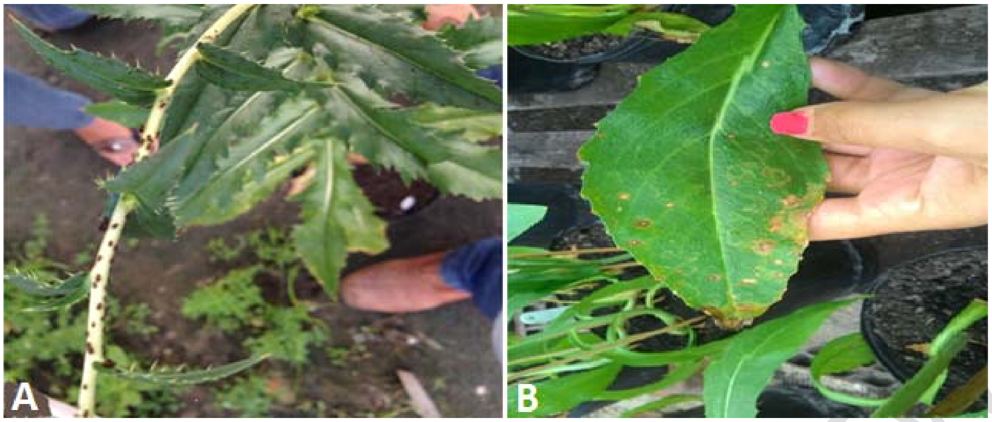

Figure 6. Safflower plants: (A) Pest attack (aphids); (B) Leaf disease (*Cercospora carthami*).

Table 3. Summary of variances analysis and genetic parameters estimates for Plant Height (PH), Stem Diameter (SD), Number of Branches (NB), Number of Flower Buds (NFB), and Flower Production (FP), Recife, 2017.

SV	DF	MS				
		PH (cm)	SD (cm)	NB	NFB	PF
Blocks	3	36.68	0.03	5.54	7.10	5.78
Accesses	1	570.94*	0.51*	283.52**	264.97**	242.91**
Densities	3	325.76*	0.27*	210.51**	191.36**	188.82**
AccessesxDensities	3	30.41^{ns}	0.04^{ns}	33.31**	27.76**	27.78**
Residual	21	79.10	0.05	2.90	3.58	2.93
Mean		60.30	1.75	10.69	10.43	10.05
CV		14.74	12.61	15.94	18.14	17.04
σ^2_g		30.74	0.03	17.54	16.34	15.00
H^2		86.15	90.46	98.97	68.65	98.79
CV_g		9.19	9.71	39.17	38.73	38.55
CV_g/CV_e		0.62	0.77	2.46	2.13	2.26

**** and ** significant at the 5% and 1% levels, respectively, of the probability by the F test and "ns" not significant by the F test.***

Figure 7 graphically shows the behavior of the accesses as a function of the different densities of plants per vase, as well as the equations and coefficient of determination (R^2) that best fit the variables studied, according to the regression analysis. All variables can be explained by the linear equation of the 1st degree, with R^2 values higher than 0.80.

Plant height and stem diameter were inversely proportional to plant density per vase, decreasing as the number of plants increased (Figure 7a). The diameter is an important feature because it is related to rigidity and quality of the stem, since low densities can lead to flexibility and breakage [29]. Pruning did not limit the final length of the plants, which reached values characteristic of the species.

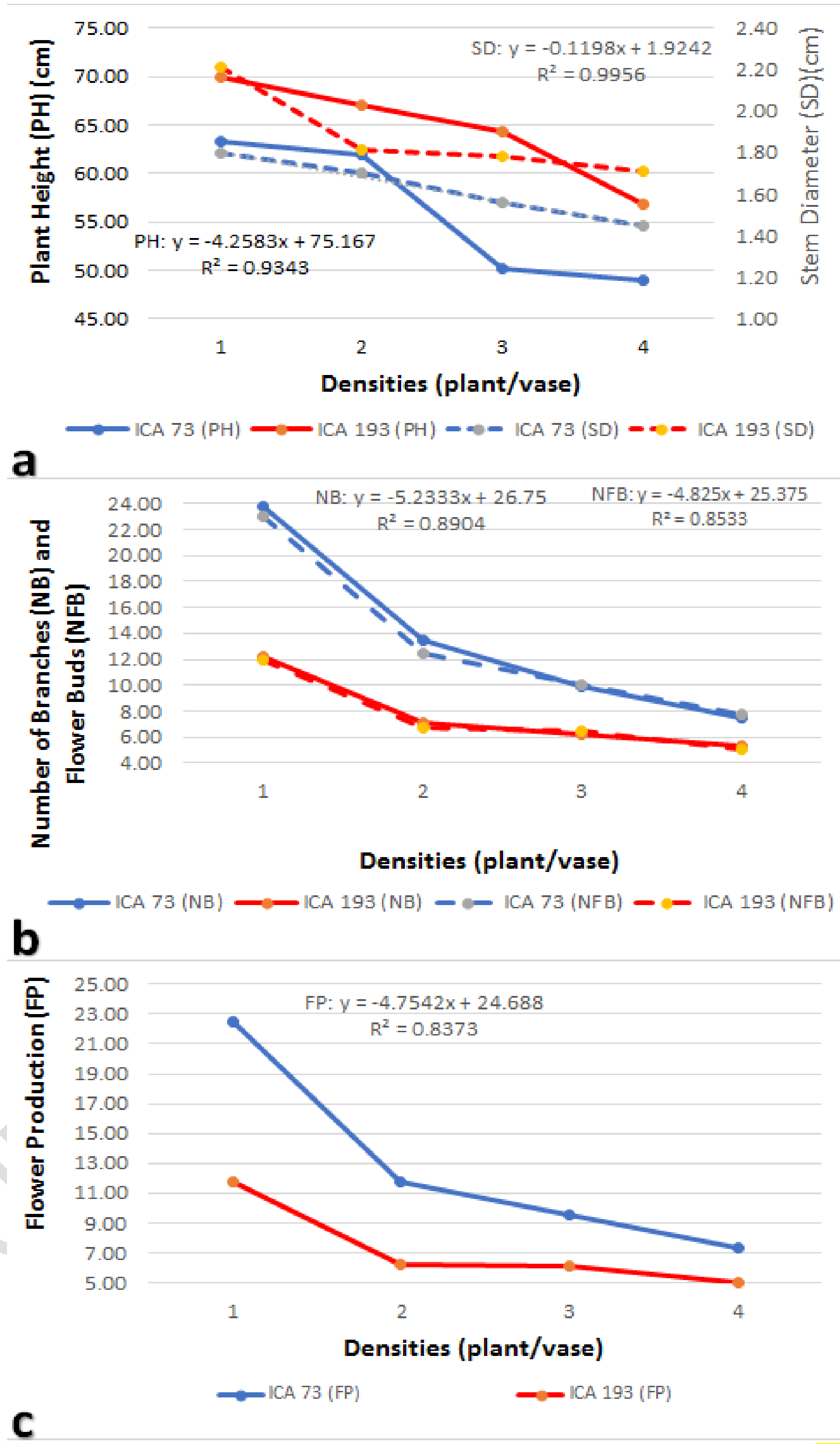

Figure 7. Plant Height (PH), Stem Diameter (SD), Number of Branches (NB), Number of Flower Buds (NFB), and Flower Production (FP) of ICA 73 and ICA 193 safflower accesses according to four plant densities per vase.

The highest values of height and diameter were reached by ICA 193 access, with values ranging from 56.75 to 70.00, and 1.71 to 2.21 (Figure 7a). In the first case, the values extrapolate the recommendation of [30] for use in vases, but is suitable for employment in other areas of social recreation. In this sense, there are already commercial safflower varieties destined for the ornamental market with heights between 60 and 80 cm, such as Orange Granade, which is highly prized for beautifying gardens [25]. In contrast, ICA 73 exhibited the smallest values of height and diameter, ranging from 49.00 to 63.25 and 1.44 and 1.80 (Figure 2a). Despite the low diameter values, the stems showed to be well lignified and no breaks were observed.

The decrease due to the increase in the number of plants per vase for number of branches, buds and flower production was also observed (Figure 7b and 7c) and is in agreement with the one verified by [31], that in its work with other safflower genotypes evidenced a linear reduction proportional to the increase of the density. This result is probably linked to competition between plants for nutrients, water and light, limiting their development [29]. For use in potted plants or gardens, plants with more branches, provide a aerial part more voluminous and visually pleasing. Access ICA 73, presented the highest values for these characteristics and the best density for both genotypes, refers to one plant per vase.

The high number of branches acts negatively on the uniformity of the opening of the flowers, due to the different flowering rates of the buds [29]. For ornamental plants destined to gardens, vases or other leisure areas, this particularity becomes attractive, because it makes possible that the prestige of the flowers can be realized by a greater period of time, since while the first flowers are close to senescence, others will still be at the beginning of the anthesis. On the other hand, this factor is not attractive for cutting stems.

3.3 Third Experiment: (Post-Harvest Characterization)

In Table 4, the analysis of variance of the third experiment and the estimation of the main genetic parameters for characters of ornamental importance evaluated in the two accesses of safflower. The results show a significant difference between the accesses at the 5% level by the F test for the characteristics analyzed. Table 5 shows the means of the variables that were submitted to the Tukey test, depending on the treatment factors: accesses and cut-off points.

Table 4. Summary of variances analysis and genetic parameters estimates for Number of inflorescences (NI), Number of Close Buds (NCB), Post-Harvest Durability (PHD), Recife, 2017.

SV	DF	MS		
		NI	NCB	PHD
Accesses	1	54.0**	84.37**	88.17**
Cut-off Point	2	26.54**	22.79**	77.17**
AccessesxCut-off	2	13.62**	15.87**	4.67^{ns}
Residual	18	1.17	1.12	1.33
Mean		5.33	3.21	10.58
CV		20.03	33.06	10.91
σ^2_g		4.40	6.94	7.24
H^2		97.84	98.67	98.49
CV_g		39.34	82.10	25.42
CV_g/CV_e		1.94	2.48	2.33

**** and ** significant at the 5% and 1% levels, respectively, of the probability by the F test and "ns" not significant by the F test.***

The maturity of the flowers is a very decisive characteristic on the quality of the product and makes it impossible in most cases to perform a mechanized harvest [15], justifying the importance of defining the best moment for cutting the stems, as far as the anthesis of flowers is concerned. Other important information that should be considered refers to the fact that the central flower opens days before the lateral flowers, about one week, leading to visual depreciation when the other flowers are opening [32], for this reason the pinch was performed, stimulating the anther of the lateral flowers in a more uniform way.

The number of inflorescences, number of close buds and post-harvest durability should be analyzed together and as a function of the cut-off point, allowing establishing the most appropriate combination for quality of the final product.

The ICA 73 had a higher average number of inflorescences (10.25) and a lower number of close buds (1.75) for the cut-off point when buds were open, however, in this same treatment the lower post-harvest durability of the stems was obtained (4.25), making it impossible to cut stems of this material at this maturation level, since it does not meet an adequate number of days of product life (Table 5). At the point of semi-open buds, the number of inflorescences (5.75) was reduced by half and the number of close buds increased (6.00), showing a nearly 1:1 ratio between flowers and buds, indicating little uniformity of flower anthesis and opening of a few buds after cutting, but exhibited longer flower durability (11.00) (Table 5). Finally, at the point of closed buds the number of inflorescences reduced even more, evidencing that some of the heads did not even develop buds and the low number of close buds also confirms this hypothesis, however, the durability of the stems was equivalent to the cutting treatment with the semi-open flowers.

Table 5 - Average of Number of Inflorescences (NI); Number of Close Buds (NCB); Post-Harvest Durability (PHD), Recife, 2017.

	Variables					
	NI		NCB		PHD	
	ICA 73	ICA 193	ICA 73	ICA 193	ICA 73	ICA 193
Open Buds	10.25Aa	4.25Ba	1.75Ac	1.25Bc	4.25Bb	9.75Ab
Semi-open Buds	5.75Ab	4.50Ba	6.00Ab	0.50Bb	11.00Ba	13.50Aa
Closed Buds	4.50Ab	2.75Bb	7.50Aa	2.25Ba	10.75Ba	14.25Aa

****Means followed by the same lower letters in column and capital letters on the lines do not differ significantly by the Tukey test at 5%.***

ICA 193 presented a lower average number of inflorescences when compared to ICA 73 at all cut-off points; however, it also exhibited a lower number of close buds, indicating a greater uniformity of flower anthesis. At the cut-off point with open buds, exhibited the second highest value of inflorescences (4.25), according to lower flower buds values (1.25) and lower post-harvest durability of the stems (9.75), however, this useful life is already acceptable to the market (Table 5). For the cut-off point with semi-open buds, it presented the highest number of inflorescences (4.50), although it does not differ statistically from the previous treatment for this characteristic, smaller number of close buds (0.50) and second highest number of days of stem durability (13.50). Finally, at the cut-off point with closed buds, the lowest number of inflorescences (2.75) and the highest number of floral buds (2.25) were observed, evidencing the difficulty of developing the buds after cutting the stems, also presented the greatest number of days of durability of the stems (14.25), but did not differ statistically from the previous treatment for this characteristic.

According to [32], the most favorable cutting stage of the stems corresponds to the period in which 20% to 30% of the central florets opened, which is equivalent to the cut-off point denominated in this work as semi-open buds, allowing the others to open in the hands of the consumer, extending the useful life of the product. In agreement with this affirmation, it is observed that ICA 193 presented the best combination of factors for this cut-off point, presenting a higher number of inflorescences, lower number of close buds and greater post-harvest durability. The same observation can be raised for ICA 73, but with some reservations, such as the performance of a removal of the secondary and tertiary branches, improving the aesthetics of the product, since despite an adequate number of inflorescences and stem durability, it presented high number of close buds, or search for improvements of this characteristic through an improvement program.

The flowers produced by both genotypes showed a yellow color at the beginning of the anthesis, changing to orange shades soon after and presented a very attractive visual aspect, with abundant beauty while fresh and even after a period of drought, offering potential for introduction into the Brazilian flower market, contributing to the supply of news for the sector and the consumer (Figure 8a and 8b). According to [23], the characteristics of greater importance and influence on the ornamental value of safflower are attributed to the color of the flowers, where the oranges and yellows stand out, along with the weak spinescent margin of the leaves and bracts.

Figure 8. (A) Bouquet of stems after cutting; (B) Change the color of the flower.

The evaluated characteristics presented high estimates of the genetic parameters of heritability and ratio between the coefficients of genetic and experimental variation, a very favorable point in breeding programs, since it indicates in a general way that these characters can be easily improved through classic methods [33, 37] and provide favorable conditions for realization of selection, allowing to obtain high genetic gain within the first cycles [34, 38].

Considering the differences evidenced between the genotypes, together with the completeness they demonstrate for characteristics of ornamental interest, these genotypes suggest potential for inclusion in an improvement program, in order to obtain a material that groups the positive characteristics presented in both accesses. [35] point out that one of the criteria for success in crossbreeding depends on the divergence between the parents, parallel to the superior performance they present referring to the characteristics of interest of the breeder.

4. CONCLUSION

The accesses ICA 73 and ICA 193 have ornamental potential, coupled with the precocity, beauty and durability of their flowers. For plant vase, the best density for cultivation refers to one plant per vase, allowing better expression of the plants' ornamental potential. The harvest point with semi-open buds was the best for obtaining stems with greater post-harvest durability.

REFERENCES

1. Romero DHS, Restrepo IME. Local competitive profile as a determining factor for the development of floriculture in Madrid (Cundinamarca). Research and reflection. 2011; 19 (2): 25-43.

2. Hortiwise. A Study on the Kenyan-Dutch Horticultural Supply Chain. The Dutch Ministry of Economic Affairs, Agriculture & Innovation The Netherlands. 2012.

3. Mitsueda NC, Costa EV; D'oliveira PS. Environmental aspects of agribusiness flowers and ornamental plants. Magazine in Agribusiness and Environment. 2011; 4 (1): 9-20.

4. Ibraflor. Brazilian Institute of Floriculture. The flower market in Brazil. 2017. Accessed: 20 Dezember 2018. Avaliable: http://www.ibraflor.com/site/2017/11/04/florente-de-flores-vera-longuini/.

5. Junqueira AH, Peetz MS. The productive sector of flowers and ornamental plants of Brazil, from 2008 to 2013: updates, balance sheets and perspectives. Brazilian Journal of Ornamental Horticulture. 2014; 20 (2): 115-120.

6. Ibraflor. Brazilian Institute of Floriculture. Sector Numbers. 2014. Accessed: 28 November 2017. Avaliable: http://www.IBRAFLOR.com/ns_mer_interno.php.

7. Dantas CVS, Silva IB, Pereira GM, Maia JM, Lima JPMS, Macedo CEC. Influence of sanity and water deficit on seed germination of *Carthamus tinctorius* L. Brazilian Journal of Seeds. 2011; 33 (3): 574-582.

8. Santos RF, Silva MA. Carthamus tinctorius L.: An alternative crop for Brazil. Acta Iguazu. 2015; 4 (1): 26-35.

9. Zareie S, Mohammadi-Nejad G, Sardouie-Nasab S. Screening of Iranian safflower genotypes under water deficit and normal conditions using tolerance indices. Australian Journal of Crop Science. 2013; 7(7): 1032-1037.

10. Landau S, Friedman S, Brenner S, Bruckental I, Weinberg ZG, Ashbell G, Hen Y, Dvash L, Leshem Y. The value of safflower (*Carthamus tinctorius* L.) hay and silage grow under Mediterranean conditions as forage for dairy cattle. Livestock Production Science. 2004; 88: 263-271.

11. Asgarpanah J, Kazemivash N. Review: Phytochemistry, Pharmacology and Medicinal Properties of *Carthamus tinctorius* L. Chin J Integr Med. 2013; 19(2): 153-159.

12. Mündel, H. H.; Blackshaw, R. E.; Byers, J. R.; Huang, H. C.; Johnson, D. L.; Keon, R.; Kubik, J.; Mckenzie, R.; Otto, B.; Roth, B; Stanford, K. Safflower production on the Canadian

prairies: revisited in 2004. Agriculture and Agri-Food Canada. Lethbridge Research Centre: Lethbridge; 2004.

13. Pintão AM, Silva IF. The Truth About Saffron. In: Workshop medicinal and phytotherapeutic plants in the tropics. Lisbon. Summaries ... Lisbon: IICT / CCCM, 2008. Electronic Version.

14. Jadhav BA, Joshi AA. Extraction and Quantitative Estimation of Bio Active Component (Yellow and Red Carthamin) from Dried Safflower Petals. Indian Journal of Science and Technology. 2015; 8(16)1-5.

15. Uher, J. Safflower in European floriculture: a review. In: Proceedings of the 7th International Safflower Conference, Wagga Wagga, New South Wales, Australia. 2008.

16. Bradley VL, Guenthner RL, Johnson RC, Hannan R M. Evaluation of safflower germplasm for ornamental use. In: Perspectives on new crops and new uses (J. Janick, ed.). ASHS, Press: Alexandria. 1999. 433-435.

17. Oliveira GG. *Trichoderma* spp. plant growth and biocontrol of *Sclerotinia sclerotiorum* and pathogens in safflower seeds (*Carthamus tinctorius*). 2007. 79 p. Dissertation (Master in Plant Production), Federal University of Santa Maria, Santa Maria, 2007.

18. Zoz T. Correlation and analysis of yield traits in grains and their components and plant characteristics in safflower (*Carthamus tinctorius* L.) and castor bean (*Ricinus communis* L.). 2012. 54 p. Dissertation (Master's degree in Agronomy) Faculty of Agronomic Sciences-UNESP; 2012.

19. Maguire JD. Speed of germination aid in selection and evaluation for seedling emergence and vigor. Crop Science. 1962;2(2):176-77.

20. Stumpf ERT, Heiden G, Barbieri RL, Fischer SZ, Neitzke RS, Zanchet B, Grolli PR. Method for evaluating the ornamental potential of native and unconventional flowers and cut foliage. Brazilian Journal of Ornamental Horticulture. 2007; 13: 143-148.

21. Cruz CD. GENES - versão Windows. Viçosa- MG: Editora UFV; 2006.

22. Gonçalves MF, Melo AGC. Floristic analysis of ornamental plants implanted in Garça Forest / SP. Electronic Journal of Forest Engineering. 2013; 21 (1): 12-24.

23. Pahlavani MH, Mirlohi AF, Saeidi G. Inheritance of flower colour and spininess in safflower. Journal of Heredity. 2004; 95:265-267.

24. Emongor V. Safflower (*Carthamus Tinctorius* L,) the underutilized and neglected crop: A review. Asian Journal of Plant Science. 2010;9(6): 299-306.

25. Sakata. Sakata´s reliable seeds. Flower seed. Sakata seed corporation, Yokohama, Japan. 2010. 87 p.

26. Geneses Seeds Ltd. Catalog Flowers. Acessed: 20 November 2017. Avaliable: http://www.genesisseeds.com/PDFs/GENESIS_CATALOG_FLOWERS.pdf.

27. Morais ÉB, Castro ACR, Silva TF, Soares NS, Silva JP. Evaluation of potential use of native Anthurium foliage. Ornamental Horticulture. 2017; 23:07-14.

28. Coronado LM. El cultivo Del cártamo (*Carthamus tinctorius* L.) em México. Instituto nacional de investigacion esforestales, agrícolas y pecuárias. México, 2010.

29. Bellé RA, Rocha EK, Backes FAAL, Neuhaus M, Schwab NT. Safflower grown in different sowing dates and plant densities. Ciência Rural. 2012; 42(12).

30. Motos J, Oliveira MJG. Produção de crisântemos em vaso. Holambra, Flortec. 1998. 34 p.

31. Sampaio MC. Cultivo de cártamo (*Carthamus tinctorius* L.) sob variação de adubações, densidades e épocas de plantio. 2016. 63p. Dissertação (Mestrado em Engenharia de Energia na Agricultura), Universidade Federal do Oeste do Paraná, Cascavel, 2016.

32. Wien HC. Cut Flower Cultural Practice Studies and Variety Trials 2012. Dept. of Hort., Cornell Univ. Ithaca, 2012.

33. Fox GP, Bowman J, Kelly A, Inkerman A, Poulsen D, Henry R. Assessing for genetic and environmental effects on ruminant feed quality in barley (*Hordeum vulgare*). Euphytica. 2008; 163: 249-257.

34. Vencovsky R, Barriga P. Genética Biométrica no Fitomelhoramento. Ribeirão Preto: SBG; 1992.

35. Cruz CD, Carvalho SP, Vencovsky R. Estudos sobre divergência genética II. Eficiência da predição do comportamento de híbridos com base na divergência de progenitores. Revista Ceres.1994; 41(234):183-190.

36. Melo GG, Costa DS, Carvalho IDE, Guerra YL, Sanglard DA, Melo Filho PA. Safflower (*Carthamus tinctorius* L.) Characterization in the Pernambuco State Forest Middle Zone Journal of Experimental Agriculture International. 2018; 25(2): 1-11.

37. Mendes AQ, Menezes D, Carvalho IDE, Silva AMF, Alves AO, Felinto Filho EF, Lima LB, Melo GG. Estimate of General and Specific Combination Ability in Tomato for Production of Hybrids Resistant to Bacterial Wilt. Journal of Experimental Agriculture International. 2018; 24(6): xxx-xxx.

38. Mendes AQ, Menezes D, Carvalho IDE, Silva AMF, Alves AO, Felinto Filho EF, Lima LB, Melo GG. Identification of Lines of Tomato Resistant to Bacterial Wilt. Journal of Experimental Agriculture International. 2018; 24(6): 1-10.