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Pollinator activity on the flowers of safflower *Carthamus tinctorius* and its effect on some qualitative and quantitative parameters of the plant in Sohag Governorate, Egypt

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Abstract

Safflower, *Carthamus tinctorius* L., has been cultivated for its seeds. Pollinators can affect the seed yield, so the current studies were conducted at the Research Farm of Agricultural Research Center at Shandaweel, Sohag Governorate, for two successive growing seasons, 2021/2022 and 2022/2023, to study the role of pollinators on the productivity of three varieties of safflower, (Giza 1, Kharga 1, and L. Assad 1). The results indicate the presence of 9 species of arthropods belonging to 5 families and 3 orders. In both seasons, *Apis mellifera* L. was detected during the last week of February. The population increased gradually and reached its peak, which recorded (6.0, 4.3, and 2.7) and (5.7, 3.3, and 2.0) individuals/m2/5min. for the cultivars, Giza1, Kharga1, and L. Assad 1, respectively, on the 1st week of March. Statistically, significant differences were found among tested safflower varieties, either open pollination or control pollination plants, for all quantitative and qualitative safflower yield parameters over two years. The pollinators of uncaged plants significantly increased the measured parameters than caged plants for all studied traits, except Oil % during both seasons. The highest oil% in our study was obtained from L. Assad 1, (19.84 and 20.21%). While the lowest oil content was determined as (18.04 and 19.03%) in the Giza 1 variety, at both seasons, respectively. L. Assad 1 is a promising line and can be used for large-scale production of edible oil.

Introduction

The discovery of safflower seeds in Egyptian tombs dates back to 4,000 years, and their use was first mentioned in China around 2,200 years. Its flowers are a source of dyes for coloring food and fibers. Also, it is cultivated for use in food, animal protein, bird feed, medicinal purposes, and for the creation of plant-based pharmaceuticals, biofuels, and distinctive oils. Its oil contains approximately 78% of the total fatty acids, making it the most abundant source of linoleic acid in commercial oils (Velasco *et al.*, 2005). It is now

mostly cultivated for the production of vegetable oil (Kumari and Pandey, 2005).

Safflower (*Carthamus tinctorius* L.) is an annual oilseed crop that belongs to the family Asteraceae (Vafaie *et al.*, 2013). Its flowers are typically brilliant orange, yellow or red, or more rarely white. Each plant produces 3-50 or more flowering heads, each head normally contains between 20 and 180 individual florets (GRDC, 2010).

About 75% of the world's most important plant species depend on pollinators for their fruits and seeds, and they contribute 35% of the global food volume and play a key role in providing essential nutrients for human livelihoods (Klein *et al.,* 2007). Entomophilous crops such as oil seeds, fruits, fibers, condiments, spices, and vegetables are the main categories that insect pollination directly benefits in terms of increasing seed production and improving breeding systems (Khalifa *et al.,* 2021).

Safflower is primarily self-pollinating, and cross-pollination rates vary between lines. Australian commercial varieties are largely self-pollinating with cross-pollination rates of less than 10% (Nabloussi *et al.,* 2013). Outcrossing rates and seed sets can be increased by insect pollinators (Li and Mündel, 1996, and GRDC, 2010). Honeybees, bumblebees, beetles, and other insects can increase the level of cross-pollination (Emongor, 2010).

Therefore, the present study aimed to survey safflower insect pollinators and study the population dynamics of dominant pollinators throughout the flowering period. Also, to study the role of pollinators on the productivity of three varieties of safflower (Giza1, Kharega1, and L. Assad 1).

Materials and methods

The current studies were conducted at the Research Farm of the Agricultural Research Center at Shandaweel, Sohag Governorate, for two successive growing seasons, 2021/2022 and 2022/2023. Approximately 1/4 feddan was assigned to various experiments conducted in the current study. The experiment area was sown with three cultivars of safflower (Giza1, Kharga1, and L. Assad 1) with 3 replicates in (RCBD). Normal agricultural practices were performed, and no insecticidal treatments were used during the whole study period. Safflower seeds were hand-planted at a depth of 3 to 5 cm with a spacing of 0.50 m and distance of 0.10 m in each row; thinned was one plant / hill. The varieties of safflower seeds were planted on 12th and 17th November during two successive agricultural seasons, winter 2021/2022 and 2022/2023, respectively.

1. Survey of insects visited safflower flowers:

The survey was carried out at an area of about half feddan cultivated with a safflower variety (Giza1). Weekly samples were collected from the field by using two sampling methods (i.e., direct count, sweep net). Samples were initiated from the last week of February and continued till the 1st week of April during both safflower growing seasons. Each collected sample was emptied into the collecting muslin bag and transferred to the laboratory. Specimens were examined under a stereomicroscope whenever it is needed. Unknown insect specimens were identified by the Taxonomic Dept. Plant Protection Research Institute, Agricultural Research Center (Giza, Egypt).

2. Population dynamics of the dominant insects visit safflower flowers:

During the flowering season, A wooden frame of 1 m^2 area was used,

and insects visiting safflower flowers in each square meter area for five minutes for each replicate were counted weekly to the end of flowering (Amro, 2021).

3. Effects of insect pollination on safflower yield:

Before flowering began, 20 sunflower plants were caged by insect screens to prevent pollinators' access to inflorescences, and 20 uncaged plants were marked for each plot. Plants were harvested at the end of the fruiting period. The increase in seed weight as a result of insect pollination was calculated from the following equation:

$$\textbf{Seed weight-increase (\%)} = \frac{Wuncagged - Wcagged}{Wuncagged} \text{X}100$$

4. Safflower quantitative and qualitative parameters:

Ten plants were randomly taken from the two central rows of each plot at harvest to measure the following characters: plant height (cm), number of branches/plants, seed yield/plant (g), seed index (100-seed weight g). The seed oil percentage was determined according to AOAC (1980). Seed yield (kg/fad) was determined by weighing the produced seeds from each plot.

5. Statistical analyses:

Data obtained from each season of the study were statistically analyzed according to Duncan's multiple range test (Snedecor, 1956) and the OPSTAT-C computer program (Sheoran *et al.*, 1998). The differences among treatment means were compared with Least Significant Differences test (LSD) at 0.05 level of probability (Steel and Torrie, 1980).

Results and discussion

1. A survey of the insects that visit safflower flowers:

The primary objective of the current survey is to determine the insect species composition visit safflower flowers at Sohag Governorate. A partial taxonomic list of insects, pollinators, and visitors collected by sweep net and direct count methods from safflower flowers at the Research Farm of the Agricultural Research Center at Shandaweel, Sohag Governorate, during the flowering period of the 2021/2022 and 2022/2023 seasons is presented in Table (1). Results indicate the presence of 9 species of arthropods belonging to 5 families under 3 orders. The identified insect species were classified as insect gathering pollen (P.), gathering nectar (N.), predator (Pre.), and phytophagous (Phyto.) insects.

As shown in Table (1), order hymenoptera was presented by honeybees (*Apis mellifera* L.), carpenter bees (*Xylocopa pubescens* Spinola), and small gorse mining bees (*Andrena ovatula* Kirby). However, the order Diptera is presented by hover fly (*Syrphus corollae* F. and *Sphaerophoria scripta* L.), common house fly (*Muca domestica* L.), little house fly (*Fannia canicularis* L.), and caliptrate fly (*Fannia incisurata* Z). On the other hand, order Lepidoptera was presented by one species, the cabbage white butterfly (*Pieris rapae* L.).

` These data were partially in agreement with those of Khalil *et al.* (1986) in Egypt, who observed 19 insect species of pollinators belonging to five orders (Lepidotera, Coleoptera, Hemiptera, Diptera, and Hymenoptera) on safflower. Pandey and Kumari (2008), Shao *et al.* (2012), and Ozenirler and Sorkun (2018) decided that the safflower plant is a huge nectar and pollen source for many insect orders, such as Hymenoptera, Diptera, Lepidoptera, Odonatan, and Coleoptera, and with Ozenirler and Sorkun (2018) who found that 95% of the insect visitors were recorded as Hymenoptera.

Also, these data were partially in agreement with those of Kumar and

Singh (2008), who reported that *A. mellifera* was the predominant one, followed by *A. cerana* indica F., *A. dorsata* F., and *A. florae* in Bihar. Navatha *et al.* (2015) recorded 20 insect species belonging to 11 families of six orders of safflower. Also, Matre *et al.* (2017) recorded 19 species of pollinators on safflower; 8 species belong to the order Hymenoptera, 4 species belong to Diptera, 5 species belong to Lepidoptera, and 2 species belong to Coleoptera. Among the total pollinators, *A. florae* was the predominant pollinator and constituted 34.40 percent followed by *Trigona* spp. which constituted 62 percent, and *A. mellifera* constituted 23.55 percent.

Table (1): A partial taxonomic list of insects collected from safflower plants during (2021/22 and 2022/23) growing seasons.

Order	Family	Common name	Scientific name	Foraging Purpose
Hymenoptera	**Apidae**	Honeybees	*Apis mellifera* L.	N. and P.
		Carpenter bee	*Xylocopa pubescens* Sp.	N. and P.
	Andrenidae	Small gorse mining bee	*Andrena ovatula* K.	N. and P.
Diptera	**Syrphidae**	Hover fly	*Syrphus corollae* F.	N. and Pre.
			Sphaerophoria scripta L.	N. and Pre.
	Muscidae	Common house fly	*Musca domestica* L.	N.
		Little house fly	*Fannia canicularis* L.	N.
		Caliptrate fly	*Fannia incisurata* Z	N.
Lepidoptera	**Pieridae**	cabbage white butterfly	*Pieris rapae* L.	N. and Phyto.

N. = Insects feed on a nectar.
P. = Insects gathering pollen.
Pre. = Predator, insects or one of their stage's feeds on other insects.
Phyto. = Phytophagous, insects feeding on plants or plant material.

2. Population dynamics of the dominant insects visit safflower flowers:

While observing the plants, honeybees were the dominant insects that visit safflower flowers throughout the flowering season. Data in Figures 1 and 2 illustrated the population densities of *A. mellifera* during the two successive safflower growing seasons (2021/2022 and 2022/2023). In both seasons, *A. mellifera* L. was detected during the last week of February. The population increased gradually and reached its peak on 7th March on the three safflower cultivars. Giza1, Kharga1, and L. Assad 1 recorded 6.0, 4.3, and 2.7 bees/ 1 m^2/ 5 min., respectively, in the first season and 5.7, 3.3, and 2.0 bees/ 1 m^2/ 5 min., respectively, in the second season. Cultivars L. Assad 1 and Giza 1 recorded additional peaks on 21st March in 2021/2022 and 2022/2023, respectively, with mean numbers of 2.0 and 3.0 bees/ 1 m^2/ 5 min., respectively. After that, the number of honeybees decreased gradually to the end of the flowering season.

These data were in partial agreement with those of Kumari and Pandey (2005), who found that the flowering period extended from the mid of February to the 2nd week of April; during this period the population of pollinators varied remarkably. Diptera spp. were the most active towards the end of the flowering period, and some of them are highly active during early flowering in February. *Apis iniiica* and *Apis dorsata* were more active when the maximum number of plants were in bloom (only in the middle of the flowering span), while *Apis mellifera*

was active during the whole period of flowering. Only certain Lepidoptera spp. Butterflies are active during the middle period of the flowering span. Towards the end of the flowering span, bees' population was drastically reduced and replaced by flies like *Dacus cucurbitae*, and Ozenirler and Sorkun (2018) found that the bee activities on the safflower plant started early in the day and new flowers were more preferred.

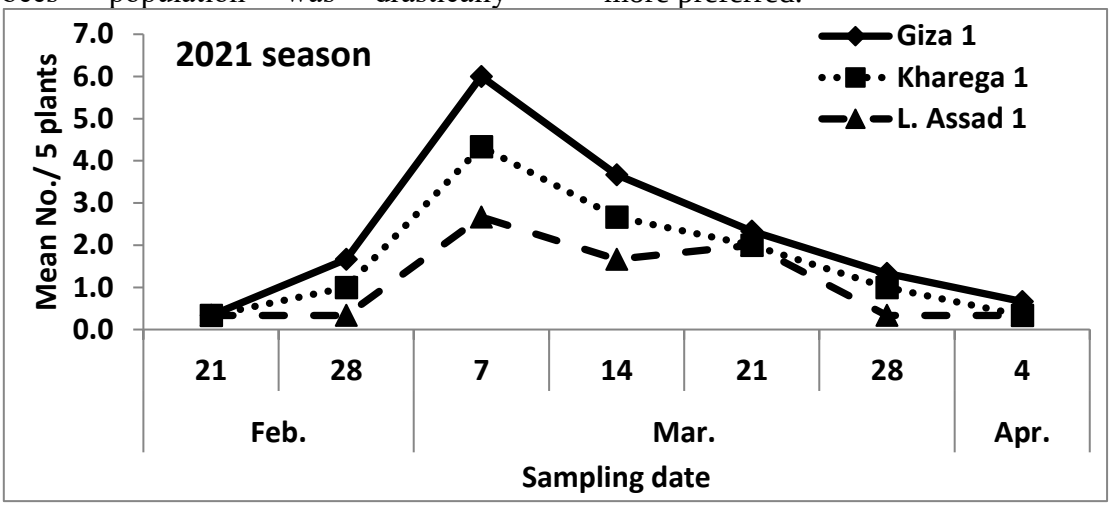

Figure (1): Population dynamics of honeybees, *Apis mellifera* visited the flowers of safflower cultivars during the 2021/2022 season.

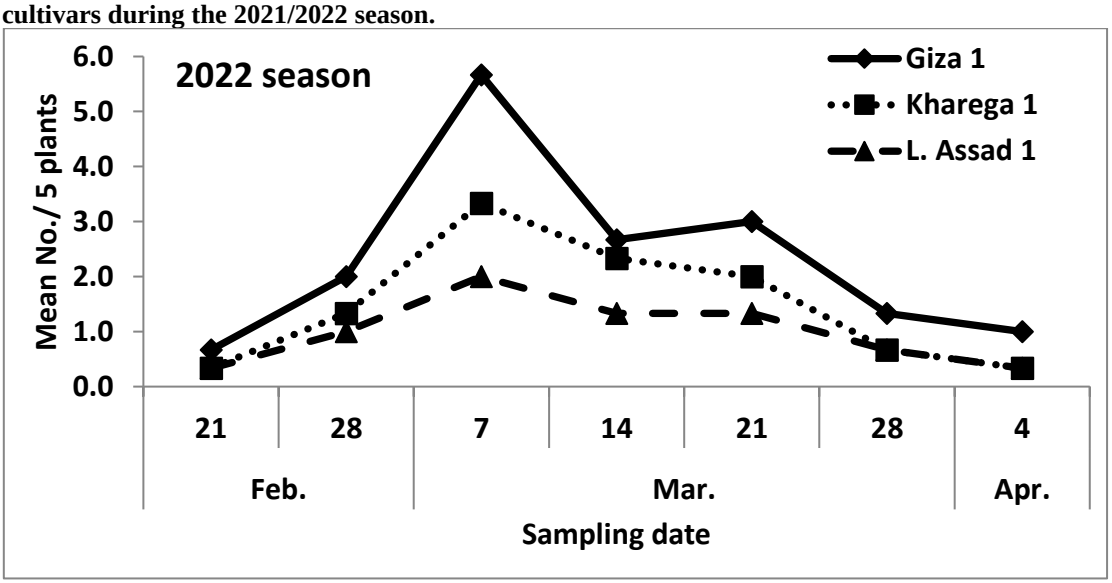

Figure (2): Population dynamics of honeybees, *Apis mellifera* visited the flowers of safflower cultivars during the 2022/2023 season.

Data indicated that the differences between the three tested safflower cultivars were significant in both seasons (Figure 3). The most attractive one was Giza 1, with an average number of 2.29 and 2.33 bees/ 1 m^2/ 5 min. in the 2021/2022 and 2022/2023 seasons, respectively. Cultivar Kharega1 came next by average number of 1.67 and 2.05 bees/ 1 m^2/ 5 min. in 2021/2022 and 2022/2023 seasons, respectively. The least attractive cultivar was L. Assad 1, with an average number of 1.10 and 1.67 bees/m^2/5 min. in the 2021/2022 and 2022/2023 seasons, respectively, with an insignificant difference with Kharega 1 in the second season.

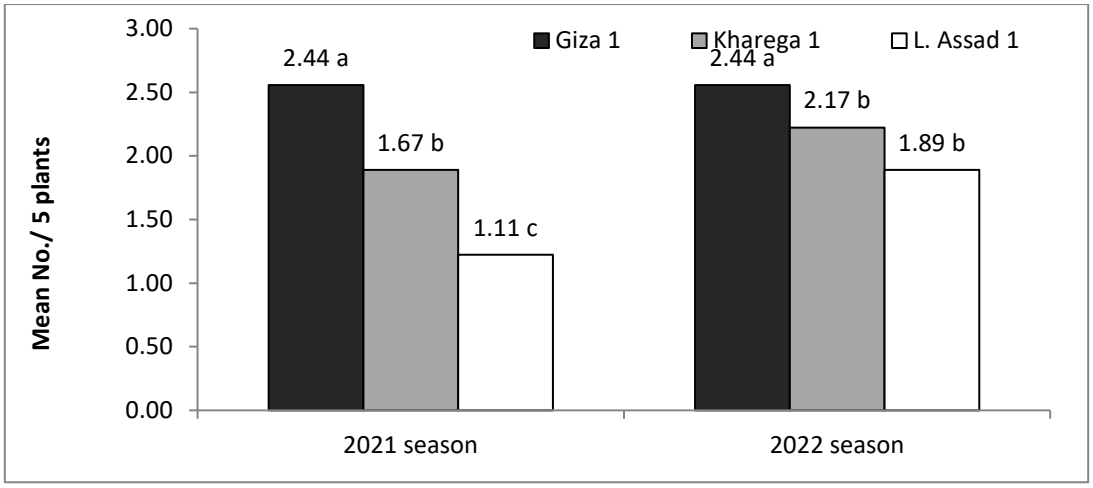

Figure (3): Mean No. of *Apis mellifera* visited the flowers of safflower cultivars during the 2021\2022 and 2022/2023 seasons.

3. Effect of pollinators on some qualitative and quantitative parameters safflower:

According to the results of the analysis of variance (Table 2), the field experiments indicated statistically significant differences among tested safflower cultivars, either uncaged or caged plants, for all quantitative and qualitative yield parameters over two years because the high densities of pollinators, except the oil% trait in the second season, were not significant. However, varieties X different pollination methods interactions were insignificance differences between the two growing seasons in uncaged and caged cases on all studied traits, similar trends were obtained by Pandey and Kumari (2008) and Ali *et al.* (2011). Safflower enhanced the quantity and quality of safflower yield compared to non-pollinated plants. Although safflower is a self-pollinating crop, it does not produce large numbers of mature heads in the absence of insect pollination.

Table (2): Analysis of variance of safflower varieties, different treatments pollination in two growing seasons of 2021/2022 and 2022/2023.

Source of Variance	D.f	M.S.					
		Plant height (cm)	Number of branches / Plant	Seed yield / plant (g)	Seed yield /plot (g)	100 seed weight (g)	Oil (%)
2021/2022							
Reps	**2**	8.67	1.28	3.40	23.43	0.03	0.04
Varieties (A)	**2**	1098.67**	42.62**	321.27**	1395931.3**	2.69**	4.98**
Pollination(B)	**1**	747.56**	16.25**	634.87**	598241.18**	9.55**	0.76**
Inter (A X B)	**2**	46.89	0.19	3.25	608.90	0.01	0.01
Error	**10**	19.40	0.63	3.22	3748.32	0.02	0.10
SE (m)		1.80	0.32	0.73	25.00	0.05	0.13
2022/2023							
Reps	**2**	117.72	0.14	9.71	17.57	0.11	0.18
Varieties (A)	**2**	1268.39**	39.03**	370.48**	1765499.8**	2.14**	2.50**
Pollination(B)	**1**	490.90**	39.03**	699.63**	649215.87**	4.94**	0.43
Inter (A X B)	**2**	2.06	0.04	1.70	2728.88	0.16	0.01
Error	**10**	8.12	0.62	4.38	3721.44	0.08	0.27
SE (m)		1.16	0.32	0.85	24.91	0.11	0.21

The obtained results showed that all studied traits were significantly different among three safflower cultivars at the two seasons (Table 3). The variety Kharega 1 registered the highest plant height (182.00 and 172.83 cm), seed yield/plant (43.93 and 41.16 g), seed yield/plot (1433.95 and 1548.42 g), and 100 seed weights (4.91 and 4.80 g), while the number of branches/plants was (13.75 and 11.50), oil % (18.69 and 20.07%) at both seasons respectively. Whereas, L. Assad 1, second place in the ranking, had the lowest only plant height (155.33 and 144.50 cm), but highest in the traits number of branches/plant (14.30 and 16.50), 100 seed weight (5.11 and 4.88 g), oil% (19.84 and 20.21%), while seed yield/plant (34.38 and 30.21 g), seed yield/plot (1114.83 and 1004.32 g) were moderated at the two seasons respectively. Lastly, Giza 1 recorded the moderated value of plant height (164.67 and 164.33 cm), number of branches/plant (9.43 and 13.11), but the lowest value of seed yield/plant (29.55 and 25.93 g), seed yield/plot (485.98 and 463.52 g), 100 seed weight (3.86 and 3.81 g), oil% (18.04 and 19.03%) at both seasons (2021/2022 and 2022/2023), respectively. The present findings are also similar to the findings of Rubis *et al.* (1966) and Thakur and Rana (2008) showed the highest percentage of pollination occurs in hand pollination (75.68%), followed by honeybee pollination (74.16%), and open pollination (62.09%). To ensure variety production in Egypt is protected in the future, farmers should consider incorporating insect pollination into crop management.

Table (3): Mean values of plant height (cm), number of branches/plants, seed yield/plant (g), seed yield/plot (g), 100 seed weight (g) and oil content (%) on three safflower varieties under two different treatments pollination for two seasons growth 2021/2022 and 2022/2023.

Traits genotypes (Varieties)	Plant height (cm)	Number of branches / Plant	Seed yield / plant (g)	Seed yield /plot (g)	100 seed weight (g)	Oil (%)
2021/2022						
Giza 1	164.67 b	9.43 b	29.55 c	485.98 c	3.86 b	18.04 c
Kharega 1	182.00 a	13.75 a	43.93 a	1433.95 a	4.91 a	18.69 b
L. Assad 1	155.33 c	14.30 a	34.38 b	1114.83 b	5.11 a	19.84 a
CD	5.74	1.03	2.34	79.78	0.16	0.40
2022/2023						
Giza 1	164.33 b	13.11 b	25.93 c	463.52 c	3.81 b	19.03 b
Kharega 1	172.83 a	11.50 c	41.16 a	1548.42 a	4.80 a	20.07 a
L. Assad 1	144.50 c	16.50 a	30.21 b	1004.32 b	4.88 a	20.21 a
CD	3.71	1.03	2.73	79.49	0.36	0.67

Means designed by the same letter at each cell are not significant at the 5% level.

The effect of pollination on various yield parameters under different treatments, viz., open pollination (OP) and control pollination (CP, pollinator exclusion), were quantified in two seasons (Table 4). The CP treatment negatively impacted crop yield variables in all the target varieties contrary to the OP, except oil% trait. The results revealed that maximum values were obtained in open pollination (Uncaged) for traits plant height (173.78 and 165.78 cm), number of branches/plant (13.44 and 14.71), seed yield/plant (41.89 and 38.67 g), seed yield/plot (1193.89 and 1195.33 g), 100 seed weight (5.36 and 5.02 g), oil% (19.06 and 19.92 %) at both seasons, respectively.

Whereas, minimum no. of value was obtained in pollinator exclusion for traits plant height (160.89 and 155.33 cm), number of branches/ plant (11.54 and 12.70), seed yield/plant (30.01 and 26.20 g), seed yield/plot (829.28 and 815.50 g), 100 seed weight (3.90 and

3.97 g), oil% (18.65 and 19.62%) at the two seasons 2021/2022 and 2022/2023, respectively, agreed with Kumari and Pandey (2005).

Generally, the pollinators of uncaged plants significantly increased the measured parameters than caged plants for all studied traits, except oil% during both seasons. This is mainly due to higher pollinator density in the OP and supplementation of the other pollination methods. Various results agree with Choudhary (1993) and Steffan-Dewenter (2003).

Total yield and yield attributes of safflower increased by (2.72 vs. 6.30 cm) for plant height, (14.14 vs.13.66) number of branches/plants, (28.36 vs.32.25 g) seed yield/plant, (30.54 vs. 31.78 g) seed yield /plot (27.24 vs. 20.92 g) 100 seed weight, (2.15 vs. 1.51%) and the oil% at both seasons, respectively, in OP than the CP also partially agreement in with Amro (2021).

Table (4): Effect of pollinators on safflower yield and its attributes in 2021\2022 and 2022\2023 seasons.

Traits treatment	Plant height (cm)	Number of branches / Plant	Seed yield / plant (g)	Seed yield /plot (g)	100 seed weight (g)	Oil (%)
2021/2022						
Open pollination	173.78 a	13.44 a	41.89 a	1193.89 a	5.36 a	19.06 a
Control pollination	160.89 b	11.54 b	30.01 b	829.28 b	3.90 b	18.65 a
Average Increase%	2.72 ±3.6	14.14 ±0.6	28.36 ±1.5	30.54 ±50.0	27.24 ±0.1	2.15 ±0.3
2022/2023						
Open pollination	165.78 a	14.71 a	38.67 a	1195.33 a	5.02 a	19.92 a
Control pollination	155.33 b	12.70 b	26.20 b	815.50 b	3.97 b	19.62 a
Average Increase%	6.30 ±2.3	13.66 ±0.6	32.25 ±1.7	31.78 ±49.8	20.92 ±0.2	1.51 ±0.4

Means within the same safflower variety with the same letters were insignificantly different between the pollination treatments.

Generally, no significant differences between the two seasons were found for the average increase percentage of all studied traits, except 100 seed weight only in the first season, plant height, and seed yield/plant in the second two. The effect of the interaction between three safflower varieties, insect pollinators, and two seasons on yield and yield attributes is presented in (Table 5).

Significant differences between parameters of the (O.P.) uncaged plants and the (C.P.) caged plants for the three safflower varieties in the two seasons 2021/2022 and 2022/2023. Kharega 1 was superior under O. P. in all traits, **viz,** plant height (186.67 and 178.67 cm), seed yield/plant (50.67 and 47.33 g), seed yield/plot (1621.67 and 1744.67 g), 100 seed weight (5.67 and 5.27 g), except the number of branches (14.87 and 12.60) and oil% (18.89 and 20.25%) were lower at both seasons respectively. Followed by L. Assad 1, had the highest in the traits number of branches/plant (15.27 and 17.47), 100 seed weight (5.82 and 5.27 g), and came in the first ranked oil% (20.06 and 20.36%), seed yield/plant (39.67 and 37.00 g), seed yield/plot (1303.33 and 1211.67 g), but the lowest only plant height (160.33 and 149.67 cm) at the two seasons, respectively. Considered,

Giza1 arrangement in ranked three, number of branches/ plant (10.20 and 14.07), seed yield/plant (35.33 and 31.67 g), seed yield/plot (656.67 and 629.67 g), 100 seed weight (4.58 and 4.51 g), oil% (18.23 and 19.15%) except the plant height recorded (174.33 and 169.00cm), which got arranged ranked two at both seasons (2021/2022 and 2022/2023), respectively , in agreement with Classen (1950) and Shubham *et al.* (2020).

Table (5): Pollination impact on some qualitative and quantitative parameters of tested three safflower varieties in Shandaweel region, Upper Egypt during two growing seasons of 2021/2022 and 2022/2023.

Genotypes (Varieties)	Traits	Plant height (cm)	Number of branches / Plant	Seed yield / plant (g)	Seed yield /plot (g)	100 seed weight (g)	Oil (%)
2021/2022							
Giza 1	**O.P**	174.33 b	10.20 c	35.33 c	656.67 e	4.58 b	18.23 d
	C.P	155.00 d	8.67 d	23.76 e	315.29 f	3.15 e	17.85 e
Kharega 1	**O.P**	186.67 a	14.87 a	50.67 a	1621.67 a	5.67 a	18.89 c
	C.P	177.33 b	12.63 b	37.19 c	1246.22 c	4.15 d	18.49 d
L. Assad 1	**O.P**	160.33 c	15.27 a	39.67 b	1303.33 b	5.82 a	20.06 a
	C.P	150.33 d	13.33 b	29.08 d	926.3 d	4.40 c	19.62 b
2022/2023							
Giza 1	**O.P**	169.00 b	14.07 c	31.67 c	629.67 e	4.51 b	19.15 b
	C.P	159.67 c	12.17 d	20.19 e	297.38 f	3.10 c	18.90 b
Kharega 1	**O.P**	178.67 a	12.60 d	47.33 a	1744.67 a	5.27 a	20.25 a
	C.P	167.00 b	10.38 e	35.00 b	1352.17 b	4.32 b	19.88 a
L. Assad 1	**O.P**	149.67 d	17.47 a	37.00 b	1211.67 c	5.27 a	20.36 a
	C.P	139.33 e	15.52 b	23.41 d	796.97 d	4.50 b	20.06 a

The Same letters in a column are not significantly different at the 0.05 probability levels.
O.P and C.P are equal: Open pollination (Uncaged) and Control pollination (Caged plant).

On the other hand, Kharega1 was also moderate in qualitative and quantitative parameters as compared to L. Assad 1 or Giza 1 under control pollination (caged plant) in both seasons which showed that (177.33 and 167.00 cm) plant height, (12.63 and 10.38) number of branches/plant, (37.19 and 35.00 g) seed yield/ plant, (1246.22 and 1352.17 g) seed yield/plot, (4.15 and 4.32 g) 100 seed weight, (18.49 and 19.88 %) oil% at the two seasons respectively. While L. Assad 1 showed superiority in number of branches/plants (13.33 and 15.52), (4.40 and 4.50 g) 100 seed weight and (19.62 and 20.06%) oil%. Finally, Giza 1 recorded the lowest value in the two seasons. In the same line Angadi *et al.* (2003), as the most important yield component in rapeseed canola production and increases with the number of primary and secondary branches. These results agree with Boch (1961). Insects, particularly honeybees, visit the safflower and assist in

pollination, and that effectively increases seed yields.

It is important to increase the cultivation area of safflower varieties to maximize edible oil production to meet the growing demand in Egypt. Therefore, the agricultural sector must focus on conserving pollinating insects and their impact due to the decreased abundance of pollinators throughout the world. This study showed that open-pollinated safflower had significantly higher yields than control pollinated (covered) safflower. The pollinators of uncaged plants significantly increased the measured parameters than caged plants for all studied traits, except oil % during both seasons.

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