Current Science International
Volume: 13 | Issue: 03| July – Sept.| 2024

EISSN:2706-7920 ISSN: 2077-4435
DOI: 10.36632/csi/2024.13.3.24
Journal homepage: www.curresweb.com
Pages: 294-304

The Effect of Different Methods and Quantities of Pollination on the Infestation Percentage by two of Early Date Fruit Insect Pests in Date Palm Farms in New Valley Governorate, Egypt

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Received: 20 May 2024 **Accepted:** 25 June 2024 **Published:** 10 July 2024

ABSTRACT

The primary cash crop in the Egyptian Oases is date palm, and insect pest infestations are a limiting factor in date production. current research concentrated on the Siwi date palm cultivar, which has a significant economic influence in El Kharga Oasis in the New Valley governorate of Egypt. There were two years of field trials to investigate the effects of the amount of pollen grain used in three pollination techniques (hand pollination with fresh pollen strands, spraying pollen grains suspension (pollens/L water) and dusting of (pollens+starch) on the infestation % with two early date palm pests,the greater date moth, *Aphomia (Arenipses) sabella* (Hampson) and the lesser date moth, *Batrachedra amydraula* (Meyrick) and also its effect on initial fruit set and fruit retention (%) of date fruits. Obtained results indicated that the infestation of date fruits by the two tested insect pests increase by the increase of whether the number of pollen strands, the amount of pollen grains, and the percentage of pollen grains during date palm pollination by the three tested methods. Regarding the effect of different ways of date palm pollination on the initial fruit set and fruit retention (%) of date fruits, the results indicated that there was no clear trend in the results. It is possible to recommend the use of the three treatments for pollination methods: hand pollination with 7 fresh pollen strands, spraying pollen grains suspension (2.5 g pollens/L water) and dusting of 2.5g pollens + 10g starch (1:4), because they led to a low infestation % by the two tested insects, and at the same time to a high percentage of initial fruit set and fruit retention. It reduces the amount of pollen required and reduces the cost of providing it, especially since the number of female palms is increasing and the need for large quantities of pollen to pollinate females.

Keywords: Date palm, pollination methods, fruit set, fruit retention, *Aphomia (Arenipses) sabella* and *Batrachedra amydraula*.

1. Introduction

One of Egypt's most profitable fruit crops is the date palm, or *Phoenix dactylifera* (Linn.), whose fruits are considered to be a balanced diet and whose various parts are used by the villagers in a variety of handcrafts (El-Lakwah *et al.* 2011; El-Shafei 2011; Zinhoum and El-Shafei 2019; Abd El-Wahab *et al.* 2020; El-Shafei *et al.* 2022). The New Valley Governorate is considered one of the most important Egyptian governorates for producing dates, as it represent one-third of the area of Egypt, and the number of palm trees in it is about 4 million palm trees. Date palm trees yield can significantly decrease as a result of infestations with different insect pests, both in terms of quantity and quality (El-Shafei *et al.* 2019; Assous *et al.* 2022; Mahmoud *et al.* 2022 and El-Shafei and Attia

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2023). The roots, trunk, fronds, and fruits of palm tree are among the several areas that these pests attack (El-Shafei 2015 ; El-Shafei *et al.* 2018 ; El-Shafei 2020).Both *Aphomia (Arenipses) sabella* (Hampson) (Lepidoptera:Pyralidae) and *Batrachedra amydraula* (Meyrick) (Lepidoptera: Batrachedridae)are considered among the most important economic insects that infest date palm fruits in the early stages of fruit growth and lead to a huge loss in the main crop as a result of their infestation(El-Shafei 2018). According to Gameel (2017), *A. sabella* and *B. amydraula* are regarded as early date palm pests in the New Valley region of Egypt. It was mentioned that in mid-January, various *A. sabella* larval instars were seen in the frond bases at full activity. The date palm males' unopened spadix revealed the earliest infestation during the final week of January. More than 80% of the date palms under inspection had the pest infestation. The clipped bunch bases generally had an average of roughly 10%. (This symptom indicates the agricultural loss for the Siwi cultivar in the El-Kharga Oasis in terms of economic loss). In El-Dakhla Oasis, the direct date fruit losses varied from (25%) on Siwi cultivar (Semi dry date) to (45%) on Tamr El Wady (Dray date). Young larvae are first observed consuming the tops of unopened spathes in March, marking the beginning of harm. The larvae enter when the spathes open, and they have the ability to remove entire strands of flowers and early fruits. Their grazing is identified by a rough silken tunnel that, when the larva is fully grown, may be 3.5 cm long and is covered in bits of grass and plant (Wiltshire, 1957 and Hussain, 1963).

In reference to the lesser date moth, which infest date fruits and causes severe harm to them and lowering the crop's yield. Its harm is summed up in, the fruit eventually dries and drops as a result of the larvae's deep tunneling into the fruit. The simple way to identify an infestation is to see it turn brown and stay bound to the fruit stalks by a silken thread. Infestation may result in a higher than 40% loss of fruits. (Saleh, 1974; Venezian and Blumberg, 1982; Temerak *et al.,* 2007; Kinawy, 2012; Gameel *et al.,* 2014 and Sayed *et al.*, 2014).

The date palm sector suffers from many problems that limit the quantity and quality of production due to the lack of optimal agricultural operations. Therefore, the efficiency of agricultural operations conducted on palm trees must be developed and increased repeatedly annually, which in turn leads to obtaining high production in quantity and quality. Pollination is considered one of the most important processes that must be paid attention to and developed, as it is the main reason for the presence of fruits (Ream and Furr, 1970; Shaheen, 1986; Gasim, 1993 and Kotb,1993). According to Nixon (1951) and Ream and Furr (1970). Hand pollination is the common and conventional method of producing dates and is required for fruit establishment and fruiting. The male strands are inserted into the female flower cluster to carry out the process (Dawson, 1956; Ahmed, 1959; Goor, 1967; Sial, 1980; Kataab, 1985 and Hamood *et al.,* 1986). The suggested technique for traditional pollination uses seven strands/spathe (Ahmed *et al.,* 2016).

Because of not all farmers follow the same recommendation, they may increase or decrease the number of strands per spathe, and also the appearance of many other methods of pollination and the spread of infestation with the two insects mentioned above. The aim of this research was to study the effect of different methods and quantities of pollination on the date fruits infestation % by *A. sabella* and *B. amydraula* as well as their effect on initial fruit set and fruit retention (%) of Siwi cultivar during 2022 and 2023.

2. Materials and Methods

2.1. The location of the Experiments

Field This experiment was carried out on a date palm farm located in (25°27'39"N 30°32'01"E) El-Kharga Oasis in the New Valley Governorate in Egypt. The planted palm trees were of the Siwi cultivar belonging to the group of semi-dry cultivar, and were 20 years old during two consecutive seasons 2022 and 2023. A selection of twenty-seven date palms in good physical condition and with consistent vigor were made. For this aim, the extra earliest, latest, and smallest spathes were removed, bringing the total number of spathes per palm down to ten. All twenty-seven palm trees selected for the experiment were subjected to the common agricultural processes applied on the farm, except the pollination process, and the ratio of shoots/leaf in each palm was set to be (1:6) bunch: leaves according to Ahmed (2002). The experiment was designed for complete randomized block design with three replications, so that 9 treatments were evaluated on the selected palm trees, with three palm trees (replicates) for each treatment.

2.2. Different treatments of the pollination process

Hand pollination with 7 fresh pollens strands (recommended).
Hand pollination with 21 fresh pollens strands.
Hand pollination with 42 fresh pollens strands.
Spraying pollen grains suspension 2.5 g pollens/L water (recommended).
Spraying pollen grains suspension 7.5 g pollens/L water.
Spraying pollen grains suspension (15 g pollens/L water.
Dusting of 2.5g Pollen+10g starch (1:4) recommended.
Dusting of 2.5g Pollen+5 g starch (1:2).
Dusting of 2.5g Pollen without starch.

2.3. Source and vitality of pollen used in experiments

All of the tested palms were using the same pollen source in order to prevent meta-xenia (Al-Tahir and Asif, 1983 and Hussein *et al.,* 1985).

Using acetocarmine staining, the vitality of the pollen grains was assessed prior to pollination. One drop of acetocarmine (1.0%) was distributed. According to Moreira and Gurgel (1941) and Furr and Enriquez (1966), pollens were tiny and any analyzed colorless or unstained pollen grains were declared non-viable. Three days after the female spathe cracked, the three pollination methods treatments were performed.One palm was used for each of the three replications of each treatment.With three replications, the experiment was set up using a complete randomized block design.

2.4. Time and manner of inspection

From the middle of April until the beginning of July, inspection times were held every two weeks. Each palm had ten randomly placed fruit strands marked on it. Fruit retention, initial fruit sit, naturally fallen fruits, and infested fruits with both greater and fewer date moths were all analyzed in each strand (El-Salhy *et al*., 2010; Ahmed, 2014 and Sayed *et al.,* 2014).

2.5. Infestation percentage

The infestation was determined for *A. sabella* based on the presence of symptoms of larvae feeding on fruits of the flower strands Fig. (1), while it was determined for *B. amydraula* based on the symptoms of infestation such as fallen fruits, which were red in color and contained larvae and silk threads Fig (2).

The infestation % by *A. sabella* and *B. amydraula* was computed using the equation that follows:

$$Infestation\ \% = \frac{Average\ number\ of\ infested\ fruits/strand}{Average\ number\ of\ all\ fruit\ /strand} \times 100$$

Fig. 1: The infestation symptoms by *A. sabella* on date palm flower strands .

Fig. 2: The infestation symptoms by *B. amydraula* on date palm fruits.

2.6. Proportion of the initial fruit set

Ten fruit strands were tested four weeks following pollination. After that, the initial fruit set was computed using the equation that follows:

$$Initial\ fruit\ set\ \% = \frac{Average\ number\ of\ set\ fruits\ per\ strand}{Average\ number\ of\ set\ fruits\ per\ strand + Average\ number\ of\ flower\ scars} \times 100$$

2.7. Retention of date fruits

The proportion of date fruits retention was computed after the preceding ten strands were examined and counted during the first week of July.

2.8. Data analysis

The acquired data was subjected to an ANOVA analysis using SAS's Proc ANOVA, and the means were compared using the LSD (P=0.05) threshold in the same software (Statistical Analysis System 2003).

3. Results and Discussion

3.1. Effect of different ways of date palm pollination on the date fruit infestation % by *A. sabella* and *B. amydraula* during 2022 and 2023

Data tabulated in Table (1) and illustrated in Fig. (3) showed the effect of different ways of date palm pollination on the date fruit infestation % by *A. sabella* and *B. amydraula* during 2022 and 2023. Obtained results revealed that the infestation % of newly set date fruits with *A. sabella* increased in the three tested pollination methods by increasing the number of pollen strands, the amount of pollen grains, and the percentage of pollen grains, as its highest percentages % (15.48, 2.47 and 40,50 %) with a significant difference with the other treatments were recorded in the treatments (hand pollination with 42 fresh pollen strands, spraying pollen grains suspension 15 g pollens/L water and dusting of 2.5g Pollen without starch) during the year 2022. The same trend was recorded in the second year 2023, were (13.10, 2.50 and 38.00 %) for treatments ((hand pollination with 42 fresh pollen strands, spraying pollen grains suspension 15 g pollens/L water and dusting of 2.5g Pollen without starch).

Curr. Sci. Int., 13(3): 294-304, 2024
EISSN: 2706-7920 ISSN: 2077-4435 **DOI: 10.36632/csi/2024.13.3.24**

Table 1: Impact of different ways of date palm pollination on the date fruit infestation % by *A. sabella* and *B. amydraula* during 2022 and 2023.

Treatments	*A. sabella* infestation%		*B. amydraula* infestation%	
	2022	2023	2022	2023
Hand pollination with 7 fresh pollen strands recommended	1.20 c	1.12 c	1.13 d	1.08 d
Hand pollination with 21 fresh pollen strands	2.30 c	2.28 c	3.60 c	3.30 c
Hand pollination with 42 fresh pollen strands	15.48 b	13.10 b	7.59 a	7.42 a
Spraying pollen grains suspension (2.5 g pollens/L water) recommended	1.21 c	1.15 c	1.10 d	1.08 d
Spraying pollen grains suspension (7.5 g pollens/L water)	1.81 c	1.62 c	2.50 cd	2.33 cd
Spraying pollen grains suspension (15 g pollens/L water)	2.47 c	2.50 c	7.52 a	7.19 a
Dusting of 2.5g Pollens + 10g starch (1:4) recommended	1.52 c	1.16 c	1.20 d	1.10 d
Dusting of 2.5g Pollens + 5 g starch (1:2)	15.69 b	14.81 b	3.45 c	3.64 bc
Dusting of 2.5g Pollens without starch	40.5 a	38.00 a	5.47 b	5.21 b
Pr	<.0001	<.0001	<.0001	<.0001
L. S. D. at 0.05	1.715	1.633	1.840	1.910

Means in column or row followed by different letter are significantly different at 5% level

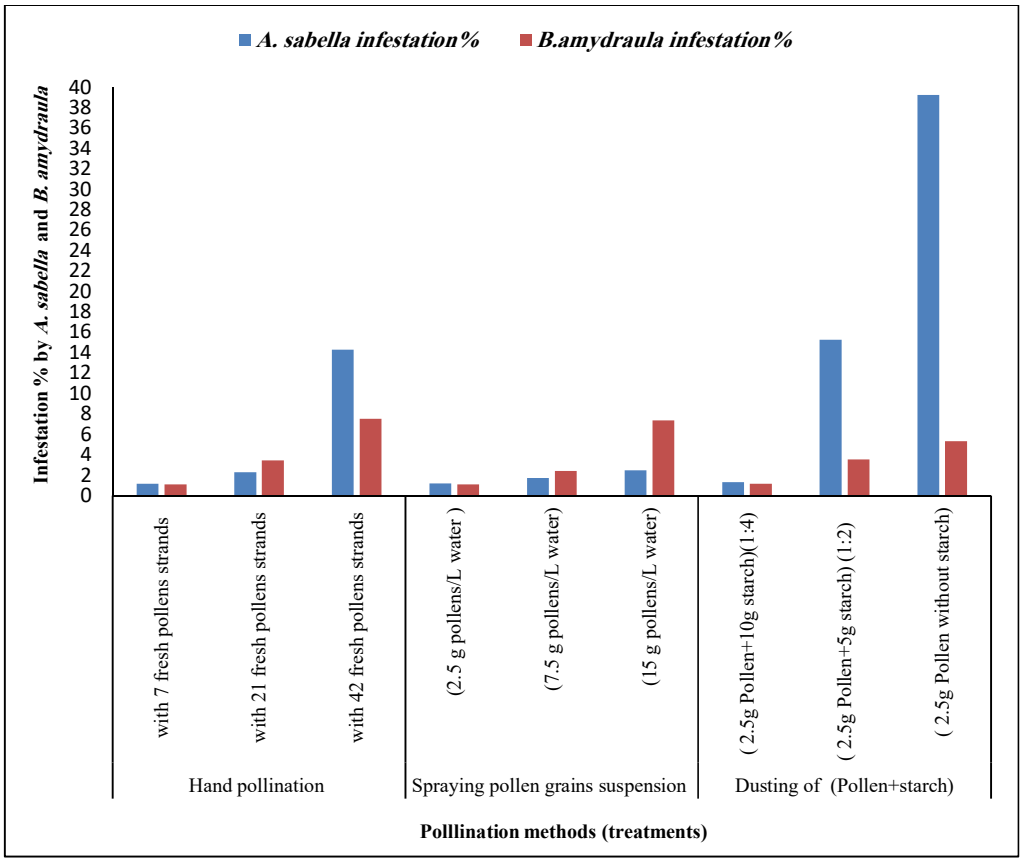

Fig. 3: Effect of different ways of date palm pollination on the mean of date fruit infestation % by *A. sabella* and *B. amydraula* during 2022 and 2023

Regarding the *B. amydraula* which tabulated in Table (1) and illustrated in Fig. (3) showed that the of infestation % with *B. amydraula* recorded the same trend as *A. sabella,* as the infestation by this insect in newly-set date fruits increased with an increase in the number of pollen strands, the amount of pollen, and the percentage of pollen grains in the different treatments. The results showed that the

highest infestation % (7.59, 7.25 and 5.47 %) with a significant difference with the other treatments were recorded in the treatments (hand pollination with 42 fresh pollen strands, spraying pollen grains suspension 15 g pollens/L water and dusting of 2.5g Pollen without starch) during the year 2022. The same trend was recorded in the second year 2023, were (7.42, 7.19 and 5.21%) for treatments ((hand pollination with 42 fresh pollen strands, spraying pollen grains suspension 15 g pollens/L water and dusting of 2.5g Pollen without starch).

It was noted through the results of this research during the two years of the study that *A. sabella* has become a very dangerous economic pest to the date palm in the New Valley recently, as the percentage of its infestation in date palms increases with an increase in whether the number of pollen strands, the amount of pollen grains, and the percentage of pollen grains during date palm pollination by the three tested methods: hand pollination with fresh pollen strands , spraying pollen grains suspension (pollens/L water) and dusting of pollens+starch, respectively , as the percentage of infestation by this pest has reached 40.50 and 38.00 % during the two years of study 2022 and 2023.While the of infestation percentage by *B. amydraula* was despite following the same trend, which reached, at its maximum treatment, infestation % of 7.52 and 7.19 % during the two years of study 2.22 and 2.23 only and did not constitute significant economic damage. The results of the increase in the infestation % of the two early insects infesting date palm fruits *A. sabella and B. amydraula* by increasing the number of pollen strands, the amount of pollen grains, and the percentage of pollen grains during date palm pollination could be explained by the fact that their increase has an attractive effect on the two insects especially *A. sabella* Gameel &Ahmed (2021). Levi-Zada *et al.* (2014) stated that only in the presence of date palm tissue was copulation seen in the lab, so indicating that great date moth *A. sabella* mating and sexual communication most likely take place in the date palm's crown. El-Shafei and Batt (2024) menthioned that the use of pollen grain fresh strands as a bait in red palm weevil (*Rhynchophorus ferrugi*neus) aggregation pheromone trap increase the effectiveness of the trap increased in attracting adults of the red palm weevil. Furthermore, Wakil *et al.* (2015) noted that more research is necessary to identify a number of significant pests of the date palm, particularly the greater date moth (*A. sapella)*, the date stone beetle (*Coccotrypes dactyliperda* F.), and the rhinoceros beetle (*Oryctes agamemnon* Burmeister), which can cause significant crop damages.

Our results were in a harmony with those of Gameel (2017) and El-Shafei (2018) revealed that the field observations and farmer complaints since the end of the 20th century have shown that *A. sabella* has been a significant pest attacking date palm trees. El-Kharga Oasis's date palms were found to be over 80% infested with *A. sabella*. Gameel &Ahmed (2021) mentioned that the infestation with *A. sabella* had a special trend, as the rate of infestation with it increased with the increase in the number of pollen strands during the hand pollination from 7 to 28 pollen strands, and that the infestation with insect *B. amydraula* was limited and not economical.

3.2. Effect of different ways of date palm pollination on initial fruit set and fruit retention (%) of Siwi cultivar during 2022 and 2023.

The results shown in Table (2) and illustrated in Fig. (4) showed the effect of different ways of date palm pollination on the initial fruit set and fruit retention (%) of Siwi cultivar during 2022 and 2023.Obtained data indicated that the initial fruit set of date fruits was at its highest value in the dusting pollinating method, with a significant difference between it and the rest of the treatments, followed by the fruits resulting from pollination using the hand pollination with pollen strands, while the lowest initial fruit set percentage resulted from Spraying pollen grains suspension (2.5g pollens/L water). Significant differences were recorded between the three methods of pollination tested. The highest percentage of initial set of date fruits in the first year of 2022 was (88.50 %) when pollination was carried out by Dusting of 2.5g pollen + 5 g starch (1:2) , and the lowest percentage was (56.90%) when pollinated by spraying pollen grains suspension (2.5 g pollens/L water).The same trend was recorded in the second year 2023, where the percentage of the initial fruit set of date fruits was at its highest value (80.90%) when pollination was carried out by Dusting of 2.5g Pollen+5 g starch (1:2), and the lowest percentage was (52.50%) when pollinated by spraying pollen grains suspension (2.5 g pollens/L water).

Table 2: Impact of different ways of date palm pollination on initial fruit set and fruit retention (%) of Siwi cultivar during 2022 and 2023.

Treatments	Initial fruit set %		Fruit retention %	
	2022	2023	2022	2023
Hand pollination with 7 fresh pollen strands recommended	84.00 bc	77.50 bcd	82.70 a	76.10 a
Hand pollination with 21 fresh pollen strands	85.00 b	78.00 bc	78.20 c	71.70 b
Hand pollination with 42 fresh pollen strands	82.80 cd	76.20 d	52.60 g	48.00 f
Spraying pollen grains suspension (2.5 g pollens/L water) recommended	56.90 f	52.50 f	55.00 f	51.30 e
Spraying pollen grains suspension (7.5 g pollens/L water)	65.80 e	61.00 e	63.70 e	59.60 d
Spraying pollen grains suspension (15 g pollens/L water)	81.50 d	76.30 cd	71.20 d	69.60 c
Dusting of 2.5g Pollens + 10g starch (1:4) recommended	83.60 bc	76.20 d	80.40 b	74.50 a
Dusting of 2.5g Pollens + 5 g starch (1:2)	88.50 a	80.90 a	55.40 f	51.00 e
Dusting of 2.5g Pollens without starch	87.10 a	79.00 b	35.70 h	33.80 g
Pr	<.0001	<.0001	<.0001	<.0001
L. S. D. at 0.05	1.783	1.366	1.846	2.145

Means in column or row followed by different letter are significantly different at 5% level

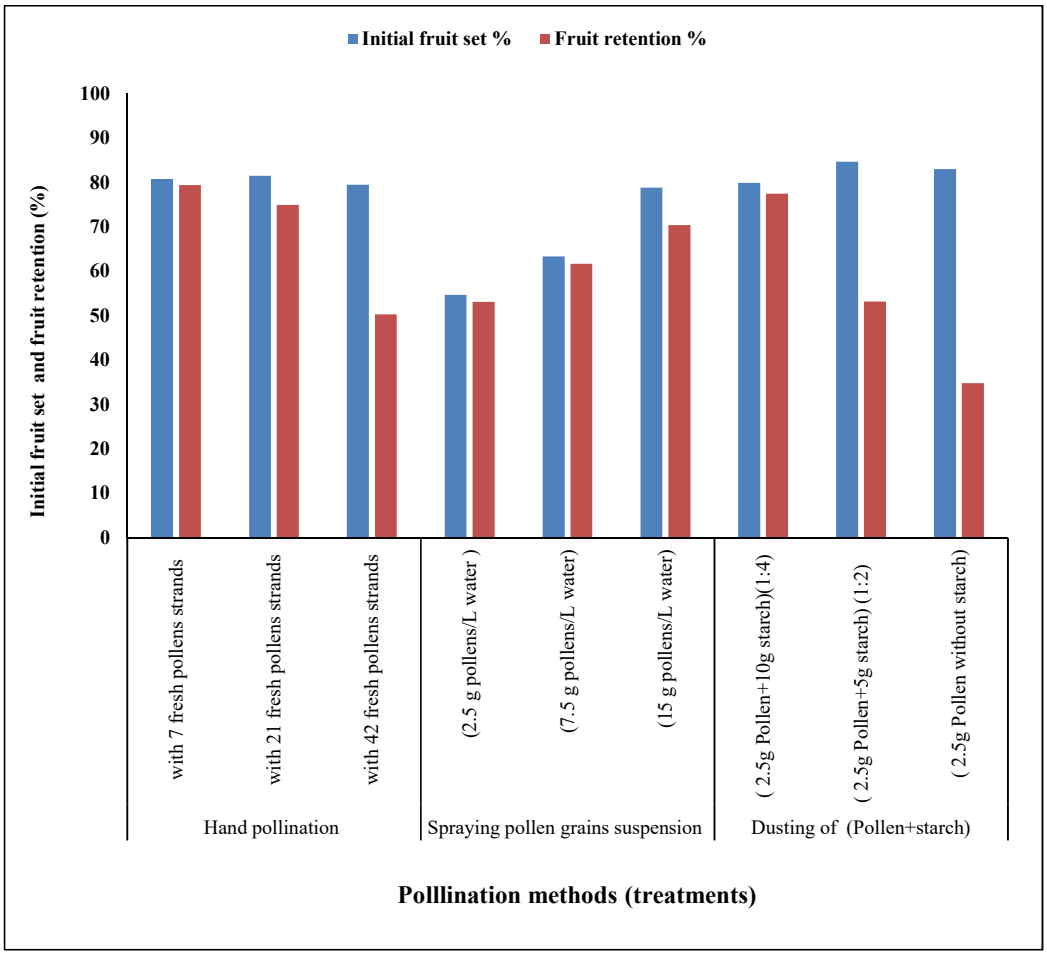

Fig. 4: Effect of different ways of date palm pollination on the mean of initial fruit set and fruit retention (%) of Siwi cultivar during 2022 and 2023.

Regarding the percentage of fruit retention, the results in Table (2) and illustrated in Fig. (4) showed that there was no clear trend in the results, as the highest percentage of fruit retention was recorded in the first year of 2022 when pollination was carried out with treatment hand pollination with 7 fresh pollen strands at a rate of (80.70%), followed by the percentage of fruit retention (80.40) resulting from pollination with treatment dusting of 2.5g Pollen+10g starch (1:4), and the lowest was in percentage of fruit retention date fruits resulting from pollination with treatment dusting of 2.5g Pollen without starch (35.70%).

While in the second year of the experiment, 2023, the results recorded the highest percentage of fruit retention resulting from pollination with both treatment hand pollination with 7 fresh pollen strands and dusting of 2.5g Pollen + 10g starch (1:4) at a rate of (76.10 & 74.50 %) respectively, without a significant difference between them, followed by the percentage of fruit retention resulting from pollination with treatment hand pollination with 21 fresh pollen strands (71.70%) , while the lowest was the percentage of date fruits resulting from pollination with the dusting of 2.5g pollen without starch treatment (33.80 %). The current results are consistent with what was mentioned by Gameel &Ahmed (2021) that Regarding the initial fruit set ratio, the results showed that the values with various treatments (7, 14, 21, and 28 fresh pollen strands per bunch) showed negligible differences from one another. Additionally, the decrease in fruit retention percentages with the increase in pollen grain strands was ascribed to the correlation between the two early date palm pest infestations, particularly A. sabella, and the quantity of pollen grain strands utilized in the pollination process.

4. Conclusion

Through the obtained results of the this research, it could be concluded that the infestation of date fruits by two early insect pests , the greater date moth, *A. sabella* and lesser date moth, *B. amydraula* increase with an increase in whether the number of pollen strands, the amount of pollen grains, and the percentage of pollen grains during date palm pollination by the three tested methods: hand pollination with fresh pollen strands, spraying pollen grains suspension (pollens/L water) and dusting of pollens starch . Regarding the **e**ffect of different ways of date palm pollination on the on initial fruit set and fruit retention (%) of date palm Siwi cultivar the results indicated that there was no clear trend in the results. In view of the results, we can recommend the use of the three treatments for pollination methods: hand pollination with 7 fresh pollen strands, spraying pollen grains suspension (2.5 g pollens/L water) and dusting of 2.5g pollens + 10g starch (1:4), because they led to a low infestation rate for the two insects, and at the same time to a high percentage of initial fruit set and fruit retention. It reduces the amount of pollen required and reduces the cost of providing it, especially since the number of female palms is increasing and the need for large quantities of pollen to pollinate females. In view of the widespread phenomenon of date fruit falling in the early stages of their growth in all date-producing countries and the lack of a clear cause for it, we suggest in-depth and expanding the study of the relationship of the increase in the amount of pollen grains during pollination to this phenomenon because we believe that it has a close relationship with attracting the two insects under study to the palm bunches and causing date fruits fall.

References

Abd El-Wahab, A.S., A.Y. Abd El-Fattah, W.K.M. El-Shafei, and A.A. El Helaly, 2020. Efficacy of aggregation nano gel pheromone traps on the catchability of *Rhynchophorus ferrugineus* (Olivier) in Egypt. Brazilian Journal of Biology, 81: 452-460.

Ahmed, E.F.S., 2014. Increasing pollination efficiency in Saidy date palms by using starch carrier along with pollens suspension. Proceeding of the Fifth International Date palm Conference, Abu Dhabi, UAE March 16 – 18, ISBN978-9948- 22-868-4, 237-243.

Ahmed, E.F.S., 2002. The productive capacity of Sewy date palms grown under New Valley conditions in response to leaves/ bunch ratio. M.Sc. Thesis Fac. Agric. Minia University.

Ahmed, E.F.S., H.H.M. Saied, and S.F.A. El-Sharabasy, 2016. Pistil receptivity of Saidy date palms grown under new valley conditions when pollinated with pollen suspension. J. Plant Production, Mansoura Univ.,7(11): 1179-1182.

Ahmed, M.S., 1959. Date palm pollination in the East. First FAO International technical meeting on date production and processing. Tripoli, Libya, Back Ground paper No. (11+12).

Al-Tahir, O.A. and M.I. Asif, 1983. Study of variations in date pollen material. In Proceedings of the First Symposium on the date palm in Saudi Arabia. Al-Hassa, Saudi Arabia, King Faisal University, 62-66.

Assous, M.T.M., W.K.M. El-Shafei, L.M. Lewaa, and Salem, Rehab E.M.E., 2022. Efficiency of Carbone Dioxide and Aluminum Phosphide Gasses on *Ephestia cautella* and *Oryzaephilus surinamensis* Insects and Microbial Load on Stored Date Fruits. Egyptian Academic Journal of Biological Sciences. A, Entomology, 15(1): 81-89. doi: 10.21608/eajbsa.2022.225822

Dawson, V.H.W., 1956. An account of the date palm by Francesco Redi, A.D. 1666. Trop. Agric.33: 207-213.

El-Lakwah F.A.M., A.A. EL-Banna, R.A. El-Hosary and W.K.M. El-Shafei, 2011. Population dynamics of the Red Palm Weevil (*Rhynchophorus ferrugineus* (Oliv.) on date palm plantations in 6th October Governorate. Egypt. J. Agric. Res., 89 (3):1105-1118. doi: 10.21608/ejar.2011.177676

El-Salhy, A.M., A.A. El-Bana, H.A. Abdel-Galil, and E.F.S. Ahmed, 2010. Effect of pollen grains suspensions spraying on yield and fruit quality of Saidy date palm cultivar Proceeding of the Fourth International Date palm Conference, Abu Dhabi, United Arab Emirates, 15-17 March Acta Horticulturae, 882: 329- 336.

El-Shafei, W.K.M., 2015. Studies on efficiency of certain methyl bromide alternatives against *Ephestia cautella* (Walker) Lepidoptera: Pyralidae , Ph.D. thesis, Benha Univ., Egypt, 195.

El-Shafei, W.K.M., 2020. Comparison between using phosphine and/or carbon dioxide for controlling *Plodia interpunctella* and *Oryzaephilus surinamensis* in stored date fruits. Middle East Journal of Applied Sciences, *10*(4): 657-664.

El-Shafei, W.K.M. and S.A. Attia, 2023. Ecological and Toxicological Studies on Date Palm Scale *Fiorinia phoenicis* Balachowsky (Hemiptera-Diaspididae) Infesting Three Date Palm Cultivars with Reference to Anatomical and Chemical Analysis of Palm Cultivars Leaflets at Giza Governorate, Egypt. Academic Journal of Entomology, 16(2): 70-83.

El-Shafei, W.K.M., R.H. Mahmoud, and S.E. El-Deeb, 2019. Impact of Controlled Atmosphere of different three gases for Controlling the stored dates mite, *Tyrophagus putrescentiae* (Schrank)(Acari: Acaridida), Acad. J. Entomol, 12(2): 49-56.

El-Shafei, W.K.M., R.H. Mahmoud, and S.S.A. Mohamed, 2022. Efficacy of some entomopathogens against Ephestia cautella (Walker)(Lepidoptera: Pyralidae) in stored date fruits. Egyptian Journal of Biological Pest Control, 32(1): 1-7.

El-Shafei, W.K.M., 2018. Population Density of some Insect Pests Infesting Fallen Soft Dates and their Associated Natural Enemies in Giza Governorate, Egypt, J. Plant Prot. and Path., Mansoura Univ., 9 (12): 815 – 821.

El-Shafei, W.K.M. and M.A. Batt, 2024. Evaluation of specific pheromone trap designs and components to improve their effectiveness in reducing the red palm weevil population in Egyptian palm farms. Menoufia Journal of Plant Protection, 9(1):45-59.
doi: 10.21608/MJAPAM.2024.261543.1029

El-Shafei, W.K.M., 2011. Ecological studies on the Red Palm Weevil, *Rhynchophorus ferrugineus* (Oliv). (Curculionidae: Coleoptera). M. Sc. Thesis, Fac. Agric., Benha Univ., Egypt, 180.

El-Shafei, W.K.M., R.A. Zinhoum, and H.B.H. Hussain, 2018. Biology and Control of Indian Meal Moth, *Plodia interpunctella* (Hubner) (Lepidoptera: Pyralidae) Infesting Stored Date, Almond and Peanut Fruits J. Plant Prot. and Path., Mansoura Univ., 9 (9): 595- 600.

Furr, J.R. and V.M. Enriquez, 1966. Germination of date pollen in culture media. Rept. Ann. Date Grs, Inst., 45: 24-27.

Gameel, S.M.M., 2017. The economic importance of the greater date moth, *Arenipses sabella* Hampson (Lepidoptera: Pyralidae). Egypt. Acad. J. Biolog. Sci., 10: 41-49.

Gameel, S.M.M. and E.F.S. Ahmed, 2021. Relationship between the quantity of pollen grains as used in the pollination process and the infestation with Arenipses sabella (Lepidoptera: Pyralidae) and Batrachedra amydraula (Lepidoptera: Batrachedridae). Egypt. J. Plant Prot. Res. Inst. 4 (4): 524 –530.

Gameel, S.M.M., M.A. Ewais, and A.A. Sayed, 2014. Using of *Trichogramma evanescens* West. (Hymenoptera: Trichogrammatidae) for controlling *Arenipses sabella* Hmpson and *Batrachedra amydraula* Meyrick in the date palm fields at the New Valley- Egypt. Egypt. Acad. J. Biolog. Sci., 6: 35-41.

Gasim, A.A., 1993. Effect of pollen quantity of fruit-setting, yield and some physical fruit properties of some date palm. Third Symp. on Date Palm in Saudi Arabia. King Faisal Univ., Al-Hassa, Saudi Arabia, January, Abstract No. B28, 91.

Goor, A., 1967. The history of the date through the ages in the holy land. Economic Botany, 21:320-340.

Hamood, H.H., E.A. Mawlood, and M.A. Al-Khafaji, 1986. The effect of mechanical pollination on fruit set, yield and fruit characteristics of date palm (*Phoenix dactylifera* L.) Zahdi cultivar. Date Palm, 4: 175-184.

Hussain, A.A., 1963. Biology and control of the dubas bug *Ommatissus binotatus lybicus* deberg. (Homoptera, Tropiduchidae), infesting date palms in Iraq. Bull. Entomol. Res., 53: 737-745.

Hussein, F., S.M. Badr, and S.S. Al- Allear, 1985. Effect of different pollination methods on quality and quantity of date palm (*Phoenix dactylifera* L.) fruit. J. Agric. Water Resources Res., 4: 265-282.

Kataab, H.A., 1985. Date palm in old Egypt. Agric. J., 40: 33-35.

Kinawy, M., 2012. Date palm pests in Oman. Mazoon Printing Press, Registration No:273/2012. 406 pp.

Kotb, A., 1993. Studies on pollination, fertilization and the effect of some hormonal treatments on three date cultivars. Third Symp. on Date Palm in Saudi Arabia Faisal Univ., Al-Hassa. Saudi Arabia. January, 1993. Abstract No. B30. pp.91-92.

Levi-Zada, A., M. David, D Fefer, V. Seplyarsky, A. Sadowsky, S. Dobrinin, T. Ticuchinski,; D. Harari, D. Blumberg, and E. Dunkelblum, 2014. Circadian release of male specific components of the greater date moth, *Aphomia (Arenipses) sabella*, using sequential SPME/GC/MS analysis. J. Chem. Ecol.,40:236-243.

Mahmoud, R., A.R. Abdel-Khalik, W.K.M. El-Shafei, 2022. Comparison between Two Physical Methods to Control the Stored Dates Fruit Mites*, Tyrophagus putrescentiae* (Schrank) and *Rhizoglyphus robini* Claparede (Astigmata: Acaridae)". Egyptian Academic Journal of Biological Sciences, B. Zoology, 14(1): 149-158. doi: 10.21608/eajbsz.2022.228058.

Moreira, S. and J.A. Gurgel, 1941. Pollen fertility and its correlation with numbe of seeds in species and forms of the genus citrus progornita, Sao Paul, L. 669-711 (Plant Breeding Abst. 14: 976).

Nixon, R.W., 1951. Fruit thinning experiments with the "Medjool “and "Barhee" varieties of dates. Annals of Date Growers Inst. Rept., 8:14-17.

Ream, C.L. and J.R. Furr, 1970. Fruit set of dates as affected by pollen viability and dust or water on stigmas. Date Grower's Inst. Rep., 47: 11.

Saleh, M.R.A., 1974. Ecological, biological and control studies on pests infesting date-bunches in the New Valley. Ph.D. Thesis. Fac. of Agric., Ain Shams Universxity.

Sayed, A. A., S.A. Temerak, S.M.M. Gameel, and A. Moussa, 2014. Alternate two different modes of actions of green chemicals to combat *Batrachedra amydraula* Meyrick and *Cadra cautella* Walk on date palm fruit, Egypt. Journal of Agricultural Science and Technology, 529-534.

Shaheen, M.R., 1986. Pistil receptivity in three cultivars of date palm (*Phoenix dactyliferaL.). Proc. 1st Hort. Sci. Conf.Tanta Univ., Egypt, September, H: 489-499.*

Sial, F.S. 1980. Development of a pneumatic date pollinator. ASAE paper No. 80-1506, Am.Soc. Agric. Eng. Winter Meeting, Chicago.

Statistical Analysis System, 2003. SAS Statistics and graphics guide, release 9.1. SAS Institute, Cary, North Carolina 27513, USA.

Temerak, S.A., Sayed H.K., Bekheit, and S.M.M. Gameel, 2007. Actinomycete natural metabolites to combat *Batrachedra amydraula* Meyrick and *Cadra* spp. At Kharga Oasis, New Valley, Egypt. Egypt. J. Agric. Res., 85:9-17.

Venezian, A. and D. Blumberg, 1982. Penology, damage and control of the lesser date moth *Batrachedra amydraula*, in date palms in Israel. Alon Hanotea.,36: 785-788.

Wakil, W., T.A. Miller, and J.R. Faleiro, 2015. Sustainable pest management in date palm: Current status and emerging challenges: Sustainability in Plant and Crop Protection. In: Soroker, V., Harari, A. and Faleiro, J.R. The role of semiochemicals in date pest management ISBN 978-3-319-24395-5 426pp.

Wiltshire, E.P., 1957. The lepidoptera of Iraq. ed. 2, 162 pp. nicholas kaye ltd. London.

Zinhoum R.A. and W.K.M. El-Shafei, 2019. Control of One of the Vital Stored Date Insects, *Plodia interpunctella* (Hübner) (Lepidoptera: Pyralidae), by Using Ozone Gas. Egypt. Acad. J. Biolog. Sci. (F. Toxicology & Pest control), 11(3): 149- 156