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EFFECT OF LIQUID POLLEN CONCENTRATIONS ON FRUIT SET, YIELD, AND QUALITY OF DHAKKI AND ZAHIDI DATE PALM IN D.I. KHAN

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Abstract

Fish represent a crucial source of affordable protein globally and contribute significantly to economic livelihoods through fisheries. The present study investigated the prevalence and intensity of helminth parasite infections in four commercially important marine fish species–Lutjanus argentimaculatus, Johnius dussumieri, Plectorhynchus cinctus, and Pampus argenteus–collected from the Karachi coast. Between January and December 2022, a total of 113 fish specimens were collected monthly using cast nets, hand nets, and fishing rods with the assistance of local fishermen. Parasitological examination revealed that 84.07% of the fish were infected with helminth parasites. The highest infection prevalence was recorded in June (45.46%), while the lowest occurred in January (3.33%). Among the studied species, Pampus argenteus exhibited the greatest mean infection intensity (2.15 parasites per infected fish), followed by Johnius dussumieri (1.89), Plectorhynchus cinctus (1.87), and Lutjanus argentimaculatus (1.70). Seasonal analysis indicated a substantially higher infection rate during summer compared to winter. These results demonstrate species-specific differences in susceptibility to helminth infections and emphasize their implications for fish health, food safety, and sustainable fisheries management.

Introduction

The date palm (*Phoenix dactylifera* L.) belongs to the family Arecaceae and is distributed in tropical and sub-tropical countries of the world. It is commonly commercially cultured in the arid areas of the Middle East and North Africa (Henderson, 2009). Dates are eaten in dried or fresh form. They are also used for the preparation of salads, syrups, cakes, etc. Date fruit contains a high number of calcium, magnesium, phosphorus, potassium, iron, zinc, copper, manganese, selenium, vitamins A, A1, B, B1, B2, B3, B5, B6, and C, as well as a variety of amino acids (Anon, 2006). Thiamine, riboflavin, niacin, and pantothenic acid are also found in dates. These vitamins and minerals aid in the production of hemoglobin, a protein found in red blood cells that binds to oxygen and transports it from the lungs to the body's tissues (Anon, 2005). Dates also deliver 3 g of dietary fibre and 29 g of natural sugars with fructose, glucose, and sucrose. To put it another way, one date has 31 g of carbs, which delivers the body with a lot of energy (Anon, 2007).

The pollen from date palm (Phoenix dactylifera) blossoms has been demonstrated to contain estrone, a form of estrogen with notable gonadotropic effects observed in young rats. Recent experimental studies have confirmed that date palm pollen extract can elevate circulating levels of estradiol, luteinizing hormone (LH), and follicle-stimulating hormone (FSH) in both male and female rats, underscoring its potential endocrine modulating properties (Abdelrahim et al., 2015; Moshfegh et al., 2016).

Pakistan ranks in the 6th position in the top 10 countries producing with an annual production of 524,286 tonnes (FAO, 2017). In Pakistan, date palm is commercially grown in all tropical and

subtropical areas of the dates to other countries and earns billions of rupees annually (Maryam et al., 2015). After Tunisia, Pakistan is the second- largest exporter (9,781 tonnes). The major distributors of Pakistani dates are India, Bangladesh, Germany, Italy, Germany, Japan, Canada, Denmark, UAE, Australia, South Africa, Saudi Arabia, the United Kingdom, and the United States.

The utmost common technique of pollination is being used by date growers are:

1) to cut the strands of male at maturity stage when pollen can fertilize female flowers and placed into the female spathe.

2) extracted dried pollen are suspended and sprayed on open spathe.

3) dusting of full fresh male spathes or extracted dried pollens are dusted by duster.

4) extracted dried pollens are rubbed into cotton bowl and placed into open spathes of female plant.

Various past studies have elaborated on the impact of different pollination techniques on the fruit set and yield of date palm. Iqbal et al. (2010) investigated the effects of different pollination techniques, i.e., placement, dusting and spray of diluted pollens on Dhakki date. Harash and Abdul Naser (2010) sprayed liquid pollen on Khalas date clusters and found that the spray approach yielded the best yield when associated with other treatments. Abdalla et al. (2011) pollinated cv. Zaghloul used the conventional approach (placing male strands) as well as pollen spray and boron. The maximal fruit set and weight were measured using the (strand placement method). Abdullah et al. (2014) observed two pollination techniques for the cv. Khalas date palm: rubbing pollen on a sponge and inserting male threads inside the fruit, and found no important changes in fruit set, yield, or morphologic features of the fruit in either strategy. Samouni et al. (2016) pollinated Saidy date palms using dusting methods (mixture of pollen + country. Pakistan spreads fresh and dried starching at different concentrations with active ingredient) and traditional methods (placement of 5 male strands/spathe) and found that dusting methods resulted in the highest fruit set, yield, and quality when compared to traditional methods. The impact of pollination with suspended pollen grains spray on the Segue cv of date palm was investigated by Soliman et al. (2017). Traditional pollination was used, which included placing 5 male strands/spathe, spraying 3 g pollen L^{-1}, 3 g pollen + 2 g sugar per L^{-1}, 2 g pollen L^{-1}, and 2 g pollen + 3 g sugar L^{-1} are all options. In terms of yield and yield components, traditional pollination was shown to be superior. Soliman at el (2017). Impact of pollination by pollen-grain water suspension spray on yield and fruit quality of the Segae date palm cultivar (Phoenix dactylifera L.). *Pakistan Journal of Botany, 49*(1), 119–123. This study reported that spray-pollination with a mix of 2 g pollen + 3 g sugar per litre significantly increased total sugar percentage, and 2 g pollen per litre led to higher acidity percentages in date fruits.

Problem Statement

Date palm (*Phoenix dactylifera* L.) is a culturally and economically vital fruit crop in arid and semi-arid regions, particularly in southern Khyber Pakhtunkhwa, Pakistan. Among the locally cultivated varieties, Dhakki and Zahidi are commercially important due to their high market value and consumer preference. However, suboptimal pollination, especially under fluctuating weather and manual labour constraints, remains a major bottleneck in achieving consistent fruit set and optimal yield. Conventional hand pollination practices are time-consuming labor labour-intensive, and often fail to ensure uniform pollen distribution, leading to poor fertilization and reduced fruit quality. In this context, liquid pollen alternative that can improve pollination efficiency and reduce dependency on traditional methods.

Despite its potential, limited scientific data exist on the impact of different concentrations of liquid pollen sprays on fruit set, yield attributes and physical fruit characteristics of leading cultivars like Dhakki and Zahidi. Moreover, no such work has been reported specifically under the agroecological conditions

of Dera Ismail Khan, a region with unique climatic features that can influence pollen viability, stigma receptivity and fruit development. This research addresses this critical knowledge gap by systematically evaluating how varying concentrations of liquid pollen affect reproductive success and post-pollination fruit quality traits.

Objectives of the Study

1. To evaluate the effect of different concentrations of liquid pollen spray on fruit set percentage in Dhakki and Zahidi date palm cultivars.
2. To determine the influence of liquid Pollen concentrations on fruit yield per bunch and per plant under field conditions.
3. To assess the changes in fruit physical traits (length, diameter, weight, pulp- to-seed ratio) in response to liquid pollen applications.
4. To compare the varietal responses (Dhakki vs. Zahidi) to liquid pollen treatments under the climatic conditions of Dera Ismail Khan.
5. To propose optimized pollen management strategies for improving pollination efficiency and productivity in commercial date palm cultivation.

Materials and Methods

The trial took place in Gomal University's Date Palm Research Orchard in Dera Ismail Khan, Pakistan, from March to August 2020. Four trees of each Dhakki application has emerged as a promising and Zahidi date palm, taking similar age and vigorous growth, were selected. The trial was conducted utilizing split plot configurations in R.C.B.D. Female cultivars were retained as the primary factor, pollen concentrations as a sub-factor, and pollination was done with a pollen source three times. In the month of March, pollen was collected. Male stamens were collected at the maturity phase and carefully transported to the laboratory. The protective sheath was removed, and these inflorescences were placed on newspaper for the extraction of pollen under the sun. After 2-3 hours, the flowers were opened, and pollen grains were released. Pollens were extracted by shaking the spathes. These pollens were dried in the sun for 1-2 hours by spreading them on a newspaper. These pollens were dried and then meshed with a porous cloth to remove any undesirable elements before being packed in an airtight glass bottle and stored at 4 °C in a household refrigerator. The number of these pollen 2, 4, 6 and 8 (g) was suspended in one litre of refined water. Three spathes of each female were sprayed by hand spray pump at noon to avoid natural pollination, and bagging was done after pollination. Throughout the research, cultural actions like as hoeing, watering, and weeding were all carried out equally.

Showing the details of treatments

Pollination treatments	Varieties	
	Dhakki	Zahidi
T1	sprig of 2 g of pollen/litre water	sprig of 2 g of pollen/litre water
T2	sprig of 4 g of pollen/litre water	sprig of 4 g of pollen/litre water
T3	sprig of 6 g of pollen/litre water	sprig of 6 g of pollen/litre water
T4	sprig of 8 g of pollen/litre water	sprig of 8 g of pollen/litre water

Statistical Analysis

The experimental data collected on fruit set percentage, yield per bunch and per plant, as well as various physical fruit traits (fruit length,

diameter, weight, pulp-to- seed ratio), were subjected to statistical analysis using SPSS version 26.0 and Microsoft Excel 2019.

The analysis of variance (ANOVA) was performed to determine the significance of treatment effects across different concentrations of liquid pollen for both Dhakki and Zahidi cultivars. Means were separated using the Least Significant Difference (LSD) test at 5% level of significance ($p \leq 0.05$) to compare varietal responses and pollen concentration impacts.

Results and Discussion Fruit set (%)

Table 1 indicated that several pollen concentrations had a significant influence on fruit set percent, whereas date varieties and contact were determined to be non- significant. The pollen concentration showed that the highest fruit set (93.9%) was observed in T4 (8 g L^{-1}), followed by T3 (6 g L^{-1}) and T2 (4 g L^{-1}), by making fruit set % (89.8 and 74.9%, respectively. Although the lowest fruit set (62.8%) was noted in T1 (2 g L^{-1}). The highest fruit set in T4 (8 g L^{-1}) might be due to the maximum number of pollens present in the solution, which fertilized the maximum number of female flowers (fruit set). These results are in agreement with the results of Munir et al. (2019), who noted the highest fruit set in cv. Zahidi and Khudrawi at a higher pollen concentration of 4 g L^{-1} instead of 1 g L^{-1}. Similarly, Zahara et al. (2019) reported the highest fruit set in cultivar Barhai and Medjhol when pollinated with higher concentrations of suspended pollen.

Days to fruit set

The data in Table 1 showed that the pollen concentration caused significant variation in days to fruit set, though date varieties and their interaction could not produce any significant result regarding days to fruit set. The maximum days to fruit set (22.75 days) were counted in T4 (8 g L^{-1}), followed by T3 (6 g L^{-1}) and T2 (4 g L^{-1}), which gave 21.02 and 19.73 days to fruit set, respectively. The minimum days to fruit set (17.3 days) were counted in T1 (2 g L^{-1}). The higher days to fruit set in T4 (8 g L^{-1}) might be due to a higher number of pollens, which continued to fertilize for a longer time as compared with lower concentration, which might have pollinated for less time. A lesser number of fruits per bunch was associated with the highest pollen concentration T4 (8 g L^{-1}), which retained the highest number of fruits per group. The carbohydrates from leaves might have been distributed among the bunches and finally to the fruits. The fewer the fruits, the higher their share of carbohydrates will be and vice versa. Similarly, Shahid et al. (2017) found that when pollination was done at different intervals, the days to fruit set in Dhakki date palms varied.

Table 1: Effect of different suspended pollen concentrations on fruit set percentage and days to fruit set of date palm cultivars Dhakki and Zahidi

Poll concentration	Fruit set (%)			Days to fruit set		
	Varieties		Mean	Varieties		Mean
	Dhakki	Zahidi		Dhakki	Zahidi	
T_1 (2 g L^{-1})	63.47 NS	62.13	62.80 d	17.79 NS	16.83	**17.31 d**
T_2 (4 g L^{-1})	75.47	74.49	74.98 c	19.99	19.46	**19.73 c**
T_3 (6 g L^{-1})	90.47	89.18	89.83	21.59	20.45	**21.02**

			b			**b**
T_4 (8 g L^{-1})	96.47	91.46	93.97 a	23.40	22.10	**22.75 a**
Mean	**81.47 NS**	**79.31**		**20.69 NS**	**19.71**	

Means having common letters are non- significant at $p < 0.05$

Fruit length (cm)

Data on the result of pollen concentration on the fruit length of date varieties showed significant differences for varieties, pollen concentration and their interaction as well (Table 2). The data in Table 4.3 showed that the maximum fruit length (4.76 cm) was measured in the Dhakki variety, while the minimum 3.87 cm) was noted in Zahidi. The maximum fruit length 5.05 (cm) was recorded in T1 (2 g/L), followed by T2 (4 g/L) and T3 (6 g/L) with 4.55 (cm) and 4.05 (cm), respectively. While the minimum fruit length of 3.61 (cm) was observed in T4 (8 g/L). The maximum fruit length was noted in Dhakki of 5.63 (cm) with pollen concentration T1 (2 g/L), followed by Dhakki variety with T2 (4 g/L) and T3 (6 g/L) by giving fruit lengths of 5.04 cm and 4.32 cm, respectively. The least fruit weight of 3.87 cm was observed in the Zahidi variety with T4 (8 g/L), followed by the Zahidi variety with T3 and T2, which gave fruit lengths of 3.78 cm and 4.07 cm, respectively. Though the minimum fruit length of 3.17 cm was measured in the Zahidi variety with the highest pollen concentration T4 (8 g L^{-1}), followed by T3, T2 and T1 (2 g L^{-1}) by producing fruit lengths of 3.78, 4.07 and 4.47 cm, respectively. The maximum fruit length in Dhakki with the lowest pollen concentration (T1) might be due to a lower number of fruits per group compared with the highest pollen concentration (T4), which retained the highest number of fruits per bunch. The carbohydrates from leaves might have been distributed among the bunches and finally to the fruits. The fewer the fruits, the higher their share of carbohydrates will be and vice versa. These findings corroborated those of Abdalla et al. (2011) in date palm cv. Zaghloul, who recorded improvement of the fruit physical quality in terms of increasing the fruit weight and dimensions using pollen grains suspension concentration from 3 to 1.5 g L^{-1}. These findings could be due to the reduction in fruit set because of a lack in the number of fruits per bunch, despite changing the number of leaves, which may induce a better supply of carbohydrates that are manufactured in the leaves.

Fruit width (cm)

Variances for date varieties as pollen concentration, while their interaction was found non-significant (Table 2). Data associated with pollen concentration indicated that maximum fruit width of 2.57 cm was measured in T1 (2 g L^{-1}), followed by T2 (4 g L^{-1}) and T3 (6 g L^{-1}) by producing 2.44 and 2.32 cm fruit width, while the lowest fruit width of 1.96 cm was recommended in T4 (8 g L^{-1}). Data concerning date varieties showed that Dhakki produced more fruit width (2.56 cm) as associated with Zahidi, which gave a fruit width of 2.09 cm. The maximum fruit width of the Dhakki variety may be due to its genetic characteristics compared to the Zahidi variety. The maximum fruit width in pollen concentration of T1 (2 g L^{-1}) might be due to a smaller number of fruits which received the maximum share of carbohydrates prepared in the leaves, as compared to T4 (8 g L^{-1}), which has the highest density of fruit per bunch. These results agreed with the findings of Abdalla et al. (2011) in date palm cv. Zaghloul, who noted improvement of the fruit width in terms of increasing the fruit weight and dimensions by using pollen grain suspension concentration from 3 to 1.5 g L^{-1}. Similarly, Munir et al. (2020) noted maximum

fruit width in unlike date palm varieties with spray different pollen concentrations.

Table 2: Effect of different suspended pollen concentrations on fruit length (cm) and fruit width (cm) of date palm cultivars Dhakki and Zahidi

Pollen concentration	Fruit length (cm)			Fruit width (cm)		
	Varieties		Mean	Varieties		Mean
	Dhakki	Zahidi		Dhakki	Zahidi	
T1 (2 g L-1)	5.63 a	4.47 c	5.05 a	2.85 NS	2.28	2.57 a
T2 (4 g L-1)	5.04 b	4.07 d	4.55 b	2.69	2.19	2.44 b
T3 (6 g L-1)	4.32 c	3.78 e	4.05 c	2.52	2.13	2.32 c
T4 (8 g L-1)	4.04 d	3.17 f	3.61 d	2.18	1.74	1.96 d
Mean	4.76 a	3.87 b		2.56 NS	2.09	

Means having common letters are non- significant at $p < 0.05$

Fruit weight (g)

Table 4.5 contains information on the weight of the fruits. There were substantial variations in the means for date varieties, pollen concentration, and their interaction, according to the data. The maximum fruit weight, 23.07 (g), was observed in Dhakki, while the minimum, 13.07 (g), was observed in Zahidi. The maximum fruit weight 20.24 (g) was recorded in T1 (2 g/L), trailed by T2 (4 g/L) and T3 (6 g/L) with 19.07 (g) and 17.53 (g), respectively. While the minimum fruit weight of 15.3 (g) was recorded in T4 (8 g/L). The data about the highest fruit weight of 25.86 (g) was recorded in the Dhakki variety with pollen concentration T1 (2 g/L), followed by the Dhakki variety with T2 (4 g/L) and T3 (6 g/L) by giving pulp weights of 24.24 g and 22.5 g, respectively. The minimum fruit weight of 11.2 g was observed in the Zahidi variety with T4 (8 g/L), followed by the Zahidi variety with T3 and T2, which gave fruit weights of 12.55 g and 13.92 g, respectively. The maximum fruit weight in the case of the Dhakki variety, as compared with the Zahidi variety, might be due to genetic potential, which caused heavy fruits in the Dhakki variety. The heavy fruit weight of Dhakki with pollen concentration of T1 (2 g L^{-1}) might be attributed to more available carbohydrates being supplied by leaves to a lesser number of fruits as compared with T4 (8 g L^{-1}), which retained the maximum number of fruits per plant. Our finding was supported by the previous finding of Abdalla et al. (2011), who reported that the pollen grain suspension at a rate of (1-3 g L^{-1}) increased the fruit weight in date palm cv. Zaghloul.

Pulp weight (g)

Significant variation was observed for pulp weight for date varieties, pollen concentration and their interaction (Table 4.6). The highest pulp weight, 22.06 (g), was recorded in Dhakki, although a minimum of 11.21 (g) was recorded in Zahidi. The maximum pulp weight, 18.75 (g), was recorded in T1 (2

g/L), followed by T2 (4 g/L) and T3 (6 g/L) with 17.81 (g) and 15.40 (g), respectively. While the minimum pulp weight of 14.59 (g) was recorded in T4 (8 g/L). The data regarding the highest pulp weight of 24.66 (g) was noted in the Dhakki variety with pollen concentration T1 (2 g/L), followed by the Dhakki variety with T2 (4 physical traits, especially pulp weight and fruit mass. For example, Al-Busaidi and Al- Habsi (2006) and Al-Sabahi et al. (2006) found that liquid pollen treatments notably improved reproductive success and physical quality in cultivars like Fard and Khalas. Similarly, El-Salhy (2010) reported that foliar spraying with pollen grain suspensions not only increased fruit set and bunch yield in the Saidy cultivar but also enhanced fruit length, diameter, and pulp- to-seed ratio, confirming the potential of this method in precision pollination strategies.

Table 3: Effect of different suspended pollen concentrations on fruit weight (g) and pulp weight (g)of date palm cultivars Dhakki and Zahidi

Pollen concent ration	Fruit weight (g)			Pulp weight (g)		
	Varieties		Me an	Varieties		Me an
	Dha kki	Zah idi		Dha kki	Zah idi	
T_1 (2 g L^{-1})	25.86 a	14.62 e	20.24 a	24.66 a	12.84 e	18.75 a
T_2 (4 g L^{-1})	24.24 b	13.92 f	19.07 b	23.77 b	11.84 f	17.81 b
T_3 (6 g L^{-1})	22.5 c	12.55 g	17.53 c	20.43 c	10.38 g	15.40 c
T_4 (8 g L^{-1})	20.83 d	11.2 h	15.3 d	19.39 d	9.78 h	14.59 d
Mean	23.07 a	13.07 b		22.06 a	11.21 b	

g/L) and T3 (6 g/L) by giving pulp weights of 23.77 and 20.43 g, respectively. The minimum pulp weight of 9.78 g was measured in the Zahidi variety with T4 (8 g/L), followed by the Zahidi variety with T3 and T2, which gave pulp weights of 10.38 and 11.84 g, respectively. The higher pulp weight in the case of Dhakki compared with Zahidi might be the result of genetic variation in the size of the fruit. The highest pulp weight of Dhakki with pollen concentration T1 (2 g L-1) might be due to a reduced number of fruits compared with T4 (8 g L-1), which has a higher number of fruits for the same available source. Recent studies have demonstrated that pollen grain concentrations significantly influence fruit set percentage, Means having common letters are non- significant at $p < 0.05$ss

Seed weight (g)

The data in Table 4 showed that significant differences were found for date varieties, pollen concentration and their interaction regarding seed weight. The highest seed weight, 1.29 (g), was recorded in Dhakki, while the minimum, 1.11 (g), was recorded in Zahidi. The maximum seed weight 1.28 (g) was recorded in T1 (2 g L-1), trailed by T2 (4 g L-1), T3 (6 g L-1) with 1.23 total yield per palm, and various fruit and 1.19 (g) respectively. While the minimum seed weight (1.11 g) was recorded in T4 (8 g L-1). As per the interactive response of pollen concentrations and date palm varieties, the highest seed weight,
1.42 (g), was recorded in T1 in the Dhakki variety, while the minimum 1.07 (g) seed weight was noted in the Zahidi variety in T4. The reason for the

higher seed weight of Dhakki as compared to the Zahidi variety might be the result of genetic variation. The variation in interaction of the highest seed weight of Dhakki with pollen concentration T1 (2 g L-1) might be attributed to the bigger size of Dhakki with larger seed weight in case of a small number of fruits per plant, compared with a greater number of fruits in T4. Our results were supported by Abdalla et al. (2011), who reported that the maximum seed weight (g) was achieved with spraying of (1-3 g L-1) of pollen.

Seed length (cm)

The data shown in Table 4 indicated significant results about seed length of date cultivars for date varieties and pollen concentrations, while their interaction was found non-significant. Data regarding the seed length of date varieties showed that higher seed length (2.79 cm) was observed in the Dhakki variety as compared to the Zahidi variety, which provided a seed length of 2.44 cm. Data about pollen concentration showed that the highest seed length of 2.83 and 2.68 cm was observed in pollen concentration of T1 (2 g L-1) and T2 (4 g L-1), while the minimum seed length of
2.51 and 2.47 cm was noted in T3 (6 g L-1) and T4 (8 g L-1) pollen concentration treatments. The maximum seed length of the Dhakki variety may be the result of the genetic potential for higher fruit and seed length as compared to the Zahidi variety. The data concerning pollen concentration showed that T1 and T2 produced the highest seed length, and it may be attributed to a
compared to T3 (6 g L-1) and T4 (8 g L-1), which retained the maximum number of fruits per bunch with smaller fruit size. Similar results were quoted by Munir et al. (2020); the maximum seed length was recorded at various levels of pollen spraying.

Table 4: Effect of different suspended pollen concentrations on seed weight (g) and seed length (cm)of date palm cultivars Dhakki and Zahidi

Pollen concentration	Seed weight (g)			Seed length (cm)		
	Varieties		Mean	Varieties		Mean
	Dhakki	Zahidi		Dhakki	Zahidi	
T1 (2 g L-1)	1.42 a	1.14 d	1.28 a	3.00 NS	2.65	2.83 a
T2 (4 g L-1)	1.33 b	1.14 d	1.23 b	2.89	2.46	2.68 a
T3 (6 g L-1)	1.26 c	1.11 de	1.19 c	2.65	2.37	2.51 b
T4 (8 g L-1)	1.15 d	1.07 e	1.11 d	2.56	2.28	2.44 b
Mean	1.29 a	1.11 b		2.79 a	2.44 b	

Means having in common. The results are non-significant at $p < 0.05$

Seed width (cm)

Significant response was observed about seed width of date palm cultivars for date palm varieties and pollen concentrations, whereas their interaction was found non-significant (4.9). The higher seed width of 0.86 cm was measured in the Dhakki variety as compared with the Zahidi variety, which produced a seed width of 0.72 cm. The data regarding pollen concentrations indicated that maximum seed width (0.84 cm) was found in T1 (2 g L- 1) followed T2 (4 g L^{-1}) which gave seed width of 0.80 cm while minimum seed width of 0.77 cm and 0.75 cm was noted in T3 (6 g L^{-1}) and T4 (8 g L^{-1}), respectively. The higher seed width of the Dhakki variety as compared to the Zahidi variety might be

attributed to the genetic makeup of these varieties. The highest seed width in pollen larger amount of fruit density per bunch as concentrations T1 might be due to a smaller number of fruits with bigger size having thick seeds as compared with T2 and T3, which retained a higher number of fruits per bunch with smaller size fruits and seeds. Our outcomes were supported by the previous research of Munir et al. (2020) that the maximum seed width was observed in different levels of pollen spray at different intervals.

Fruit drop percentage

Fruit drop% % presented in Table 4.10 depicted significant results regarding date variety, pollen concentration and their interaction. The maximum fruit drop, 38.73, was observed in Dhakki, while the minimum, 22.68, was observed in Zahidi. The maximum fruit drop, 35.27, was noted in T4 (4 g L^{-1}), trailed by T3 (6 g L^{-1}) and T2 (4 g L^{-1}) with 33.27 and 29.53, respectively. While lowest fruit drop, 24.64, was recorded in T1 (2 g/L). The data about the highest fruit drop of 43.73 was recorded in T4 (8 g/L) in the Dhakki variety, whereas the minimum 17.41 fruit drop was noted in the variety Zahidi in T1 (2 g/L). While the lowest fruit drop (17.41%) was recorded in the Zahidi variety with pollen concentration T2 and T3 (6 g L^{-1}) by giving (21.74 and 24.78%) respectively. The highest fruit drop% % in Dhakki with T4 might be attributed to heavy fruit holding per plant as compared to pollen concentration T1 (2 g L^{-1}), in which a smaller number of fruits were maintained due to less fruit set% %. The thickly populated fruit per bunch might have pushed the adjacent fruits and caused the dropping of less developed fruits in the bunch. These results are similar to those of Iqbal et al. (2011) and Shafique et al. (2011), who discovered that pollinizers can reduce fruit drop.

Table 5: Effect of different suspended pollen concentrations on seed width (cm)and fruit drop percentage of date palm cultivars Dhakki and Zahidi

Pollen concentration	Seed width (cm)			Fruit drop percentage		
	Varieties		Mean	Varieties		Mean
	Dhakki	Zahidi		Dhakki	Zahidi	
T1 (2 g L-1)	0.93 NS	0.75	0.84 a	31.86 d	17.41 h	24.64 d
T2 (4 g L-1)	0.87	0.73	0.80 b	37.31 c	21.74 g	29.53 c
T3 (6 g L-1)	0.82	0.71	0.77 c	41.99 b	24.78 f	33.39 b
T4 (8 g L-1)	0.80	0.68	0.75 c	43.74 a	26.81 e	35.27 a
Mean	0.86 a	0.72 b		38.73 a	22.68 b	

Means having common letters are non- significant at $p < 0.05$

Days to maturity

The length of the rising season has a profound effect on the marketability of date palm in different regions. The data regarding days to maturity presented in Table 6 indicated significant variation, whereas date varieties and their interaction were found to be non-significant. The maximum days to maturity (155.10 days) were noted in pollen concentration treatment T1 (2 g L^{-1}), followed by statistically similar days to maturity in T2 (4 g L^{-1}), T3 (6 g L^{-1}) and T4 (8 g L^{-1}) treatments. The higher days to maturity taken by T1 (2 g L^{-1}) as compared to other treatments might be due to maximum competition among the fruits for light and nutrients continuous supply for the development of larger and heavier fruits. These findings are consistent with those of Al-Khalifa (2006) and Iqbal et al. (2011), who found that pollen sources influenced fruit ripening time. Similar findings were reported by Abdel (2012).

Fruit weight bunch^{-1} (kg)

The major yield parameters of date palm are the cluster weight and the number of bunches per plant. The data presented in Table 6 indicated that date palm varieties and pollen concentrations produced important variation in bunch weight, whereas their interaction could not produce any significant response among the interaction means. The maximum bunch weight of 9.44 kg was noted in the Dhakki variety as compared to the Zahidi variety, which produced a bunch weight of 5.77 kg. The data concerning pollen concentrations indicated that maximum bunch weight of 8.77 kg was noted in T4 (8 g L^{-1}) followed by statistically like bunch weight of 8.05 and 7.76 kg in T3 (6 g L^{-1}) and T2 (4 g L^{-1}), respectively, while the lowest bunch weight of 6.82 kg was observed in T1 (2 g L^{-1}). The higher single bunch weight of Dhakki as compared to Zahidi variety is a direct response to the genetic potential of the Dhakki variety. The maximum bunch weight in T4 treatment might be the result of the highest fruit set and retention as compared with the rest of the treatments, which had lower fruit set % and retention. These results agreed with the results of Awad (2010), who observed maximum bunch weight when pollinated with higher concentrations of suspended pollen.

Table 6: Effect of different suspended pollen concentrations on Days to maturity and Fruit weight bunch^{-1} (kg) of date palm cultivars Dhakki and Zahidi

Pollen concentration	Days to maturity			Fruit weight bunch^{-1} (kg)		
	Varieties		Mean	Varieties		Mean
	Dhakki	Zahidi		Dhakki	Zahidi	
T_1 (2 g L^{-1})	155.17 NS	155.04	155.10 a	8.49 NS	5.16	6.82 c
T_2 (4 g L^{-1})	153.73	153.07	153.40 b	9.81	5.71	7.76 b
T_3 (6 g L^{-1})	153.07	152.67	152.87 b	10.32	5.78	8.05 b
T4 (8 g L^{-1})	152.43	152.63	152.53 b	11.13	6.41	8.77 a
Mean	153.60 NS	153.35		9.94 a	5.77 b	

Means having common letters are non- significant at $p < 0.05$

Fruit yield (kg plant^{-1})

The final goal of all the running performs is to increase the fruit yield of any date palm variety. The significant variation was noted between varieties, pollen concentrations, whereas their interaction was found non-significant (Table 7). The maximum fruit yield plant (159 kg) was observed in Dhakki as compared to the Zahidi variety, which produced a fruit yield of 57.66 kg plant^{-1}. The data with respect to pollen concentrations presented that the highest fruit yield of 121.13 kg per plant was noted in T4 (8 g L^{-1}), followed by T3 (6 g L^{-1}) and T1 (2 g L^{-1}) by producing 111.48 kg and 107.48 kg per plant, respectively. The lowest fruit yield of 93.68 kg per plant was noted in the T1 (2 g L^{-1}) treatment. The highest fruit yield plant^{-1} of Dhakki as compared to the Zahidi variety may be due to the genetic potential of high yield as compared to the Zahidi variety. Data about pollen concentrations showed that the highest fruit yield per plant in T4 (8 g L^{-1}) and T3 (6 g L^{-1}), as compared to T2 (4 g L^{-1}) and T1 (2 g L^{-1}), might be due to heavy fruit set% % and retention capacity in T4 and T3 treatments. These findings are consistent with those of Iqbal et al. (2008).

Table 7: Effect of different suspended pollen concentrations on the yield of date palm cultivars Dhakki and Zahidi

Pollen concentration	Varieties		Mean
	Dhakki	Zahidi	
T1 (2 g L^{-1})	135.79 NS	51.57	93.68 c
T2 (4 g L^{-1})	156.96	57.10	107.48 b
T3 (6 g L^{-1})	165.12	57.83	111.48 ab

T4 (8 g L^{-1})	178.13	64.13	121.13 a
Mean	159.00 a	57.66 b	

Conclusion

It was concluded from the present research study that Pollen concentrations (treatments) had varying influences on fruit set, fruit set percent, fruit size, bunch weight, and fruit production per plant, among other things. T4 (8 g L-1) treatment had the maximum fruit set and fruit production per plant. Treatment T3 (6 g L-1) and T2 (4 g L-1) also produced reasonable fruit yield with high-value dates. T1 (2 g L-1) treatment produced the highest quality fruits, but with a lesser total yield. The effect of pollen concentration was equal and independent on both varieties under study. The highest fruit yield in the Dhakki variety, as compared to the Zahidi variety, may be the result of improved genetic potential of the Dhakki variety.

Conflict of interest

The authors acknowledged that the present study was completed in the absence of any conflict of interest.

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