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Variations in Achene Traits, Germination, and Seedling Growth of *Pluchea dioscoridis* (L.) DC. as Affected by Maternal Climatic Aridity

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THE COLLECTION and germination of seeds for conspecific population distributed along climatic gradients can elucidate maternal environmental effects on achene traits, germination, and seedling establishment and fitness. The current study explored this approach for the natural populations of *Pluchea dioscoridis* (L.) DC. (Asteraceae), which grows over a wide range of climatic regions in Egypt (Mediterranean, semiarid, and arid). The arid region showed the smallest achene size and pappus length, whereas the achene size of the Mediterranean region was >36% and >27% larger than those of arid and semiarid regions, respectively. In general, seed viability decreased with aridity and ranged from 41.96% in semiarid to 9.32% in arid regions. Achenes from the three maternal climatic regions began germinating at approximately the same time, but the germination rates proceeded differently. The achene germination percentage ranged from 10% in arid regions to 33.54% in semiarid regions. The study showed a significant effect of maternal climatic aridity on achene traits, germination rate, and final germination percentage of *P. dioscoridis*. However, the survival rate in the three climatic regions became constant after 130 days of sowing. The results demonstrated how such widespread species acquire multiple maternal traits and mechanisms to optimize their adaptation, regeneration, and conservation of populations in stressful environments. However, further studies are required to demonstrate the phenotypic plasticity, reproductive efforts, and mechanism of dormancy loss of *P. dioscoridis* under different natural climatic conditions.

Keywords: Achene traits, Climatic gradient, Dormancy, Fitness, Germination, Seed viability.

Introduction

The production of seeds and their quality are important for plant continuity through a compatible offspring. The maternal effects have an intensive impact on the offspring phenotype and consequently the next-generation performance through maternal genes and phenology and the environment experienced by the mother plant (Wolf & Wade, 2009; Baroux & Grossniklaus, 2015). Climatic conditions are the forefront factors that affect mother plants (Li et al., 2017; Nilofer et al., 2018). Given their impact on the subsequent plant generation, the changes in plant environment and climatic gradients resulted in concentrated interest on the effect of such events on plant life cycle starting from seed viability and germination to plant fitness (Münzbergová et al., 2017; Alshoaibi, 2021). On the other hand, several plants lose a few of their seeds, seedlings, or individuals (Funkenberg et al., 2012); others display adaptive plasticity under climatic changes (Mclean et al., 2014). Long day length and photoperiod during seed development of the maternal plant environment have been associated with high seed dormancy and low germinability (Baskin & Baskin, 1998; Gutterman, 2000). Several studies recorded changes in the reproductive traits and resource allocations of numerous species in response to climate changes (Hegazy, 2000;

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Kathiresan & Gualbert, 2016; Wang et al., 2017). Moreover, certain plant species shift their life cycles to either annual or perennial depending on water availability (Hegazy, 2001).

Maternal environment affects seed development and metabolism, size, composition (Bradford & Nonogaki, 2007), seed number (Yang, 2018), and dormancy (Andersson & Milberg, 1998), and this effect extends after seed dispersal during germination and fitness (Boratyński et al., 2016; Yang, 2018). These seed traits are largely affected by the maternal environmental factors, such as temperature, water availability, soil moisture and nutrients, light quality, and photoperiod (Andersson & Milberg, 1998; Hrdličková et al., 2011; Sales et al., 2013; Li et al., 2017).

Several studies reported low levels of seed dormancy and high seed germination associated with short days, high temperature, and drought of the maternal environment (Lehtinen & Kaukovirta-Norja, 2011; López et al., 2019). A low seed dormancy is generally associated with high temperature during seed development, and it can be due to the high synthesis of promoting compounds (e.g., gibberellins) or reduced synthesis of inhibitory substances (e.g., abscisic acid) at high temperature (Wang et al., 2016; Gallon et al., 2018). On the other hand, environmental conditions, such as drought and photoperiod, increase seed coat thickness during seed development and consequently reduce seed germinability (Gutterman, 1992 & 2000; Baskin & Baskin, 1998; Silva et al., 2018).

Delayed germination through seed dormancy and existence in seed banks are buffering mechanisms against harmful effects under a temporally stress environments (Valleriani, 2005). Consequently, seed maturation in such a stressful environment is associated with a low germination, whereas seeds that matured under more predictable conditions should exhibit higher germination fractions. Specific mature seeds can remain dormant and viable to allow them to disperse in space and time and overcome a stressing and unfavorable environment (Bentsink & Koornneef, 2008; Bewley et al., 2013). These seeds can modulate their schedule to germinate only when environmental signals predict successful seed germination and seedling establishment to maximize plant fitness (Bradford & Nonogaki, 2007). However, most of these studies attributed these differences to the formation of various ecotypes than to adaptive maternal effects. Therefore, the importance of aridity and/or drought as a climatic induced maternal effect has not been conclusively established. Furthermore, limited pieces of evidence indicate that the maternal aridity environment can have important fitness consequences for the next generation of perennial shrubs compared with annual herbs and grasses (Kigel, 1992; del Cacho et al., 2013).

Climatic aridity gradient is a well-recognized key selective force and represent a standard approach for investigating local adaptation of maternal seeds to aridity (Del Pozo et al., 2002; Petrů et al., 2006). In Egypt, climatic aridity gradients exist over relatively short distances along the coastal and inland deserts of Egypt (El-Bana, 2008; Sheded, 2008; Shaltout et al., 2020). The collection and germination of seeds for conspecific *P. dioscoridis* populations (two or more individuals within the same population) distributed along climatic gradients can elucidate the maternal environmental effects on seed viability and fitness. The current study explored this approach for the natural populations of *Pluchea dioscoridis* (L.) DC. (Asteraceae), which grows over a wide range of climatic regions and natural and anthropogenic habitats in Egypt (Shaltout & El-Kady, 1999; Shaltout & Slima, 2007; El-Bana, 2015; Abdelaal, 2017). *Pluchea dioscoridis* is common in all geographic regions, including Mediterranean coastal strip, Western and Eastern Deserts, the Nile region, and Sinai Peninsula (Shaltout & Slima, 2007: Boulos, 2009). *P. dioscoridis* is mainly propagated by seeds which are easily dispersed by wind and flowing water due to the presence of fine, capillary pappus hairs. However, the formation and effect of such pappus on seed germination have not been explored for *P. dioscoridis*.

This study examined the maternal effect of climate aridity on seed germination and early seedling fitness of *P. dioscoridis* because it invaded numerous habitats in Eastern and Western Deserts and resulted in their degradation and biodiversity loss (Abd El-Ghani et al., 2011; Ahmed et al., 2018). Climatic aridity was hypothesized to be a key factor affecting maternal seed development and consequently seed germination rate. This research specifically highlighted the following questions: (1) Do achene traits in terms of size and pappus length affect by aridity? (2) Do seeds from the population of an arid maternal environment differ in in terms of germination rate from those of semiarid and Mediterranean regions? (3) Does the presence of pappus extend or amplify the influence of maternal aridity on seed germination? (4) How does the aridity of seed environment affect the establishment and fitness of seedlings?

Materials and Methods

Study sites

Ten populations of *P. dioscoridis* were explored within three climatic regions from the Mediterranean coast in the north to the inland desert in the south over a 350km gradient (Table 1). The mean annual rainfall in the Mediterranean coast is around 100–130mm, whereas the mean annual rainfall in the southern part in Suez desert is below 50mm (Table 2). Accordingly, water availability is the main driving force that represents severe north–south aridity gradient. The annual mean of precipitation from 2000 to 2018 ranged from 46.11mm/year in the arid region to 103.35mm/year in the Mediterranean coast. In addition, the relative humidity ranged from 49.6% to 64.5% in the arid and Mediterranean regions.

Achene collection and traits

Freshly maturated achenes of *P. dioscoridis* were collected randomly from each population in the three climatic regions (Mediterranean, semiarid, and arid) during the dispersal period from May 2017 to September 2017. Achenes were gathered from at least 10 shrubs in each population. They were stored for one year at room temperature with labeled paper bags for each population type. Achenes have a leathery pericarp and persistent pappus, which are difficult to separate from seeds (Boulos, 2002; Gamal et al., 2017). A sample of 10 random achenes from each population was selected to measure their traits. Digital images of whole achenes were photographed with Optica C-B5 camera attached to an Optica stereo microscope (Model: LAB 20). The images were exported to Adobe Photoshop software CC (2015), where the achene area and pappus length were measured automatically in the horizontal view (Riba et al., 2005).

TABLE 1. Locations, latitude, longitude, and abbreviation of the studied populations

Climate region	Population location	Latitude	Longitude	Abbrev.
Mediterranean	Port Said Governorate	31° 16’ 17.742” N	32° 15’ 45.1548” E	PSD1
	Port Said – Al Ismailia highway	31° 12’ 48.0348” N	32° 17’ 59.028” E	PSD5
	Port Said – Damietta highway	31° 16’ 39.3888” N	32° 15’ 58.932” E	PSD6
Semi-arid	Port Said – Al Ismailia highway	30° 56’ 36.5316” N	32° 18’ 30.7152” E	ISM1
	Al Ismailia Governorate	30° 34’ 23.0376” N	32° 11’ 38.5908” E	ISM2
	Port Said – Al Ismailia highway	30° 44’ 38.6592” N	32° 15’ 32.2812” E	ISM4
	Port Said – Al Ismailia highway	30° 56’ 32.2044” N	32° 18’ 31.5324” E	ISM5
Arid	Al Ismailia – Al Suez highway	30° 31’ 11.1144” N	32° 15’ 6.9768” E	SUZ2
	Al Ismailia – Al Suez highway	30° 13’ 25.5432” N	32° 24’ 52.3224” E	SUZ3
	Al Suez - Cairo highway	29° 58’ 12.9” N	32° 8’ 26.4984” E	SUZ4

TABLE 2. Annual record of precipitation, relative humidity at 2 meters%, dew/frost point at 2m, temperature (°C), temperature range, and minimum and maximum temperature from 2000 to 2018 at Port Said, Ismailia, and Suez area meteorological stations (https://power.larc.nasa.gov/data-access-viewer/)

Parameter	Mediterranean	Semi-arid	Arid
Precipitation	103.35	62.11	48.44
Relative humidity%	64.5	53.89	49.71
Dew/frost point	14.29	11.25	9.295
Temperature	21.58	21.67	21.13
Temp range	6.5	12.56	13.345
Temp. max	25.24	28.69	28.38
Temp. min	18.73	16.13	15.04

Seed viability

Seed viability was examined by the tetrazolium chloride method (Lakon, 1949). At least 100 seeds from each population were examined. Seeds were soaked in distilled water for 24h and immersed in (1%) tetrazolium chloride for 24h. Seed coats were detached under a stereomicroscope. Stained viable seeds were recorded and expressed as a percentage. Seed viability was tested at the same time during the planting experiment to avoid any loss in viability during storage.

Seed germination

The germination experiment was carried out in the greenhouse at the Faculty of Science, Port Said University (31° 15′ 29.196″ N, 32° 16′ 35.076″ E). During the experiment, the green house was covered with a shade net and plastic sheet to avoid rains. For each population, three replicates of 40 seeds (counted under the stereomicroscope because of their small size and light weight) were sown in experimental pots (14cm deep and 20cm in diameter) filled with a mixture of 1:1 sand:peat moss and exposed to natural day light and ambient temperature on 23 November 2018. This sowing date synchronized with the germination of *P. dioscoridis* at the field sites. The experimental germinated seedlings were grown for 172 days. Seeds were considered to have germinated as soon as cotyledons emerged above the soil and germination, which is represented by the percentage of germinated seeds that was calculated using the following formula:

Germination %= (number of germinated seeds)/ (number of sown seeds)× 100%

The germination time from sowing to the last germinated seed in each population was calculated.

Seedling survival, establishment, and fitness

The survival was recorded for populations which had at least five seedlings. It was calculated periodically over 134 days starting from the end of germination time to the end of the experiment. The seedling survival was calculated as follows:

Seedling survival %= (Number of survived seedlings)/ (Total number of germinated seeds) × 100

The seedlings were considered to be established when a constant survival percentage was observed. The establishment was calculated at the end of experiment duration (172 days from planting) as follows:

Establishment %= (Number of established seedlings at 172 days (end of experiment))/ (Total number of germinated seeds)× 100

Plant early-stage fitness is the probability of a plant to reach the reproductive stage. Germination and establishment are important factors for the prediction of the probability of plant survival until this stage. Thus, they can be used as predictors of fitness (Zaghloul & Moustafa, 2011).

Fitness= Germination% * Establishment%

Statistical analysis

Statistical analyses of achene traits and germination indices were performed using IBM SPSS 25 software. One-way analysis of variance (ANOVA) followed by Tukey's honestly significant difference pairwise comparisons were used to evaluate the differences among climatic regions and populations.

Results

Achene traits

The arid region showed the smallest achene size and pappus length (Fig. 1). The largest achene size and the longest pappus were recorded in the Mediterranean region. The achene size from the Mediterranean region population was >36% and >27% larger than those of arid and semiarid regions, respectively. Similarly, the lengths of pappus from the Mediterranean region were 18% and 16% larger than those from arid and semiarid regions, respectively.

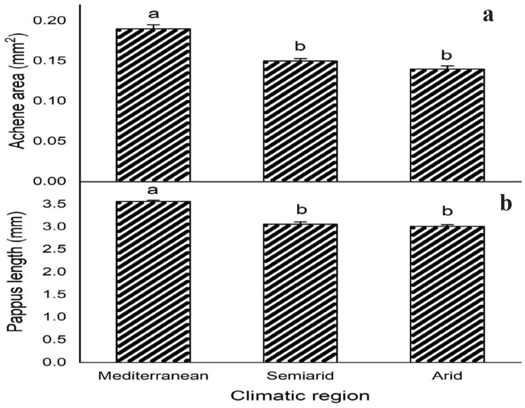

Fig. 1. Achene size and pappus length in the three different climate regions [Bars with different letters are significantly different at P≤ 0.05 (Tukey's test)]

Seed viability

The seed viability results showed a high significant difference (P≤ 0.01) among different climatic regions and populations. In general, seed viability decreased with aridity and ranged from 41.96% in semiarid to 9.32% in arid regions (Table 3). Similarly, the lowest seed viability was recorded for SUZ4 population (1.6%) in the arid region, whereas the highest seed viability was found for ISM1 population (80.8%) in the semiarid region.

Seed germination

In general, the germination of *P. dioscoridis* seeds varied greatly between the three regions, and five weeks were needed to record the last germinating seeds for semiarid region populations (ISM1, ISM4, and ISM5). Meanwhile, in the Mediterranean region populations, the results showed a high variation in germination period, ranging from 10 days (PSD6) to five weeks (PSD5 population) (Fig. 1a, b). The lowest period for germination, that is, 14 days, was recorded in the arid region populations (SUZ2, SUZ3, and SUZ4). Seeds from the three maternal climatic regions began to germinate at approximately the same time, but their germination rates proceeded differently (Fig. 2). The final percentage of germinating seeds was strongly affected by maternal climatic environment. The seeds produced in semiarid maternal plants germinated faster than those from either the Mediterranean or arid populations. Germination was the lowest for achenes produced by plants grown in the arid region (Fig. 2). The germination percentage significantly differed between the regions and populations (Table 3). The achene germination percentage ranged from 10% for the arid region to 33.54% for the semiarid region (Fig. 3a). Among populations, the germination percentage ranged from 4.17% in PSD6 population in Mediterranean region to 75% in ISM1 population in the semiarid region.

Survival rate, establishment, and fitness of seedlings

Most populations of the three climatic regions showed a constant survival rate after 130 days of sowing. The last recorded decrease in survival percentage was 115 days in SUZ4 population in the arid region (Fig. 3). The highest mean establishment percentages were recorded for seedlings of the Mediterranean region (91.14%) and its populations PSD1, PSD5, and PSD6 (88.89%, 84.53%, and 100%, respectively) (Table 3). Meanwhile, the lowest mean establishment percentage was for semiarid region (34.36%) and its populations ISM1 and ISM4 (18.79% and 6.27%, respectively). Early-stage fitness of seedlings ranged from 0.05 to 0.15 for arid and Mediterranean regions. The lowest fitness index was 0.017 in the ISM4 population of the semiarid region, whereas the highest one was 0.308 in population PSD5 of the Mediterranean region (Table 3).

Discussion

Climatic aridity affected achene traits, seed germination, seedling survival, and establishment of *P. dioscoridis.* The current study explored how climatic maternal environment is related to seed germination and survival of *P. dioscoridis*, with wide distribution and differences in reproductive traits. Our results showed that the arid achenes were smaller and had a shorter pappus compared with those present in the semiarid and Mediterranean regions. Such differences in achene morphology can be related to the differences in soil resources and probably to the dispersal ability of different populations, indicating that the level of risk strategy can vary for the various climatic regions. This condition suggests that the great risk of *P. dioscoridis* in the arid region is associated with the low cost of resources invested in the production of small achenes and short pappus. This strategy has been documented as an evolutionary adaptation in species that grow in highly harsh environments (Venable & Levin, 1985; Yan et al., 2019).

Pappus length and fruit size are indicators of seed dispersal (Riba et al., 2005). Seed dispersal allows offspring to escape from stressful conditions, inhabit new areas, and avoid inbreeding depression (Levin et al., 2003; Teller et al., 2014; Rubio de Casas et al., 2015). As extension to phenotypic variations, the results showed the capability of climate change to affect *P. dioscoridis* reproductive output, showing a significant decrease in achene size and pappus length toward the south direction with the increase in aridity. As for other morphological parameters, they were correlated positively with water-related climatic factors and negatively with temperature. Similar results were obtained for Mediterranean and desert shrubs (Kigel, 1992; del Cacho et al., 2013).

TABLE 3. Achene size and pappus length in the three different climate regions. Bars with different letters are significantly different at $P \leq 0.05$ (Tukey's test)

Region	Population	Viability%		Germination%		Establishment%		Fitness index	
		Mean	S.E	Mean	S.E	Mean	S.E	Mean	S.E
Mediterranean	PSD1	36.26	3.02	12.50	1.44	88.89	11.11	0.108	83.33
	PSD5	47.12	0.28	36.67	4.41	84.52	3.83	0.308	333.33
	PSD6	19.30	11.03	4.17	1.67	100.00	0.00	0.042	166.67
Semi-arid	ISM1	80.79	7.17	75.00	3.82	18.79	11.30	0.132	743.10
	ISM2	15.26	3.50	13.33	3.00	45.24	24.86	0.075	433.01
	ISM4	31.43	2.80	28.33	3.00	6.27	3.29	0.017	83.33
	ISM5	26.20	5.05	17.50	4.33	67.14	8.92	0.125	433.01
Arid	SUZ2	23.33	5.09	6.67	0.83	61.11	5.56	0.042	83.33
	SUZ3	3.03	3.03	11.67	3.63	43.81	22.15	0.067	363.24
	SUZ4	1.59	1.59	11.67	6.01	19.44	10.02	0.033	166.67
Mediterranean		38.52 a	4.72	17.78 a	5.08	91.14 a	4.10	0.15 a	0.04
Semi-arid		41.96 a	8.17	33.54 b	7.56	34.36 b	9.41	0.09 ab	0.02
Arid		9.32 b	3.93	10.00 a	2.20	41.46 b	9.40	0.05 b	0.01
ANOVA among populations		12.1	< 0.00**	35.50	< 0.00**	6.529	< 0.00**	5.776	0.001**
ANOVA among regions		7.46	0.003**	4.23	0.025*	12.93	< 0.00**	3.179	0.058

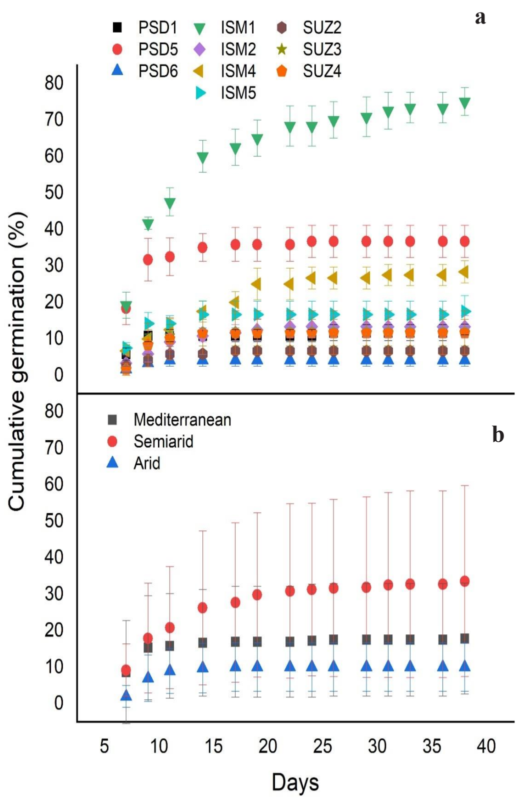

Fig. 2. Cumulative germination percentage ± S.E. of the achenes of *Pluchea dioscoridis* from different populations and climatic regions

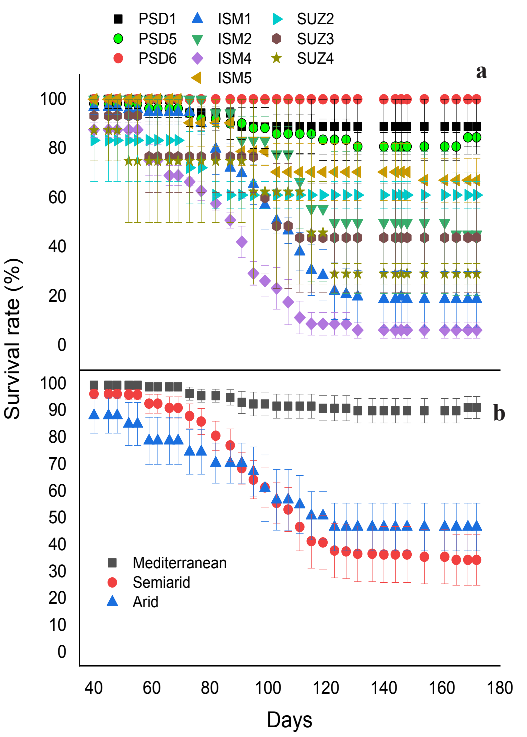

Fig. 3. Survival rate ± S.E. of *Pluchea dioscoridis* from different populations and climatic regions over 172 days

The stressed environmental conditions experienced by mother plants strongly affected the percentage and quality of their achene germination and may explain the functional variability in germination and establishment within the same species (Roach & Wulff, 1987; Sales et al., 2013). The present study showed that the germination percentage of arid achenes was lower compared with those of Mediterranean and semiarid regions. The achenes from semiarid mothers were over 20% more likely to germinate than seeds from arid mothers at the end of the germination experiment. Thus, the loss of dormancy was lower in the arid region than in either Mediterranean or semiarid regions. The dormancy of *P. dioscoridis* achenes collected from the arid climatic region may have ecological significance because they mature in habitats with relatively high temperature and highly unpredictable soil moisture. Dormancy and delayed germination in achenes of Asteraceae species, which mature in high temperature and low water availability, are considered as an adaptive strategy to cope with stressful environmental habitats (Venable & Lawlor, 1980). Such strategy can create long-term soil seed banks that enhance seedling establishment and survival during favorable germination conditions (Bentsink & Koornneef, 2008; Bewley et al., 2013; Yan et al., 2019).

On the other hand, the low seed germination of arid achenes can be related to the to the small achene size, short pappi length, and substantial reduction in seed viability compared with the other climatic achenes. As indicated in numerous cases, small-seed germination is slower than that of large ones (Vleeshouwers et al., 1995; Soltani et al., 2018). The length of pappi either increases, decreases, or is unaffected by the germination percentage (Van Auken, 2013; Francoline et al., 2018). Pliszko & Kostrakiewicz-Gierałt (2020) observed that the positive or negative effect of pappus removal on seed germination and speed of germination is species dependent. Thus, *P. dioscoridis* produces small achene and short pappi in arid climate to ensure the contact of achenes with the soil surface and continuity of moisture conditions for enhanced water imbibition and germination at the beginning of the rainy season. The viability of the tetrazolium test demonstrated that most arid achenes were in a state of dormancy and did not germinate.

The effects of maternal environment are

frequently the strongest in seed traits and seedling stages, but they become less important at the maturity stage (Stevens et al., 2020). The maternal environment exhibited the significant effect of maternal climatic aridity on achene traits, germination rate, and final germinating percentage of *P. dioscoridis*. However, the survival rate of the three climatic regions was constant after 130 days of sowing. The results showed that achenes from the arid maternal population germinated earlier than those from semiarid or Mediterranean climatic regions. Furthermore, achenes of *P. dioscoridis* demonstrated considerable variation in germination among populations. Achenes from different populations started germination at the same time, whereas their rates and final germination were different. Altogether, these climatic- and population-induced effects can result in significant differences in fitness due to the maternal environment and may give a fitness advantage in environmental conditions as those experienced by the mothers (Farnocchia et al., 2019). Such advantage can be conferred to the high establishment and fitness of Mediterranean seedlings grown in the same climatic conditions of their mothers.

Conclusion

The present results indicate that the different climatic achenes of *P. dioscoridis* with various germination patterns can be responsible for their widespread temporally and spatially. Furthermore, the results demonstrated how such common species acquire multiple maternal traits and mechanisms to optimize their adaptation, regeneration, and conservation of populations in stressful environments. However, further studies are required to demonstrate the phenotypic plasticity, reproductive efforts, and mechanism of dormancy loss of *P. dioscoridis* under different natural climatic conditions.

Conflict of interest: The authors declare no conflict of interest.

Author contributions: Raghda H. Shahda: Conceptualization, methodology, software, formal analysis, investigation, data curation, writing original draft, review & editing. Magdy El-Bana: Conceptualization, methodology, software, investigation, validation, writing, review & editing, supervision. Mona El-Bous: Conceptualization, methodology, investigation, validation, supervision. Mohamed S. Zaghloul: Conceptualization, methodology, software, investigation, validation, writing, review & editing, supervision.

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الاختـــلاف في صفـــات الثمار (فقيرة) والانبـــات ونمـــو البادرات لنبـــات البرنـــوف (Pluchea dioscoridis (L.) DC) نتيجة تأثر النبات الأم بالمناخ القاحل

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تنقب هذه الدراسة عن مدى تأثير بيئة النبات الام على كل من صفات الثمار الناتجة والانبات ومعدل البقاء خلال المراحل الاولى من عمر البادرات والملائمة للبيئة من خلال جمع وانبات بذور العشائر الموزعة طوليا علي دوائر عـرض مختلفة. تهـدف الدراسة الحاليـة لاستكشاف هــذه الصفات في عشائــر نباتــات البرنوف (*Pluchea dioscoridis* (L.) DC) التي تنتمي للعائلة النجمية (المركبة) والتي تنمو على نطاق واسع من المناطق المناخية في مصر (البيئة المتوسطية وشبه القاحلة والقاحلة). سجلت ثمار المناطق القاحلة اصغر حجم للفقيرة وطول الزغب، بينما كانت ثمار عشائر منطقة البحر المتوسط اكبر بنسبة 36% و27 % من ثمار المناطق القاحلة والشبه قاحلة على الترتيب. بصورة عامة تقل حيوية البذور بزيادة الجفاف؛ فتراوحت حيويتها من 41.96% في المناطق شبه القاحلة إلى 9.32% في المناطق القاحلة. على مستوي الانبات: بدأت نباتات المناطق الثلاث في الانبات في نفس الوقت تقريبا لكن معدل الانبات كان مختلفًا. كما تراوحت نسبة انبات الثمار من 10% إلى 33.54% في المناطق الشبه القاحلة والقاحلة على التوالي. اوضحت الدراسة التأثير المعنوي للجفاف المناخي على النباتات الام من خلال معدل الانبات ونسبته النهائية. ومع ذلك، فإن معدل البقاء على قيد الحياة كان ثابتا بعد 130 يوما من الزراعة. اظهرت النتائج كيف يتأثر هذا النبات الشائع بالبيئة المحيطة بالنباتات الام فيكتسب منها صفات التكيف مع البيئات المجهدة. ومع ذلك هناك حاجة للمزيد من الدراسات للدونة المظهرية وآليات الكمون والتكاثر في ظل الظروف المناخية المختلفة.