HPSI of date palm (*Phoenix dactylifera* L.) varieties/ genotypes against fruit borers, *Batrachedra amy*draula and *Arenipses sabella* in hot arid region

SM Haldhar, RS Singh & D Singh

Journal of Agriculture and Ecology

ISSN: 2456-9410

Volume: 11

Journal of Agriculture and Ecology (2021) 11: 26-36
http://doi.org/10.53911/JAE.2021.11103

Journal of Agriculture and Ecology, 2021, Vol. 11, 26-36
http://saaer.org.in

Research Article Open Access

HPSI of date palm (*Phoenix dactylifera* L.) varieties/ genotypes against fruit borers, *Batrachedra amydraula* and *Arenipses sabella* in hot arid region

SM Haldhar*, RS Singh[1] & D Singh[1]
[1]*ICAR-Central Institute for Arid Horticulture, Sri Ganganagar Highway, Beechwal Industrial Area, Bikaner (Rajasthan) – 334006, India*
**Present Address: Department of Entomology, College of Agriculture (CAU), Iroisemba, Imphal, Manipur–795004, India*
Corresponding author: SM Haldhar, E-mail: haldhar80@gmail.com

Article Info

Article history
Received: 01 March 2021
Accepted: 20 June 2021
Available online: 30 June 2021

Key Words: HPSI, differential susceptibility, date palm, *Batrachedra amydraula* and *Arenipses sabella*.

Abstract

Host plant resistance is an important component for management of the fruit borers, *Batrachedra amydraula* and *Arenipses sabella* owing to difficulties associated with its chemical and biological control. A total of 32 date palm varieties/ genotypes were evaluated for screening against the fruit borers in hot arid region. The results showed that the percentage of fruit infestation of fruit borers, *B. amydraula* and *A. sabella* on tested varieties/ genotypes of datepalm varied significantly. Pooled data showed that the Migra, Tayer, Javantri and Medjool were found highly tolerant varieties/ genotypes with fruit infestation (5.32%, 8.40%, 8.40%, 8.78% of *B. amydraula* and 4.33%, 5.27%, 5.62%, 5.52% of *A. sabella*, respectively). Whereas, the varieties/ genotypes Zahidi, Suriya, Khasab and Khuneizi had fruit infestation (29.88%, 28.33%, 28.27%, 27.05% of *B. amydraula* and 20.67%, 19.83%, 17.40%, 19.95% of *A. sabella*, respectively) and declared as highly infestation varieties/ genotypes to the fruit borers. Lower values of host plant susceptibility indices based on fruit infestation (HPSI) were recorded on resistance varieties/ genotypes, Migra, Tayer, Javantri and Medjool (31.63%, 49.97%, 49.97%, 52.25% of *B. amydraula* and 40.16%, 48.81%, 52.05%, 51.13% of *A. sabella*, respectively) which could be used as a source of resistance for developing date palm varieties/ genotypes resistant to fruit borers.

Preferred citation: Haldhar SM, Singh RS & Singh D. 2021. HPSI of date palm (*Phoenix dactylifera* L.) varieties/ genotypes against fruit borers, *Batrachedra amydraula* and *Arenipses sabella* in hot arid region. *Journal of Agriculture and Ecology*, 11: 26-36; http://doi.org/10.53911/JAE.2021.11103.

Introduction

Date palm cultivation is traditional to the arid zones and it is prone to biotic stresses that have detrimental effects on its growth, development, production and productivity. In India, Gujarat, Rajasthan and Punjab are major states for datepalm cultivation. The area under date palm orchards is 500 ha in Rajasthan and 10 ha Punjab. The coastal belt

of Kachch in Gujarat has is the major producer giving a production of 85,000 tones of khalas fruits. However, the production and productivity is concern low as compared to world average maily because of biotic and abiotic stresses and non availability quality planting material. Unlike the traditional methods of date palm cultivation, presently tissue culture propagated plants widely planted by the farmers therefore, the it needs essentially extra care especially at pre-propagation stage (also called stage 0) requires proper maintenance of the mother plants in the greenhouse under disease- and insect-free conditions. Clean enclosed areas, glasshouses, plastic tunnels, and net-covered tunnels, provide high quality explant source plants with minimal infection. Collection of plant material for clonal propagation should be done after appropriate pretreatment of the mother plants with fungicides and pesticides to minimize contamination in the *in vitro* cultures (Holdgate & Zandvoort 1997; Swaminathan & Haldhar 2010; Haldhar et al. 2017).

Many arthropod species are known as pests of the date palm (*Phoenix dactylifera* L.) throughout the World. Carpenter and Elmer (1978) reported on more than 50 species of insects and mites as pests of date palms in worldwide. In Israel, approximately 25% of these species of insects and mites are considered serious pests. The most dominant and economically important pests are scale insects (*Parlatoria blanchardii*, and *Phoenicococcus marlatt*), a mealy bug (*Dysmicoccus brevipes*), the lesser date moth (*Batrachedra amydraula*), greater date moth (*Arenipses sabella*), red palm weevil (*Rhynchophorus ferrugineus*), rhinoceros beetle (*Oryctes rhinoceros*) and the termite, *Psammotermes hypostoma* (Blumberg 2008; Haldhar et al. 2015). The lesser date moth (*Batrachedra amydraula* Myer) is a pest that damages fruits in both fields and stores (Dowson 1982). It is one of the major pests of date palm cause the yield loss upto 50-70% (Elwan 2000). Larvae found to damage the large number of young fruits from April to June or July (Zaid 1999). Since1980s, it has gradually spread throughout most of the date growing plantations of the country, where it has become a major pest of newly set and young green date fruits. The moth is highly specific to the date palm and no reports are known of infestation of other host plants by this moth. In severe infestation most of the infested fruits drop to the ground; the bunch ceases to grow, and then dries. Thus lesser date moth injuries to the palms cause considerable fruit drop and losses of upto 75% of the yield (Blumberg 1975). The greater date moth (GDM) generally occurs throughout the date-growing regions of North Africa, the Middle East and northern India (Carpenter & Elmer 1978). Damage is caused by both the spring and the summer generations. Larvae of the spring generation infest mainly tender fronds of young leaves; they feed upon inflorescences and immature dates, and burrow through fruit stalks at the point where the fruit strands arise. Cultivation of varieties/ genotypes tolerant to fruit borers is a crucial component of integrated pest management programmes for date palm because of difficulties associated with chemical and biological control. Development of date palm varieties/ genotypes tolerant to fruit borers has

been limited in India owing to inadequate information on the sources of plant traits associated with tolerant to pest infestations. The present study was designed to screen of date palm varieties/ genotypes for tolerance against fruit borers in terms of fruit infestation under field conditions.

Materials and Methods

The established thirty-two varieties/ genotypes of date palm at the field gene bank at experimental farm of ICAR-CIAH, Bikaner (at 28°06'45.0"N 73°20'52.4"E and altitude of 234.84m above sea level) were used for preliminary resistance study. Twenty fruits were randomly selected from each replication and average incidence was recorded as percent fruit infested with fruit borers, *Batrachedra amydraula* and *Arenipses sabella* during 2017 and 2018.

Calculation of host plant susceptibility indices (HPSI)

The host plant susceptibility indices were to determine the role of varieties/ genotypes towards susceptibility in percentage within the test materials. The HPSI was calculated by the following formula (Haldhar et al. 2013).

Percent HPSI = 100 – (B-A)/ B × 100

Where, A is larval population per fruit or percent fruit infestation in individual genotype of date palm and B is larval population per fruit or percent fruit infestation on all varieties/ genotypes of date palm on average basis.

Statistical analysis

Transformations (angular) were used to achieve normality in the data before analysis (Steel et al. 1997), but untransformed means are presented in tables. The data on percentage fruit infestation was analyzed through one-way ANOVA using SPSS 16 (O'Connor 2000). The means of significant parameters, among tested varieties/ genotypes, were compared using critical difference (CD) tests for paired comparisons at probability level of 5%.

Results and Discussion

The significant differences were found in percentage fruit infestation of fruit borers, *B. amydraula* and *A. sabella* among the 32 tested varieties/ genotypes of date palm during screening (Plate 1). Pooled data showed that the Migra (5.32%), Tayer (8.40%), Javantri (8.40%) and Medjool (8.78%) varieties/ genotypes were found highly tolerant with fruit infestation of *B. amydraula* and Migra (4.33%), Tayer (5.27%), Medjool (5.52%) and Javantri (5.62%) varieties/ genotypes were also tolerant to fruit infestation of *A. sabella*. Whereas, the varieties/ genotypes Zahidi (29.88%), Suriya (28.33%), Khasab (28.27%) and Khuneizi (27.05%) had highly infested with *B. amydraula*. The varieties/ genotypes of date palm, Zahidi (20.67%), Suriya (19.83%), Khuneizi (19.95%) and Khasab (17.40%) were also highly incidence of fruit borer, *A. sabella*.

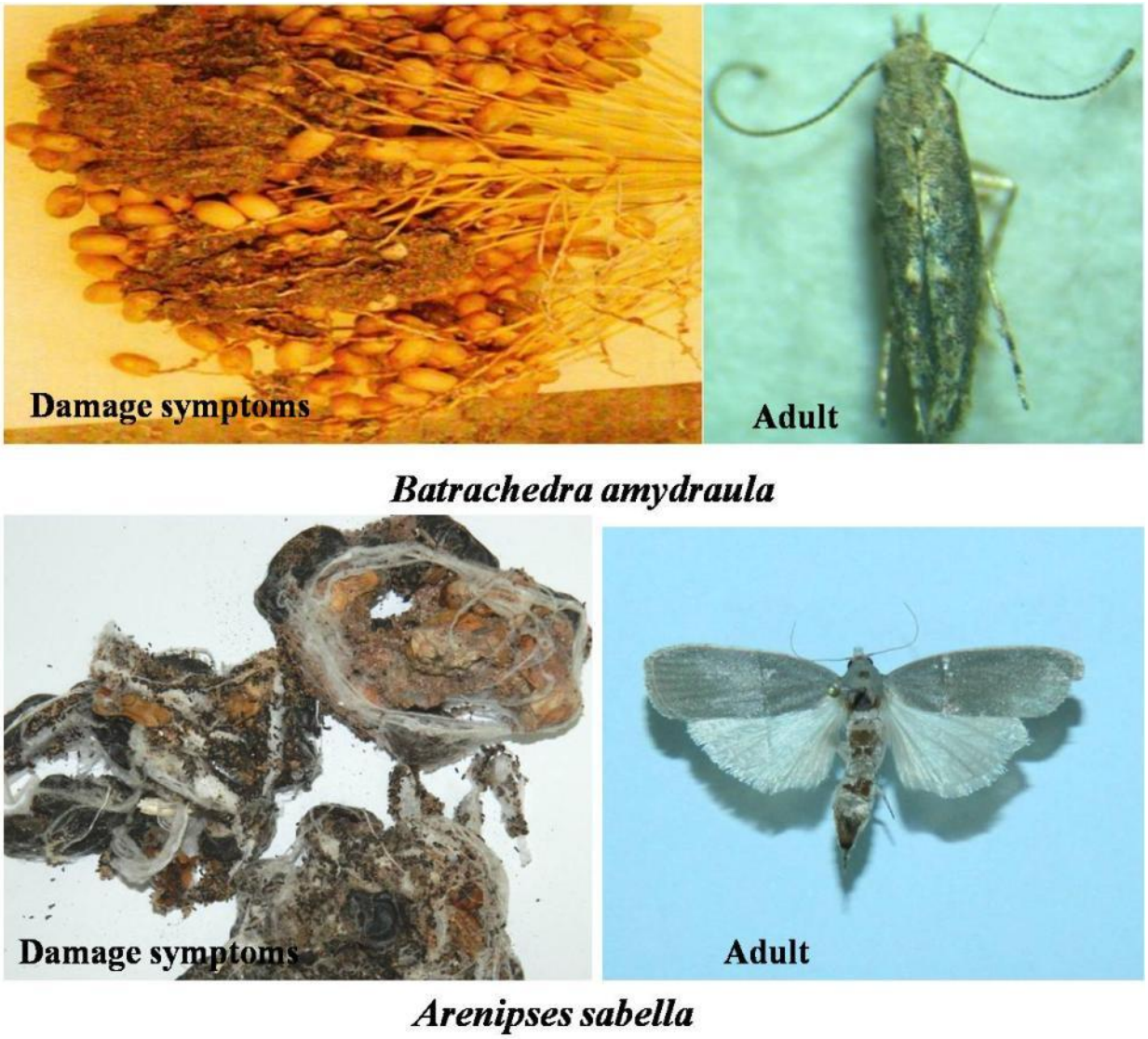


Plate 1. Damage symptoms and adults of fruit borers, *B. amydraula* and *A. sabella*

The per cent fruit infestation was lowest in Migra (5.32% & 4.33% of *B. amydraula* and *A. sabella*, respectively) followed by Tayer (8.40% & 5.27% of *B. amydraula* and *A. sabella*, respectively) and Javantri (8.40% & 5.62% of *B. amydraula* and *A. sabella*, respectively) and highest in Zahidi (29.88% & 20.67% of *B. amydraula* and *A. sabella*, respectively) followed by Suriya (28.33% & 19.83% of *B. amydraula* and *A. sabella*, respectively). The fruit infestation was ranged from (5.32 to 29.88 % & 4.33 to 20.67% of *B. amydraula* and *A. sabella*, respectively) and significantly low in tolerant varieties/ genotypes and high in susceptible varieties/ genotypes (Table 1, Graph 1, Plate 2). Faleiro et al. (2014) revealed that the popular date palm cultivar Khalas had the least antixenotic effect on female RPW adults where a high degree of attraction to palm tissue volatiles was recorded, which was statistically similar to the cultivars Reziz,

Sheshi and Hatmi. The cultivars Khasab, Shahal and Gaar exhibited high degree of non-preference (antixenosis). Further, Reziz registered the highest egg lay by red palm weevil and was statistically on par with the cultivars Khalas and Sheshi. Similar and non-significant values for egg hatch and larval tunneling in the cultivars tested indicate no antibiotic effects against RPW in the 7 date palm cultivars. The studies carried out in Qatar (Elmeer et al. 2011) using new microsatellite markers to assess the genetic diversity among 10 major date palm cultivars (including 5 from our study) revealed 2 distinct groups. Among the cultivars we studied for resistance to RPW, the report from Qatar placed Khalas, Sheshi and Reziz in one cluster of the 6 cultivars while the cultivars Khasab and Shahal in another cluster of 4 cultivars. Since seedling date palms are the original source of most of the present well established cultivars (Johnson et al. 2013), the RPW susceptible (Khalas, Sheshi and Reziz) and resistant cultivars (Shahal and Khasab) may have evolved from 2 separate seeding date palm progenies with distinctly different genes for resistance to RPW. Numerous studies have shown that varieties of different crops with same insect species could significantly differ in their resistance to insect pests (Sarfraz et al. 2006; Gogi et al. 2010, Haldhar et al., 2013) and it is caused by biochemical traits of plants.

Table 1. Per cent fruit infestation of fruit borers, *Batrachedra amydraula* and *Arenipses sabella* on different varieties/ genotypes of datepalm in arid region

S. No.	Varieties / genotype	2017		2018		Pooled 2017-18	
		B. amydraula fruit infestation (%)	*A. sabella* fruit infestation (%)	*B. amydraula* fruit infestation (%)	*A. sabella* fruit infestation (%)	*B. amydraula* fruit infestation (%)	*A. sabella* fruit infestation (%)
1	Halawy	17.67 (24.82)	11.97 (20.20)	17.77 (24.90)	12.20 (20.41)	17.72 (24.86)	12.08 (20.31)
2	Khalas	14.30 (22.21)	9.20 (17.63)	14.47 (22.34)	9.40 (17.83)	14.38 (22.27)	9.30 (17.73)
3	Khaderavy	18.33 (25.34)	12.70 (20.87)	18.63 (25.56)	12.90 (21.04)	18.48 (25.45)	12.80 (20.95)
4	Shamran	11.53 (19.82)	8.20 (16.61)	11.90 (20.15)	8.37 (16.79)	11.72 (19.98)	8.28 (16.70)
5	Zahidi	29.80 (33.06)	20.57 (26.96)	29.97 (33.17)	20.77 (27.10)	29.88 (33.12)	20.67 (27.03)
6	Braim	13.60 (21.61)	8.20 (16.61)	13.83 (21.81)	8.40 (16.82)	13.72 (21.71)	8.30 (16.72)
7	Chip-Chap	15.93 (23.49)	7.70 (16.05)	16.20 (23.70)	7.87 (16.23)	16.07 (23.60)	7.78 (16.14)

8	Sewi	11.33	5.67	11.53	5.83	11.43	5.75
		(19.62)	(13.75)	(19.80)	(13.96)	(19.71)	(13.86)
9	Khuneizi	26.97	19.80	27.13	20.10	27.05	19.95
		(31.27)	(26.40)	(31.37)	(26.61)	(31.32)	(26.51)
10	Binte-	12.97	6.43	13.23	6.53	13.10	6.48
	Aisha	(21.07)	(14.67)	(21.30)	(14.78)	(21.18)	(14.73)
11	Medjool	8.70	5.40	8.87	5.63	8.78	5.52
		(17.13)	(13.39)	(17.30)	(13.69)	(17.22)	(13.54)
12	Hayani	14.73	10.33	14.97	10.60	14.85	10.47
		(22.55)	(18.70)	(22.74)	(18.94)	(22.64)	(18.82)
13	Khair	13.73	9.80	13.93	10.00	13.83	9.90
		(21.73)	(18.20)	(21.90)	(18.40)	(21.82)	(18.30)
14	Dayari	22.03	13.40	22.30	13.57	22.17	13.48
		(27.97)	(21.46)	(28.16)	(21.60)	(28.07)	(21.53)
15	Medini	26.20	14.30	26.37	14.57	26.28	14.43
		(30.76)	(22.21)	(30.87)	(22.42)	(30.82)	(22.31)
16	Saidy	12.70	7.73	13.00	7.93	12.85	7.83
		(20.85)	(16.09)	(21.11)	(16.30)	(20.98)	(16.20)
17	Sabiah	16.07	8.20	16.30	8.37	16.18	8.28
		(23.59)	(16.61)	(23.78)	(16.79)	(23.69)	(16.70)
18	Javantri	8.30	5.53	8.50	5.70	8.40	5.62
		()16.71	(13.54)	(16.92)	(13.75)	(16.82)	(13.64)
19	Local	13.97	8.23	14.20	8.37	14.08	8.30
	Bikaner	(21.92)	(16.66)	(22.11)	(16.80)	(22.02)	(16.73)
20	Gulchati	10.07	7.50	10.20	7.67	10.13	7.58
		(18.47)	(15.87)	(18.59)	(16.05)	(18.53)	(15.96)
21	Punjab	14.13	8.70	14.37	8.80	14.25	8.75
	red	(22.06)	(17.14)	(22.25)	(17.24)	(22.15)	(17.19)
22	Khasab	28.17	17.33	28.37	17.47	28.27	17.40
		(32.03)	(24.59)	(32.16)	(24.69)	(32.10)	(24.64)
23	Muscat	18.23	12.63	18.47	12.97	18.35	12.80
		(25.25)	(20.79)	(25.43)	(21.08)	(25.34)	(20.93)
24	Sayar	12.73	8.27	13.07	8.43	12.90	8.35
		(20.88)	(16.65)	(21.16)	(16.83)	(21.02)	(16.74)
25	Tayer	8.27	5.20	8.53	5.33	8.40	5.27
		(16.67)	(13.16)	(16.95)	(13.33)	(16.81)	(13.25)
26	Nagal	25.13	16.13	25.37	16.33	25.25	16.23
		(30.07)	(23.67)	(30.22)	(23.82)	(30.15)	(23.75)

27	Suriya	28.20 (32.06)	19.73 (26.35)	28.47 (32.23)	19.93 (26.49)	28.33 (32.14)	19.83 (26.42)
28	Ahmat	18.50 (25.45)	14.50 (22.36)	18.77 (25.65)	14.70 (22.53)	18.63 (25.55)	14.60 (22.44)
29	Migra	5.17 (13.12)	4.23 (11.85)	5.47 (13.51)	4.43 ()12.13	5.32 (13.32)	4.33 (11.99)
30	Kotho	25.97 (30.62)	16.50 (23.95)	26.23 (30.79)	16.67 (24.08)	26.10 (30.70)	16.58 (24.02)
31	Hamara	18.70 (25.60)	10.93 (19.27)	18.87 (25.73)	11.03 (19.36)	18.78 (25.66)	10.98 (19.32)
32	Seddani	12.03 (20.27)	7.17 (15.47)	12.17 (20.38)	7.40 (15.72)	12.10 (20.32)	7.28 (15.59)
SEm±		**0.69**	**0.67**	**0.70**	**0.68**	**0.69**	**0.67**
CD (P = 0.05)		**1.96**	**1.91**	**1.94**	**1.91**	**1.95**	**1.91**

Data presented are mean of three replications

Figures in parentheses are angular value

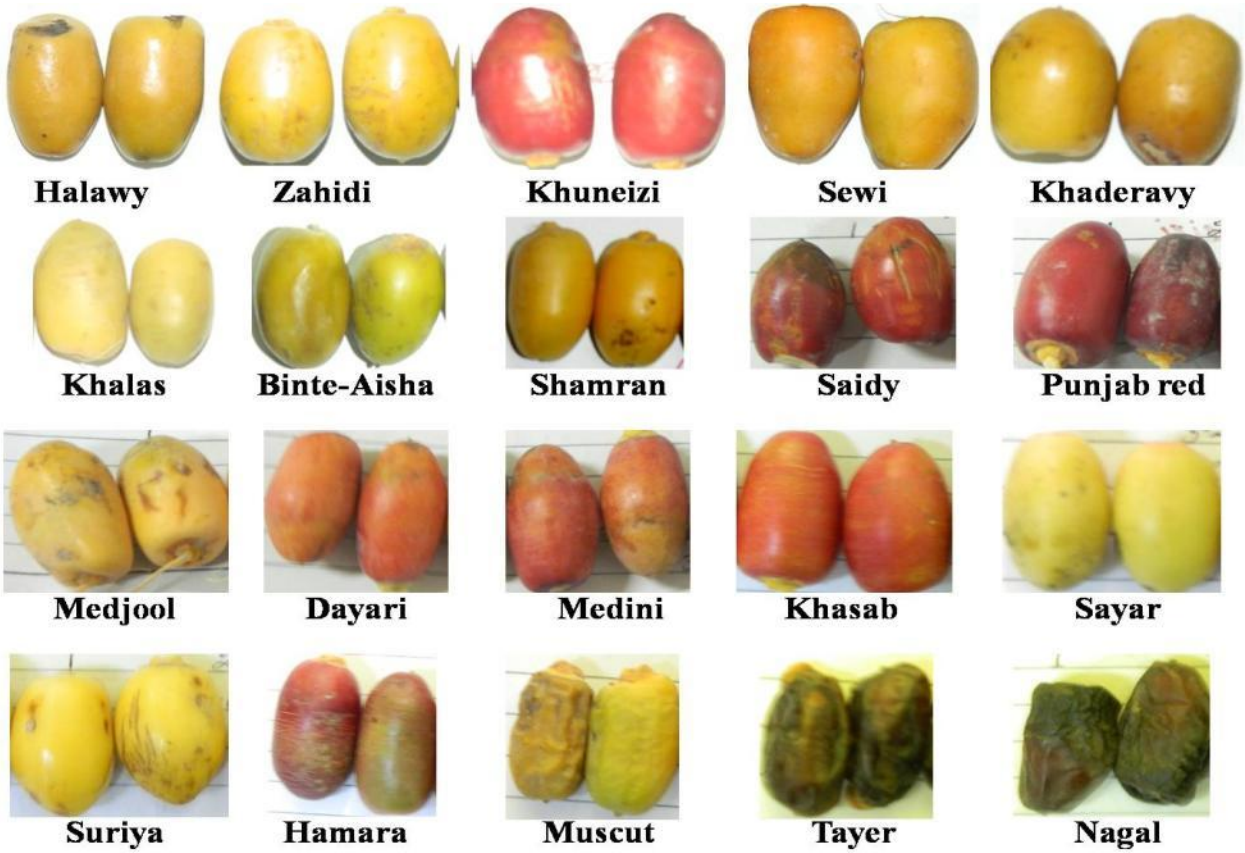
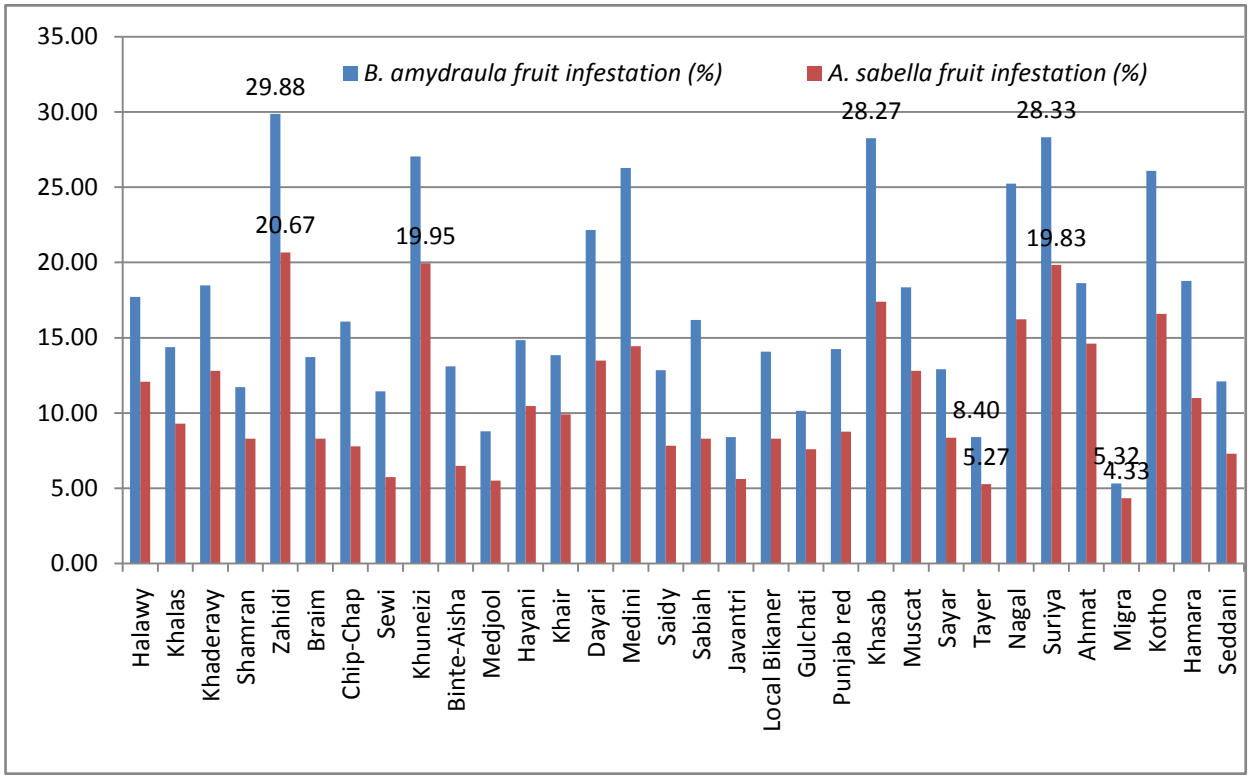


Plate 2. Differernt varieties of date palm using for screening against fruit borers, *B. amydraula* and *A. sabella*

Journal of Agriculture and Ecology, 2021, Vol. 11, 26-36
http://saaer.org.in

Figure 1. Per cent fruit infestation of fruit borers, *Batrachedra amydraula* and *Arenipses sabella* on different varieties/ genotypes of datepalm in arid region



The results presented in Table 2 are regarding HPSI in different varieties/ genotypes of date palm based on the percent fruit infestation of fruit borers, *B. amydraula* and *A. sabella* during 2017, 2018 and pooled of 2017-18. It was observed that the genotype Zahidi showed maximum HPSI based on fruit infestation *i.e.*, 177.77% followed by Suriya showing 168.55 % HPSI against fruit borer, *B. amydraula*. The minimum HPSI based on fruit infestation was 31.63% for Migra which was found to be tolerant genotype followed by Tayer (49.97% HPSI) against fruit borer, *B. amydraula*. HPSI was observed that the genotype Zahidi showed maximum HPSI based on fruit infestation *i.e.*, 191.54% followed by Khuneizi showing 184.89 % HPSI against fruit borer, *A. sabella*. The minimum HPSI based on fruit infestation was 40.16% for Migra which was found to be tolerant genotype followed by Tayer (48.81% HPSI) against fruit borer, *A. sabella*. On the basis of percent fruit infestation, the highest HPSI was recorded in Zahidi categorized as highly susceptible to fruit borers and lowest HPSI was found in Migra categorized as resistance to fruit borers. According to Shahid et al. (2014), the genotype Cool Sun-70 showed 27% HPSI followed by Cauliflower Desi 26%. The minimum HPSI was calculated 9% for Pari F1 and Shumila F1. The genotypes Cashmere and White Island were categorized as intermediate with 14% and 15% HPSI, respectively. The genotype Cool

Sun-70 showed a maximum population of *P. brassicae* and was found to be comparatively susceptible with 30.02 populations per plant whereas, the genotype Pari F1 appeared comparatively resistant with the lowest population of *P. brassicae i.e.* 3.44 per plant.

Table 2. Host plant susceptibility indices (HPSI %) for fruit borers, *Batrachedra amydraula* and *Arenipses sabella* on different varieties/ genotypes of datepalm in arid region

S. No.	Varieties/ genotypes	HPSI based on *B. amydraula* fruit infestation (%)			HPSI based on *A. sabella* fruit infestation (%)		
		2017	2018	Pooled 2017-18	2017	2018	Pooled 2017-18
1	Halawy	105.85	105.00	105.39	111.94	112.13	111.99
2	Khalas	85.68	85.50	85.56	86.06	86.40	86.19
3	Khaderavy	109.85	110.13	109.95	118.80	118.57	118.63
4	Shamran	69.10	70.33	69.70	76.71	76.90	76.77
5	Zahidi	178.55	177.11	177.77	192.39	190.87	191.54
6	Braim	81.49	81.76	81.60	76.71	77.21	76.92
7	Chip-Chap	95.47	95.74	95.58	72.03	72.30	72.13
8	Sewi	67.90	68.16	68.02	53.01	53.62	53.29
9	Khuneizi	161.57	160.36	160.92	185.22	184.74	184.89
10	Binte-Aisha	77.69	78.21	77.93	60.18	60.05	60.09
11	Medjool	52.13	52.40	52.25	50.51	51.78	51.13
12	Hayani	88.28	88.46	88.34	96.66	97.43	97.00
13	Khair	82.28	82.35	82.29	91.67	91.91	91.75
14	Dayari	132.02	131.80	131.87	125.35	124.69	124.96
15	Medini	156.98	155.83	156.36	133.77	133.88	133.77
16	Saidy	76.09	76.83	76.44	72.34	72.92	72.60
17	Sabiah	96.27	96.34	96.27	76.71	76.90	76.77
18	Javantri	49.73	50.24	49.97	51.76	52.39	52.05
19	Local Bikaner	83.68	83.92	83.78	77.02	76.90	76.92
20	Gulchati	60.32	60.28	60.28	70.16	70.47	70.28
21	Punjab red	84.68	84.91	84.77	81.38	80.88	81.09
22	Khasab	168.76	167.65	168.15	162.15	160.54	161.26
23	Muscat	109.25	109.14	109.16	118.18	119.18	118.63
24	Sayar	76.29	77.23	76.74	77.33	77.51	77.39
25	Tayer	49.53	50.43	49.97	48.64	49.02	48.81
26	Nagal	150.59	149.92	150.21	150.92	150.12	150.45
27	Suriya	168.96	168.24	168.55	184.60	183.21	183.81

28	Ahmat	110.84	110.91	110.85	135.64	135.11	135.31
29	Migra	30.96	32.31	31.63	39.60	40.75	40.16
30	Kotho	155.58	155.04	155.26	154.35	153.19	153.69
31	Hamara	112.04	111.51	111.74	102.28	101.41	101.79
32	Seddani	72.10	71.91	71.98	67.04	68.01	67.50

The present study explores new horizons of providing detailed characteristics of various date palm varieties/ genotypes regarding susceptibility and tolerant to fruit borers. The results show that the Migra, Tayer, Medjool and Javantri were found to be tolerant against fruit borers, *Batrachedra amydraula* and *Arenipses sabella*. However, further investigations are required to elucidate the response of morphological and biochemical factors on these varieties/ genotypes against fruit borers and other pests.

Acknowledgements

Authors are thankful to Director, ICAR-Central Institute for Arid Horticulture, Bikaner, for providing facilities, land and other inputs required for experimentation and Dr. R. Swaminathan, Associate Professor, Department of Entomology, MPUAT, Udaipur for critical discussion and suggestions.

References

Blumberg D. 1975. Preliminary notes on the phenology and biology of *Batrachedra amydraula* Meyrick (Lepidoptera: Cosmopterigidae) a new pest of date palms in Israel. *Phytoparasitica*, 3: 55-57.

Blumberg D. 2008. Review: Date palm arthropod pests and their management in Israel. *Phytoparasitica*, 36 (5):411-448.

Carpenter JB & Elmer HS. 1978. Pests and diseases of the date palm. U.S. Dep. Agric. Agric. Handbk, 527: 1-42.

Dowson VHW. 1982. Date production and protection. Food and Agriculture organisation of the United Nations, Roma, FAO. Plant production and protection paper 35, pp.1-294.

Elmeer K, Sarwath H, Malek J, Baum M & Hamwieh A. 2011. New microsatellite markers for assessment of genetic diversity in date palm (*Phoenix dactylifera* L.). *Biotechnology*, 1: 91-97.

Elwan AA. 2000. Survey of the insect and mite pests associated with date palm trees in Al-Dakhliya region. Sultanate of Oman. *Egypt. Agriculture Research*, 78 (2): 653-664.

Faleiro JR, El-Shafie HAF, Ajlan AM & Sallam AA. 2014. Screening date palm cultivars for resistance to red palm weevil, *Rhynchophorus ferrugineus* (Coleoptera: Curculionidae). *Florida Entomologist*, 97(4):1529-1536.

Gogi MD, Ashfaq M, Arif MJ, Sarfraz RM & Nawab NN. 2010. Investigating phenotypic structures and allelochemical compounds of the fruits of *Momordica charantia* L. genotypes as sources of resistance against *Bactrocera cucurbitae* (Coquillett) (Diptera: Tephritidae). *Crop protection*, 29: 884–890.

Haldhar SM**,** Choudhary BR, Bhargava R & Sharma SK. 2013. Screening of ridge gourd varieties/ genotypes (*Luffa acutangula*) for resistance fruit fly (*Bactrocera cucurbitae*) in hot arid

region of Rajasthan. *Indian Journal of Arid Horticulture*, 8 (1-2): 21-24.

Haldhar SM, Karuppaiah V, Muralidharan CM & Sharma SK. 2015. Insect-pests of date palm and their management. '*Insect Pests Management of Fruit Crops'* edited by A. K. Pandey and Pramod. Mall published by Biotech Books, New Delhi: 405- 421**,** ISBN: 978-81-7622-358-4.

Haldhar SM**,** Maheshwari SK & Muralidharan CM. 2017. Pest status of date palm (*Phoenix dactylifera*) in arid regions of India: a review. *Journal of Agriculture and Ecology*, 3: 1-11.

Holdgate DP & Zandvoort EA. 1997. Strategic considerations for the establishment of microorganism free tissue cultures for commercial ornamental micropropagation. In: pathogen and microbial contamination management in micropropagation. Cassells, A.C. (Ed.) Kluwer Academic Publications, Dordrecht. Pp.15-22.

Johnson DV, Al-Khayri JM & Jain SM. 2013. Seedling date palms (*Phoenix dactylifera* L.) as genetic resources. *Emirates Journal of Food and Agriculture*, 25(11): 809-830.

O'Connor BP. 2000. SPSS and SAS programs for determining the number of components using parallel analysis and Velicer's MAP test. *Behavior Research Methods, Instrumentation and Computer*, 32: 396–402.

Sarfraz M, Dosdall LM & Keddie BA. 2006. Diamondback moth–host plant interactions: implications for pest management. *Crop Protection*, 25: 625–639.

Shahid I, Muhammad A, Muhammad AK & Nazir J. 2014. Cultivar variation of cauliflower against cabbage butterfly *Pieris brassicae* (L.) Pieridae: Lepidoptera. *Pakishtan Journal of Agriculture Science*, 51(2), 325-329.

Steel RGD, Torrie JH & Dickey DA. 1997. *Analysis of variance II*: multiway classifications. In: Steel RGD, Torrie JH, Dickey DA, Editors, Principles and Procedures of Statistics: A Biometrical Approach (third ed.), WCB/McGraw-Hill, USA, 204–252.

Swaminathan R & Haldhar SM. 2010. Biotic stresses in date palm due to pests- a review. National workshop on Date Palm, 4th October, 2010 at CIAH, Bikaner, pp 173-183.

Zaid A. 1999. African palm weevil, *Rhynchophorus phoenicis* F. attack on date palm in the Republic of South Africa and Zimbabwe. Middle East Red Palm Weevil Workshop, 26-29 January, 1999; Cairo-Egypt.