

Influence of Pinnae Position, Leaf Age and Some Fungicides on the Development of Graphiola Leaf Spot on Date Palm

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Abstract

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Fifteen date palm (*Phoenix dactylifera* L.) cultivars were evaluated against leaf spot or false smut caused by *Graphiola phoenicis* (Mung.) Poit. The % infection and number of sori caused by *Graphiola* were compared in relation to leaf age and pinnae position on leaves. Most of the cultivars did not express disease symptoms on their one year old leaves. However, significant correlations between % infection and number of sori for second and third year old leaves were established. Correlation studies and 't' test revealed that recording disease severity on middle and basal position of pinnae and second year old leaves represent a better indicator for evaluation of cultivars against *Graphiola* leaf spot. Thus, cultivar 'Abdul Rehman' and 'Muskat no. 2' were found to be the most tolerant while 'Bint Ashia' and 'Pakistan' were categorised as highly susceptible to *Graphiola* infection. On the basis of minimum apparent infection rate (r), four sprays of carbendazim + mancozeb (0.1+0.3%) or copper oxychloride (0.2%) at an interval of 30 days starting from November were found significantly superior in controlling *Graphiola* leaf spot on a susceptible cultivar 'Halaway'.

Key words: Date palm, *Phoenix dactylifera*, False smut, *Graphiola phoenicis*

Introduction

The date palm (*Phoenix dactylifera* L.), one of the oldest cultivated fruits of the world, serves as a staple food for the bulk of the population in many Arab countries and elsewhere. Leaf spot or false smut caused by *Graphiola phoenicis* (Mung.) Poit. is a serious disease in most of the date palm growing regions of the world (2, 5, 7). The intensity of the disease is considerably high on the palms grown in arid and semi-arid regions of India in spite of low humidity (4, 10), though data are not available on effect of the disease on yield. Chemical control of the disease by systemic fungicides has been recommended (8).

Nixon (9) has observed variation in the response of leaves of different age to fungal infection. Due to such variations, it was found difficult to ascertain the intensity of *Graphiola* infection on different varieties and efficacy of fungicides for its effective management. The present investigation, therefore, aims to develop an effective screening procedure to evaluate date cultivars and study efficacy of fungicides against *Graphiola* leaf spot under arid conditions.

Materials and Methods

Evaluation of Cultivars

The experiments were conducted at the Central Arid Zone Research Institute, Jodhpur, India. Fifteen 7-8 year old date palm cultivars (Table 1) maintained at the experimental orchard of the Institute were screened for a period of three years under field conditions. Severity of *Graphiola* leaf spot under natural field conditions was considerably high, therefore, it was not considered necessary to create artificial epiphytic conditions. To develop a screening procedure, two leaves representing annual growth (1, 2 and 3 year old) were tagged randomly at the apical, middle and basal section and labeled as 11-12, 21-22 and 31-32 where first letter denoted the age and second as the leaf number. The date leaf age can be determined approximately by its position on the trunk in relation to inflorescence which is being subtended by leaves that emerged the previous year (9).

One plastic sheet was cut in the a similar to that of a pinnae and two rectangular holes, each of 2² cm (1 x 2 cm) were made at a distance of 2.5 cm. The number of sori were

counted in these openings in both the adjoining pinnae of apical, middle and basal region of each leaf. Thus, there were 12 and 72 observations on each leaf and tree, respectively. Simultaneously, % infection due to *Graphiola* leaf spot was recorded visually on the same leaves following the scale developed on the basis of area covered.

Chemical Control

Chemical control studies were conducted on a susceptible cultivar 'Halaway' for two years. Four sprays of fungicides viz., benomyl (0.05 and 0.1%), carbendazim (0.05 and 0.1%), mancozeb (0.3 and 0.4%), mancozeb + carbendazim (0.3 + 0.1%) and copper oxychloride (0.1 and 0.2%) were applied at an interval of 30 days starting from November until February. Plants sprayed with water at same intervals served as control treatment. One tree served as one unit and each treatment was replicated four times in a completely randomized block design. Observations on the development of *Graphiola* leaf spot in the form of sori (4 sq cm) and disease incidence (%) were recorded before every spray and 30 days after the last spray on 2nd and 3rd year old leaves as described for screening date cultivars. Disease development in each treatment was calculated after pooling the data recorded for one tree by using the following formula:

$$\% \text{ Disease control} = \frac{[\% \text{ infection in the final observation} - \% \text{ infection at the initial observation}]}{[\% \text{ infection at the initial observation}]}$$

The apparent infection rate ('r') /unit/ day was calculated on the basis of disease intensity at different time intervals as per the method of Van-der Plank (14).

$$r = \frac{2.3}{t_2 - t_1} \log \frac{x_2(1 - x_1)}{x_1(1 - x_2)}$$

Where 'r' denotes the apparent infection rate/unit/day, $t_2 - t_1$ is the time interval between the first and the last observation, x_1 and x_2 represent the disease intensity at t_1 and t_2 time intervals, respectively.

The data on % infection or apparent infection rate were subjected to analysis of variance (ANOVA) to identify the

significance of main effects of cultivars and efficacy of fungicides in relation to leaf age and pinnae position and their 2- and 3- factor interactions on the development of *Graphiola*. Fisher's LSD test was used for mean separation of various treatments (11). Correlation analysis was done to determine the relationship between % infection and number of sori, and regression equations were determined. Paired "t" test was performed to compare % infection and number of sori on apical, middle and basal leaf position.

Results and Discussion

Evaluation of Cultivars

Incidence of *Graphiola* leaf spot increased significantly in three year compared to two year old leaves in all the fifteen date cultivars evaluated for three consecutive seasons (Table 1). Nine date cultivars did not express manifestation of the *Graphiola* symptoms in their one year old leaves in spite of close proximity of heavily infected two and three year old leaves on the same tree. Similar increase in disease development were noted on onion infected with *Botrytis* blight, with older leaves more severely affected than younger leaves (1). Among infected leaves, significant variation in infection was observed with regard to the pinnae position on the leaves.

Table 1. Mean % infection due to *Graphiola* leaf spot at different pinnae positions on date palm cultivars.

Cultivars	Pinnae positions on leaf *			
	Apical	Middle	Basal	Mean
Muskat No 2	4.1	6.7	10.2	7.0
Pakistan	6.1	19.1	23.8	16.3
Umshok	9.7	17.6	19.3	15.5
Gizaz	5.0	14.4	19.4	12.9
Abdul Rehman	3.2	6.4	10.8	6.8
Halaway	5.3	11.4	17.4	11.3
Shamran	7.7	14.8	15.5	12.6
Sedami	3.9	10.2	15.8	9.9
Bikaner	8.1	12.9	21.0	14.0
Bint Ashia	7.2	21.6	28.9	19.2
Nagar hill	4.6	9.1	12.1	8.6
Medjool	10.0	16.2	15.4	13.8
Khadraway	6.3	10.5	18.1	11.6
Dayari	7.2	10.3	14.5	10.6
Medani	3.9	15.7	23.6	14.4
Mean	6.1	13.1	17.7	12.3

* Average of 2nd and 3rd year old leaves

LSD at P=0.05 for Cultivars= 1.18, Age of leaf = 0.64, pinna position = 0.68, Cultivars x age of leaf = 1.71, Cultivars x P=pinna position = 1.81, Age of leaf x pinna position = 0.96, Cultivar x age of leaf x pinna position = 2.75

In general, apical pinnae contracted minimum whereas, basal pinnae had maximum infection *Graphiola*. The % infection and number of sori caused by *Graphiola* on leaves of fifteen date palm cultivars were compared in terms of age or pinnae position on a leaf using paired 't' test. The test revealed significant differences among cultivars for all the pinnae positions and age of the leaf (Table 2). The middle and basal pinnae position on leaf had higher 't' values compared to apical position. Maximum contribution in mean infection was also recorded on basal (40.75%) followed by middle (35.13%) and apical pinnae (24.10%). This could be attributed to relatively younger age of the apical portion

compared to the other two positions. This was further substantiated by our observation that only traces of infection was recorded in one year old leaves. Deposition of more wax on young leaves may act as a structural defense against *Graphiola* infection besides some other biochemical parameters. Waxes are thought to play a defensive role on leaf and fruit surface by forming a hydrophobic surface that acts as water repellent (13, 12). Significant correlation between % infection and number of sori for 2nd and 3rd year was established (Table 3). Since number of sori and % infection are highly correlated, varieties in the field can be screened by visual recording of % infection. The number of sori and per cent infection were more significantly correlated when observations were recorded at middle or basal pinnae positions irrespective of leaf age compared to average of all the three positions (Table 3). Correlation coefficient did differ at middle or basal position in each year. Generally, pruning of date palm leaves is recommended once they attain an age of more than three years. Thus, for recording consistent observations for screening cultivars, middle and basal pinnae positions and second year old leaves are a better choice.

Table 2. Paired 't' test between % infection and number of sori on different pinnae positions on leaf of date palm

Position of pinnae on leaf	% infection	Number of sori
Apical (A)	- 4.76**	- 2.92*
Middle (M)	- 5.50**	- 4.85**
Basal (B)	- 7.23**	- 5.50**
Average of A, M & B	- 6.93**	- 5.84**

** P = 0.01

Analysis of variance for *Graphiola* development on seven selected cultivars (Muskat no.2, Pakistan, Gizaz, Abdul Rehman, Bint Ashia, Nagar hilli and Medani) in relation to leaf age and pinnae position showed that all the cultivars significantly differed in expressing reaction to *Graphiola* (Table 1). Significant differences were also observed within second and third year old leaves, pinnae position and their interactions. On the basis of a three years study, cvs. Abdul Rehman and Muskat No. 2 appeared as most tolerant while cv. Bint Ashia and Pakistan were grouped as highly susceptible. Mehta *et al* (8) screened date cultivars against *Graphiola* leaf spot and found cvs. Khadrawi as resistant. However, in the present study and those of Gaur (6), this cultivar has been classified as moderately susceptible. Occurrence of *Graphiola* is dependent on sufficient atmospheric moisture (9, 4). Rainfall and other climatic conditions during the period of this study were quite conducive for disease occurrence.

Chemical control

On the basis of average of apical, middle and basal pinnae of two and three year old leaves of date palm, minimum apparent infection rate 'r' of 0.008 was recorded for the treatment having a combined spray of carbendazim + mancozeb (Table 4), and was similar to the spray of copper oxychloride (0.2%). Among other fungicides, spray of carbendazim (0.1%), copper oxchloride (0.1%), benomyl (0.1%), mancozeb (0.3%) and carbendazim (0.05%) were not found significantly better than the control.

Table 3. Correlation coefficients (r) and regression equation between % infection (y) and number of sori (x) caused by *G. phoenicis* on fifteen date palm cultivars.

Position of pinnae	2 year old leaf	r	3 year old leaf	r
Apical (A)	Y= 2.95+0.22X	0.32	Y= 4.78+.97X	0.71**
Middle (M)	Y= 2.36+1.24X	0.72**	Y= 6.25+1.27X	0.78**
Basal (B)	Y= 3.32+1.20X	0.72**	Y= 12.70+.98X	0.79**
Average of A, M & B	Y= 3.15+1.01X	0.67**	Y= 7.99+1.09X	0.71**

** P = 0.01

Table 4. Efficacy of fungicides on development of *Graphiola* leaf spot at different pinnae positions of two and three year old date palm leaves.

Fungicides	Concentration %	Apparent infection rate (r)*						Mean
		Two Year old leaf			Three year old leaf			
		Apical	Middle	Basal	Apical	Middle	Basal	
Benomyl	0.05	0.029	0.030	0.023	0.027	0.026	0.025	0.026
	0.1	0.021	0.021	0.018	0.025	0.023	0.016	0.020
Carbendazim	0.05	0.023	0.025	0.022	0.028	0.025	0.021	0.024
	0.1	0.018	0.021	0.010	0.022	0.018	0.013	0.017
Mancozeb	0.3	0.028	0.021	0.022	0.027	0.025	0.021	0.023
	0.4	0.021	0.025	0.018	0.023	0.024	0.017	0.021
Copper oxychloride	0.1	0.019	0.021	0.012	0.027	0.023	0.019	0.020
	0.2	0.016	0.013	0.006	0.013	0.016	0.012	0.012
Mancozeb + carbendazim	0.3+0.1	0.009	0.011	0.003	0.009	0.006	0.010	0.008
Control (Water Spray)	---	0.028	0.026	0.027	0.038	0.026	0.024	0.029

* Pooled average of two year's observations

LSD at P=0.05 for Fungicide = 0.008, leaf age = 0.003, pinnae position.=0.003, Fungicide x leaf age = 0.010, Fungicide x pinnae position = 0.011, leaf age x pinnae position=0.005, Fungicide x leaf age x pinnae position=0.017.

Analysis of variance for efficacy of fungicides on the development of *Graphiola* leaf spot showed that leaf age did not significantly influence the efficacy of fungicide but significant differences were observed with respect to position of pinnae on a leaf (Table 4). Maximum apparent infection rate was recorded at apical position followed by middle and basal position of pinnae. This indicated that rate of spread of *Graphiola* infection is comparatively faster in apical compared to middle and basal position of a leaf. This may be due to availability of more area for infection at the apical part compared to middle and basal part of pinnae on a leaf. Vander Plank (14) also postulated that apparent infection rate decreases with the increase in area under disease.

Our studies demonstrated efficiency of copper oxychloride in the control of *Graphiola* leaf spot. In earlier studies, sprays of a copper based fungicide Bordeaux mixture (2:2:250) was also found effective in the control of disease after the pruning of infected pinnae (4, 9). In the present study, the spray schedule was started in November only after the pruning of infected older leaves, a time coinciding with the maximum development of the disease under arid conditions (6).

Superiority of the carbendazim + mancozeb in controlling *Graphiola* indicate that better control of the pathogen could be achieved by a combination of systemic and contact fungicide. Mehta *et.al.* (8) found effective control with carbendazim but obtained variable results with mancozeb, that could be attributed to the low concentration of mancozeb used. In our experiment also, mancozeb (0.3%) alone was not found effective. Hard and waxy nature of leaves perhaps required higher concentration of fungicide(s).

Infection of *Graphiola* exists round the year on date leaves and the spread of disease varies with the age and position of pinnae on the leaf. Recording % disease index (PDI) on the basis of merely one time observation may provide misleading information. Calculation of apparent infection rate, on the other hand, is the most appropriate scoring system to evaluate efficacy of fungicides for a fast spreading disease (14). These findings can be of practical value in regions where *Graphiola* leaf spot is a serious disease on date palm.

الملخص

لودها، ساتيش. 2003. تأثير موقع الريش، عمر الورقة وبعض مبيدات الفطور في تطور تبقع غرافيو لا (أو التفحم الكاذب) على نخيل التمر. مجلة وقاية النبات العربية. 21: 162-165.

تم تقويم 15 صنفاً من نخيل التمر (*Phoenix dactylifera* L.) إزاء تبقع غرافيو لا أو التفحم الكاذب الذي يحدثه الفطر (*Graphiola phoenicis* (Mung.) Poit. وقد تمت مقارنة نسبة الإصابة وعدد البثرات التي يشكلها الفطر مع عمر الورقة وموقع الريش على الورقة. ولم تظهر معظم الأصناف أعراض المرض على الأوراق بعمر سنة واحدة. على أنه وجد ارتباط مهم ما بين النسبة المئوية للإصابة وعدد البثرات على الأوراق بعمر سنتين وثلاث سنوات. وأظهرت دراسات الارتباط واختبار "t" أن تسجيل شدة المرض على المواقع الوسطى والقاعدية من الريشة وعلى الأوراق بعمر سنتين يشكلان خياراً أفضل لتقويم الأصناف إزاء المرض. وعليه، تبين أن الصنفين "عبد الرحمن" و "المسكي رقم 2" كانا الأكثر تحملاً للإصابة، في حين تم اعتبار الصنفين "بنت عشا" و "الباكستاني" عليا القابلية للإصابة بالمرض. وبلارتكاز على المعدل الأدنى للإصابة الظاهرية (r)، وجد أن أربع رشات من الكارباندازيم + المانكوزيب (0.1 + 0.3%) أو أوكسي كلورو النحاس (0.2%) وبفاصل 30 يوماً بدءاً من شهر تشرين الثاني/نوفمبر كانت الأفضل في خفض شدة المرض على الصنف الحساس "حلوي".

كلمات مفتاحية: نخيل التمر، *Phoenix dactylifera*، تفحم كاذب، *Graphiola phoenicis*.

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