

## EVALUATION OF SOME RAPESEED AND MUSTARD GENOTYPES FOR RESISTANCE TO WHITE RUST DISEASE CAUSED BY *Albugo candida*

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### ABSTRACT

One hundred and six *Brassica* genotypes of four species i.e. *B. napus*, *B. juncea*, *B. campestris*, *B. carinata* were evaluated for resistance to white rust (caused by *Albugo candida*) at seedling stage under controlled conditions (in greenhouse, under artificial epiphytotic conditions) and at adult stage under natural conditions, during the two successive growing seasons 2002/03 and 2003/04 in the experimental farm of Sakha Agricultural Research Station, Kafr El-Sheikh, Egypt. At seedling stage, all *B. napus* lines (55 lines), 4 lines (*B. campestris*) and 3 lines (*B. carinata*) were completely resistant. Four lines of *B. juncea* were moderately resistant, while twenty lines of both *B. juncea* and *B. campestris* were moderately susceptible. The rest of the tested lines (*B. juncea*) were susceptible.

At adult stage, the results showed that 60 lines of *B. napus*, *B. campestris* and *B. carinata* were free from disease during the two growing seasons, whereas 6 lines of *B. juncea* and 4 lines of *B. campestris* exhibited resistance or moderate resistance response during the two seasons. Thirteen lines were moderately susceptible during 2002/03 and eight lines during 2003/04. The rest of the tested lines were susceptible or highly susceptible during the two seasons. The obtained results also showed that, the most susceptible lines had similar consistent percent of disease severity, in general, through the two growing seasons.

Ten lines of *B. juncea* were used to study the occurrence and development of white rust disease under natural field conditions. The results indicated that, almost all of the tested lines gave high reaction (local infection, as pustules on leaves). As regard to systemic infection (stag-head formations), the obtained results indicated that the highest values of stag-head/plant were recorded with line i.e. *B. juncea* Int. 233 that showed severe infection with the disease progress, followed by lines i.e. Int. 239 and Int. 234 that exhibited moderate infection; lines i.e. Int. 333, Int. 160 and Int. 151 that showed slight infection. While, lines i.e. Int. 176, Int. 237 and Int. 246 remained free from symptoms (stag-head formations) although it had localized pustules on leaves.

In general, the present work would be of a great importance and fruitful tool in screening and evaluating canola crop against white rust disease.

### INTRODUCTION

Rapeseed and mustard are grown in large parts of the world for their edible oil and meal. In Egypt they are of recent introduction but still not a commercial crops (El-Ahmar, 1989). Rapeseed crop is subject to be attacked by several diseases which cause serious losses in seed yield and their quality (Kolte, 1983). White rust caused by *Albugo cruciferarum* (*A. candida*) is one of the most serious diseases attacking rapeseed in Egypt (El-Deeb *et al.*, 1989 and Hilal *et al.*, 1989). Two types of infection could be recognized: local and general or systemic (Walker, 1957). Local infections are manifested by

scattered pustules on leaves under surfaces. The symptoms of systemic infection are distortion, hypertrophy, hyperplasia and sterility of inflorescence (stag-heads). Yield loss due to systemic is greater than those resulted from local infections (Harper & Pittman, 1974).

The objectives of this work were to screen for resistance against white rust disease within the available lines of rapeseed and mustard at seedling and adult stages, and studying the development of disease symptoms (local and systemic infection).

## **MATERIALS AND METHODS**

The present work was carried out at Experimental Farm of Sakha Agricultural Research Station, Kafr El-Sheikh, during the period of 2002 to 2005, while the greenhouse experiment was performed at Plant Disease Research Department, Sakha Agric. Res. Stn., Kafr El-Sheikh, during the same period.

The experiments aimed to study the effect of the white rust pathogen (*Albugo candida*) on different types of rapeseed and mustard lines (genotypes) at both seedling and adult stages to determine their resistance and to study the different forms of disease symptoms (local and systemic infection).

The materials used in this study included 106 lines of rapeseed and mustard (*Brassica napus*, *B. juncea*, *B. campestris* and *B. carinata*) were kindly supported from the stocks of Oil Crop Res. Sec., Sakha, Institute of Field Crops ARC, Egypt.

### **At seedling stage:**

106 rapeseed and mustard lines listed in Table (1) were used. The method of inoculation adopted by Verma, 1989 was followed, in which a suspension of zoospores of *Albugo candida* was obtained. Four week old plants grown in 15 cm. diameter pots (4-5 plants/pot for each line) were inoculated with zoospore suspension. Inoculation was accomplished by using a plastic bottle sprayer. Plants were incubated in the dark for 24 hours at 100% RH and 20 °C. The inoculated plants were removed from humidity chambers and returned to the original environment in which they were grown. Seedling reaction was estimated 14 days after inoculation according to the following system (Pettersen et al., 1948).

- 0= Highly Resistant (HR): No visible infection on plant leaf (no pustules).
- 1= Resistant (R): 1 to 10% of leaf area occupied with pustules.
- 2= Moderately Resistant (MR): 11 to 25% of leaf area occupied with pustules.
- 3= Moderately Susceptible (MS): 26 to 50 of leaf area occupied with pustules
- 4= Susceptible (S): 51 to 75% leaf area occupied with pustules.
- 5= Highly Susceptible (HS): over 75% leaf area occupied with pustules

### **At adult stage:**

Experiments were carried out during two successive growing seasons 2002/2003 and 2003/2004. The 106 tested rapeseed and mustard lines mentioned before were used. The experiments were laid out in

randomized complete block design with four replications. The experiments were sown in ridges 0.6m apart and 10 cm between plants, plot size was 9.6 m<sup>2</sup>. Cultural practices *i.e.* planting date, irrigation, thinning, fertilization, etc. were carried out at the proper time according to the recommend method. The previous 106 lines were tested naturally against white rust (*A. candida*). Disease severity of white rust was recorded as the percent of area covered with the rust pustules according to the modified Cobb's scale, adopted by Petterson *et al.* (1948).

#### **The critical experiment:**

From the standpoint of a previous experimental data, ten rapeseed and mustard lines were selected to study the different forms of disease symptoms under natural infection condition. The experiment was conducted only during 2004/2005 growing season.

The experiment was laid out in randomized complete block design with three replicates. The experimental unit consisted of two rows with 2 m. long, each row included 10 plants with 20 cm between plants. The cumulative data were only restricted on disease parameters.

The occurrence and development of white rust disease under natural field conditions were estimated. Five plants were taken from each plot at random to determine local infection expressed in terms of disease severity of white rust as the percent of area covered with the rust pustules on leaves, according to Cobb's scale (Petterson *et al.*, 1948), and systemic infection expressed in terms of number of infected primary branches (stag-heads)/plant, according to Harper & Pittman (1974). The number of systemically infected branches and the total number of branches were recorded for each plant. Plants from each plot were segregated into the degrees of disease categories. These categories were: healthy, slight, moderate and severe and represented 0,1 to 25%, 26 to 50% and over 50% of systemically infected branches, respectively. This classification ignored the occurrence of pustules on leaves. The statistical analysis using Duncan's new multiple range test was applied.

## **RESULTS**

One hundred six rapeseed and mustard lines (*B. napus*, *B. Juncea*, *B. campestris*, *B. carinata*) were tested to determine their response against *Albugo candida*, the causal agent of white rust disease at seedling and adult stages.

#### **At seedling stage:**

A total of 106 rapeseed and mustard lines was tested against *A. candida* under favorable environmental conditions (in the greenhouse). Data presented in Table 1 indicated that, 55 lines *i.e.* (from No. 1 to No. 55, *B. napus*); 4 lines *i.e.* No's 100 to 103, *B. campestris*; 3 lines *i.e.* No's 104 to 106, *B. carinata*) showed complete resistance against the disease. Four lines *i.e.* No's 76 to 78 and 87 (*B. juncea*) were moderately resistant. Data also showed that 20 lines *i.e.* No's 60 to 64, 66 to 69, 73 to 74, 79, 86, 88, 91 to 94 of *B. juncea* and 98 to 99 of *B. campestris* were moderately

susceptible. The rest of the tested lines were susceptible i.e. No's 56 to 59, 65, 70 to 72, 75, 80 to 85, 89 to 90 and 95 to 97 of *B. juncea* in respect.

**At adult stage :**

The previous 106 rapeseed and mustard lines were naturally tested against white rust. This study was carried out under field conditions during the two successive growing seasons 2002/03 and 2003/04 to determine their response and stability to white rust at adult stage.

Data presented in Table 1 showed that 60 lines i.e. all of the *B. napus* lines from No. 1 to No. 55; from No's 101 to 102 of *B. campestris* and from No's 104 to 106 of *B. carinata* were free from rust during the two growing seasons, since they rated "0" disease score. Whereas 6 lines i.e. No's 76 to 78, 98 (*B. juncea*) and 100 to 103 (*B. campestris*) exhibited resistance or moderate resistance response, during the two seasons, since they rated 10% to 30% disease severity. Thirteen lines during 2002/03 i.e. No's 58, 62, 64, 66 to 67, 69, 71, 73, 75, 79, 84, 86 to 87 (*B. juncea*) and eight lines during 2003/04 i.e. No's 62, 67 to 68, 73 to 74, 86 to 87 and 94 (*B. juncea*) were moderately susceptible, since they rated 40% to 60% disease severity. The rest of the tested lines (27 lines and 32 lines during 2002/03 and 2003/04, respectively) were susceptible or highly susceptible, that it gave the high values of disease severity (70% to 100%). In general the obtained results also showed that, the most susceptible lines had similar consistent percent of disease severity through the two growing seasons.

Generally, data presented in Tables 1 and 2 showed that, all of the *B. napus* rapeseed lines, *B. campestris* lines No's 100 to 103 and *B. carinata* lines No's 104 to 106 were highly resistant ("0" reaction) at seedling stage and during the two growing seasons of adult stage. While *B. juncea* No's 76 to 78 and 87 were moderately resistant in both seedling and adult stages in the two growing seasons. Data also showed that most of *B. juncea* lines were moderately susceptible (disease score =3), susceptible and highly susceptible (disease score = 4 and 5, respectively) at seedling stage. Also these *B. juncea* lines gave almost the same high reaction at adult stage during the two growing seasons.

**The critical experiment:**

Data in Table (3) reveal the response of ten lines of *B. juncea* as affected by white rust disease incited by *Albugo candida*. These data indicated that local infection (pustules on leaves, fig. 1) resulted in nearly complete invasion of all the tested plants of each line with the exception of lines i.e. Int. 176 and Int. 237.

As regard to systemic infection (stag-head phase, Fig. 2) the present data indicated that the highest mean number of stag-heads/plant was recorded with lines i.e. *B. jucea* Int. 235 (severe infection) followed by lines Int. 239 and Int. 234 (moderate infection); Int. 233, Int. 160 and Int. 151 (slight infection), while lines i.e. Int. 176, Int. 237 and Int. 246 remained free from symptoms (stag-head) throughout the growing season, although it exhibited localized pustules on leaves.



**Fig. (1).** Symptoms of white rust (*A. candida*) on leaves of rapeseed.



**Fig. (2).** Symptoms of white rust (*A. candida*) on rapeseed, systemic infection (stag-head phase).

Table (1): Reaction of 106 *Brassica* genotypes of four species (*B. napus*, *B. juncea*, *B. campestris*, *B. carinata*) against white rust (*Albugo candida*) at seedlings stage.

No.	lines	White Rust		No.	lines	White Rust	
		Infection type	Reaction			Infection type	Reaction
<b><i>Brassica napus</i></b>							
1	Int. 2	0	R	28	Int. 265	0	R
2	Int. 3	0	R	29	Int. 266	0	R
3	Int. 4	0	R	30	Int. 267	0	R
4	Int. 5	0	R	31	Int. 268	0	R
5	Int. 6	0	R	32	Int. 269	0	R
6	Int. 7	0	R	33	Int. 280	0	R
7	Int. 15	0	R	34	Int. 283	0	R
8	Int. 16	0	R	35	Int. 284	0	R
9	Int. 19	0	R	36	Int. 286	0	R
10	Int. 20	0	R	37	Int. 287	0	R
11	Int. 21	0	R	38	Int. 288	0	R
12	Int. 50	0	R	39	Int. 289	0	R
13	Int. 51	0	R	40	Int. 296	0	R
14	Int. 52	0	R	41	Int. 297	0	R
15	Int. 54	0	R	42	Int. 300	0	R
16	Int. 65	0	R	43	Int. 301	0	R
17	Int. 67	0	R	44	Int. 303	0	R
18	Int. 69	0	R	45	Int. 308	0	R
19	Int. 70	0	R	46	Int. 315	0	R
20	Int. 150	0	R	47	Int. 316	0	R
21	Int. 151	0	R	48	Int. 322	0	R
22	Int. 152	0	R	49	Int. 323	0	R
23	Int. 153	0	R	50	Int. 361	0	R
24	Int. 154	0	R	51	Int. 362	0	R
25	Int. 155	0	R	52	Int. 363	0	R
26	Int. 200	0	R	53	Int. 365	0	R
27	Int. 255	0	R	54	Int. 366	0	R
				55	Int. 367	0	R
<b><i>Brassica Juncea</i></b>							
56	Int. 149	4	S	82	Int. 234	5	S
57	Int. 151	4	S	83	Int. 237	4	S
58	Int. 153	4	S	84	Int. 238	4	S
59	Int. 160	5	S	85	Int. 239	4	S
60	Int. 161	3	S	86	Int. 240	3	S
61	Int. 162	3	S	87	Int. 241	2	R
62	Int. 163	3	S	88	Int. 242	3	S
63	Int. 165	3	S	89	Int. 243	4	S
64	Int. 167	3	S	90	Int. 245	4	S
65	Int. 169	4	S	91	Int. 246	3	S
66	Int. 170	3	S	92	Int. 248	3	S
67	Int. 172	3	S	93	Int. 329	3	S
68	Int. 173	3	S	94	Int. 331	3	S
69	Int. 174	3	S	95	Int. 332	4	S
70	Int. 176	4	S	96	Int. 333	4	S
71	Int. 179	4	S	97	Int. 364	5	S
<b><i>Brassica campestris</i></b>							
72	Int. 180	5	S	98	Int. 164	3	S
73	Int. 182	3	S	99	Int. 232	3	S
74	Int. 183	3	S	100	Int. 235	0	R
75	Int. 191	4	S	101	Int. 352	0	R
76	Int. 192	1	R	102	Int. 356	0	R
77	Int. 193	2	R	103	Int. 357	0	R
78	Int. 194	2	R	<b><i>Brassica carinata</i></b>			
79	Int. 200	3	S	104	Int. 178	0	R
80	Int. 230	5	S	105	Int. 193	0	R
81	Int. 233	5	S	106	Int. 220	0	R

Table (2). Reaction of 106 *Brassica* genotypes of four species (*B. napus*, *B. juncea*, *B. campestris*, *B. carinata*) against white rust (*Albugo candida*) at adult stage under field conditions during two successive growing seasons.

No.	lines	Seasons/ Disease severity		No.	lines	Seasons/ Disease severity	
		2002/03	2003/04			2002/03	2003/04
<b><i>Brassica napus</i> :-</b>							
1	Int. 2	0	0	28	Int. 265	0	0
2	Int. 3	0	0	29	Int. 266	0	0
3	Int. 4	0	0	30	Int. 267	0	0
4	Int. 5	0	0	31	Int. 268	0	0
5	Int. 6	0	0	32	Int. 269	0	0
6	Int. 13	0	0	33	Int. 270	0	0
7	Int. 15	0	0	34	Int. 283	0	0
8	Int. 16	0	0	35	Int. 284	0	0
9	Int. 19	0	0	36	Int. 286	0	0
10	Int. 20	0	0	37	Int. 287	0	0
11	Int. 21	0	0	38	Int. 288	0	0
12	Int. 50	0	0	39	Int. 289	0	0
13	Int. 51	0	0	40	Int. 296	0	0
14	Int. 52	0	0	41	Int. 297	0	0
15	Int. 54	0	0	42	Int. 300	0	0
16	Int. 65	0	0	43	Int. 301	0	0
17	Int. 67	0	0	44	Int. 303	0	0
18	Int. 69	0	0	45	Int. 308	0	0
19	Int. 70	0	0	46	Int. 315	0	0
20	Int. 150	0	0	47	Int. 316	0	0
21	Int. 151	0	0	48	Int. 322	0	0
22	Int. 152	0	0	49	Int. 323	0	0
23	Int. 153	0	0	50	Int. 361	0	0
24	Int. 154	0	0	51	Int. 362	0	0
25	Int. 155	0	0	52	Int. 363	0	0
26	Int. 208	0	0	53	Int. 365	0	0
27	Int. 253	0	0	54	Int. 366	0	0
				55	Int. 367	0	0
<b><i>Brassica juncea</i> :-</b>							
56	Int. 149	100 S	70 S	83	Int. 237	70 S	80 S
57	Int. 151	100 S	70 S	84	Int. 238	60 S	90 S
58	Int. 159	60 S	100 S	85	Int. 239	70 S	80 S
59	Int. 160	70 S	100 S	86	Int. 240	40 S	50 S
60	Int. 161	80 S	90 S	87	Int. 241	40 S	40 S
61	Int. 162	70 S	80 S	88	Int. 242	70 S	70 S
62	Int. 163	40 S	50 S	89	Int. 243	90 S	80 S
63	Int. 166	70 S	100 S	90	Int. 245	100 S	80 S
64	Int. 167	60 S	80 S	91	Int. 246	90 S	100 S
65	Int. 169	90 S	100 S	92	Int. 248	80 S	90 S
66	Int. 170	60 S	100 S	93	Int. 329	70 S	80 S
67	Int. 172	40 S	40 S	94	Int. 331	80 S	60 S
68	Int. 173	70 S	60 S	95	Int. 332	80 S	100 S
69	Int. 174	50 S	70 S	96	Int. 333	80 S	90 S
70	Int. 176	100 S	70 S	97	Int. 364	100 S	100 S
71	Int. 179	60 S	100 S	<b><i>Brassica campestris</i></b>			
72	Int. 180	80 S	100 S	98	Int. 304	20 S	20 S
73	Int. 182	40 S	60 S	99	Int. 232	70 S	70 S
74	Int. 183	70 S	60 S	100	Int. 235	10 S	10 S
75	Int. 191	60 S	70 S	101	Int. 352	0	0
76	Int. 192	30 S	20 S	102	Int. 356	0	0
77	Int. 193	20 S	20 S	103	Int. 357	Tr s	Tr s
78	Int. 194	5 S	*Tr S	<b><i>Brassica carinata</i></b>			
79	Int. 200	50 S	90 S	104	Int. 178	0	0
80	Int. 230	100 S	100 S	105	Int. 193	0	0
81	Int. 233	100 S	100 S	106	Int. 220	0	0
82	Int. 234	90 S	100 S				

\* Tr (Trace): < 5 % Disease severity.

Table (3): Symptoms development of white rust (*Albugo candida*) on ten lines of *Brassica juncea* in terms of pustules on leaf and stag-head phase.

No.	Lines	Adult Reaction				
		Local infection (pustules on leaf)	Systemic infection (Stag-head)			Disease catogrie *
			Mean No. of primary branches/plant	Mean No. of stag-heads/plant	Percentage infection (%)	
1	Int. 151	100.0	9.33	1.13	12.15 <sup>a</sup>	Slight
2	Int. 160	100.0	10.60	2.53	24.03 <sup>c</sup>	Slight
3	Int. 176	73.3	9.67	0.0	0.00 <sup>a</sup>	Healthy
4	Int. 230	100.0	10.67	6.53	61.63 <sup>b</sup>	Severe
5	Int. 233	100.0	9.73	2.20	21.23 <sup>c</sup>	Slight
6	Int. 234	100.0	9.93	4.00	40.27 <sup>b</sup>	Moderate
7	Int. 237	76.7	9.67	0.0	0.00 <sup>a</sup>	Healthy
8	Int. 239	83.3	9.53	3.93	41.28 <sup>b</sup>	Moderate
9	Int. 246	90.0	9.93	0	0.00 <sup>a</sup>	Healthy
10	Int. 333	100.0	9.47	2.33	24.59 <sup>c</sup>	Slight

\* Primary branches systemically infected by *A. candida* as follows:

Healthy = No infection; Slight = 1-25%; Moderate = 26-50%; Severe = over 50%.

### Discussion

The obtained results of rapeseed and mustard screening experiments revealed different reactions against white rust caused by *Albugo candida* at seedling stage in greenhouse under artificial epiphytic conditions and at adult stage under natural conditions. Generally, the results showed that, all of the *B. napus* lines, four lines of *B. campestris* and three lines of *B. carinata* were highly resistant at seedling and adult stages, while three lines of *B. juncea* were moderately resistant in both seedling and adult stages. Data also showed that, most of *B. juncea* lines were moderately susceptible, susceptible and highly susceptible at seedling stage. likewise these *B. juncea* lines gave almost the same high reaction at adult stage. These results run in parallel lines with those of Bains & Jhooty 1979; Chang 1981; Srivastava & Verma 1987; Saharan *et al.*, 1988; Draz 1995; Bansal *et al.*, 1997; Shivpuri *et al.*, 1997; Dubeg 1999; Sudheer *et al.*, 2002 and Rajbir & Pankaj 2004 who confirmed most of the results.

Regarding the developmental symptoms of white rust (*A. candida*), the obtained results gave evidence to the presence of local infection expressed as white pustules on each of the tested *B. juncea* lines. The obtained results also revealed the existence of systemic infection (stag-head formation). The high rate of stag-head was recorded with *B. juncea* line Int. 230 (Severely infected) followed by lines i.e. Int. 239 and Int. 230 (Moderate); Int. 333, Int. 160 and Int. 151 (Slight) while lines i.e. Int. 176, Int. 237 and Int. 246 (proved to be resistant). These results were supported by the findings of Harper & Pittman, 1974 who stated that white rust disease caused by *A. candida* produced discrete pustules on leaves and stems in many cruciferous hosts. On rapeseed and mustard, this fungi may become systemic in developing stems, branches and pods causing hypertrophy, distortion and sterility. This phase of disease is commonly called



"stag-head". The findings of Serivastava & Verma 1987; Sudheer *et al.*, 2002 and Rajbir & Pankaj, 2004 supported our results and were in accordance with the same viewpoint. This would explain the extent of loss when the fruiting parts converted to sterile distorted bodies. On the other hand, the present work maximized the urgent need for the screening tests against such disease within Canola vars. and/or lines in breeding programs

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تقييم بعض التراكيب الوراثية لمحصول لفت الزيت (الكانولا) من حيث المقاومة  
لمرض الصدأ الأبيض المتسبب عن الفطر البيوجو كاتيديا  
إعتماد عبيد اسماعيل دراز<sup>1</sup> - محمد السيد أبوغزالة<sup>2</sup>  
1- معهد بحوث أمراض النباتات - مركز البحوث الزراعية - مصر  
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يعتبر مرض الصدأ الأبيض المتسبب عن فطر *Albugo candida* من أهم الأمراض التي تصيب محصول لفت الزيت - الكانولا - في مصر. وفي هذا البحث تم دراسة صفة المقاومة لمجموعة من التراكيب الوراثية (١٠٦ سلالة نباتية) لعشيرة نباتية تابعة لجنس *B. Brassica*, *B. juncea*, *B. campestris*, *B. carinata*, *B. napus*) في كل من طورين البانورة (في الصوبة المكيفة، وتحت ظروف العتوي الصناعية بجرانيم المتسبب المرضي) وطور النبات البالغ (في الحقل وتحت الظروف الطبيعية لحدوث المرض في موسمي ٢٠٠٢/٢٠٠٣، ٢٠٠٣/٢٠٠٤). وأظهرت النتائج المتحصل عليها مايلي :- في طور البانورة، أن جميع السلالات التابعة للنوع *napus* (٥٥ سلالة)، وأربعة سلالات تابعة للنوع *campestris*، وثلاثة سلالات تابعة للنوع *carinata* كانت مقاومة، وكانت ٢٠ سلالة تابعين للنوعين *juncea*، *campestris* متوسطة القابلية للإصابة، بينما أظهرت النتائج أن باقي السلالات النباتية المختبرة كانت قابلة للإصابة وكلها تتبع النوع *juncea*.

أما فيما يخص اختبارات الحقل (في طور النبات البالغ) دلت النتائج المتحصل عليها على وجود ٦٠ سلالة نباتية تابعة للأنواع *napus*، *campestris*، *carinata* خالية تماما من المرض خلال موسمي الاختبار، بينما أظهرت ٦ سلالات تابعة للنوع *(juncea)*، ٤ سلالات تابعة للنوع *(campestris)* صفة المقاومة (M) إلى متوسط المقاومة (MR) خلال موسمي الاختبار. وبينت النتائج أيضا أن ١٣ سلالة نباتية، ٨ سلالات خلال موسمي ٢٠٠٢/٢٠٠٣، ٢٠٠٣/٢٠٠٤، على التوالي، كانت متوسطة القابلية للإصابة (MS). كما أعطت باقي السلالات النباتية المختبرة رد فعل قابل للإصابة (S) أو عالية القابلية للإصابة (HS). عامة أظهرت النتائج المتحصل عليها أن معظم السلالات النباتية ذات صفة القابلية للإصابة (S) أو عالية القابلية للإصابة (HS) كانت متشابهة إلى حد كبير في النسبة المتوقعة للإصابة خلال موسمي الدراسة.

عند دراسة ظاهرة الرؤس العقيمة *stag-heads* للسلالات العالية القابلية للإصابة، تم أخذ ١٠ سلالات تابعة للنوع *juncea* وتم دراسة هذه الصفة تحت ظروف العتوي الطبيعية في الحقل. وأوضحت النتائج أن جميع السلالات النباتية تحت الدراسة أظهرت شدة إصابة عالية على الأوراق إصابة محلية (Local infection) أو بشرات على الأوراق. أما فيما يخص الإصابة الجهازية *Systemic infection* [على هيئة رؤس عقيمة *stag-heads* (فروع زهرية متحورة)] فقد دلت النتائج على أن أعلى قيمة للرؤس العقيمة *Sever infection* سجلت مع السلالة *B. juncea* Int 233، 234 بلديها السلالتين *B. juncea* Int. 239، 234 فكانت متوسطة الإصابة *Moderate infection* ثم السلالات *B. juncea* Int. 151، Int. 160، Int. 333 فكانت ضعيفة الإصابة *Slight infection*. بينما ظلت السلالات *B. juncea* Int. 176، Int. 237 بدون تكوين رؤس عقيمة حتى نهاية الموسم بالرغم من تكون البشرات على أوراقها بدرجة عالية.

وهذا البحث بصفة عامة يعتبر ذا أهمية كبيرة وأداة مثمرة في برامج تقييم محصول الكانولا ضد الأمراض المختلفة.