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SUCCESSFUL MANAGEMENT OF POTATO LATE BLIGHT DISEASE UNDER EGYPTIAN CONDITIONS

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ABSTRACT: *Nowadays, the successful management of potato late blight disease under Egyptian conditions requires evaluating the resistance of common potato cultivars and testing the effectiveness of fungicides. Testing the aggressiveness of three Egyptian Phytophthora infestans isolates on thirty three potato cultivars under greenhouse conditions revealed that the two 13-A2 isolates were virulent on all tested cultivars, meanwhile, the 23-A1 isolate was virulent on twenty three cultivars. Also, testing the resistance of fourteen commercial potato cultivars against late blight under natural infection in field exhibited that the least disease severity percentage was recorded in cvs Cara, Valor, and Billini. The least area under the disease progressive curve (AUDPC) was recorded with cvs. Valor, Cara, Burren, Billini and Provento comparing with the other tested potato cultivars whereas, the highest value of AUDPC was recorded with cv. Mondial. Among the tested fungicides, twenty fungicide treatments significantly reduced the incidence of potato late blight disease compared with the untreated control. Moreover, fungicides contain mixtures of active ingredients were superior in their effect than other fungicides which contain only one active ingredient. In addition, fungicides contain mixture of contact with translaminar active ingredients reduced potato late blight incidence more than contact fungicide with one active ingredient.*

Key word: *Late blight, Phytophthora infestans, Fungicides, Resistance.*

INTRODUCTION

Potato (*Solanum tuberosum* L.) is the fourth largest food crop worldwide after wheat, maize, and rice. The economic Losses due to late blight are estimated to be at $ 6.7 billion (Haverkort *et al*. 2008). Over the years, it has become an important vegetable crop for Egyptian growers as well as consumers. In Egypt, potato occupied an area of 183990 feddans with a production of 1951438 tons (Economic Affairs Sector, 2011*). Many factors can limit the potato production. One of the most important factors is late blight disease that caused by the oomycete pathogen *Phytophthora infestans*. Unfortunately the weather conditions allow the disease to start from the early of November and many outbreaks occur during December to the mid of April resulting sever yield losses. Yield losses under favorable environmental conditions ranged from 50 – 70% potato yield (Haq *et al*., 2008).

Screening potato genotypes for resistance to *Phytophthora infestans* is the most effective and environmental friendly way to prevent widespread devastation by late blight. Seed tubers infected with *P. infestans* will either rot in storage, after planting in the field or survive and initiate new epidemics of potato late blight (Stevenson *et al*., 2007 and Kirk *et al*., 2009). Tubers can become blighted shortly after the disease is established on the foliage.

P. infestans survives in tubers where it rots tubers intended for commercial use (Niemira *et al*., 1999). Management of late blight requires aggressive measures that include combined use of cultural, scouting, sanitation, and most importantly the

*Economical Statistic Report, Agricultural Statistics, Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, 2011).

combination of host plant resistance with application of fungicides (Johnson *et al.*, 1998, Kirk *et al.,* 2005). The use of protectant and systemic fungicides for managing late blight has perhaps been the most studied aspect of this disease management in temperate countries (Olanya *et al.,* 2001). Protective fungicides principally inhibit spore germination and penetration, but once the pathogen enters the leaves, these fungicides become ineffective. Under such conditions a product having some curative and systemic activity, such as metalaxyl is desirable (Schwinn and Margot, 1991). However, pathogen can easily develop resistance to systemic fungicides like metalaxyl because they have single site mode of action (Deahl *et al.,* 1995).

The aim of this study was screening of resistance in potato cultivars and evaluation the effectiveness of common fungicides for management of late blight as well as to control potato late blight under favorable conditions in Egypt.

MATERIALS AND METHODS

All laboratory and greenhouse trials were carried out at Vegetable Diseases Research Department, Plant Pathology Research Institute, Agricultural Research Center, Giza, Egypt.

1. Evaluation of commercial potato cultivars to late blight:

a. Under Greenhouse conditions:

Thirty three potato commercial cultivars were evaluated under greenhouse conditions during season 2011/12 using three isolates including EG-5 (13-A2), EG-44 (23-A1), and EG-76 (13-A2). Black plastic pots (25 cm in diameter) were filled with mixture of sterilized sand and soil (1:1, v/v). Single potato seed tuber was sown in each pot, three pots were employed as replicates for each isolate. Pots were irrigated and fertilized as usual . After 50 days of planting date, whole plants were sprayed with each isolate inoculum at a concentration of 5×10^4 of sporangia per ml. Final data were scored after 10 days of spray inoculation time as disease severity according to James (1971).

b. Under naturally infested field conditions :

A total of 14 commercial potato cultivars were evaluated under field conditions at location Menouf, Menofiya governorate in December 2011 in complete randomized blocks with three replicate plots per treatment. Each plot (3 x 7 m^2) contained six rows where each row contained 30 tubers. Disease severity was recorded seven times, every 7 days interval. The obtained data served in the determination of area under disease progress curve (AUDPC).

AUDPC was estimated to compare different responses of the tested potato commercial cultivars according to Pérez and Forbes (2010) using the following formula:-

((C4+B4)/2)*(C3-B3) +
((D4+C4)/2)*(D3-C3) +
((E4+D4)/2)*(E3-D3) +
((F4+E4)/2)*(F3-E3) +
((G4+F4)/2)*(G3-F3) +
((H4+G4)/2)*(H3-G3)

Where

B4 = the percentage of foliar blight at the first evaluation,

C4 = the percentage of foliar blight at the second evaluation,

(C3-B3) = the interval time between the first and the second evaluation,

D4 = the percentage of foliar blight at the third evaluation,

(D3-C3)= the interval time between the second and the third evaluation,

E4 = the percentage of foliar blight at the fourth evaluation,

(E3-D3) = the interval time between the third and the fourth evaluation,

F4 = the percentage of foliar blight at the fifth evaluation,
(F3-E3)= the interval time between the fourth and the fifth evaluation,
G4 = the percentage of foliar blight at the sixth evaluation,
(G3-F3)= the interval time between the fifth and the sixth evaluation,
H4 = the percentage of foliar blight at the seventh evaluation and
(H3-G3)= the interval time between the sixth and the seventh evaluation.

2. Efficacy of fungicides against potato late blight:

Twenty one fungicides assigned for late blight control were evaluated (Table 1). This work was conducted in Tamalay, Menofiya governorate during season of 2011/12.

A complete block randomized design with 3 replications was adopted in this respect. The susceptible cultivars. Lady Rossetta was selected for this experiment on the basis of its susceptibility for the late blight disease. The experimental unit was a plot measured (7×6 m^2) included 18 rows with 7 m long and 20 cm. apart. All cultural practices were applied according to the technical recommendation of the crop as normal.

The first symptom was observed after 40 days from planting date in 10th January, 2012. The treatments were applied at 7 day interval. Application doses were applied as mentioned in Table (1). Disease severity was scored when untreated control reached 70% foliar blight. The disease severity was scored as previously described.

Efficacy of each fungicide was computed according to the following formula adopted by Rewal and Jhooty (1985).

$$\text{Efficacy} = \frac{\text{\% infection in the control- \% inf. in treatment}}{\text{\% Infection in the control}}$$

Data analysis and statistics:

Data were analyzed using analysis of variance (ANOVA), and the means were compared by the least significant differences (LSD) at P ≥ 0.05 described by Snedecor and Cochran (1980).

RESULTS

1. Evaluation of commercial potato cultivars to late blight:-

a. Under greenhouse conditions:

Thirty three potato cultivars were sprayed at night with inoculum of three *P. infestans* isolates, EG-5 (13-A2), EG-44 (23-A1), and EG-76 (13-A2). The first symptoms were seen after 3 days post inoculation on whole inoculated plants with isolate EG-76 while symptoms on plants which inoculated with the other two isolates were observed at the fourth day post inoculation. This indicates that the latent period of the isolate EG-76 was shorter than the other two isolates. After 10 days, disease severity on each plant was scored. Data presented in Table (2) and Fig. (1) show that both isolates EG-76 and EG-5 were virulent on the tested 33 cultivars but differ in their aggressiveness. Disease severity on plants inoculated with isolate EG-76 , EG-44 , and EG-5 ranged from 21.67 to 93%, 4 to 87.33%, and 13.67 to 82.76%, respectively.

In contrast, isolate EG-44 was not virulent on Zafira, Provento, Excellent, Srtirling, S.W, Kuroda, Sante, Cara, Billini, and Valor. While EG-76 followed by EG-5 were the most aggressive isolate. It is concluded from the obtained results that Potato cultivars that might be have general partially resistance to virulent isolates are Cara, Valor, Billini, Sante, Marijke, Kuroda, S.w, Ditta, Stirling, Excellent, and Nieta. Meanwhile, potato cultivars having moderately resistance are Fontana, Picasso, Arika, Markies, Monak, Provento, Zafira, Arnova, Ambition, and Taloka. Whearas, the lowest resistant cultivars were Faluka, Diamant, Seniora, Germindin, Mustang, Nicola, Sofia, Lady Rossetta, Festival, Spunta, and Agria.

Table 1

Table (2): Aggressiveness of 3 Egyptian *P. infestans* isolates on 33 commercial potato cultivars as disease severity%.

Cultivar	Isolate		
	EG-44	EG-76	EG-5
Faluka	47.67	84.00	43.33
Arnova	27.33	55.33	55.00
Agria	84.00	85.67	82.67
Sofia	72.33	81.00	65.00
Arika	4.00	63.67	42.33
Zafira	1.00	71.67	53.33
Picasso	14.00	51.67	41.67
Provento	1.00	77.33	45.00
Fontana	14.00	60.67	31.67
Markies	12.33	66.00	39.00
Nieta	7.67	42.33	25.00
Lady Rossetta	65.00	84.00	82.33
Germindin	55.00	68.33	63.33
Seniora	55.00	74.33	48.33
Monak	5.33	58.33	55.00
Excellent	1.00	44.00	42.33
Stirling	1.00	41.67	26.67
Ditta	6.67	39.00	27.67
S.w	1.00	34.33	27.33
Kuroda	1.00	39.00	23.33
Diamant	28.33	82.33	66.00
Marijke	6.33	43.33	27.33
Mustang	62.33	84.00	67.67
Festival	80.00	92.00	64.00
Sante	1.00	55.00	37.67
Spunta	79.33	92.33	66.67
Armada	87.33	93.00	79.33
Ambition	42.67	69.67	57.00
Taloka	29.00	80.33	60.33
Cara	1.00	40.33	22.33
Billini	1.00	21.67	13.67
Valor	1.00	32.33	25.33
Nicola	58.00	87.33	68.67
$LSD_{(0.05)}$			
Isolates		2.29 ***	
Cultivars		5.10 ***	
Isolates × Cultivars		1.87 ***	

- Each value represents the mean three replicates of the scored disease severity %.
- ***: Highly significant.

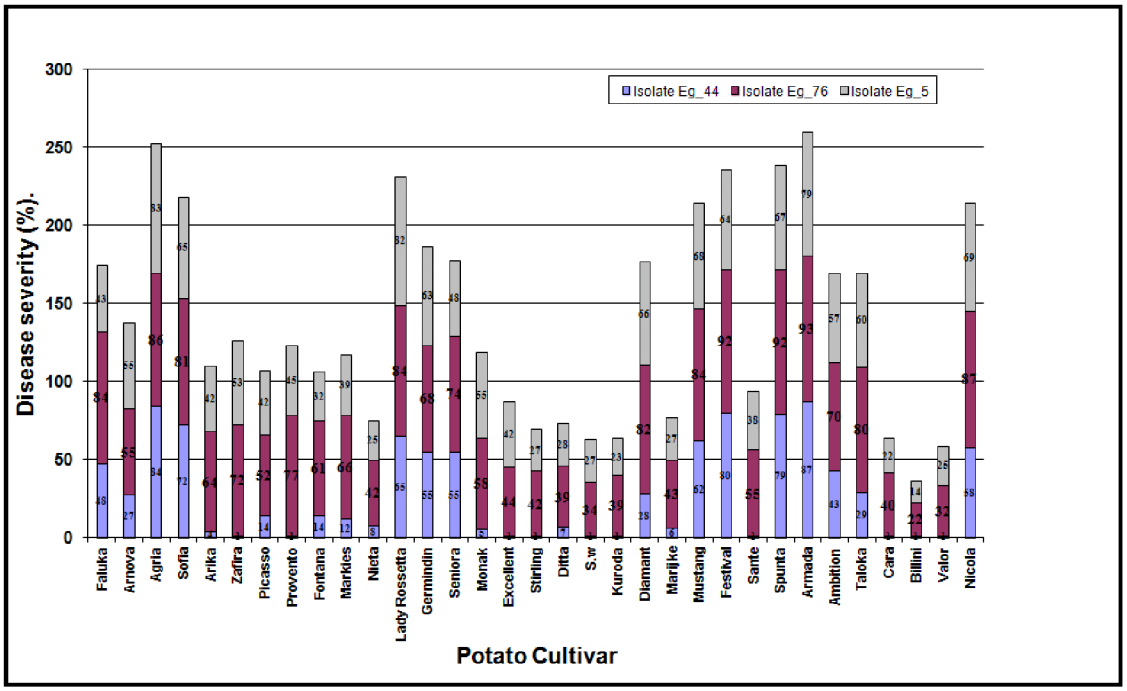


Fig. (1). Aggressiveness of 3 of *P. infestans* isolates on 33 commercial potato cultivars as disease severity%.

b. Under naturally infested field:

Late blight resistance of fourteen commercial potato cultivars was evaluated under naturally infested field. Initial symptoms were observed on Agria, Mondial, Spunta, Hermes, Markies and Lady Rosetta at the plant age of 40 days in January, 2012 where the weather conditions were favorable for the disease epidemic infection.

After seventy days of planting date, disease severity reached 100% on Agria and Mondial. At the end of season, the least value of disease severity was observed on Cara, Valor, and Billini. AUDPC for Valor was close to AUDPC for Cara and Burren and the highest value of AUDPC was recorded with cv. Mondial.

Data from AUDPC divided the tested14 cultivars into 3 groups, the first one included all cultivars with AUDPC ranged from 556.5 to 948.5, the second group included all cultivars with AUDPC ranged from 1235.5 to 1995, and the last one included the most susceptible cultivars with AUDPC ranged from 2222.5 to 3132.5 (Fig. 2).

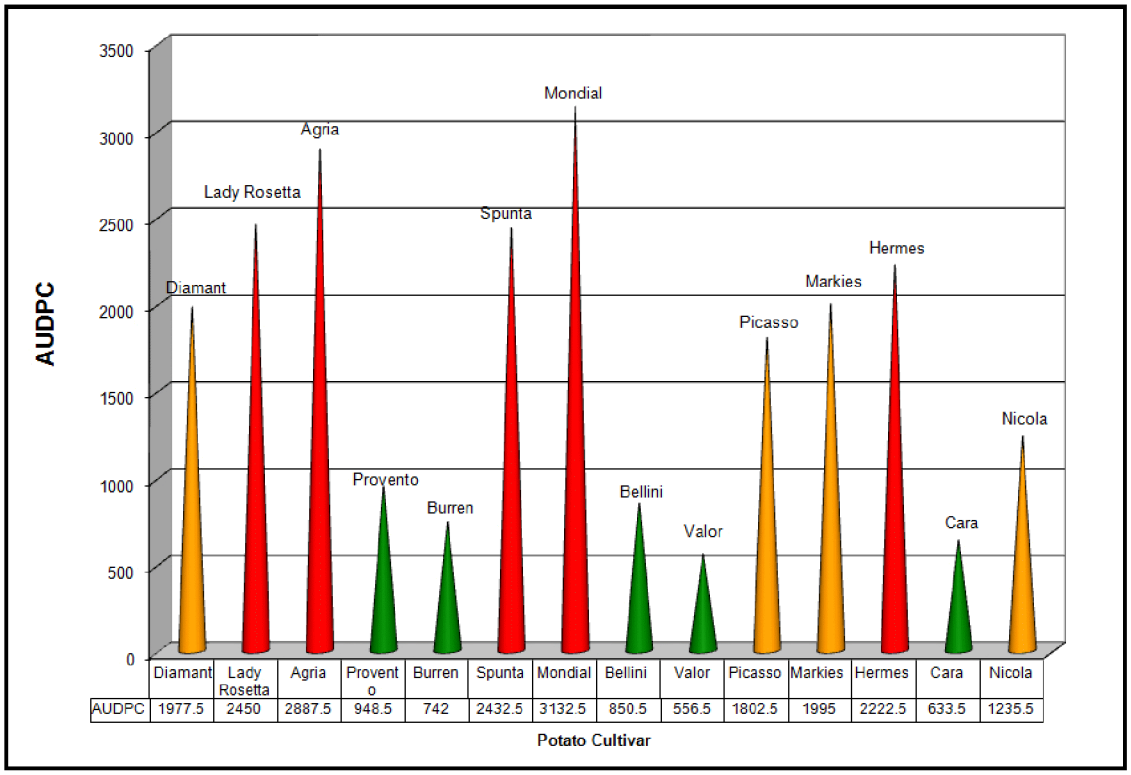
2. Efficacy of fungicides against potato late blight:

Twenty one fungicides were evaluated for their efficacy against late blight disease. The percentages of foliage blight at the end of the growing season are given in Table (3). All fungicide treatments significantly reduced the incidence of foliage blight compared with the untreated control except Protect Pro which dramatically rose foliar blight to 72%. Fungicides that contain mixtures of active ingredients were superior to other fungicides which contain only one active ingredient. Protect Pro at concentration 2% SL resulted in increasing of foliar blight severity to 72 % compared with untreated control. Data presented in Table (3) show that Revus Top significantly reduced foliar blight (3.67%) compared with untreated control (70%) under moderate disease pressure. No significant differences in mean final late blight score among contact fungicides Manfil, Shirlan, Dithane M45, Winner, and Novicure, which foliar blight score ranged from 10.33 to 11.67%. Mixture of contact and translaminar active ingredients recued

blight incidence more than contact fungicide with one active ingredient. The efficient active ingredients for chemical management of late blight were Mandipropamid+Difeconazole, Cymoxanil+Mancozeb+Copper oxychloride, Propamocarb-HCL+ Fluopicolide, Propamocarb hydrochloride, Mancozeb+ Metalaxyl, Dimethomorph + Mancozeb, Mancozeb+Zoxamide, Azoxystobin, Cyazofamid, and Dimethomorph + Mancozeb. On the other hand, contact fungicides *i.e.* Mancozeb, Fluzinam, Copper oxycloride, and Tri Basic Copper Sulfate were significantly differed from the previous fungicides.

DISCUSSION

Potato late blight caused by *phytophthora infestans* is the most destructive disease threats potato in Egypt and worldwide. The three tested isolates of *P. infestans* differed in their aggressiveness and virulence profile. Elsewhere, high virulence diversity was also reported in many countries in the world (Bouws and Finckh 2007, Guo *et al* 2009, and Van Poppel *et al* 2009). Greenhouse experiment was a convenient way to evaluate resistance in potato cultivars under applied favourable conditions. The highest disease severity% were recorded on susceptible potato cultivars inoculated with the most aggressive isolate 13- A2 (EG-76) at 10 days post inoculation. Potato cultivars had totally different responses depending on the pathogen genotype. These obtained results are in accordance with Vanderplank (1984) who reported that General resistance was considered effective against all races of the pathogen. Some authors, however, proposed an alternative hypothesis for resistance, in which some degree of race specificity exists for all resistance types (Parlevliet and Zadoks, 1977), and pathogen adaptation to plant genotypes with general resistance has been identified for some diseases (Parlevliet, 1989).



	Diamant	Lady Rosetta	Agria	Provento	Burren	Spunta	Mondial	Bellini	Valor	Picasso	Markies	Hermes	Cara	Nicola
AUDPC	1977.5	2450	2887.5	948.5	742	2432.5	3132.5	850.5	556.5	1802.5	1995	2222.5	633.5	1235.5

Fig. (2). Area under disease progress curve (AUDPC) of 14 potato cultivars under naturally infested field conditions in Egypt.

Table (3). The effectiveness of twenty one commercial fungicides against potato late blight disease under naturally infested open field.

No	Commercial name	Effectiveness (%)	% Foliar blight
1	Alectis	89.10	7.67
2	Rado Elnasr	89.58	7.33
3	Flash	90.52	6.67
4	Medomil	87.68	8.67
5	Triomax	93.36	4.67
6	Prove	91.94	5.67
7	Dithane M 45	83.89	11.33
8	Revus Top	94.78	3.67
9	Primozeb	91.94	5.67
10	Manfil	85.31	10.33
11	Winner	83.89	11.33
12	Rival	92.42	5.33
13	Chemotrobin	88.16	8.33
14	Achromorf MZ	86.25	9.67
15	Kastro	89.09	7.67
16	Metalman	87.67	8.67
17	Shirlan	84.83	10.67
18	Novicure	83.41	11.67
19	Protect Pro	-2.37	72.00
20	Infinito	92.42	5.33
21	Ranman	88.15	8.33
22	Control	0.00	70.33
	L.S..D. (0.05)		2.85 ***

Disease development on the most resistant cultivars, *i.e* Cara, Bellinin and Valor was very slow with two virulent strains *i.e* EG-76 and EG-5 while no symptoms were seen with EG-44 strain, which indicated that the presence of resistant genes may slow down the aggressiveness of the virulent strain and prevent colonization of the avirulent strain via hypersensitive cell death response (HR) due to rapid detection of the pathogen invasion. Isolate EG-44 was avirulent on cultivars Zafira, Provento, Excellent, Srtirling, S.W, Kuroda, Sante, Cara, Billini, and Valor This indicated that isolate EG-44 may have the avirulent form of genes which recognized by correspoding resistance genes in the above mentioned potato cultivars. These results are in agreement with Kamoun *et al*. (1999) who reported that specific resistance was closely associated with the HR, which is a particular type of programmed cell death that enables plants to limit invading pathogens. Application of preventive

fungicides is essentially to protect potato crop against the late blight pathogen, *Phytophthora infestans*. All fungicedes reduced the incidence and disease severity on foliar blight but varied in their effectiveness. The obtained results are in harmony with the findings of Schepers and van Soesbergen (1995) who reported that not all fungicides are equally effective in controlling tuber blight via foliar application. Different ways in mobility of fungicides active ingredients affected on reducing disease developments. Systemic fungicides were more effective than contact ones but they were not necessary to apply at the early age of plants while the contact fungicides were essential. Contact fungicide treatments applied after the appearance of late blight symptoms or after disease establishment may be effective for disease control. Other late blight research reports showed that Mancozeb applied as a protectant can be effective in reducing the impact of late blight under tropical conditions (Namanda *et al*. 2004).

The use of systemic fungicides was obligatory with abundant foliage whereas the humidity rose around contacted plants and favorable conditions became more available. Application of fungicides which contain translaminar active ingredients were more effective than contact fungicides at the appearance of initial symptoms. We conclude that the most effective fungicide application schemes start with contact fungicides (protectant) followed by translaminal fungicides (super protectant) then end by systemic fungicides. This is in accordance with Inglis and Vestey (1998), they reported that fungicide application schemes that included cymoxanil, dimethomorph, or propamocarb hydrochloride provided slightly better control of late blight in a North American fungicide trial than schemes that did not include those fungicides.

REFERENCES

Bouws, H. and E.M. Finckh (2007). Effects of cropping history and origin of seed potatoes on population structure of *Phytophthora infestans*. Eur. J. Plant Pathol. 117: 313-327.

Deahl, K.L., S.P. Demuth and A. Pena-Rivera (1995). Identification of mating types and metalaxyl resistance in North American populations of *Phytophthora infestans*. Am. Potato J., 72: 35-49.

Guo, J., T.A.J. van der Lee, D.Y. Qu, Y.Q. Yao, X.F. Gong, D.L. Liang, K. Y. Xie, X.W. Wang and F. Govers (2009). *Phytophthora infestans* isolates from Northern China showhigh virulence diversity but low genotypic diversity. Plant Biology 11: 57-67.

Haq, I. , Rashid, A. and Khan. S.A. (2008). Relative efficacy of various fungicides, chemicals and biochemicals against late blight of potato. *Pak. J. Phytopathol*., 21:(1) 129-133.

Haverkort, A.J., P.M. Boonekamp, R. Hutten, E.Jacobsen, L.A.P Lotz, G. J. T. Kessel, R. G. F. Visser and E. A. G. van der Vossen (2008). Societal Costs of Late Blight in Potato and Prospects of Durable Resistance Through Cisgenic Modification. Potato Research. 51: 47-57.

Inglis, D. B. and E. Vestey (1998). Evaluation of fungicides for control of potato late blight. Page 158 in R.N. Raid (ed.), Fungicide and Nematicide Tests. American Phytopathological Society, St. Paul, MN.

James, C. (1971). A manual of assessment keys for plant diseases. Canada Department of Agriculture. Publication No. 1458.

Johnson, D.A., J.R. Alldredge and P.B. Hamm (1998). Expansion of potato late blight forecasting models for the Colombian Basin of Washington and Oregon. Plant Disease, 82: 642-645.

Kamoun, S., E. Huitema and V.G.A.A. Vleeshouwers (1999). Resistance to oomycetes: A general role for the hypersensitive response? Elsevier Trends Journals 4:196-200.

Kirk, W.W., F. Abu-El SamenTumbalam, P. Wharton, D. Douches, C. A. Thill and A. Thompson (2009). Impact of different US genotypes of *Phytophthora infestans* on potato seed tuber rot and plant emergence in a range of cultivars and

advanced breeding lines. Pot. Res., 52:121-140.

Kirk, W.W., F.M. Abu-El Samen, J.B. Muhinyuza, R. Hammerschmidt, D.S. Douches, C.A. Thillc, H. Groza and A.L. Thompson (2005). Evaluation of potato late blight management utilizing host plant resistance and reduced rates and frequencies of fungicide applications Crop Prot., 24: 961-970.

Namanda, S., O.M. Olanya, E. Adipala, J.J. Hakiza, R. El- Bedewy, A.S. Baghsari and P. Ewell (2004). Fungicide application and host-resistance for potato late blight management: benefits assessment from on-farm studies in S.W. Uganda. Crop Prot. 23 : 1075-1083.

Niemira, B.A., W.W. Kirk and J.M. Stein (1999). Screening for late blight susceptibility in potato tubers by digital analysis of cut tuber surfaces. Plant Disease,83: 469-73.

Olanya, O.M., E. Adipala, J.J. Hakiza, J. C. Kedera, P. Ojiambo, J. M. Mukalazi, G.A. Forbes and R. Nelson (2001). Epidemiology and population dynamics of *Phytophthora infestans* in Sub-Saharan Africa: Progress and Constraints. African Crop Science Journal 9: 185 - 193.

Parlevliet, J.E. (1989). Identification and evaluation of quantitative resistance, In Leonard K.J. and Fry, W.E. (Eds.), Plant Disease Epidemiology. Vol. 2: Genetics, Resistance and Management (pp. 215-247). New York: MacMillan.

Parlevliet, J.E. and J.C. Zadoks (1977). The integrated concept of disease resistance, a new view including horizontal and vertical resistance in plants. Euphytica 26:5-21.

Pérez, W. and G. A. Forbes (2010). Technical manual potato late blight. International Potato Center (CIP). P. 28 –31.

Rewal, H.S. and J.S. Jhooty (1985). Differential response of wheat cultivars to systemic fungi toxicants applied Ustilaga tritici (Pers). Rost Indian Journal of Agricultural Sciences 55 (8)- 548-549.

Schepers, H.T.A.M. and M.A.T. van Soesbergen (1995). Factors affecting the occurrence and control of tuber blight. In Dowley, L.J., Bannon, E., Cooke, L.R., Keane, T., and O'Sullivan, E. (Eds.), *Phytophthora infestans* (pp. 171-176). Dublin, Ireland: Boole Press.

Schwinn, F.J. and P. Margot (1991). *Phytophthora infestans*, the cause of late blight in potato, Chapter 8, Control with chemicals. In: Ingram, D.S., Williams, P.H. (Eds.), Advances in Plant Pathology, Vol. 7: pp. 225–265.

Snedecor, G.W. and W.G. Cochran (1980). Statistical Methods. 7th Ed. Iowa State Univ. Press, Iowa, USA.

Stevenson, W.R. , W.W. Kirk and Z.K. Atallah (2007). Management of foliar disease, early blight, late blight and white mold. In *Potato Health Management*, ed. D.A. Johnson, pp. 209-22. St. Paul, MN, USA: APS Press.

Van Poppel, P.M.J.A., D.J. Huigen and F. Govers (2009). Differential recognition of *Phytophthora infestans* races in potato R4 breeding lines. Phytopathology 99: 1150-1155.

Vanderplank, J.E. (1984). Disease Resistance in Plants. San Diego, CA: Academic Press.

المكافحة الناجحة لمرض لفحة البطاطس المتأخرة تحت الظروف المصرية

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الملخص العربي

تتطلب المكافحة الناجحة الآن لمرض اللفحة المتأخرة علي البطاطس تحت الظروف المصرية إلي تقييم المقاومة في اصناف البطاطس المنزرعة والشائعة واختبار فعالية المبيدات المستخدمة. وقد اظهر اختبار ضراوة 3 عزلات من الفيتوفثورا انفستانس علي ثلاثة وثلاثون صنف بطاطس تحت ظروف الصوبة أن العزلة EG-76 والعزلة EG-5 هما الأكثر مرضية وضراوة علي كل الأصناف المختبرة وفي نفس الوقت كانت العزلة EG-44 ممرضة لثلاثة وعشرون صنفا من البطاطس. كما اظهر ايضا اختبار مقاومة أربعة عشر صنف تجاري من أصناف البطاطس ضد مرض اللفحة المتأخرة تحت ظروف العدوي الطبيعية في الحقل أن اقل شدة مرضية قد سجلت علي أصناف البطاطس كارا وفالور وبيلليني كما سجلت اقل قيم AUDPC مع اصناف فالور، كارا، بيرن، بيلليني وبروفينتو مقارنة بأصناف البطاطس الأخرى المختبرة في حين أن اعلي قيمة ل AUDPC قد سجلت مع صنف موندیال.

وقد خفضت معاملات عشرون مبيد فطري معنويا من حدوث مرض اللفحة المتأخرة علي البطاطس مقارنة بمعاملة الكنترول الغير معامل. فضلا عن ذلك فقد كانت المبيدات الفطرية المحتوية علي خليط من المواد الفعالة أفضل في تأثيرها عن المبيدات الفطرية الأخرى المحتوية مادة فعالة واحدة. بالإضافة إلي ذلك فقد خفضت المبيدات الفطرية المحتوية علي خليط من المواد الفعالة المؤثرة بالملامسة والتي تنتقل سطحيا داخل النسيج إلي خفض حدوث مرض اللفحة المتأخرة بدرجة اكبر من المبيدات الفطرية بالملامسة المحتوية علي مادة فعالة واحدة.

Table (1): Twenty one commercial fungicides assigned for potato late blight management.

No.	Commercial name	Active ingredient	Concentration-Formulation type	Mobility in the plant	Dose/ 100L
1	Alectis	Mancozeb+Zoxamide	75.00 % wG	Contact+Contact	200g
2	Rado Elnasr	Mancozeb+ Metalaxyl	72 .00% WP	Contact+Systemic	250g
3	Flash	Dimethomorph + Flopet	71.30 % WG	Translaminar+ Contact	200g
4	Medomil	Mancozeb+ Metalaxyl	72.00 % WG	Contact+Systemic	200g
5	Triomax	Cymoxanil+Mancozeb+Copper oxychloride	45.00 % WP	Translaminar+Contact+Translaminar	250g
6	Prove	Propamocarb hydrochloride	72.20 % SL	Systemic	250ml
7	Dithane M 45	Mancozeb	80.00 % WP	Contact	250g
8	Revus Top	Mandipropamid+Difeconazole	50.00 % SC	Systemic+Systemic	100ml
9	Primozeb	Mancozeb+ Metalaxyl	72.00 % WP	Contact+Systemic	250g
10	Manfil	Mancozeb	75.00 % WG	Contact	200g
11	Winner	Copper oxycloride	84.00 % WG	Contact	250g
12	Rival	Propamocarb hydrochloride	72.20 % SL	Systemic	250ml
13	Chemotrobin	Azoxystobin	23.00 % SC	Systemic	250ml
14	Achromorf MZ	Dimethomorph + Mancozeb	69.00 % WP	Translaminar+ Contact	300g
15	Kastro	Azoxystobin	25.00 % EC	Systemic	75ml
16	Metalman	Mancozeb+ Metalaxyl	72.00 % WP	Contact+Systemic	200g
17	Shirlan	Fluzinam	50.00 % SC	Contact	50ml
18	Novicure	Tri Basic Copper Sulfate	70.00 % WG	Contact	125g
19	Protect Pro	Ascorbic acid	2.00 % SL	Systemic	100ml
20	Infinito	Propamocarb-HCL+ fluopicolide	68.75 % SC	Systemic+Translaminar	100ml
21	Ranman	Cyazofamid	40.00 % SC	Translaminar	30 ml
22	Control				