

EFFICIENCY OF HOST RESISTANCE AND FUNGICIDE APPLICATION FOR CONTROL OF POTATO LATE BLIGHT

[47]

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ABSTRACT

Late blight caused by *Phytophthora infestans* is one of the most destructive diseases potato in Egypt and world wide. Stability of resistance to late blight was evaluated in twenty five potato cultivars during 2003 and 2004 successive seasons under heavy natural infection. Data showed that the potato cultivars Altesse, Occania, Safrane and Soleia highly resistant while cultivars Daisy, Hermine and Isabel recorded the highest susceptibility to late blight. Application different fungicide against potato late blight revealed that Aquagen Bro and Previcur-N were the best effective fungicides in reducing disease severity and progress of late blight. Data showed also that the losses of tubers due to late blight in season 2003 ranged from 11.75 Kg/plot (cultivar Hermes) to 18.0 Kg/plot (cultivar Lady Roseta) while in season 2004, yield losses ranged from 11.25 Kg/plot (cultivar Hermes) to 23.75 Kg/plot (cultivar Spunta). The results demonstrate that integration of Previcur-N treatment with host resistance was effective in reducing late blight and tuber yield loss of potato.

Keywords: Potatoes, Cultivars, Disease resistance, Late blight, Chemical control, Yield losses

INTRODUCTION

Potato (*Solanum tuberosum* L.) is an important food and cash crop in Egypt. The crop has the potential to increase agricultural production; however, the damage attributed to late blight disease causes by *Phytophthora infestans* has been significant and occasionally resulted in total potato crop failure in some production areas of Egypt. Average yield losses due to late blight range from 40% to 60% (Olanya *et al* 2002), but losses up

to 100% have been reported in other studies (Namanda *et al* 2004). When Frias-Trevino *et al* (2001) evaluated the resistance of 18 potato genotypes towards late blight under natural field conditions in Mexico in 1991, they found that Atzimba, Greta, Mexiquense, Tollocan, 750489, 750815, I-1039 and I-1150 genotypes showed damage below 10%, while the control and variety Alpha had 100% damage. In Lithuania Valskyte *et al* (2003) found that cultivar Aistes recorded the highest resistance to late blight, exhi-

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(Received June 13, 2006)

(Accepted June 26, 2006)

biting a final disease rating of 63 and 13.7% during 2000 and 2001, respectively.

Potato cultivars were evaluated for their resistance responses to aggressive strains of *P. infestans* in field experiment by **Manivel et al (2003)** in France, **Tatarowska et al (2003)** in Poland and **Bruyere and Culiez (2004)** in Uttar Pradesh, India. The cultivars were classified into 3 categories (resistant, intermediate and susceptible) based on the severity of infection at the beginning of the season and on the level of infection during the epidemic stage. In Egypt during winter seasons 1999-2001, potato late blight could destroy virtually 100% of the aboveground parts of susceptible potato cultivars under favourable conditions and in the absence of any control measures (**Fahim et al 2003**).

Application of fungicide treatments considerably reduced late blight progress, with a corresponding increase in tuber yield. **Khan et al (2003)** tested five fungicides viz., Acrobat MZ 90/600 WP [dimethomorph], metalaxyl + mancozeb 72 WP, Ridomil Gold (mancozeb + metalaxyl) 68 WP, Banko (chlorothalonil) 500 SC and Score (difenoconazole) 250 EC against late blight disease (*P. infestans*) developed on 30 potato cultivars/lines under natural conditions in Faisalabad, Pakistan. All the fungicides reduced disease severity significantly on most of the cultivars/lines compared to untreated control. Based on monitoring of late blight disease occurrence and weather variables, two applications of the contact fungicide mancozeb on a moderately resistant variety was the most economic (**Namanda et al 2004**). **Sarekanno et al (2004)** evaluated various fungicides (Acrobat MZ, Dithane M45, Tattoo, Glory, Sereno, Tat-

too + Sereno, and Glory + Sereno) in Saku, Estonia, against *P. infestans* on potato cultivars Berber, Varajane Kollane and Piret. They found that Tattoo was the most effective in protecting stems, foliage and tubers, and in enhancing the yield. Under conditions favouring disease development, fungicides with higher concentration of the systemic active ingredient than the contact ingredient were more effective.

Basu, (2002) reported that Cardinal not only increased plant growth in terms of plant weight, tuber number per plant and tuber weight per plant but also enhanced the yield (297.0 q/ha), i.e. 22.5% increase compared to the control (230.0 q/ha) by reducing late blight severity (8.0%) relative to the control (30.0%). The next best performance was shown by Diamont in all tested parameters, i.e. plant growth, yield (290.0 q/ha) and late blight severity reduction (8.5%). This was followed by the newly released Indian processing cultivar, Kufri Chipsona-1, showing increased plant growth and yield (275.0 q/ha) by reducing late blight severity (9.0%) in comparison to other cultivars, including the control. Kufri Jyoti, on the other hand, stated that a widely cultivated cultivar in this region showed more or less similar performance with another newly released processing cultivar, Kufri Chipsona-2, in all respect.

Fontem et al (2003) found that high yielding resistant cultivars or foliar applications of Ridomil Plus may be incorporated in integrated pathogen management schemes against late blight in huckleberries (*Solanum scabrum* L.) to minimize fungicide application.

This study investigated the effects of fungicide application, and host resistance on late blight epidemics and potato yield.

MATERIAL AND METHODS

Cultivars reaction

Reaction of different potato cultivars to natural infection with *P. infestans* in open field were tested. Twenty five potato cultivars were obtained from Horticulture Research Institute "Agricultural Research Centre". The field experiment was carried out in the Nili plantation starting September of 2003 and 2004 at Nobaria locality, Behira Governorate. The experiment was designed in randomized complete blocks with four replicates. Potatoes were cultivated using the usual "Herati" plantation method commonly used by potato growers in Egypt. Potato seed tubers were planted in hills, 25 cm apart. Natural infection with late blight was recorded after 70, 80 and 90 days from plantation and assessed using the scale described by **Anonymous (1947)** as follows:

- (0) = No disease observed.
- (0.1) = A few scattered blighted plants, no more than 1 or 2 spots in 10 m radius.
- (1.0) = Up to 10 spots per plant, or general light infection.
- (5.0) = About 50 spots per plant, up to 1 in 10 leaflets infection.
- (25.0)= Nearly every leaflet was infected, but plants retaining normal, field look green although every plant is affected.
- (50.0)= Every plant affected and about 50% of the leaf area is destroyed, field green flecked with brown.

(75.0) = About 75% of leaf area was destroyed, field appears neither predominantly brown nor green.

(95.0) = Only few leaves on plants, but stems are green.

(100.0)= All leaves dead, stems dead or drying.

From field assessments of late blight severity, cultivars were grouped in susceptible and resistance categories as follow:

Highly susceptible (HS): more than 50%, Susceptible (S): 25-50%, Moderately resistant (MR):15-25%, Resistant (R):10-15% and Highly resistant (HR): Less than 10% of leaf area.

Effect of fungicide application

Seven different fungicides (**Table 1**) were tested for their efficiency in controlling late blight under field conditions. Two experiments were carried out at Nobaria locality in Behira Governorate during seasons 2003 and 2004. The cultivar used in this work was Sputa. Each of the two experiments was carried out in a randomized complete block design with four replicates. A set of four plots were left without treatment as control. Plot was 1/100 feddan. Four sprays were carried out after 45, 55, 65, 75 days from plantation. The average of infection percentage was determined in the treated as well as the untreated plots.

Estimation of yield loss

Six selective different potato cultivars of different degrees of susceptibilities to late blight (Lady Roseta, Nicola, Sputa, Atlas, Diamont and Hermes) were ex-

amined for yield evaluation. Two experiments were carried out at Nobaria locality Behira Governorate during the 2003 and 2004 seasons. Each of the two experiments was carried out in a randomized complete block design with four replicates. The fungicide used in this work was Previcur-N. Plot was 1/100 feddan. Four sprays carried out at 45, 55, 65, 75 days from plantation were. Tuber yield in each replicate plot was determined and

average of tubers yield loss percentage was calculated using of the **Formula Leclerg (1967)**

$$T=X1 - (X2/Sd)$$

Where: T, tuber yield loss; X1 mean yield of the treated plots; X2 mean yield of the untreated plots and Sd standard error of the difference between the two mean yields.

Table 1. Fungicides tested against potato light blight their product name, formulation, active ingredient and dose

Products name	Formulation	Active ingredient	Dose/100 L. water
Acrobat-MZ	WP	59% Mancozeb + 10% dimethomorph	250 gm.
Ridomil gold MZ	WP	64% Mancozeb + 4% metalaxyl	200 gm.
Aquagen Bro	WGD	30% Cymoxanil + 22.5% famoxadone	40 gm.
Galben-MZ	WP	48% Mancozeb + 10% benalaxylyl	250 gm.
Dithane-M45	WP	80% mancozeb	250 gm.
Previcur-N	SL	72% propamocarb hydrochloride	250 cm.
Champ DF	DF	57.6% Copper Hydroxide	250 gm.

RESULTS AND DISCUSSION

Late blight was recorded on all potato cultivars in Nubaria during 2003 and 2004 planting seasons. Results in **Tables (2) and (3)** showed that reaction of potato cultivars was consistent in the two experiments giving the same trend under natural infection conditions. It was obvious that Daisy, Hermine and Isabel were the highly susceptible cultivars. Late blight developed in these cultivars was more vigorous than in other cultivars giving high infection rates after 90 days. Cultivars Occania, Soleia, Altesse and Safrane recorded the highest resistant to late blight, exhibiting a final disease rating of 3.0%, 4.5%, 5.1% and 6.5 during 2003. In 2004, it was 4.0% for Occania, 6.25% for Soleia and 7.30% for Safrane. But Anais, Atlas, Cordle and Penelope potato cultivars were moderately resistant in season 2003.

The obtaind results in **Table (2) and (3)** are in consistent with those of **Manivel et al (2003); Tatarowska et al (2003), Valskyte et al (2003) and Bruyere and Culiez (2004)**. In this respect, **Basu, (2002)** reported that Diamont cultivar was resistant against late blight in the field; it was followed by the newly released Indian processing cultivar, Kufri Chipsona-1, which showing increased plant growth and yield (275.0 q/ha) by reducing late blight severity (9.0%) in comparison to other cultivars.

The results shown in **Table (4)** demonstrate that all fungicide treatments have significantly reduced incidence of late blight compared with the untreated Control. Application of Aquagen Bro and Previcur-N resulted in the highest reduction in late blight followed by Acrobat-MZ and Galben-MZ in both season. Gen-

erally, all the fungicides reduced disease severity compared to untreated control. In this regard **Fontem et al (2003)** recorded that spraying four times with Ridomil Plus (12% metalaxyl + 60% cuprous oxide) at 2.5 kg/ha significantly reduced late blight severity and consequently increased huckleberry (*Solanum scabrum*) yield. The results of the present study are in agreement with those of **Hofman et al (2003)**.

Meanwhile, of treatment **Geary et al (2004)** reported that the protectant fungicides metiram, mancozeb and chlorothalonil were not significantly different from dimethomorph + mancozeb, cymoxanil + mancozeb, and propamocarb hydrochloride + chlorothalonil in late blight control when applied by aircraft. However, cymoxanil + mancozeb had limited efficacy when applied by chemigation.

The results in **Table (5)** showed the percentage of late blight severity and tuber yield of six potato cultivars grown in Nubaria during Nili seasons 2003 and 2004. On Lady Roseta when disease infection was 42.60% tuber yield losses was 18 Kg/plot. Whereas on Hermes, when disease infection was 11.25% yield losses was 11.75Kg/plot in season 2003. Results indicated that yield losses increased with increasing late blight severity. Cultivar Spunta recorded the highest yield losses to light blight and exhibited a final yield losses of 16.5 and 23.75 Kg/plot during 2003 and 2004 respectively. Meanwhile the highest yield in season 2003 was obtained from Diamont (192.25 Kg/plot), followed by Spunta (141.00Kg/plot). The lowest yield losses recorded with Hermes (11.25 Kg/plot), and the highest was exhibited by Spunta (23.75Kg/plot) in season 2004.

Table 2. Field resistance of potato cultivars to late blight infection at various periods under natural infection. (Nobaria locality, Behira Governorate) (Nili plantation of 2003)

Cultivars	% foliage infection *			Cultivar reaction**
	70	80	90	
Daisy	22.50	41.60	65.65	HS
Isabel	14.85	30.60	56.50	HS
Hermine	11.20	23.50	50.00	HS
Elodie	10.90	30.50	43.50	S
Lady Roseta	9.50	23.40	42.60	S
Doline	9.45	20.75	31.80	S
Bailla	7.60	15.55	28.90	S
Nicola	5.50	15.25	28.00	S
Spunta	5.75	10.00	27.50	S
Alaska	6.25	11.00	26.50	S
Agria	6.60	10.40	25.70	S
Anais	5.60	14.50	24.85	MR
Justine	6.50	12.35	23.50	MR
Cordle	5.00	13.50	21.75	MR
Penelope	6.50	10.00	19.50	MR
Atlas	3.90	7.54	15.00	MR
Floreal	4.55	8.45	15.50	R
Rutis	4.25	8.00	14.00	R
Florice	2.90	6.45	13.54	R
Diamont	3.85	6.50	11.30	R
Hermes	2.50	4.35	11.25	R
Safrane	2.25	5.00	6.50	HR
Altesse	1.50	3.75	5.10	HR
Soleia	0.00	2.25	4.50	HR
Occania	0.00	1.50	3.00	HR

* Disease severity was measured on a visual scale after 70, 80, 90 days from sowing.

** Cultivar reaction taken after 90 days where HS=Highly susceptible, S=Susceptible, MR= Moderately resistant, R=Resistant and HR= Highly resistant.

Table 3. Field resistance of potato cultivars to late blight infection at various periods under natural infection. (Nobaria locality, Behira Governorate) (Nili plantation of 2004)

Cultivars	% foliage infection *			Cultivar reaction**
	70	80	90	
Isabel	19.75	45.00	73.60	HS
Daisy	18.30	41.25	70.50	HS
Hermine	15.55	27.90	60.25	HS
Elodie	16.75	30.25	59.90	HS
Alaska	15.50	27.90	50.00	HS
Spunta	7.50	17.25	38.00	S
Doline	11.25	25.30	40.25	S
Agria	11.30	23.25	40.50	S
Anais	7.30	16.30	38.50	S
Bailla	6.80	17.25	36.25	S
Justine	8.55	15.50	36.50	S
Nicola	7.25	13.90	34.25	S
Lady Roseta	12.35	18.25	31.25	S
Cordle	7.00	15.00	27.50	S
Floreal	4.25	11.22	27.35	S
Atlas	5.25	13.25	25.30	S
Rutis	6.25	13.00	24.00	MR
Penelope	6.50	12.30	19.50	MR
Diamont	5.25	10.25	14.00	R
Florice	5.50	11.00	14.25	R
Hermes	2.75	4.25	9.25	HR
Altesse	2.50	5.25	8.25	HR
Safrane	3.50	5.90	7.30	HR
Soleia	2.25	5.00	6.25	HR
Occania	2.00	3.25	4.00	HR

* Disease severity was measured on a visual scale after 70, 80, 90 days from sowing.

** Cultivar reaction taken after 90 days where HS=Highly susceptible, S=Susceptible, MR= Moderately resistant, R=Resistant and HR= Highly resistant.

Table 4. Effect of foliage spray of different fungicides on late blight incidence in a naturally infected field

Treatments	Seasons			
	2003		2004	
	Disease severity	Efficiency	Disease severity	Efficiency
Acrobat-MZ	4.3	84.40	6.4	83.20
Ridomil gold MZ	5.4	80.40	7.2	81.10
Aquagen Bro	2.8	91.40	4.6	87.90
Previcur-N	3.0	89.80	5.5	85.50
Galben-MZ	4.6	83.30	6.9	81.80
Dithane-M45	7.7	72.00	10.6	72.10
Champ DF	7.4	73.10	9.5	75.00
Control	27.5	----	38.00	----
L.S.D.at 0.05	2.66		3.09	

Efficiency= (control – treatment)/ control X 100

Table 5. Relationship between late blight infection and yield/plot during 2003 and 2004 seasons

Cultivars	%infection 2003	Weight of tubers yield per plot (Kg)			%infection 2004	Weight of tubers yield per plot (Kg)		
		treated	untreated	yield losses		treated	untreated	yield losses
Lady	42.60	93.50	75.50	18.00	31.25	88.75	74.5	14.25
Roseta								
Nicola	28.00	128.00	112.50	15.50	34.25	122.50	105.75	16.75
Spunta	27.50	141.00	124.50	16.50	38.00	143.75	120.00	23.75
Atlas	15.00	96.50	83.75	12.75	25.30	91.50	77.00	14.50
Diamont	11.30	192.25	180.25	12.00	14.00	187.00	172.75	14.25
Hermes	11.25	117.75	106.00	11.75	9.25	120.50	109.25	11.25

The results of the present study demonstrate that host resistance plays an important role in management of potato late blight. Application of fungicide treatments considerably reduced late blight progress. Khan *et al* (2003) stated that control of late cultivation of resistant/moderately resistant cultivars combined with one or two sprays of fungicides would be helpful to control late blight of potato successfully. Fontem *et al* (2003) reported that fungicide applications significantly reduced late blight intensity and consequently increased yields. The results show that late blight infections, if not controlled, decrease yields, and consequently lower net farm incomes. High yielding resistant cultivars or foliar applications of Ridomil Plus may be incorporated in integrated pathogen management schemes against late blight to minimize fungicide use. However, the most efficient use of fungicide is to apply a reduced level of fungicide to a cultivar of field resistance according to a prediction modal (Gunwald *et al* 2000).

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مجلة اتحاد الجامعات العربية للدراسات والبحوث الزراعية ، جامعة عين شمس ، القاهرة، 14(2) ، 753-743 ، 2006

تأثير مقاومة العائل واستخدام المبيدات الفطرية لمكافحة مرض الندوة المتأخرة فى البطاطس

[47]

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المحصول . أوضحت النتائج أيضاً أن الفقد فى المحصول بسبب اللفة المتأخرة فى موسم 2003 تراوح بين 11.75 كجم/قطعة فى الصنف هيرمز إلى 18.0 كجم/قطعة فى الصنف ليدى روزيتا بينما فى موسم 2004 تراوحت الخسائر من 11.25 كجم/قطعة فى الصنف هيرمز إلى 23.75 كجم/قطعة فى الصنف سبونتا مقارنة بتلك النباتات المعاملة بالمبيد. توضح الدراسة أن المعاملة بمبيد بريفيكبور-إن مع الأصناف مقاومة كانت فعالة فى اختزال الإصابة باللفة المتأخرة وكذلك الفقد فى محصول الدرنات بدرجة كبيرة وهو ما يوضح أهمية التكامل بين المعاملة بالمبيد الفطري ودرجات المقاومة للصنف فى برام -ج المكافحة المتكاملة لأمراض البطاطس فى مصر.

تعتبر اللفة المتأخرة المسببة عن الفطر فيتوفورا إنفستانس أحد أهم العوامل المؤثرة فى إنتاج البطاطس فى مصر وفي مناطق عديدة من العالم. قيمت درجة المقاومة فى خمسة وعشرون صنف من أصناف البطاطس خ لال موسم ي 2003 و 2004 تحت ظروف الإصابة الطبيعية فى منطقة النوبارية بمحافظة البحيرة فى مصر. سجلت الأصناف التنسى وفلوري ل وأكانيا وسافرنى وسوليا مقاومة عالية للمرض بينما سجلت الأصناف دايزى وهيرمن وإيزابل قابلية عالية للإصابة بالمرض في كل الموسمين. بعض الأصناف اختلفت درجة مقاومتها من موسم إلى آخر. بينت الدراسات الحقلية أن أفضل المبيدات الفطرية لمكافحة اللفة المتأخرة فى البطاطس هي أكواجين برو وبريفيكبور-إن مما أدى إلى زيادة

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