Performance of a phosphite formulation against late blight in potatoes

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Worldwide use of phosphites (phosphonates) as fungicides against oomycete related diseases in many crops eg. grapes, pineapples, avocados and citrus have increased dramatically over the past decade. For some unknown reason late blight (*Phytophthora infestans*) in potatoes as an obvious target, was overlooked.

To explore the possible values of phosphites as fungicides in the control of blight, a series of local field trials was conducted. After preliminary work it was decided to concentrate on ammonium phosphite (Brilliant SL), a new fungicide member of this chemical group. Excellent and consistent control of blight with this compound was obtained. Curative action was excellent and residual action was short which necessitated combining the product with a non-systemic broad spectrum fungicide such as Trimangol SC, a maneb containing micro fine suspension. Curative properties could be very useful under situations when growers have noticed blight too late or when the program followed did not give the necessary protection. The most welcome property of the product is its affordability when compared to current systemic blight fungicides.

Furthermore new chemistry that could be used to alternate with current systemic fungicides in program spraying is always most valuable in slowing the development of resistance in the blight pathogen populations.

Research reports from Ireland supported by limited local work indicated that the product may also control tuber blight by translocation from foliage to tubers through the vascular system. This finding is further pursued locally and if repeated could play an important role in minimizing the role of tuber transmission and dissemination of the blight pathogen.

The discovery that fosetyl-aluminium is virtually inactive in vitro and that it is converted within the plant to the fungotoxic phosphonic acid (1), the use of phosphorous acid as fungicide in neutralized form has drastically increased firstly in Australia and thereafter in South Africa as well as the United States of America. Development of phosphonates was principally directed at oomycete related diseases in accordance with the spectrum of activity of phosphorous acid (2).

Prime crop and disease targets were grapes against downy mildew (*Plasmopara viticola*), citrus against Phytophthora crown and root rot and avocados for the control of *Phytophthora* root and stem rot (3). The big attraction is that the product has both acropetal and basipetal mobility in plant tissue after application. This means that phosphorous acid can be applied to the foliage and it will be translocated to the lower stems and roots. Few if any fungicides has this textbook property. When applied to the roots it is translocated upwards.

No work has so far been reported locally and elsewhere except Ireland (5,6) to exploit these highly sought after properties on potatoes that could greatly assist pathologists and growers in the never ending effort to reduce the risk of late blight.

The present study was initiated to expose and exploit the phosphorous acid fungicidal properties in a new formulation. Most of this work has been conducted in the George area where late blight constantly occurs and where the presence of resistant races of the pathogen to metalaxyl have been recorded.

MATERIALS AND METHODS

Trial location and design

Trials were conducted in the George area because of the regular appearance of blight and other logistic reasons.
The cultivar BP1 was used because of high susceptibility to blight that was necessary to establish levels of efficacy of the different fungicides. In all cases field trials were laid out in growers plantings which then received normal maintenance care but without insect and disease control.

Trials were laid out as random blocks with four replicates of treatments without controls included as treatment to avoid inter-plot and uneven spread of inoculum from untreated to treated plots. Instead control buffer rows were left between blocks which served as even source of inoculum to all replicate plots and as controls next to treated replicates (4). Plots normally consisted of a ten meter section of rows of which the center eight meters were used for yield purposes and for disease assessments. Rows were either double on ridges or single which did not affect trial design.

Fungicide formulation and application

The standard fungicide combinations included for comparison were:

- dimethomorph + mancozeb 90/600 g/kg WP Reg No L 5878
- cymoxanil + mancozeb 60/700 g/kg WP Reg No L 5689
- phosphorous acid as ammoniumphosphite equivalent to 300 g phosphorous acid per liter (BRILLIANT SL Reg No L 7225) - ZA Prov Pat Appl 2002/6621
- maneb/Zn0 435/4,7 g/l SC (TRIMANGOL) SC Reg No L 5985)

The foliar application was made with a

Technoma backpack sprayer fitted with 0,05 hollow cone nozzles, operated at a pressure of ca 1,5 bar in volumes varying from 250-1000/ water per hectare. Rows were sprayed from both sides to ensure even distribution of fungicide deposit on the foliage. At these volumes complete cover was not possible especially at later stages when the plants approached maximum size.

Blight and defoliation assessments:

- compound leaves with blight symptoms. - The 3rd and 4th fully expanded compound leaves from the apical tips on ten random vines from the center eight meter section of each replicate plot were collected and rated as "with symptoms" and "without symptoms".
- defoliation. - 20 vines were randomly chosen from the center of each replicate plot and the percent defoliation recorded. The average of two unbiased ratings was taken as a representative figure.

Yield and density of tubers

Only in one trial was the yield measured, where eight meters of the center of ten meter rows were lifted and the tubers graded into large, medium and small and the mass of each category recorded.

Composite samples of randomly chosen tubers of each of the four replicates of each treatment were subjected to density testing with Food Association potato hydrometer at TuinroeteAgri. Similar samples were collected from four control replicates, pooled and subjected to the same tests and expressed in g/cm^3.

Analyses

Results were subjected to analyses of variance by The Biometrics Unit of the ARC, Silverton, Pretoria and treatment means compared with the Fischer LSD test. Treatment means in tables below followed by the same letter do not differ significantly at the 95 % probability level.

RESULTS AND DISCUSSION

In the tables below only the relevant treatments with their significance are listed as other treatments are still under review for registration.

Boplaas, JA Barnard, George. BP1 potatoes planted 18 Jan 2000.

Two applications were applied on 17 and 23/03/2000 before defoliation assessments were made on 29/03/2000. Blight was firmly established at time of first spray and offered excellent circumstances for the testing of the curative properties of the fungicides. (See Table 1)

Skimmelkrans, G Botha George. BP1 potatoes planted 03.10.2001.

The applications were made on 23.11.2001, 30.11.2001, 07.12.2001, 14.12.2001, 21.12.2001 and 03.01.2002. The blight assessments were made on 09.01.2002 at a stage when the control rows were almost completely defoliated. (See Table 2)

Buffelsdrift, G Barnard, George. BP1 potatoes planted 1st week of July 2002.

The application dates were 12.09.2002,

Table 1 The effect of two curative sprays on defoliation of BP1 potatoes due to late blight. 29.03.2000. Boplaas, George. JA Barnard.

treatment	dosage product per ha	% defoliation as on 29.03.200
1.control* - no fungicide	-	86,2 a
2. cymoxanil/mancozeb 60/700 g/kg WP	3 kg	7,5 b
3. Brilliant SL 300 g phosphorous acid eq. per l (not combined with Trimangol SC)	6,7 l	11,3 b

* In this trial a control was included as a treatment.

Table 2 The effect of program spraying with systemic fungicides on late blight levels on BP1 potatoes. Skimmelkrans, George. G Botha.

fungicide coformulations/mixtures	dosage product per ha	mean % compound leaves blight free
1. dimethomorph/mancozeb 90/600 g/kg WP	2,0 kg	80,0 c
2. ammoniumphosphite 300 g/ l phosphorous acid eq. (Brilliant SL) + maneb/ZnO 435/4,7 g/l SL (Trimangol SC)	6,7 l + 2,0 kg (tank mixed)	89,4 ab

Table 3 The effect of three critical curative sprays on the progress of blight on BP1 potatoes. Buffelsdrift, George. 03.10.2002.

fungicide	dosage as product per ha	percent blight control 3.10.2002	tuber yield (kg) per 5m row 14.11.2002	specific gravity of tubers(g/cm3)14.11.2002
1. dimethomorph +mancozeb 90/600 g/kg WP	2,0 kg	72,50 a (92,5)*	15,05 a	1,083 (1,078)*
2. ammonium-phosphite 300 g/l phosphorous acid eq.(Brilliant SL) + maneb/ZnO 435/4,7 g/l SC (Trimangol SC)	6,7/ plus 2,0 kg (tank mixed)	88,61 b (84,4)* * number in bracket above is the mean % leaves with symptoms in adjacent controls	14,80 a	1,088 (1,075)* *number in bracket above is mean recorded for control tubers

19.09.2002, 26.09.2002, 03.10.2002,10.10.2002, 17.10.2002, 24.10.2002 and 02.11.2002. Blight assessments were made on 03.10.2002.

At the stage when the trial was initiated on 10.10 the grower had already commenced with chemical control which was subsequently followed by the treatments in the trial area. (See Table 3)

In the above trials situations were deliberately chosen where blight epidemics had already started in plantings with many infections in incubation phase before the first curative application was made. This would test the curative properties of the different fungicides included. In above tables only the treatments that are relevant are listed.

In all three trials above Brilliant SL resulted in outstanding curative control of blight and proved to be very useful in situations where infections have progressed beyond the reach of preventive fungicides such as the dithiocarbamates mancozeb and maneb or chlorothalonil (3). The fact that it is translocated downwards soon after application to the lower stems and tubers, results in a very short residual action and must be assisted with a residual fungicide (5,6). In the work reported here maneb in micro fine suspension was chosen as mixing partner because it is also a liquid (Trimangol SC) and would compliment Brilliant SL in this respect.

In the last two trials Brilliant SL was partnered with a residual fungicide and the cumulative curative and residual effect as reflected in the blight level at that stage can hardly be bettered as indicated by the comparative numbers (Tables 1,2 & 3) (Figs 1 & 2) Work on the Mpumalanga Highveld not reported here, clearly indicated the excellent curative action but also the need to combine the product with a residual partner.

The basipetal movement of phosphite ions to the tubers via the vascular system after foliar application and suppression of tuber infection is of great significance as tuber transmission and its role as source of primary inoculum and spread of blight can now possibly be addressed. This property and the increase in specific gravity of tubers from plants treated foliarly with phosphite (Table 3) are currently under review.

The work reported here provides further evidence of the activity of phospites (phosphonates) against oomycete related diseases on potatoes such as late blight (*Phytophthora infestans*). Of great interest to growers is the very favourable cost profile when compared to existing systemic blight fungicides. Growers are cautioned that resistance by the late blight pathogen to phosphite as in Brilliant SL, despite the mixing with Trimangol SC, could become a reality and should the mixture therefore be alternated with chemically unrelated products.

References:

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Photo left: A view on BP1 potato plants in a field trial after three sprays with dimethomorph + mancozeb 90/600 g/kg WP at 2 kg/ha (Reference registered standard fungicide). Buffelsdrift, George, 3 October 2002. Photo right: A view on BP1 potato plants in a field trial after three sprays with a tank mixture of HYPERPHOS 300 (= Brilliant SL) (300 g phosphorous acid equivalent per liter (6,7 liter per ha) and TRIMANGOL SC (435/4,7g maneb/ZnO per liter) (2,0 liter per ha). Untreated control on the right. Buffelsdrift, George, 3 October 2002.