Effect of adjuvants on the efficiency of benthiavalicarb plus mancozeb (Valbon 1.6 kg/ ha) on the control of late blight in potato

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Summary

Industrial adjuvants were tested in combination with benthiavalicarb plus mancozeb (Valbon 1.6 kg/ ha) in the field to investigate their efficacy on foliar late blight caused by *Phytophthora infestans*. The tested adjuvant-fungicide treatments for late blight control were applied 6 times at 7-day intervals. The effect of the adjuvant-fungicide treatments on epidemic development, tuber blight and tuber yields were determined. Because of the favourable weather conditions a high disease pressure could be observed. The incidence of foliage blight was scored and at the end of the growing season the disease level was lower in plots sprayed with the Valbon-adjuvant combinations than in plots treated with only Valbon. The addition of an adjuvant had a clearly positive effect on the tuber yield although the differences were not significant. In the plots treated with Valbon 6.9 % infected tubers were observed. The mean tuber infection of plots sprayed with the Valbon-adjuvant combinations fluctuated between 2.3 and 15.6 %.

Key words: potato, late blight, *Phytophthora infestans*, fungicide adjuvant combination efficacy of adjuvants on fungicide efficiency

Introduction

An adjuvant is broadly defined as any substance added to the spray tank, separate from the pesticide formulation, that will improve the performance of the pesticide or the physical properties of the spray mixture, or both. The right adjuvant may reduce or even eliminate spray application problems, thereby improving overall pesticide efficacy. Adjuvants are designed to perform specific functions, including wetting, spreading, sticking, penetrating, reducing

evaporation, reducing volatilization, buffering, dispersing,.... No single adjuvant can perform all these functions, but different compatible adjuvants often can be combined to perform multiple functions simultaneously.

Within the scope of a research project financed by the Institute for the Promotion of Innovation by Science and Technology in Flanders a range of industrial adjuvants were screened for possible application in agriculture. They were tested in different model systems. One model system was potato-*Phytophthora infestans* since potato late blight remains one of the most serious constraints to potato production world wide. To control *P. infestans* and to protect the potato crop, potato plants are sprayed preventively with fungicides. Therefore, successful production of healthy potato crops relies on repeated applications of several fungicides during the potato growing season. A good rainfastness, spreading and sticking of a fungicide are important characteristics to improve the efficacy of fungicides.

The objective of this study was to investigate the efficacy of Valbon (benthiavalicarb plus mancozeb) in combination with adjuvants to control late blight during the growing season. Benthiavalicarb is a translaminar fungicide while mancozeb is a contact fungicide.

Material & Methods

Field trial

A field experiment was carried out on the experimental farm of the 'University College Ghent' at Bottelare during the growing season 2008. The first two treatments were the same for the different objects (mancozeb 2.2 kg/ ha). Later on the different adjuvants were compared in a spray system based on 7-day intervals to test their effect on the efficiency of benthiavalicarb plus mancozeb (Valbon). The experiment was set up with the variety 'Bintje'. The different objects were separated by two rows of the resistant variety Gazoré. Treatments were carried out with a AZO sprayer to 3 m wide and 10 m long plots. The spray boom was equipped with TeeJet nozzles (Teejet XR 11003 VK: 300 l water/ ha or XR 110015 VK: 150 l water/ ha) spaced 50 cm apart. The water volume was always 300 l/ ha with the exception of Magic Sticker for wich a water volume of 150 l/ ha was used. The tested adjuvants and the applied doses are summarized in table 1.

Due to low temperatures and rainy weather the potato field was infected naturally by *Phytophthora*. Those weather conditions favoured the development of late blight all over the plots so that no artificial infection was necessary.

The experimental design was a completely randomised block design with four replicates. The adjuvants fungicide treatments were randomised within the blocks.

Following crop husbandry measures were taken: planting date of certified seed potatoes: 7 May 2008; row distance: 0.68 m; fertilisation 6 May 2008: 240 kg/ ha N, 140 kg/ ha P_2O_5 and 180 kg/ ha K_2O. Herbicide treatment 9 May 2008: linuron + pendimethalin + prosulfocarb: 750 g + 800 g + 3,2 kg/ ha (Luxan Linuron 1,5 l/ ha + Stomp 2 l/ ha + Defi 4 l/ ha); control of Colorado potato beetle 31 July 2008: lambda-cyhalothrin: 7,5 g/ ha (Karate 75 ml/ ha).
Diquat 600 g/ ha (3 l/ ha Reglone, Zeneca) was used to dessicate leaves and stems on 13 September. Potatoes were harvested on 6 October.

Disease estimates
To measure the intensity of foliage blight caused by *P. infestans* the foliar blight assessment key of the Blight Workshop in Tallinn was used: 0.0 % blight: no disease observed; 0.1 %: more than 1 lesion in a plot of 100 plants; 0,2 %: up to 25 lesions in a plot of 100 plants; 0,3 %: up to 50 lesions in a plot of 100 plants; 0,4 %: up to 75 lesions in a plot of 100 plants; 0,5 %: up to 100 lesions in a plot of 100 plants or 1 lesion per plant; 0,6 %: 2 lesions per plant in a plot of 100 plants; 0,7 %: 4 lesions per plant in a plot of 100 plants; 0,8 %: 6 lesions per plant in a plot of 100 plants; 0,9 %: 8 lesions per plant in a plot of 100 plants; 1 %: 10 lesions per plant in a plot of 100 plants; 5 %: 1 lesion per compound leaf or 50 lesions per plant in a plot of 100 plants; 10 %: 2 lesions per compound leaf or 100 lesions per plant in a plot of 100 plants; 25 %: nearly every leaflet with blight lesions, but plants retain normal form, plants may smell of blight, 75 % of plot leaf area remains green; 50 %: about 50 % of leaf area destroyed by blight; 75 %: about 75 % of leaf area destroyed by blight; 95 %: only a few leaves on plants, but stems green; 100 %: all leaves dead, stems dead or dying.
The overall amount of percentage blight was assessed at regular intervals for all the plots.

Data were analysed by performing analysis of variance (SAS 2.0). The One-sample Kolmogorov-Smirnov test was used to analyse the normal distribution of the obtained results. The Tukey test

was used to compare treatment means when data were normally distributed. The non parametric test Kruskall-Wallis was used when the data were not normally distributed.

Harvest

Tubers were harvested mechanically. Two rows central of each plot were harvested over a distance of 7 m. All tubers were washed, weighed after grading and assessed for blight within 2 months after harvest. Washed tubers were examined visually for the presence or absence of lesions symptomatic of late blight. Furthermore, infected tubers were cut longitudinally to confirm the presence of dry brown corky rot in the tuber beneath the lesion, a symptom typical of late blight tuber infection. The diagnosis of tuber blight was further confirmed by observing sporangia production after incubating tubers with characteristic lesions in plastic containers containing moist paper towels.

Results & Discussion

The growing season 2008 was characterized by a cloudy, rather cold and wet summer. In June the mean temperature was 16.2 °C and 76 mm of rain was fallen. In July the mean temperature was 18.2 °C and in total 61.4 mm rain was fallen. In August the mean temperature was 17.5 °C and 103.2 mm rain. These weather conditions were very favourable for late blight development.

The incidence of foliage blight was scored weekly from 23 June until 16 September. The field experiment in 2008 indicated that Valbon (benthiavalicarb plus mancozeb) and the Valbon plus adjuvants combinations had a significant suppressive effect on established epidemics compared to untreated plots. The differences in control efficiency for the fungicide combinations tested were rather small and statistically not significant. Only at the end of the growing season differences in efficiency between the tested adjuvants were observed (Fig. 1). On the first of September a foliage incidence of 13 % was observed for Valbon (benthiavalicarb plus mancozeb). For the treatments of Valbon (benthiavalicarb plus mancozeb) combined with an adjuvant the percentage foliage blight fluctuated between 5 and 10 % with a mean infection of 7 %. On 16 September the foliage incidence reached 34 % for Valbon (benthiavalicarb plus mancozeb). For Valbon in combination with adjuvants the infection fluctuated between 12 and 33 % with a mean infection of 19 %. The addition of adjuvants to Valbon (benthiavalicarb plus mancozeb) resulted in a better foliage protection compared to Valbon without adjuvants. Bond,

Famee 5 and Certain ES had a clearly positive effect on the efficiency of Valbon (benthiavalicarb plus mancozeb).

No significant differences in yield per plant were observed for the Valbon combinations tested (Table 2 and Figure 2). For Valbon (benthiavalicarb + mancozeb) the mean yield per plant was 1.7 kg/ plant. For the different adjuvants combinations applied the mean yield per plant was 1.8 kg/ plant.

No significant differences in total yield, yield of grade lower than 32 mm and yield of grade higher than 32 mm were observed for the different treatments applied (Table 2 and Figure 2). The total yield of the untreated plot was 38,3 ton/ ha and the yield for Valbon (benthiavalicarb + mancozeb) was 52,2 ton/ ha. For the treatments of Valbon in combination with an adjuvant the yield fluctuated between 52.3 and 63.0 ton/ ha with a mean yield of 55.7 ton/ ha. Valbon combined with TB5031 had the lowest yield: 52.3 ton/ ha. The addition of an adjuvant had in general a clearly positive efffect on the tuber yield: a mean increase of 3,5 ton/ ha was obtained. A yield of more than 60 ton/ ha was obtained for the adjuvants Zipper, PBG, Softanol 70, Bond and BIOT 3. The lowest yield was obtained with Magic Sticker: 54.6 ton/ ha.

In the control plots 6.1 % infected tubers were observed (Table 3). The plots sprayed with Valbon (benthiavalicarb + mancozeb) had a tuber incidence of 6.9 %. The mean tuber infection of plots sprayed with the Valbon-adjuvant combinations was 9.3 %: the percentage diseased tubers fluctuated between 2.3 and 15.6 %. The adjuvants Softanol 70 and BC02 in combination with Valbon (benthiavalicarb + mancozeb) had a distinctly positive effect on tuber protection: only an infection of respectively 2.3 and 5.0 % was observed against 6.9 % diseased tubers for Valbon (benthiavalicarb + mancozeb) without adjuvant.

Conclusions

The growing season 2008 was characterized by a cloudy, rather cold and wet summer. These weather conditions were very favourable for the development of late blight. In a field experiment the effect of the tested adjuvants on the efficiency of Valbon (benthiavalicarb plus mancozeb) on incidence of foliage blight, tuber yield and tuber blight was investigated. From this field trial can be concluded that the tesed adjuvants, with the exception of BIOT 2, had a positive effect on

foliage protection in combination with Valbon (benthiavalicarb plus mancozeb). The addition of an adjuvant had in general a clearly positive efffect on the tuber yield: the yield fluctuated between 52.3 and 63.0 ton/ ha while the yield for Valbon (benthiavalicarb plus mancozeb) was 52.2 ton/ ha. The adjuvants Softanol 70 and BC02 in combination with Valbon (benthiavalicarb + mancozeb) had a distinctly positive effect on tuber protection: only an infection of respectively 2.3 and 5.0 % was observed against 6.9 % diseased tubers for Valbon (benthiavalicarb + mancozeb) without adjuvant.

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