Effects of Crop Sanitation and Ridomil MZ Applications on Late Blight Severity and Tomato Yields in Cameroon

D.A. Fontem*, P.C. Younyi & M.N. Suh

Keywords: Disease control- fungicide- late blight- *Lycopersicon esculentum- Phytophthora infestans*- Tomato

Summary

*Tomato (*Lycopersicon esculentum*) production in Cameroon is usually handicapped by late blight caused by* Phytophthora infestans*. A field trial was conducted during 1997 in Dschang, Cameroon, to assess the effect of Ridomil MZ (8% metalaxyl + 64% mancozeb) sprays, and sanitation (a weekly picking of diseased leaves) on late blight development and yield of five tomato varieties. Plots received Ridomil MZ (2.5 kg/ha) and sanitation singly or combined. Control plots were neither sprayed nor cleaned from diseased leaves. All treatments were applied ten times in a weekly schedule. Late blight intensity was assessed every 7 days and marketable fruit yields were obtained at maturity. Differences in late blight intensity between sanitation and control plots were not significant (P= 0,05). Fungicide treatments were more effective than sanitation in reducing late blight severity. Percent fruit infection was 100% in control or sanitation plots of ARP I366-1, ARP D1, ARP D2, Roma, and no marketable fruits were harvested on these treatments. Late blight was less severe on Mecline compared to the other varieties. Consequently, Mecline out-yielded Roma, ARP I366-1, ARP D1 and ARP D2 varieties. Results suggest that the fungicide-alternative method of late blight control, using sanitation is not as effective in tomato late blight management as appropriate fungicide sprays.*

Résumé

Effets de l'effeuillage sanitaire et des traitements au Ridomil MZ sur la sévérité du mildiou et le rendement de la tomate au Cameroun

*La production de la tomate (*Lycopersicon esculentum*) au Cameroun est souvent entravée par les infections du mildiou causé par* Phytophthora infestans*. Les essais ont été menés pendant la saison culturale de 1997 à Dschang, Cameroun, afin de déterminer les effets de traitements au Ridomil MZ (8% metalaxyl + 64% mancozèbe) et de l'effeuillage sanitaire (prélèvements hebdomadaires des feuilles atteintes) sur le développement du mildiou et le rendement de cinq variétés de la tomate. Les parcelles ont reçu des traitements au Ridomil MZ (2,5 kg/ha) et sanitaires individuellement ou en combinaison. Les parcelles témoins n'ont pas reçu ces traitements. Tous les traitements ont été appliqués dix fois tous les 7 jours. L'intensité du mildiou a été évaluée chaque semaine et les rendements en fruit commercialisable ont été obtenus à la maturité. Les différences en intensité d'infections foliaires du mildiou entre les parcelles soumises à la récolte sanitaire et celles ayant reçu les traitements fongicides n'ont pas été significatives (P= 0,05). Le traitement fongicide a été plus efficace dans la réduction de l'intensité du mildiou que le traitement sanitaire. Le pourcentage de fruit infecté a été total (100%) dans les parcelles témoins ou celles sous traitement sanitaire des variétés ARP I366-1, ARP D1, ARP D2 et Roma et aucun rendement commercialisable n'a été obtenu sur les plants de ces traitements. Le mildiou a été moins sévère sur* Mecline par rapport aux autres variétés. Par conséquent, les rendements commercialisables ont été significativement plus élevés sur Mecline par rapport à Roma, ARP I366-1, ARP D1 et ARP D2. Les résultats suggèrent que l'utilisation de la récolte sanitaire comme moyen de lutte contre le mildiou de la tomate est moins fiable que les traitements au fongicide.

Introduction

Tomato (*Lycopersicon esculentum* Mill.) yields in Cameroon are very low (5) because of high disease severities (6, 10, 13). Late blight incited by *Phytophthora infestans* (Mont.) de Bary is the most important field disease (6, 10, 12, 13). Although many tomato varieties have been screened for resistance to

*Plant Protection Department, Faculty of Agriculture, University of Dschang, P.O. Box 208, Dschang, Cameroon.
Email: dfontem@yahoo.com
Received on 26.09.03. and accepted for publication on 06.02.04.

late blight, resistant ones have not been reported in Cameroon (10, 11, 13). Consequently, tomatoes are usually produced in the wet season under an intensive fungicidal spray regime and late blight management forms an integral component of tomato cultural techniques. During the wet season, when plants are most susceptible to the disease (14, 16), tomato growers usually apply 2 - 3 fungicidal sprays per week to limit late blight infections (12). The most used fungicide for late blight protection in tomato in Cameroon is maneb, followed by Ridomil Plus or Ridomil MZ (11, 12). The latter fungicide has the advantage of combining both protectant and curative actions against the oomycete pathogen (*P. infestans*) (4, 17).

Pesticides, in general, are not always accessible to growers. Consequently, identification of fungicide alternatives, such as sanitation practices (regular picking of diseased leaves) may be necessary. Sanitation has been used successfully to retard late blight development and improve tuber yields in potato (7 - 9). This study was designed to evaluate the single and combined effects of Ridomil MZ (8% metalaxyl + 64% mancozeb, 72 WP) and crop sanitation (weekly picking of diseased leaves) on late blight severity and tomato yields in Cameroon.

Materials and methods

Field plot design and cultural techniques

Field experiments were conducted during 1997 in Dschang, Western highlands of Cameroon, to assess the effect of Ridomil MZ and sanitation on tomato yields. A split block design was used with three replicates. Blocks of 20 x 16 m contained 4 main plots. Blight management methods were randomly assigned to main plots, while varieties were randomised within the sub-plots. Each sub-plot contained four raised beds (3.2 x 5 m). Blocks were separated by an uncultivated land 2 m wide.

The plant material consisted of the determinate tomato varieties ARP-D1, ARP-D2, Mecline and Roma, and the indeterminate variety ARP I366-1. Varieties Mecline, ARP-D1, ARP-D2 and ARP I366-1 were obtained from the Asian Vegetable Research and Development Centre/Africa Regional Programme (AVRDC/ARP) Arusha, Tanzania, while Roma was used as a local check.

A nursery plot was fertilised with 250 kg/ha cowdung and 240 kg/ha 20-10-10 (NPK). The nursery was set 9 April and seeds were drilled 0.05 m apart in rows spaced 0.10 m. After sowing, the beds were shaded with fresh grass mulch until germination was completed. After germination, plants were sprayed twice with Ridomil MZ (2 kg/ha) at a 2-weekly interval before transplanting.

Seedlings were transplanted when plants had developed 4 - 5 true leaves (21 May). They were planted in rows spaced 0.80 m apart with 0.40 m between plants within the row. Field beds were fertilised with 180 kg/ha N-P-K and 100 kg/ha ammonium sulphate. Both fertiliser treatments were split into two: half was applied during transplanting and the rest 7 weeks later. Chicken droppings (3-2-4 N-P-K) were applied to the beds at 1200 kg/ha before transplanting. Ammonium sulphate was applied at 270 kg/ha during flowering. After transplanting all plants received two weekly sprays of Ridomil MZ at 2 kg/ha. Three sprays of a foliar fertiliser, Fertigofol 313 (4 l/ha), were applied on leaves every two weeks following fruit initiation. Plants were staked and the field was hand weeded as needed.

Late blight management was performed weekly from 7 June [17 Days After planting (DAT)] with crop sanitation, Ridomil MZ applications, or both. All treatments were initiated at the apparition of first visible foliar late blight symptoms. Ten weekly foliar sprays of the fungicide were applied at 2 kg/ha. A sticker, Excell (0.1% v/v), was incorporated into the spray solution. Crop sanitation was performed ten times by picking late blighted leaves weekly. Control plots were neither sprayed, nor rid of diseased leaves. Deltamethrin (Decis 25 EC, 2.5 g a.i./ha) was applied thrice on the foliage at two-weekly intervals to control aphids and whiteflies. All pesticide treatments were applied with a Hardi knapsack sprayer, using a spray volume of 700 l/ha at a maximum pressure of 4 kg/cm^2 with a single flat fan nozzle.

Disease and yield evaluations

Ten weekly disease severity ratings were scored on five randomly selected plants in the middle row of each plot. The assessments were initiated 28 DAT. The severity (percent tissue area diseased) of late blight was scored using the modified Horsfall-Barratt rating scale (2). Standardised values for area under disease-progress curve (SAUDPC), expressed in percentages, were calculated for each plot using the formula (3):

$$SAUDPC = \sum_{i}^{n-1} \frac{(y_i + y_{i+1})}{2[t_n - t_1]}(t_{i+1} - t_i)$$

where y_i = percent disease severity at the i^{th} observation, t_i = time (days) from planting at the i^{th} observation, n = total number of observations.

At maturity (65 DAT), fruits were harvested twice per week from the central plants in each plot. They were sorted, counted and weighed and marketable yields were expressed in tonnes fresh wt/ha. Percent fruit rot due to late blight infection was assessed for each plot. Disease and yield data were subjected to analyses of variance and Duncan's new multiple range test ($P \leq$

0.05) was used to compare means among varieties and disease control methods.

Results

The effects of variety x management method interactions on disease variables (SAUDPC, epidemic rate, and final blight severity) were not significant. The main effects of varieties and management methods on these variables are presented in table 1.

SAUDPC, epidemic rate or final blight severity compared to the control or those that received sanitation alone. Late blight management with sanitation practices did not provide any significant reduction in SAUDPC, blight progress rates or final blight severity over the untreated control (Table 1).

A highly significant (P= 0.001) variety x management method interaction was recorded for both marketable yield and percent fruit infection. Besides Mecline,

Table 1

Main effects of variety and management method on standardized area under disease progress curve (SAUDPC), epidemic rate and final tomato late blight severity

Main effect	SAUDPC (%)	Epidemic rate	Final blight severity (%)
Variety			
Mecline	17.9 b[z]	0.227 c	62.7 b
ARP I366-1	45.6 a	0.330 a	82.9 a
ARP-D1	39.7 a	0.299 ab	83.4 a
ARP-D2	48.8 a	0.340 a	85.3 a
Roma	45.7 a	0.256 bc	75.4 ab
Management method			
Control	61.1 a	0.380 a	98.8 a
Sanitation	56.2 a	0.365 a	96.1 a
Ridomil MZ	21.2 b	0.208 b	59.6 b
Sanitation + Ridomil MZ	19.6 b	0.210 b	57.3 b

[z]Means within a column for each main effect followed by different letters are significantly different according to Duncan's new multiple test (P= 0.05).

The least values for SAUDPC epidemic rate or final blight severity were recorded on Mecline. Consequently, late blight was less severe on Mecline compared to the other varieties tested. Late blight progress rates were fastest on ARP I366-1 and ARP D2 and slowest on Mecline (Table 1).

Plots on which late blight was managed with Ridomil MZ or Ridomil MZ + sanitation had the least values for other varieties did not yield any marketable fruits in control or sanitation plots as all the fruits were blighted on these plots. The highest yield on each variety was obtained on plants exposed to a combination of Ridomil MZ + sanitation treatments, closely followed by those treated with Ridomil MZ alone. For all the varieties, marketable fruit yields ranged from 3.90 - 18.20 t/ha in Ridomil MZ plots and 5.77 - 23.35 t/ha in plots that received the combined treatments (Table 2).

Table 2

Effect of late blight management method on marketable yield (t/ha) of tomato

Variety	Control	Sanitation (S)	Ridomil MZ (R	S + R
Mecline	2.94 c[z]	3.20 c	18.20 a	23.35 a
ARP I366-1	0 c	0 c	16.38 b	10.56 a
ARP-D1	0 b	0 b	13.90 ab	15.77 a
ARP-D2	0 b	0 b	15.19 ab	17.10 a
Roma	0 c	0 c	16.84 b	22.76 a

[z]Means within a row followed by different letters are significantly different according to Duncan's new multiple test (P= 0.05).

Except for Mecline, no marketable fruits (100% fruit loss) were harvested on untreated plants or on those that received sanitation treatments. Plants treated with Ridomil MZ alone or in combination with sanitation had the least amount of fruit infections. Fruit infections were ranged 29 – 45% in fully treated plots and 28 – 53% in Ridomil MZ plots (Table 3).

Table 3

Effect of late blight management method on percent fruit rot incidence of tomato

Variety	Control	Sanitation (S)	Ridomil MZ (R	S + R
Mecline	64 a[z]	69 a	32 b	30 b
ARP I366-1	100 a	100 a	53 b	45 b
ARP-D1	100 a	100 a	53 b	39 c
ARP-D2	100 a	100 a	35 b	29 b
Roma	100 a	100 a	28 b	29 b

[z]Means within a row followed by different letters are significantly different according to Duncan's new multiple test (P= 0.05).

Discussion

Tomato growers in Cameroon usually control late blight with an intensive fungicide usage (10, 12). Weekly picking of diseased leaves was laborious and did not provide any significant reduction in late blight intensity or progress in the field. However, when this tactic was combined with chemical fungicide treatments, there was a significant improvement in marketable yields for ARP I366-1 and Roma. Despite the regular picking of diseased foliage in the field, late blight progress and intensity was not significantly different between picked and unpicked plants. As reported for potato late blight (7 - 9), some healthy leaf area is lost during picking of blighted leaves and could account for the low yields on picked plants. Moreover, picking of diseased leaves provide more wounds for further late blight infections.

The sanitation treatments did not provide any significant increase in yields over unsprayed controls. Sanitation was effective only when used in association with the fungicide treatment. This could be attributed to the fact that the fungicide also protects the wounds from re-infection by the pathogen. Although, sanitation has been successfully used in potato to limit late blight severity and improve tuber yields in potato (7 - 9), the implementation of this disease management tactic on tomato still needs to be further investigated.

Despite the weekly fungicidal spray schedule used in this trial, percent fruit infection was still high, indicating that the weekly spray schedule might not have been adequate in controlling the disease. Shorter spray intervals (of 4 days) were reported to be more effective against late blight in Indonesia although disease incidence was also reported to be high (18, 19). In Uganda, two fungicide sprays per week are recommended for an integrated disease management system for tomato late blight (1, 15).

Conclusion

Mecline was the most tolerant to late blight and out-yielded Roma, the most widely grown variety in Cameroon (12). It also out-yielded varieties obtained from AVRDC/ARP, such as ARP I366-1, ARP D1 and ARP D2. This variety may, therefore, be recommended for tomato farmers in the country. Our results suggest that fungicide-alternative methods of late blight protection, such as a regular picking of diseased leaves is not effective in controlling late blight epidemics compared to weekly sprays of chemical fungicides, such as Ridomil MZ.

Acknowledgements

This study was funded by a grant from the International Foundation for Science. We thank the AVRDC/ARP Arusha, Tanzania, for providing seeds used in the experiments.

Literature

1. Akemo M.C., Ssekyewa C., Kyamanywa S., Adipala E., Wilson H. & Erbaugh M., 2002, Developing IPM systems for tomato: a case study from Uganda. pp 362-368. *In*: Proceedings of IPM Conference for Sub-Sahara Africa. 8-12 Sept. 2002. Kampala, Uganda.

2. Berger R.D., 1980, Measuring disease intensity. pp 28-31. *In*: Proc. E.C. Stakman Commemorative Symposium on Crop Loss Assessment. Univ. of Minnesota Misc. Publ. 7.

3. Campbell C.L. & Madden L.V., 1990, Introduction to plant disease epidemiology. John Wiley & Sons, New York. 532 p.

4. Dowley L.J. & O'Sullivan E., 1994, The effect of phenylamide/mancozeb mixtures on the control of late blight of potatoes. Irish J. Agricultural & Food Research, 33, 177-181.

5. FAO, 1999, Food and Agriculture Organisation Production, Quarterly Bulletin of Statistics. Vol. **12**: 3/4. FAO, Rome.

6. Fontem D.A., 1993, Survey of tomato diseases in Cameroon. Tropicultura, **11** (3), 87-90.

7. Fontem D.A., 1995, Yield of potato as influenced by crop resistance, sanitation and fungicidal treatments against late blight. pp 551-554. *In*: M.O. Akoroda & I.J. Ekanayake (Editors), Root crops and poverty alleviation. IITA, Ibadan, Nigeria.

8. Fontem D.A., 1995, Yield of potato as influenced by crop sanitation and reduced fungicidal treatments. Tropicultura, **13** (3), 99-102.

9. Fontem D.A., 1998, Dynamics and integrated management potato late blight in Cameroon. PhD Thesis. University of Benin, Lomé, Togo. 161 p.

10. Fontem D.A., 2003, Quantitative effects of early and late blights on tomato yields in Cameroon. Tropicultura, **21** (1), 36-41.

11. Fontem D.A. & Bouda H., 1996, Situation de la lutte contre le mildiou de la pomme de terre à l'ouest-Cameroun. Conf. on the Contributions of Biotechnology in Potato Production in Central Africa. Dschang, Cameroon. 13 - 17 Feb. 1996.

12. Fontem D.A., Gumedzoe M.Y.D. & Nono-Womdim R., 1998-99, Biological constraints in tomato production in the western highlands of Cameroon. Tropicultura, **16-17** (3), 89-92.

13. Fontem D.A., Nono-Womdim R., Opena R.T. & Gumedzoe M.Y.D., 1996, Impact of early and late blights on the tomato yields. Tropical Vegetable Inform. Ser. 1, 7-8.

14. Jones J.B., Jones J.P., Stall R.E. & Zitter T.A. (eds), 1981, Compendium of tomato diseases. American Phytopathological Soc. Press, St Paul. 73 pp.

15. Kasenge V., Akemo M.C., Taylor D.B., Kyamanywa S., Adipala E. & Mugonola B., 2002, Economics of fresh market tomato production in peri urban farmers in Wakiso district. pp 301-306. *In*: Proceedings of IPM Conference for Sub-Sahara Africa. 8-12 Sept. 2002. Kampala, Uganda.

16. Messiaen C.M. & Lafon R., 1970, Les maladies des plantes maraîchères. Institut National de la Recherche Agronomique, Paris. 441 pp.

17. Nuninger C., Steden C. & Staub T., 1995, The contribution of metalaxyl-based fungicide mixtures to potato late blight control. pp 122-129. *In*: L.J. Dowley, E. Bannon, L.R. Cooke, T. Keane & E. O'Sullivan, (Editors), Phytophthora 150: Proceedings. Boole Press, Teagasc, Dublin.

18. Suhari., 1976, Fungicides screening against *Phytophthora infestans* on tomato. Bull. Penelitian Hortikultura, 4, 13-22.

19. Suhari, Masdiar B., Bismo, Vermeulen H. & Widjorini S., 1976, The chemical control of *Phytophthora infestans* on tomatoes in Indonesia. Bull. Penelitian Hortikultura, 4, 45-54.

D.A. Fontem, Cameroonian, Ph.D. (plant pathology), Associate Professor, University of Dschang, Cameroon.

P.C. Younyi, Cameroonian, Ingénieur Agronome, Ministry of Agriculture, Bamenda, Cameroon.

M.N. Suh, Cameroonian, Ingénieur Agronome, Ministry of Agriculture, Buea, Cameroon.