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Impact of farmers' selected idm options on potato late blight control and yield

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Abstract: Ethiopian potato farmers from the highlands of Jeldu, Galessa, Welmera and Degem Weredas selected some IDM options from the regional coordinated potato late blight control experiment at Holetta in the year 2004-05. These options were demonstrated at Jeldu, Degem and Erob Gebiya areas in the year 2005-06 with the objective of identifying a fungicide which is profitable, safe to users and the environment. The experiment was laid in split block design in three replications. Replications were locations in this case. Main plots were varieties (Moderately resistant and susceptible) and sub plots were spray regimes. All spray treatments significantly reduced the late blight severity as compared with the unsprayed control. Three sprays of Ridomil gave the lowest area under disease pressure curve (AUDPC) and the highest yield. Mancozeb sprayed treatment at emergence and then followed at 15 days interval gave the second highest yield though there was no significant difference between the above two treatments. One Ridomil spray at symptom appearance gave the third highest yield and there was no significant difference between it and Mancozeb treatment. All the spray regimes gave a highly significant difference when compared with the unsprayed control. This performance was observed in both varieties of potato though there was again a highly significant difference between the two varieties. Farmers were convinced on the advantage of using MR varieties by complementing them with reduced amount of fungicide spray.
Key Words: Area under disease pressure curve (AUDPC), Integrated disease management options (IDM), Late blight disease.

Introduction

Potato late blight disease which is caused by *Phytophthora infestans* (Mont) de Bary is the major bottleneck in potato production in Ethiopia (Bekele and Yaynu, 1996) and other parts of the world (Fry and Goodwin, 1997). Yield losses ranged from 31-100% in Ethiopia depending on the variety used (Holetta Progress Report, 2006-07). Farmers had stopped using their old local potato varieties due to the devastation of their plot by the late blight disease. Use of fungicides in controlling the disease was found to boost potato yield in various east African countries (Nsemwa et al., 1992; Rees et al., 1992; Mesfin, 2007) though there was a report from Uganda contradicting this opinion when used on improved potato varieties (Sikka et al., 2000).

Excellent control of the late blight disease was achieved through the use of the Phenyl amide fungicides like Ridomil across the Sub Saharan region (Dekker, 1984). However, the failure of Ridomil in some countries of the region in giving perfect control of the disease and in some cases the intensive frequency of usage (Davidse et al., 1981; Schiessendoppler et al., 2003; Williams& Gisi, 1992) necessitated an urgent action to be taken in a coordinated manner throughout the region.. Along this line, the potato late blight group of the region developed an IDM (integrated disease management) experiment involving resistant and susceptible varieties and fungicide spray regimes to be carried out by the potato late blight group in the member countries (Burundi, DR Congo, Ethiopia, Kenya, Rwanda and Uganda) with the objective of identifying a controlling option which is profitable, environmentally friendly and safe to users. Therefore, each country implemented the regional IDM experiment and farmers' were invited to select their own choice. Finally, after harvest a thorough discussion on the results of the experiment and the net benefit were discussed with farmers. Based on mutual agreement, some treatments were selected and advanced for final confirmation test.

Materials and Methods

In the year 2004/2005 main crop season, the design used for the regional fungicide trial was a split plot using the main plot as varieties and the sub-plot as fungicide spray options. Three replications were used with a plot size of 4.2X4.8 metres and a spacing of 80X30 centimetres. Two potato varieties (Alemaya 624 as susceptible and Jalenae as moderately resistant varieties) were used in this experiment at Holetta Research Centre, 25 km west of Addis Ababa. Fungicide sprays of eight treatments(comprised of Ridomil and Dithane) were applied on the various potato plots of different treatments and the dosage composition was 2.5grams of Ridomil and 2grams of Dithane per litre of water(Table 1). Disease data was collected regarding late blight severity in each experimental potato plot at 30, 50, 70 and 90 days after planting. Farmers from different areas (Weredas) were invited on a field day and evaluated the various treatments based on visual observation. These data were interpreted into area under the disease pressure curve (AUDPC) using the formula of Campbell and Madden (1990). Yield data was finally collected and analysis regarding this experiment was done using SAS program. Net benefit analysis was also done in accordance to the procedures developed by the International Maize and Wheat Improvement Centre (CIMMYT, 1988). Based on disease severity, yield, net benefit data and environmental consequences, the farmers narrowed their best choices to few treatments (three sprays of Ridomil, Mancozeb every 15 days after emergence and one spray of Ridomil). These treatments along a non- sprayed control were promoted for further verification on farmers' field with farmers' research group in the year 2005/2006. The moderately resistant material (Jalenae) and a local susceptible variety were picked by farmers to be considered in this experiment.

Farmers' selected IDM options were implemented in the highlands of Ethiopia at Jeldu, Degem and Erob-Gebeya. Plot sizes of 3X3meters with a spacing of 75X30 centimetres were used. Potato varieties representing resistant material (Jalenae) and a susceptible variety (Local cultivar) were used in the experiment. Three farmers' Research Group consisting of 5-8 members (farmers) were selected as replications in each site/ wereda. Disease data and all other important parameters were taken as usual. Data analysis was done using the SAS program (SAS, 1985). A split-plot analysis of variance (ANOVA) was used to analyse yield data, residual checks showed that no transformation of the data was necessary. Specific treatment comparisons were made using Fisher's protected least significant difference (FPLSD).

Results

The impact of the various treatments of the regional IDM experiment (2004/2005) on AUDPC, yield and net benefit for the two potato varieties was put in table 2.

Based on the AUDPC value, yield and net benefit, three sprays of Ridomil, Mancozeb at fifteen days interval were advanced based on farmers' selection and another treatment which is the practice of the potato farmers'(one spray of Ridomil at symptom) were considered along a control (no spray at all) for final validation of the selected IDM options. The moderately resistant variety (Jalenae) which gave the lowest AUDPC value of 95 was sprayed with Ridomil four times and the cost for application will be very high (Table 2) and as a result lowered the net benefit (Table 2). On the other hand, three sprays of Ridomil on the same variety gave AUDPC value of 123 which was the second lowest but with higher net benefit (Table 2&3).One spray of Ridomil gave 389 AUDPC value which was not as such very big compared with the least ones and resulted in modest benefit which is comparable with the many times sprayed treatments (Table 2&3).

Results of the validation experiment revealed the need of combining resistant materials of potato with fungicide sprays to minimize the late blight damage ((Table 2&3). Ethiopian farmers' at Jeldu, Erob- Gebiya and Degem highlands were impressed by the performance of the moderately resistant variety (Jalenae) as it gave a highly significant yield difference (35t/ha A and 7t/ha B) not shown in table 2 but part of the analysis) due to its inherent resistance genes which are complemented with few sprays of the systemic and contact fungicides. Interaction of fungicide sprays with varieties was significant ($p=<0.001$). Fungicide sprayed treatments were significantly different from the unsprayed control on both improved and local varieties. The yield trend revealed a non-significant difference among the spray treatments on local variety while there was significant difference between fungicide sprayed treatment one and three only on improved variety (Jalenae) (Table 4).

Table 1. Fungicide treatments used in the regional fungicide spray regime experiment at Holetta in 2004-05

Fungicide treatment	Description
Protectant calendar	1st spray Dithane at 80-100% emergence, followed by spraying every 14 days till first symptoms of senescence
Systemic calendar	1st spray Ridomil at 80-100% emergence, followed by spraying Ridomil 3 weeks and 6 weeks later
Protectant rainfall	1st spray Dithane at 80-100% emergence, followed by spraying after every ≥100 mm accumulated rainfall till first symptoms of senescence; minimum interval of 7 days and maximum of 28 days
One spray	Spray Ridomil at first symptoms of late blight only
Two sprays	1st spray Dithane at 80-100% emergence, followed by Ridomil at first symptoms of late blight only
Three sprays	1st spray Dithane at 80-100% emergence, followed by Ridomil at first symptoms of late blight followed by Dithane 3 weeks later, if not yet senescing
Damage threshold	Spray Ridomil at first symptoms, followed by sprays at 5, 10 and 15% leaf area infection; minimum interval of 14 days
Calendar spray	Mancozeb every three weeks
Unsprayed control	No spray

Table 2. Impact of Fungicide treatments on AUDPC, Yield (Q/ha) and Net benefit in birr

Treatments	AUDPC		Yield(Q/ha)		Net Benefit(Birr)	
	AL624	Jalenae	AL624	Jalenae	AL624	Jalenae
M@e+14DI	1457 ^{D}	601 ^{F}	102 ^{FG}	189 ^{CD}	19894	65644
R@e+3WL+6WL	1276 ^{E}	123 ^{H}	140 ^{DEF}	305 ^{A}	27412	106222
M@e+every 50mm RF	1352 ^{DE}	467 ^{FG}	139 ^{DEF}	262 ^{AB}	27050	90995
R@sym.	1279 ^{E}	389 ^{G}	120 ^{EF}	252 ^{AB}	23824	88129
M@e+R@sym.	1353 ^{DE}	424 ^{G}	124 ^{EF}	211 ^{BC}	24522	73617
M@e+R@sym.+M 3WL	1335 ^{DE}	361 ^{G}	121 ^{EF}	210 ^{BC}	23781	72976
R@sym.+5,10,15% LI	1217 ^{E}	95 ^{H}	170 ^{CDE}	294 ^{A}	33356	102196
M@3W interval	1838 ^{AB}	1630 ^{C}	107 ^{FG}	119 ^{EF}	20995	41245
Unsprayed control	1993 ^{A}	1757 ^{BC}	95 ^{FG}	62 ^{G}	18934	21816
CV (%) =	8.9		18			

Note: Means followed with the same letters at each category of column are not significantly different at 5% probability level A Quintal equals to hundred kilograms.

Keys: M@e refers to mancozeb at emergence; R@sym.refers to Ridomil at symptom; DI refers to days interval; WL refers to weeks later and LI refers to leaf infection severity.

Table 3 Impact of Farmers' selected IDM options on potato yield and late blight control

Treatments	AUDPC	Yield(Q/ha)
3R(emerg., 3WL, 6WL)	376.1 ^{C}	259.56 ^{A}
6M(emergence, every 15days)	964.4 ^{B}	237.56 ^{AB}
1R(at symptom)	1194.4 ^{B}	230.56 ^{B}
Unsprayed control	2202.8 ^{A}	118.61 ^{C}
LSD=	382.99	27.9

Means with the same letter are not significantly different at 5% probability level.

Keys: R refers to three sprays of ridomil at emergence, three and six weeks later too.
6M refers to six sprays of mancozeb at 15 days interval

Table 4. Mean potato yield (Q/ha) for the interaction of fungicide by variety in the IDM verification experiment

Fungicide Treatment	Variety	Yield(Q/ha)
Unsprayed	Local	7.9 ^{A}
Ridomil at symptom	Local	68.9 ^{B}
Mancozeb every 15days (6X)	Local	87.8 ^{BC}
Ridomil 3X(E, 3W, 6W)	Local	114.8 ^{C}
Unsprayed	Jalenae	229.3 ^{D}
Ridomil at symptom	Jalenae	387.3 ^{E}
Mancozeb every 15days (6X)	Jalenae	392.2 ^{E}
Ridomil 3X(E, 3W, 6W)	Jalenae	402.3 ^{E}

Discussion

The moderately resistant variety (Jalenae) gave superior yield both under sprayed and unsprayed condition and as a result the farmers were convinced to shift in using improved potato varieties in their area along fungicide sprays. Based on the above information, the highland farmers' of Ethiopia especially where the experiment was conducted got convinced on the advantage of using recently released elite potato clones in order to overcome the devastation of the late blight fungus along few sprays of some fungicides.

Though three sprays of Ridomil gave highest yield, the farmers' preferred one spray of Ridomil as it gave comparable yield with Mancozeb sprayed every 15 days interval (table 3). Reasons for the selection were easy application, sound financial input and safe to users and the environment, and reasonable disease control (table 3). Besides, the price of Ridomil is expensive and if they use three sprays their financial input will also shoot up. On the other hand, when we check the disease severity using AUDPC values the difference between treatment 2 (Mancozeb sprayed every 15 days interval) and treatment 3 (Ridomil sprayed at symptom) was very small and comparable. This also supports the treatment selected by the farmers' to be reasonable and acceptable by users as the price to be invested in chemical control will be small. Therefore, it seems advantageous to use alternative application of Ridomil spray and Mancozeb to minimize the chance of emergence of resistant *Pi* strains as the pathogen can easily adapt to the fungicide that will be used repeatedly. Hence, alternative application of the above two fungicides either in consecutive main rainy seasons or every two years interval is supported based on this result.

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