Epidemiology and Control of Potato Early Dying in Israel

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Potato Production in Israel: In Israel there are two major seasons of potato growing. For the spring season (7500 ha, with average yields of 45 t/ha), seed tubers imported from Northern Europe (23,000 ton) are planted during December to February, harvested from April through July, with a total production of 300,000 tons (50K tons of processing and 35K tons of seed tubers for the autumn season). In autumn (8,000 ha, with average yield of 40 t/ha) domestic seed tubers are planted from August to October, harvested from December to March; 180K ton of fresh potatoes (140K tons of new potato and 40K tons of baby potato) are exported to Europe, and 120K tons are for the domestic market. Major cultivars for export are Nicola, Vivaldi, Rodeo, Winston, and the major cultivars for domestic are Mondial, Desiree, Nicola.

PED syndrome, caused primarily by *Verticillium dahliae* (VW), *Colletotrichum coccodes* (BD) and root-lesion nematodes *Pratylenchus*, is one of the limiting factors in potato production in Israel. It is characterized by stunting, chlorosis and wilting. Severe reduction in yields can occur (up to 50% loss in susceptible cultivars). BD alone may also cause economic damage through reduction of tuber quality. *Colletotrichum coccodes* is a seed-borne (on tuber surface and in latent infections of the vascular bundles), and also a soil- and air-borne pathogen.

The major strategies of controlling soil-borne pathogens include: resistant-tolerant cultivars, disease-free seed tubers and soil (data can be obtained by monitoring diseases on seed tuber, and by field mapping for *V. dahliae* and *C. coccodes*), soil fumigation (by metham sodium (Edigan), formaldehyde (Fordor), chloropicrin (Telopic)), biofumigation (by green manure), seed and in-furrow treatment by application of pesticides, crop rotation, and sanitation.

In the present summary, studies of BD and VW control are reported. In a field experiment (autumn 1999) conducted at the central Negev, reduction in yield was significantly correlated with Verticillium wilt severity ($y = -6.6988\text{Ln}(x) + 87.774$, $R^2 = 0.9863$) (Fig 1). Infection with *C. coccodes* alone caused up to 30% yield reductions in several cultivars (Fig 2).

Soil fumigation experiments were conducted in the Negev as a randomized complete block design (4 replications). Fumigants were applied with a commercial device that injects the chemical to a 30-cm depth and covers the soil with a plastic film, in a single operation. The films were removed after a week. Certified potato seed tubers (cv. Nicola) were planted 4 weeks later.

In autumn 1998, disease incidence, fungal colonization, and incidence of infected dry stems were significantly reduced by all fumigation treatments (Telopic, Bromopic, methyl bromide, and Fordor) (Table 1). Also the yields in the Telopic, Bromopic, and methyl bromide treatments were significantly higher than in the non-fumigated control; whereas, the Fordor was less effective (Fig 3).

In autumn 1999, AUDPC (area under disease progress curve) and incidence of dry stems were significantly reduced in all treatments (Telopic, Bromopic, and methyl bromide) (Table 2). The yields in all fumigation treatments were significantly higher than in the non-fumigated control (Fig 4).

In two autumn experiments (2000 and 2001), Verticillium wilt incidence and severity were significantly reduced by metham sodium (MS) treatments of 600 L/ha applied into 30cm depth or 60cm, and 900 L/ha to 60cm as compared with the control (Table 3). In autumn 2001, disease incidence was significantly reduced by 600 L/ha MS applied to 30 or 60 cm, however, 300 L/ha applied to 30cm was not effective in disease reduction (Table 3). Yield obtained in all MS treatments were significantly higher than in the control, except the 300 L/ha applied to 30cm treatment (Fig 5).

In autumn 2000, seed tuber and in-furrow treatments were applied to reduce Verticillium wilt. All fungicides significantly reduced disease incidence compared with the control (Table 4). The combined seed and in-furrow application of Prochloraz-Mn was the most efficient; yield was increased and disease incidence was reduced.
In spring 2004, most seed treatments, alone or combined with in-furrow treatment, significantly reduced black dot incidence. Seed treatment with chlorothalonil was similar to the control (Table 5).

Biofumigation (green manure) experiments for the suppression of soilborne diseases prior to potato planting were conducted in plots contaminated with *V. dahliae*, *C. coccodes*, and *Rhizoctonia solani*. Green manure crops (cabbage, pea, wheat, fenugreek, and alfalfa) were plowed down 90 days after sowing (Feb-April). The plots remained non-irrigated, and weeds were cut down immediately before the potato planting in August. Experiment design was in complete randomized blocks with four replications. Disease incidence was significantly reduced by the cabbage treatment; whereas, in green manure treatments of pea, wheat and fenugreek, disease incidence was higher than in the control (fallow) (Fig 6).

To summarize, chemical fumigation with MS and C-35 is efficient for control of Verticillium Wilt on potato. Telopic is efficient also in control of black dot, but MS is less effective. Seed tuber treatment alone or combined with in-furrow treatment is effective in black dot control; with Verticillium wilt, it can be considered as a part of integrated pest management (IPM). Biofumigation can be an important role in PED control, especially in sustainable management.

Table 1: Effect of soil fumigation on disease levels, Negev (B'sor), Autumn 1998

Treatment	Disease incidence %	Infected dry stems %	Fungal colonization %
Control	55.0 a	49.8 a	52.5 a
C-35	0 c	1.0 c	0 c
BrP	7.5 c	2.7 c	2.5 c
MBr	0 c	1.9 c	0 c
Fordor	32.5 b	22.3 b	30.0 b

Table 2: Effect of soil fumigation on disease levels, Negev (Alumim-Saad), 2000

Treatment	AUDPC	Infected dry stems %
Control	4860 a	91.0 a
C-35	1050 b	4.8 b
BrP	930 b	7.1 b
MBr	870 b	9.2 b

Table 3: Effect of metham sodium (MS) treatments on Verticillium wilt

Experiment	Treatment		Disease evaluation		Disease incidence (%)	
	Dose (L/ ha)	Depth (cm)	AUDPC	% of green foliage	Dry stems	Daughter tubers
1999/2000	Control	-	3141 a		98.2 a	10.3 a
Nicola	MS 600	30	631 c		40.6 b	0 b
	MS 600	60	1353 b		46.8 b	1.6 b
	MS 900	60	1280 b		24.2 c	1.6 b
2000/2001	Control	-		28.8 c	97.3 a	0.3 a
Dita	MS 300	30		46.6 b	79.7 b	1.8 a
	MS 600	30		63.8 a	60.5 b	0 a
	MS 600	60		67.2 a	39.5 c	0.7 a

Table 4: Effect of seed and furrow treatments on Verticillium incidence and yields, Negev (Gilat), Autumn 2000

Treatment	Disease incidence (%)	Yield (ton/ha)
Control	85.0 a	38.2 b
Prochloraz-Mn seed	47.5 b	42.3 a
Prochloraz-Mn furrow	50.0 b	43.8 ab
Prochloraz-Mn s+f	27.5 c	45.9 a
Prochloraz-Zn s+f	35.0 bc	40.5 a
Azoxystrobin seed	42.5 b	41.4 b
Azoxystrobin s+f	40.0 b	39.7 ab
Prochloraz seed	40.0 b	38.3 b

Table 5: Effect of seed and furrow treatments on Black dot incidence and yields, Negev (Gilat), spring 2004

Treatment	Disease incidence (%)
Control	13.9 a
Prochloraz-Zn seed	2.0 c
Prochloraz-Zn s+f	2.9 c
Azoxystrobin seed	6.8 b
Azoxystrobin s+f	2.9 c
Chlorothalonil seed	12.0 a
Chlorothalonil s+f	3.9 c
Fludioxonil seed	3.8 c

Fig 1: Correlation between yield and disease severity

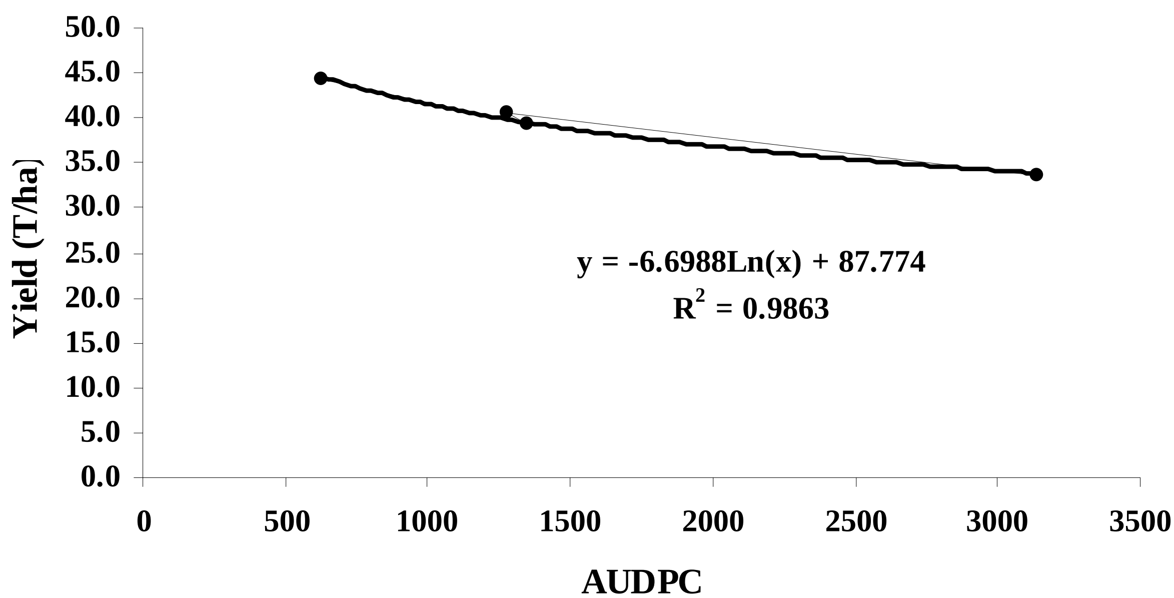


Fig 2: Effect of *C. coccodes* on yield (tons/ha)

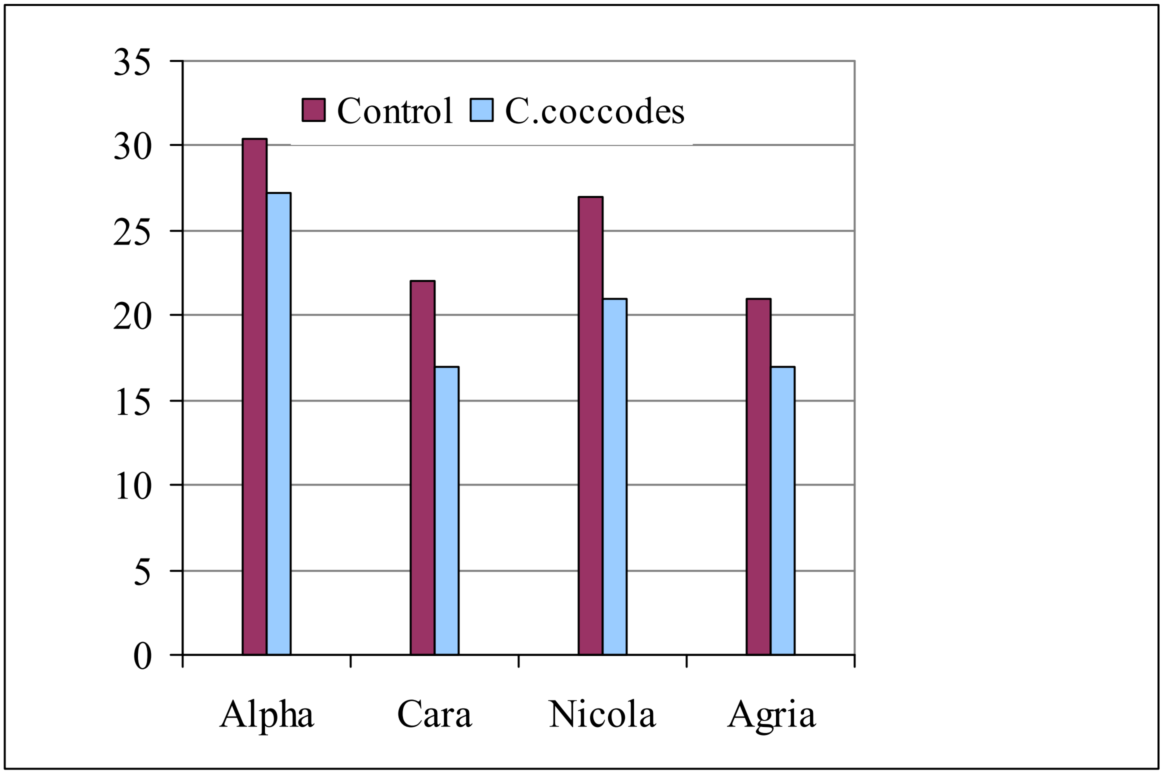


Fig 3: Effect of soil fumigation on yield, Autumn 1998

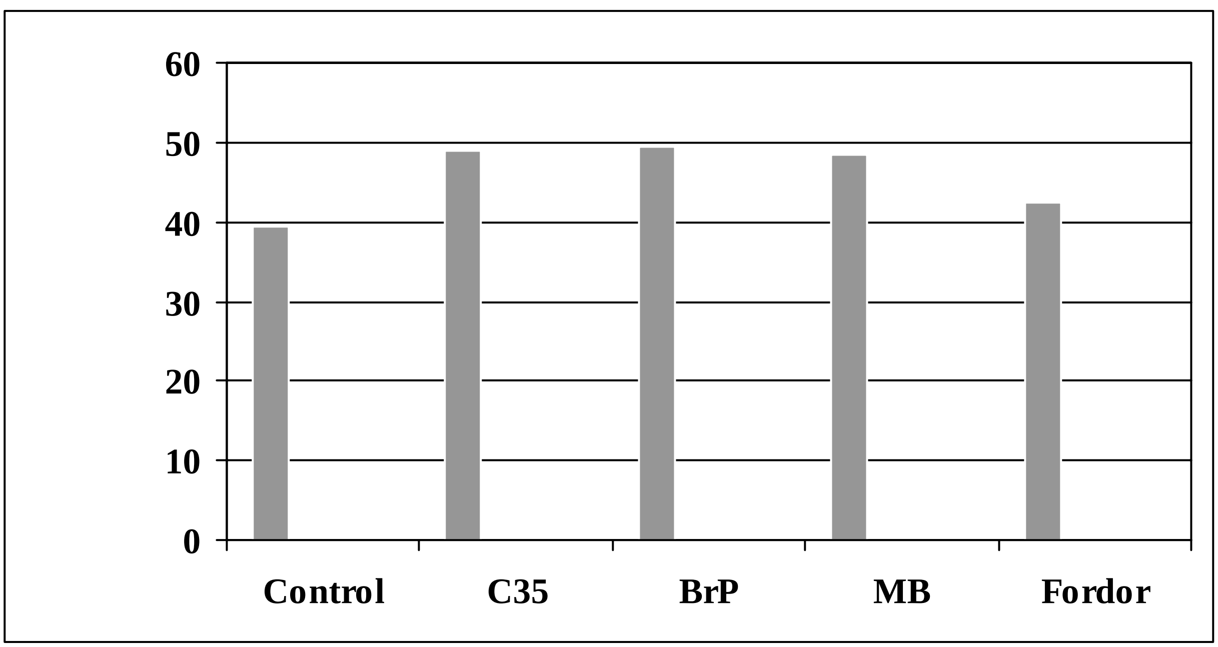


Fig 4: Effect of soil fumigation on yield, Autumn 2000

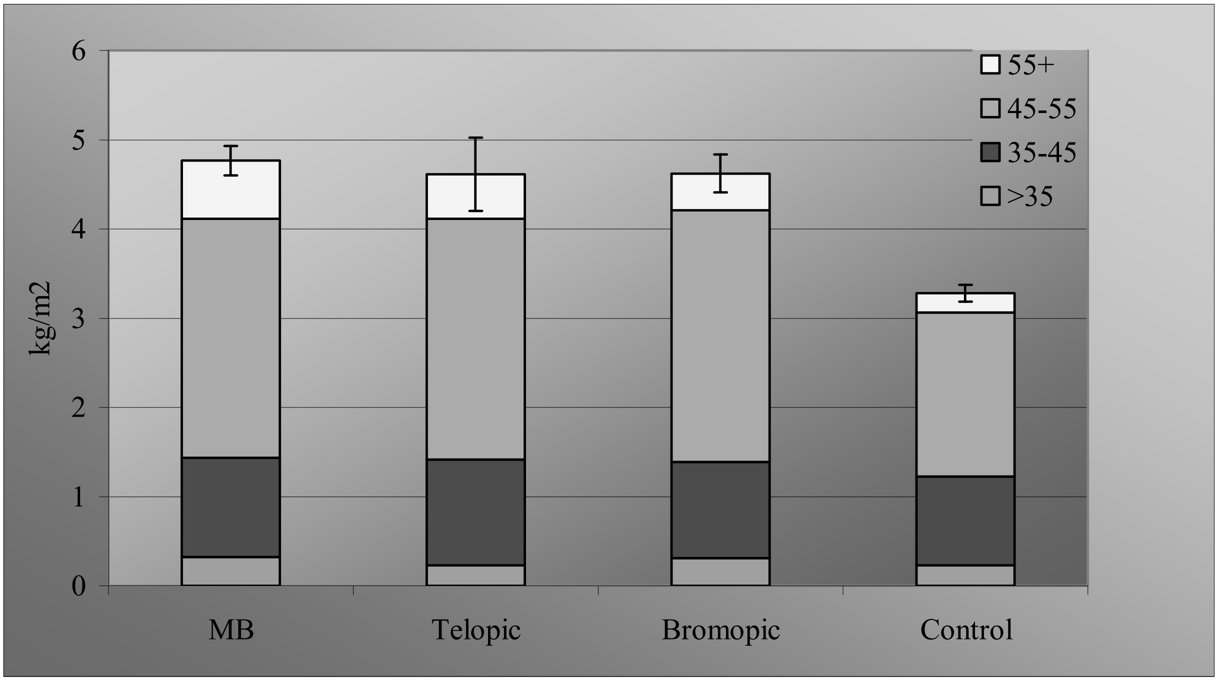
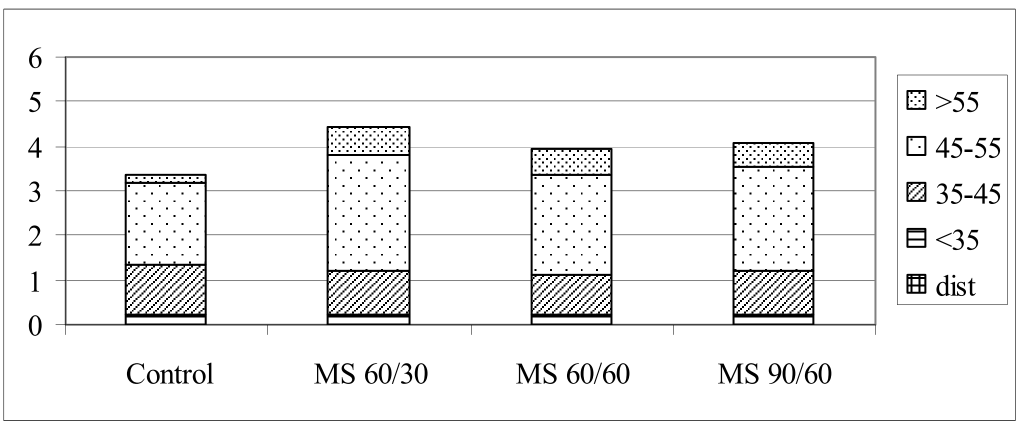


Fig 5: Effect of metham sodium treatments on yield, Autumn 2000, 2001



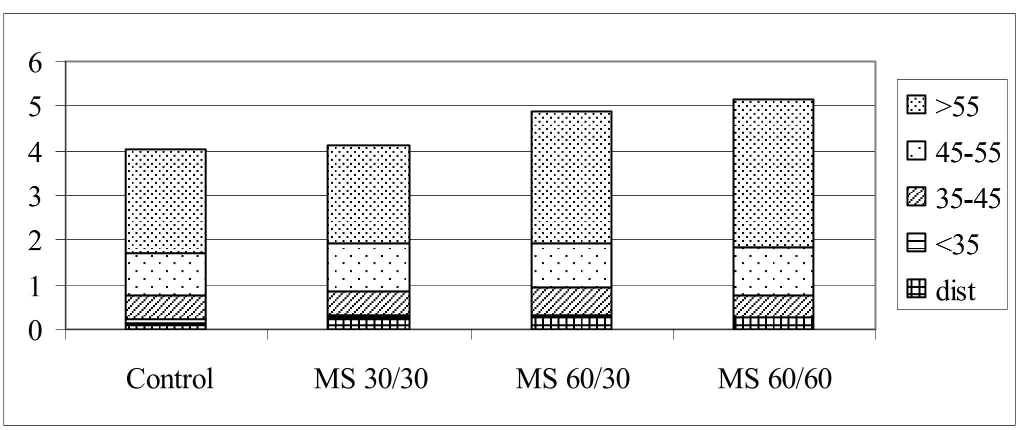


Fig 6: Effect of green manure on Verticillium incidence, Autumn 1999