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CHEMICAL CONTROL OF STRAWBERRY FRUIT ROTS IN THE FIELD AND DETERMINATION OF PROCYMIDONE AND VINCLOZOLIN RESIDUES

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Abstract

Wounded strawberry fruits showed higher infection with rots than unwounded fruits. *Botrytis cinerea, Rhizopus nigricans, Rhizoctonia solani, Phytophthora cactorum and Penicillium* sp. were the most virulent fungi causing severe rots, while *Mucor* sp., *Alternaria* sp. and *Sclerotinia sclerotiorum* caused moderate injuries. *Aspergillus* sp. and *Fusarium* sp. were the least virulent.

Fungicides spraying of strawberry plants, grown under natural infection in the field, showed that Rovral (iprodione), Sumisclex (procymidone) and Ronilan (vinclozolin) were the most effective fungicides for controlling fruit rots followed by Daconil 2787 and Euparen. Significant increase in yield was obtained with all fungicidal treatments compared with the control.

The amounts of procymidone residues in treated strawberry fruits were decreased from 1.52 to 0.96 and 0.08 ug/ml after 1 and 12 days from application, respectively. Vinclozolin deposits of 1.107 ug/ml were decreased to reach 0.066 , 9 days after treatment. No residues were detected , 15 days after application of procymidone and 12 days for vinclozolin.

Harvest can be done after 3 days as a prehevest interval with no health hezard.

INTRODUCTION

Fruit rots are important diseases of strawberry in Egypt causing considerable losses in field, during storage and marketing. Several fungi, such as *Botrytis cinerea* Pers ex. Fr., *Phytophthora cactorum* Leb & Cohn, *Rhizoctonia solani* Kuehn, *Rhizopus* sp., *Sclerotinia* spp., *Mucor* spp., *Penicillium* spp., *Aspergillus* spp., *Alternaria* spp., *Cladosporium* spp. *Fusarium* spp., *Sclerotium* spp. and *Colletotrichum* spp. were associated with strawberry fruit rots (Mass 1984) . Hunter *et al.* 1980) demonstrated that vinclozolin, procymidone and iprodione gave the best control measures of *B. cinerea.* Zanini (1980) found that vinclozolin residues in strawberries were 0.05 ug.

The present investigation is an attempt to study the ability of the isolated fungi to cause fruit rots, chemical control in the field and determination of fungicide residues in strawberries.

MATERIALS AND METHODS

1 - Pathogenicity test

The pathogenicity of the isolated fungi was tested using mature fruits of Sequoia variety. Fruits were carefully chosen , free from mechanical injury or diseases as far as possible. Wounded and unwounded fruits were sterilized and inoculated with agar discs (4mm in diameter) with each of the isolated fungi. Four replicates, 10 fruits each , were used for each treatment. The inoculated fruits were incubated at room temperature (23-29^{o}C). The control was left without inoculation. Percentages of infection and disease severity were recorded, according to Townsend and Heuberger (1943) , 5 days after inoculation.

2 . Chemical control

The experiment was conducted at Arab El-Ghadery (Kalubia Governorate). A complete randomized block design with four replicates was used .Plot size was 1/ 100 feddan. Plants were left for natural infection. Thirty days after planting , plants were sprayed with the fungicides , Rovral 50% W.P. (3-(3,5- dichlorophenyl)-N-isopropyl-l,4 dioxoimidazolidine -1-carboxamide)., Sumisclex 50% W.P. (N-

(3,5-dichlorophenyl-1,2-dimethyl - cyclopropane 1,3 -dicarboximide (1 UPAC)., Ronilan 50% W.P. (3-(3,5 - dichlorophenyl) 5-ethenyl - 5-methyl 2,4-oxazolidinedione)., Daconil - 2787 75% W.P. (tetrachloro isophthalonibrii)., Euparen 50% W.P. (N.N. dimethyl-N- phenyl-(N-flouorodichloromethyl thiosulfamide), Ridomil MZ 58 (8% Metalaxyl + 58 Mancozeb), Topsin M 70% W.P. (1, 2 bis (3-ethoxycarbonyl 1,2 thiurediobenzine), Kima z (Curzto) and Tecto 45% FL (2-(4-thiazolyl) benzimidazole) at the recommended doses; 90g , 90g , 250 g, 250g, 25g, 150g, 60g, 150g, and 100cc/100 L water, respectively . Control treatment was sprayed with the same amount of water. Spraying was repeated every two weeks beginning from first flower opening, so plants received a total of 8 sprays. The usual agricultural practices were followed. Percentages of infection and disease severity were estimated. Fruit yield (kg / feddan) was calculated as the total of several pickings, carried out at two or three days intervals.

3 . Determination of procymidone and vinclozolin residues in strawberries:

Sampling : Representative strawberry fruit samples of variety Sequoia , sprayed with procymidone and vinclozolin at 90 g/100 L each , were picked at random from each plot, one hour, 24 hours, 3,6,9 12 and 15 days after spraying. Control samples were picked from untreated plots. All samples were kept in foiled paper bags in a deep freezer at -20^{o}C until analyzed.

Residue Analysis

Extraction : Redistilled ethyl acetate was found to be suitable for extracting procymidone and vinclozolin from strawberry fruits . The frozen fruits were left to reach ambient temperature, weighed and then cut into small pieces and macerated for 3 minutes with redistilled ethyl acetate (2ml/gram fruit) and few grams of anhydrous sodium sulphate in a waring blender at a moderate speed . The extracts were filtered through few grams of anhydrous sodium sulphate and a dry pad of cotton wool. Extraction was repeated twice with the same solvent . Extracts were collected in one flask and concentrated to 2.3 ml volume in a rotary evaporator at 35^{o}C. Samples were then quantitatively transferred to volumetric flasks with redistilled ethyl acetate. The solvent was evaporated to dryness. Samples were cleaned up using co-agulating solution method. Interferences and plant pigments were eliminated using the ammonium chloride co-agulating solution and filtered through hyflo-cupor cel suggested by Johnson(1963) with some modifications according to

Almaz (1985).

Gas chromatographic determination:

PYE Unicam 104 gas chromatograph equipped with Ni ^{63} electron capture detector and the following conditions: 6 ft x 4 mm i.d. glass, packed with 1.5% OV. 17+1.95% OV-210 on 80-100 mesh Gas chrom O.

Temperature (^{o}C) : Colum 240^{o}, injector 250^{o} detector 250^{o} , Nitrogen flow rate 80 ml / min.

Using these condition, retention time (R+) for procymidone was 6.57 min. and for vinclozolin was 5.57 min.

Rates of recovery

The rates of recovery of each of procymidone and vinclozoline from strawberry fruits were estimated following the same technique mentioned above. The mean percentage recovery of procymidone and vinclozolin from sprayed strawberry fruits fortified by either chemical at the levels of 1.0, 0.1 and 0.01 ppm were 90.94 % and 79.29 % , respectively.

RESULTS AND DISCUSSION

Pathogenicity tests

Mature fruits of Sequoia were used for etiological studies. Data presented in Table 1, indicate that wounded fruits were more easily infected with the fungi than un-wounded ones. *Botrytis cinerea*, *R. nigricuans*, *R. solani*, *P. cactorum* and *Penicillium* sp. were the most virulent fungi causing severe rots , while *Mucor* sp., *Alternaria* sp. and *Sclerotina sclerotiorum* were moderately. On the other hand, *Aspergillus* sp. and *Fusarium* sp. were the lest virulent. This may be due to the virulent abudant growth of the most virulent pathogens. Similar results were obtained by Stoddard *et al.* (1924) who recorded about 25% loss of the whole crop of strawberry fruits due to *R. solani*. Powelson (1959) found that *B. cinera* caused over 90% of strawberry rots. Wright *et al.* (1964) stated that losses of 15 to 100% due to leather rot orgainsm, *P. cactorum*, occurred on certain shipments of Louisiana strawberries arriving to Chicago market. Ellis and Grove (1982) observed that grey mould was the most serious fruit rot disease of strawberries in Ohio.

Chemical control

Effect of fungicidal spray on strawberry to protect fruits during harvesting and maketing and yield production was recorded in Table (2). All tested fungicides, significantly reduced infection percentage and severity of strawberry fruit rots as compared with control. Rovral, Sumisclex and Ronilan were the most effective fungicides against fruit rotting fungi. Daconil 2787 and Euparen were effective in reducing infection with fruit rots. Topsin, Kima Z and Tecto 45 were less effective in controlling the rots during the two seasons. These results conformed with many ivestigators such as Duchon-Dories (1980), Hunter *et al.* (1980) and Freeman (1983) who reported that Ronilan recorded effective control against strawberry fruits infected with *B. cinerea*.

Concerning fruit yield, all fungicides significantly increased fruit yield as compared with the control. The most effective fungicides, in this respect , were Rovral, Ronilan and Sumisclex, followed by Daconil 2787 and Euparen. Bal (1976) found that Euparen gave good control against *B. cinerea*.

Table 1. Pathogenicity tests of isolated fungi on fruits of sequoia variety.

Isolated fungi	Unwounded fruit		Wounded fruits	
	Infection %	Disease severity%	Infection %	Disease severity%
1. Botrytis cinerea	78	46.8	100	89.2
2. Rhizopus nigricans	51	29.6	100	85.0
3. Rhizoctonia solani	32	13.8	55	42.4
4. Phytophtora cactorum	31	12.8	52	39.8
5. Penicillium sp.	30	12.2	48	39.2
6. Mucor sp.	19	10.4	33	28.8
7. Alternaria sp.	12	9.4	29	22.6
8. Sclerotina scleratiarum	11	7.6	18	21.4
9. Aspergillus sp.	8	4.6	12	17.2
10. Fusarium sp.	6	2.4	9	13.2
11. Control	0	0.0	0	0.0
L.S.D. at 5%	10.4	4.61	12.07	5.88

Sumisclex and Ronilan residues in treated strawberry fruits:

Procoymidone and vinclozolin residues, rates of losses and half life values (RL50) are listed in Table (3). The procymidone residues decreased rapidly from 1.520 to 0.959 ug/g. after 24hr. from application . Residual amounts on and in strawberry fruits decreased gradually by increasing the period after spraying with the fungicide.

However, vinclozolin initial deposits decreased by increasing the time after treatment from 24hr to 15 days.

The corresponding rates of losses after increasing periods for procymidone residues were less than vinclozolin. No residues could be detected after 15 days from application in strawberry fruits treated with procymidone and after 12 days with vinclozolin. Fifty percent of the residues disappeared after 114 and 22.6 hours for procymidone and vinclozolin, respectively. These results are in agreement with those of Kamoen and Jamart (1977) and El-Neshwy (1988) who found that residues of vinclozolin after 48 hours, one week and two weeks were less than the permissible levels.

Table 2. Effect of spraying different fungicides on strawberry fruit rots and yield production under field conditions.

Treatments	Recommended dosq 100L	Strawberry fruit rots and yield production during					
		1986 - 1987			1987 - 1988		
		Infection %	Disease severity	Yield (Ton/feddan)	Infection %	Disease severity	Yield (Ton/feddan)
1. Rovral	90g	12.50	7.30	6.6	10.40	6.30	6.9
2. Sumisclex	90g	13.70	8.50	6.5	11.40	7.60	6.7
3. Ronilan	90g	15.80	9.60	6.4	11.60	8.20	6.6
4. Daconil 2787	250g	17.60	11.10	5.9	15.20	10.30	6.3
5. Euparen	25g	18.50	12.80	5.7	16.10	11.50	6.1
6. Ridomil M58%	150g	20.30	15.90	5.4	18.20	14.30	5.7
7. Topsin	65g	21.80	16.40	5.1	19.50	15.20	5.3
8. Kima Z	150g	23.40	18.60	4.8	21.20	17.70	4.9
9. Tecto 45	100cc	25.60	19.40	4.6	23.50	18.30	4.8
10. Control	-	39.80	30.60	3.5	33.60	25.80	3.7
L.S.D. at (0.05)		3.11	1.60	1.55	2.30	2.08	0.59

Table 3. Residues and percentage loss of procyamidone and vinclozolin on and in strawberry fruits.

Time after treatment (days)	Residues in and on fruits			
	Procyamidone		Vinclozolin	
	ug/g	% loss	ug/g	% loss
Initial**	1.520*	00.0	1.107	00.0
1	0.959	36.91%	0.524	52.66%
3	0.886	41.71%	0.476	57.00%
6	0.675	55.59%	0.132	88.07%
9	0.200	86.84%	0.066	94.04%
12	0.080	94.74	ND	-
15	ND	-	ND	-
RL_{50}(hours)	114		22.6	

* Each figure is the mean of three replicates.
** Samples were taken one hour after spraying
*** ND Not-detected.

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المقاومة الكيماوية لأعفان ثمار الفراولة في الحقل وتقدير بقايا البروسيميدون والفينكلوزولين

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تصاب ثمار الفراولة المجروحة بالفطريات أكثر من الثمار الغير مجروحة ، وسببت فطريات بوترايتس سيناريا، ريزوباس نيجريكانس، رايزوكتونيا سولاني ، فيتوفثورا كاكتورم، والبنيسيليوم أعفانا شديدة للثمار بينما أظهرت فطريات ميوكر ، الترناريا، سكليروتينيا سكليروتيورم اضراراً متوسطة ، في حين كان الاسبرجلس والفيوزاريوم أقل مقدرة مرضية.

أدى الرش بمبيدات الروفرال ، السوميسكلكس ، الرونيلان الي خفض كبير لأعفان الثمار متبوعين بالداكونيل ٢٧٨٧ والايوبارين مع زيادة المحصول . ونقصت بقايا السوميسكلكس (البروسيميدون) في ثمار الفراولة المرشوشة من ١,٥٢ جزء في المليون الي ٠,٩٦ ثم ٠,٠٨ جزء في المليون بعد يوم واثني عشر يوما في حين نقص الرونيلان (الفينكلوزولين) من ١,١٠٧ الي ٠,٠٦٦ جزء في المليو ن بعد تسعة أيام. ولم تكتشف أى بقايا للبروسيميدون وللفينكلوزولين بعد ١٥ يوما و ١٢ يوما علي التوالي.

وكانت بقايا المبيدين في الثمار أقل بكثير من الحد المسموح به ويمكن جمع الثمار بعد اليوم الثالث من رش نباتات الفراولة واستعمالها بدون ضرر علي صحة الانسان.