

Rust (*Puccinia canaliculata*) and Nutsedges (*Cyperus* sp.)

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Abstract

Rust fungus (*Puccinia canaliculata*), indigenous in many countries, has excellent potential for biological control of nutsedge. This rust has been extensively studied in the recent years. Studies on storage, effect of surfactants, and application rates are reported in this paper. Urediniospores were stored at -73°C for 2000 days without loss of virulence. Spores were retrieved from ultra low temperatures by rapid thawing in a water bath at 40°C for 4 minutes. Triton B 1956, paraffinic oil (11N) and Herbimax (emulsifiable paraffinic oil) were compared as surfactants for application of rust spores. Both paraffinic oils (11N and Herbimax) were significantly better than Triton B 1956. However, for conventional applications Herbimax was better because it kept spores in emulsified suspension without problems; e.g., no germination of urediniospores. Spore rates of 0.25, 2.5, 5.0, 2.5 and 250 g/ha were compared with checks. Data indicates that 2.5 g/ha of rust spores was adequate for near maximum level of disease development and nutsedge control.

Introduction

Yellow nutsedge (*Cyperus esculentus* L.) and purple nutsedge (*C. rotundus* L.) (Cyperaceae) are troublesome weeds in many crops worldwide (Holm *et al.* 1977). One of these species occur in every state in the United States and several provinces in Canada (Mulligan and Junkins 1976) and have been listed among the ten worst weeds of field crops in the United States (Lewis and Worsham 1970). Nutsedges (*C. esculentus* and *C. rotundus*) are considered the most serious weeds in Africa (Mulligan and Junkins 1976), and the worst weeds in the world by Holm *et al.* (1977).

Over 150 organisms have been associated with *C. esculentus* and/or *C. rotundus* (Phatak and Callaway 1985, Phatak *et al.* 1987). Of these, only two insect genera, *Bactra* (Lepidoptera: Tortricidae) and *Aithesapeuta* (Coleoptera: Curculionidae), and a rust, *Puccinia canaliculata* (Schw.) Lagerh. (Uredinales), have been studied as biological control agents (Callaway 1985, Frick 1978, Frick and Chandler 1978, Julien 1982, Phatak *et al.* 1983, Sutker 1983). Nutsedge rust offers the most promising method for control of nutsedges (Bruckart *et al.* 1985, Callaway 1985, Phatak *et al.* 1983). This rust is indigenous in many countries. Nutsedge rust was first reported in 1832. It was assigned various scientific names. The scientific name used presently was assigned in 1894 (Arthur 1934). Arthur (1922) demonstrated that *P. canaliculata* was a macrocyclic, heteroecious rust on *Cyperus* sp., with cocklebur (*Xanthium canadense* L.) as an alternate host. Recently *X. strumarium* and *Helianthus annuus* L. have been demonstrated as other alternate hosts (Callaway *et al.* 1985). These and other alternate hosts belong to the family Compositae (Phatak 1987). Extensive work has been done on this rust in recent years (Bruckart *et al.* 1985, Callaway *et al.* 1985a,b, 1986, Phatak *et al.* 1982, 1983, 1984, 1985, 1986, Sutker 1983, Sutker and Phatak 1984, Wetzstein and Phatak 1986, 1987). This paper presents information on urediniospore storage, application rates and effect of surfactants on disease development.

Materials and Methods

Storage Duration

Urediniospores were stored in Ziplock® plastic bags (7.62 x 7.62 cm) at -73°C in a So-Low® Environmental Deep Freezer (model pp-100-5). Spores were retrieved by rapid thawing in a water bath at 40°C for 4 mins. For virulence tests, five sampling replications were done and at least five yellow nutsedge plants were evaluated for each storage period assessed. Spore virulence was assessed after 100, 200, 300, 400, 500, 1000, 1500, and 2000 days storage. High Performance Liquid Chromatography grade water (HPLC water) and Triton B 1956 at 0.1% were used to apply spores. Plants were kept in a dew chamber for 3 d and then removed to the greenhouse that was maintained at 25°C. Pustule counts were made 3 wks after inoculations.

Surfactants and Spreader-stickers

Triton B 1956, paraffinic oil (11N) and Herbimax® (emulsifiable paraffinic oil) were compared. The study was conducted outdoors in microplots in the summer. All treatments were replicated four times. Pustule counts were made 3 wks after application. A pump-up hand sprayer was used for application of spores in glass distilled water.

Rate Studies

To determine the optimum rate of spores 0.25, 2.5, 5.0, 25, 250 g spores/ha were applied in paraffinic oil (11N) thickened with Soloid (0.1%) through center pivot similar in 0.25 cm water. Controls were included for comparisons. All treatments were replicated four times.

Results and Discussion

Storage Duration

Data from storage and retrieval by thawing indicated that urediniospores of nutsedge rust can be stored for a long period without loss of virulence (Table 1). The number of leaves with pustules and percent of leaves with pustules were lower after 300 and 1000 d storage. The variation in the number of leaves infected and percent of leaves infected may be due to environmental conditions in the growth chamber and greenhouse during evaluation rather than the influence of storage. Spores maintained virulence up to 2000 d. These observations support the studies by Sutker (1983) in that spores stored up to 400 d were virulent on greenhouse grown plants.

Surfactants

During preliminary screening Triton B 1956® was found to be an effective surfactant. Other surfactants inhibited infection. However, Triton B 1956® was not effective in keeping all spores in water. Thus, it was essential to identify other surfactants. Urediniospores of nutsedge rust are lypophyllic, therefore paraffinic oils were tested as surfactants (Table 2). The numbers of leaves with pustules and percent leaves with pustules were not affected by the surfactants. However, the number of pustules/leaf was significantly affected. Paraffinic oil (11N) and Herbimax, when used as surfactants, produced significantly higher numbers of pustules when compared with Triton B 1956. With paraffinic oil spores stayed in the oil phase and continuous shaking was essential. Thus, for practical purposes it was difficult to apply spores in oil without specialized equipment. Herbimax is an emulsifiable paraffinic oil and mixed well in water and spores stayed suspended well in the emulsion. Thus, Herbimax proved to be a better surfactant for use with conventional sprayers.

Table 1. Effect of duration of storage of fungi on virulence.

Storage (d)	Leaves with pustules		Pustules per leaf
	No.	%	
0	6.0 <i>a</i> ¹	58 <i>ab</i>	4.12 <i>a</i>
100	5.5 <i>ab</i>	55 <i>ab</i>	3.25 <i>a</i>
200	6.1 <i>a</i>	61 <i>a</i>	2.75 <i>a</i>
300	4.2 <i>c</i>	42 <i>b</i>	4.10 <i>a</i>
400	5.3 <i>abc</i>	53 <i>ab</i>	3.10 <i>a</i>
500	5.4 <i>ab</i>	54 <i>ab</i>	3.65 <i>a</i>
1000	4.3 <i>c</i>	43 <i>b</i>	3.48 <i>a</i>
1500	6.0 <i>a</i>	60 <i>ab</i>	3.87 <i>a</i>
2000	6.2 <i>a</i>	62 <i>a</i>	4.10 <i>a</i>

¹ Mean separation within columns by Waller-Duncan k-ratio.

Table 2. Effect of surfactants on rust development.

Surfactant	%	Leaves with pustules		Pustules per leaf
		No.	%	
Triton B 1956	0.1	20	54 <i>a</i> ¹	2 <i>b</i>
Paraffinic oil	5.0	18	42 <i>a</i>	15 <i>a</i>
	10.0	22	47 <i>a</i>	18 <i>a</i>
Herbimax®	5.0	20	51 <i>a</i>	14 <i>a</i>
	10.0	19	45 <i>a</i>	19 <i>a</i>
		NS		

¹ Mean separation within columns by Waller-Duncan k-ratio.

NS = Not significant *F*-test.

Rate Studies

The first pustule count is an effective measure of infection when studying the differences between treatments. There were significant differences due to the rate of spores at first count (Table 3). Data shows that rates of 2.5 g/ha and higher produced significantly higher pustules than checks and 0.25 g/ha rate. There was no significant difference between 2.5 g/ha and higher application rates for pustules counted on 15 July 1986. This indicated that 2.5 g/ha spore application rates is adequate for the development of disease at near maximum level. At the second pustule count on 23 July 1986, 25 g/ha and 250 g/ha rates produced significantly higher numbers of pustules when compared with all other treatments including checks. However, due to rapid secondary spread, the percent of dead plants were not different. These results are similar to those obtained from the studies conducted with oil sprays and dusting spores mixed in talc (Phatak, unpublished data). Based on these studied 2.5 to 5.0 g/ha rate is used for all of our field studies.

Table 3. Effect of rate of spores on disease development.

Rate (g/ha)	Pustules/leaf		Plants dead (%) 01.viii.1986
	15.vii.1986	23.vii.1986	
Control (0)	0.0 c ¹	24.7 b	69.2 a
0.25	5.4 b	25.7 b	77.4 a
2.50	18.5 a	25.9 b	65.9 a
5.00	20.7 a	27.7 b	70.2 a
25.00	21.8 a	58.6 a	72.1 a
250.00	24.2 a	54.9 a	73.4 a

¹ Mean separation within columns by Waller-Duncan *k*-ratio.

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