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CONTROL OF SMUT DISEASE OF SUGARCANE BY CERTAIN CULTURAL PRACTICES AND CHEMICALS

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Abstract

The winter crops, clover, broad bean, lupin, chick pea, lentile and fenugreek and the summer crops, maize, grain sorghum and soybean were rotated with sugarcane in artificially infested soil. Longevity of teliospores bioassayed by infection in sugarcane was examined. No infection occurred and spores either died or germinated in the absence of the host; however, the remaining live spores were below the infective potential. Root exudates of these crops drastically decreased teliospores germination. While, that of sugarcane (NCo 310, susceptible variety) was nearly the same like the control (in distilled water).

Intercropping of these crops with sugarcane in infested potted soil suppressed and/or decreased infection to one third its level in the control for winter and summer crops, respectively.

However, the use of dip inoculation technique of seed-cuttings prevented the control effect of these crops. The results suggest the use of crop rotation containing such crops and intercropping for disease control.

In vitro, Benlate 50%, Bayleton 25%, Vitavax/captan 75% and Tilt 10% at 5 ug/ml and above, in a descending order were effective against mycelial growth and Benlate was fungitoxic. In pot experiment, Benlate, Bayleton and Vitavax/captan prevented infection in artificially inoculated seed cuttings. Chemical treatment is feasible under high disease incidence.

INTRODUCTION

Crop rotation:

Starving teliospores of *Ustilago scitaminea* in soil through crop rotation has been recommended as one of the control measures (Fawcett 1941). Arruda (1953) recommended the practice of planting maize after susceptible sugarcane variety to allow rogueing (volunteer plant). Robinson (1959) considered that rotations which include a fallow or green manure crop, such as normally practiced in Kenya, give good control of smut.

Crop rotation was found to decrease blister smut of maize caused by *Ustilago maydis* (Kozheven, 1975 and Mazhara, 1978).

Mansour *et al.* (1990) found that soil fungistasis decreases spore germination considerably and different soils gave different effects on smut incidence in which soil extract inhibits spore germination confirming the fungistatic effect of soil.

Chemical control:

In vitro, El-Zayat *et al.* (1986) found that Benlate caused 100% inhibition of growth of *U. scitaminea* on potato dextrose agar with a toxic effect even at 5 mg/ml (a.i.). Vitavax/captan and/or Thiram exhibited the same effect but were fungistatic. Bayleton at higher levels only reduced and retarded the radial growth.

In vivo, Goyal *et al.* (1983) reported that in trials with highly susceptible CV 1158, a 2-hour dipping of 2-bud setts in 0.2% Bayleton (Triadimfon) gave the best control of the pathogen.

Maneghany (1984) found that in soil drenching tests with 5 fungicides Benomyl and Oxycarboxin completely suppressed systemic smut disease caused by *U. scitaminea* in sugarcane at 0.15 and 0.5 gm/litre, respectively or higher.

Olufolaji and Olofinbola (1984) mentioned that soaking of sugarcane setts in solutions of the fungicide proved more economical than spraying in furrow. It is more effective due to its retention for a considerably longer period within the setts.

MATERIALS AND METHODS

Sugarcane variety:

The highly susceptible cane variety NCo 310 was used. Spore viability was bio assayed and results were expressed as % incidence of smut in growing sugarcane plants.

Crops for crop rotation and intercropping:

Crops normally grown in sugarcane growing areas of Upper Egypt either alone or intercropped with sugarcane were selected. The winter crops such as clover, broad bean, lupin, chick-pea, fenugreek and lentil and summer crops such as maize, grain sorghum and soybean were used.

Soil infestation:

Soil in No. 30 pot was infested by teliospores having known initial germinability. Spores at the rate of 500 mg/pot were thoroughly mixed with the upper 10 cm soil layer.

Seed-cuttings dipping inoculation technique:

The technique adopted by Srinivasan and Chenulu (1965) was used. Seed-cuttings were dipped in heavy spore suspension for half an hour before planting. Spore suspension was prepared at the rate of 5 gm of mature teliospores per litre of water.

Effect of crop rotation on survival of teliospores in soil:

The winter and summer crops were tried in soil infested with teliospores with initial germination of 42% prepared as described above. Infested pots were immediately planted with the respective crops (suitable number of seeds/pot). Crop plants received normal irrigation and left until ripening, then harvested. Pots were re-planted with NCo 310 cane variety (4 one-bud seed cuttings/pot) for bioassay of spore survival. Readings were recorded after 70-80 days for cane after winter crops (summer plantation) and about 200 days for cane planted after summer crops (autumn plantation). Control treatments were provided in infested-noncultivated-irrigated soil followed by sugarcane for both seasons. Five replicate pots were pre-

pared for each treatment.

Effect of root exudates of non-host plants on teliospore germination:

Root exudates of winter and summer crops tested in the crop rotation trials were examined. Wide, long test tubes filled to a depth of 5-7 cm with 0.5 cm diameter glass beeds were used to grow seeds of tested crops. Tubes were filled to the beeds surface with distilled water, plugged and autoclaved. Plugged Ehrlenmayer flasks (250 cc) containing 100 ml distilled water were prepared and autoclaved.

Crop seeds were surface sterilized in 0.2% corrosive sublimate for 2 minutes, then thoroughly washed in 3 changes of sterile water. Seeds were planted in the prepared tubes under aseptic conditions and left at room temperature for 15 days. Three to five-bud seed cuttings of NCo 310 cane cultivar were planted vertically in the prepared flasks and left for one month at room temperature. After the respective periods, root exudates were obtained and examined for their effect on spore germination on glass slides at 30°C. Control treatment used distilled water. Results were expressed as % spore germination after 24 hours.

Effect of intercropping and inoculation technique on smut incidence:

The summer and winter crops were intercropped with NCo 310 cane variety in two ways:

1. In soil infested prior to planting.
2. The use of dipping inoculation technique of cane cuttings prior to planting.

Number 30 pots were used. Four one-bud seed-cuttings of sugarcane together with a suitable number of the respective crop seeds per pot were planted for each of the two inoculation methods.

The results were expressed as % infection in sugarcane plants, as usual for both summer and winter crops. Infection indicates the effect of intercropping on disease control.

Chemical control:

A. *In vitro*: The systemic fungicides, Benlate 50%, Bayleton 25%, Vitavax/Captan 75% and Tilt 10% were tested against the mycelial growth of *U. scitaminea*.

Fungicides were incorporated into molten sterilized potato dextrose agar kept at 50°C at the rate of 5, 10, 15, 20 and 25 ug/ml, a.i., (WV) in 250 ml Ehrlenmayer flasks. Five 9 cm replicate plates (each containing about 20 ml medium) were prepared for each of the above levels for each fungicide. Fungicides-free plates were prepared and served as control. Plates were inoculated in the centre, each with a 4 mm agar culture disc cut from a 10-day old smut culture. Plates were incubated at 30°C. After 21 days, results were expressed as percent reduction in colony diameter and the nature of the fungicide effect, either fungicidal or fungistatic was determined. Discs giving no growth after 21 days were re-placed on fresh PDA and incubated for a suitable period for viability test.

B. *In vivo*: Seed-cuttings (one-bud-11 month-old) after dipping in teliospore suspension, 5 gm/litre, for 48 hours at room temperature (25-30°C) were dipped in solutions containing 0.5, 1 and 2 gm per litre of three systemic fungicides, Benlate 50%, Bayleton 25% and Vitavax/Captan 75% for 2 hours prior to planting.

Five treated seed cuttings were planted in each of 5 replicates No. 30 pots. Fungicide-untreated but inoculated seed-cuttings were planted in the same way and served as a control. Pots were left under the glass house conditions during the summer season.

Readings were expressed as % whipped plants 90 days after planting.

EXPERIMENTAL RESULTS

Effect of crop rotation on teliospore survival:

Presence of teliospores infesting the soil and bioassayed by infection in sugarcane showed that after both summer and winter crops no infection occurred. The results indicate the disappearance or inactivation of teliospores.

Effect of root exudates of non-host plants on teliospore germination:

The results (Table 1) show significant differences in teliospore germination on root exudates of certain crops and also as compared with sugarcane root exudates (43%) and the control (46.0%). Exudates of all crops drastically reduced spore ger-

mination. Lupin, broad bean and maize reduced germination to 28.84, 23.16 and 25.62%, respectively and were the most effective. Germination in exudates of sugarcane (the host) was nearly similar to the control.

Effect of intercropping and inoculation technique on smut incidence:

The results (Table 2) show that intercropping with summer crops, in infested soil, significantly lowered infection to about one third to one fourth its level in the respective control. However, in case of winter crops, infection was completely suppressed except with lupin which scored 8% cane infection. Infection in continuous sugarcane planting was 45.0 and 30% for summer and winter plantations, respectively.

Using the dipping inoculation technique of seed cuttings, data in Table (3), showed very little effect of intercropping with both summer and winter crops.

Chemical control:

A. *In vitro*: The results (Table 4) show that benlate 50% at 5 ug/ml was highly effective and at 10, 15, 20 and 25 ug/ml caused 100% reduction on colony diameter. When the inoculum discs were re-examined for viability on PDA, no growth occurred indicating fungitoxic effect at these levels.

Bayleton 25% was highly effective at 5, 10 and 15 ug/ml. It caused 100% reduction in colony diameter at 20 and 25 ug/ml; however, with fungistatic effect.

Vitavax/Captan caused a drastic reduction in colony diameter at 5 and 10 ug/ml. It caused 100% reduction in colony diameter at 15, 20 and 25 ug/ml, but was fungistatic.

Tilt, at all levels, caused drastic reduction in colony diameter.

B. *In vivo*: The results showed that no infection occurred after 90 days in infested seed cuttings treated with Benlate, Bayleton and Vitavax/Captan at all levels. Fungicide-untreated seed cuttings showed 25% infection.

Table 1. Effect of root exudate of certain non-host summer and winter crop plants on the germination of teliospores of *Ustilago scitaminea* affected at 30°C for 24 hours.

Exudate of	Teliospore* germination
Clover	39.66
Lupin	28.84
Chick pea	36.17
Broad bean	23.16
Fenugreek	34.51
Lentil	34.34
Soybean	33.29
Maize	25.65
Sorghum	32.69
Sugarcane	43.99
Distilled water	46.46

L.S.D. at: 1% = 6.88 , 5% = 5.14

* Percentages transformed to degrees (Fisher, R.A. and Yates, F., 1953).

Table 2. Effect of intercropping with certain summer and winter crops, in infested soil, on smut incidence in NCo cane cultivar under the glass house conditions.

Crops	Cane infection %
Maize + cane	16.0
Sorghum + cane	12.0
Soybean + cane	12.0
Sugar cane only (Summer plantation)	45.0
Clover + cane	0.0
Lupin + cane	8.0
Chick pean + cane	0.0
Broad bean + cane	0.0
Fenugreek + cane	0.0
Lentil + cane	0.0
Sugar cane only (Winter plantation)	30

Table 3. Effect of intercropping with certain summer and winter crops, using the dipping inoculation technique, on smut incidence in NCo 310 cane cultivar under glass house conditions.

Crops	Cane infection %
Maize + cane	55
Sorghum + cane	60
Soybean + cane	60
Sugar cane only (Summer plantation)	60
Clover + cane	40
Lupin + cane	40
Chick pean + cane	40
Broad bean + cane	35
Fenugreek + cane	40
Lentile + cane	45
Sugar cane only (Winter plantation)	50

Table 4. Effect of four systemic fungicides, incorporated in PDA on the mycelial growth of *Ustilago scitaminea* expressed as percentage reduction in colony diameter after 21 days at 30°C.

Crops	Level (ug/ml) and % reduction in colony diameter				
	5	10	15	20	25
Benlate 50%	82.97	100*	100*	100*	100*
Bayleton 25%	69.57	78.92	84.45	100*	100*
Vitavax/Captan 75%	70.21	80.85	100**	100**	100**
Tilt 10%	78.72	82.97	85.1	87.23	90.42

* Fungitoxic effect.

** Fungistatic effect.

DISCUSSION

Growing summer and winter non-host plants in artificially infested soil in a crop rotation with sugarcane showed in all cases that no infection occurred in sugarcane. This indicates either the inactivation of the teliospores due to the probable effect of root exudates of the non-host plants, teliospores germinated in the absence of the host and died and/or the remaining live spores were below the infective potential level. This is in agreement with Fawcett (1991), Arruda (1953) and Robinson (1953).

Root exudates of clover, lupin, chick pea, broad bean, fenugreek, lentile, soybean, maize and sorghum, which may be intercropped with sugarcane, drastically inhibited or decreased spore germination, lupin, broad bean and maize were the most effective. Germination in sugarcane exudate was equal to the control (in distilled water). This partially agrees with Saxena and Khan (1962) who observed that sugarcane bud diffusates stimulate spore germination.

The deleterious effect of root exudates of winter and summer crops on spore germination was examined for disease control in infested soil through intercropping with sugarcane. Summer crops significantly lowered smut incidences, while in case of winter crops infection was suppressed. In summer crops, cane germination occurred quickly and growing buds may be penetrated before the action of the deleterious effect of root exudates on spore germination. While, winter crops germinate normally and sugarcane is delayed. Hence, the root exudates can inhibit spore germination before cane germination resulting in suppression of infection.

Using the dipping inoculation technique of seed-cuttings, the results showed very little effect of intercropping with both crop types (summer and winter). This may be due to the relatively quick movement of the spores deeper to inside the bud scales escaping the deleterious effect of root exudates.

With respect to chemical control some trials were made using certain fungicides. *In vitro*, Benlate 50% was highly effective against mycelial growth and showed toxic effect at 5 ug/ml and above. Bayleton and Vitavax/Captan 75% were highly effective and proved to be fungistatic. The results are in agreement with El-Zayat *et al.* (1986). Tilt 10% at all concentrations caused drastic reduction in colony diameter.

In vivo, the results of fungicides-treated-seed cuttings under artificial inoculation showed that infection was completely prevented by the use of Benlate, Bayleton and Vitavax/Captan even at the lowest level (0.5 gm/litre). This is in agreement with Maneghany (1984) who found that in soil drenching tests, Benomyl and oxycarboxin completely suppressed systemic smut disease caused by *U. acitaminea*.

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مقاومة مرض تفحم ساق قصب السكر ببعض الطرق الزراعية والكيماوية

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درس تأثير الدورة الزراعية للمحاصيل الشتوية – البرسيم والفول والترمس والحمص والعدس والحلبة والمحاصيل الصيفية الذرة الشامى والذرة الرفيعة وفول الصويا مع القصب على البقاء الحى للجراثيم التيليتية للفطر المسبب للمرض بزراعتها فى تربة ملوثة بالجراثيم. أختبرت حيوية الجراثيم بزراعة القصب بعد هذه المحاصيل وتقدير نسبة الإصابة فيه ولم تحدث أصابة للقصب مما يدل على : إما موت الجراثيم أو انباتها فى غياب العائل أو أن عدد الجراثيم الحية المتبقية كان دون الحد اللازم لحدوث الإصابة.

وجد أن افرازات جذور هذه المحاصيل تقلل كثيرا إنبات جراثيم الفطر التيليتية بينما لا تؤثر عليه إفرازات جذور القصب. وأدى تحميل هذه المحاصيل على القصب فى تربة ملوثة الى منع حدوث الإصابة أو خفضها الى الثلث بإستعمال المحاصيل الشتوية والصيفية على التوالى. الا أن استعمال طريقة الغمر فى معلق الجراثيم لعدوى عقل زراعة القصب منع تأثير هذه المحاصيل وتشير هذه النتائج الى امكانية استخدام كل من الدورة الزراعية والتحميل مع القصب لمقاومة المرض.

أثبتت التجارب المعملية أن المبيدات بنليت ٥٠٪ بابليتون ٢٥٪ وفيتافاكس / كابتان ٧٥٪ وتلت ١٠٪ عند تركيز ٥ ميكروجرام / ملليلتر وأعلى وفى ترتيب تنازلى كانت فعالة فى تأثيرها ضد النمو الميسليومي للفطر وكان البنليت ذو تأثير سام. وفى تجارب الأصص منعت المبيدات البنليت والبابليتون والفيتافاكس كابتان حدوث الإصابة مع استعمال العدوى الصناعية فى عدوى عقل الزراعة وتعتبر المعاملة الكيماوية عملية فى حالة انتشار المرض.