STUDIES ON ASPARAGUS TIP ROT

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SUMMARY

Pre-storage treatment of asparagus did not affect the development of tip rot. The longer the storage time at 0°C, the faster tip rot developed post-storage. No biocides applied in the field or in the laboratory arrested development of tip rot. Those evaluated were: streptomycin, cupric hydroxide, propiconazole, mancozeb, metalaxyl and benomyl. Soil moisture did not affect the development of tip rot. Tip rot developed more slowly in spears held with their butts in water than in spears held dry. Rhizome extracts did not affect the development of tip rot. No pathogenic microbes were consistently associated with spears with tip rot syndrome. Tip rot is probably caused by physiological deterioration.

INTRODUCTION

Decline in the quality of fresh asparagus is commonly associated with a syndrome known as tip rot. The cause of tip rot is unknown. A wide range of soil micro-organisms, both fungal and bacterial, have been found associated with the syndrome (Ramsay and Wiant 1941; Menzies unpub.). It has not been found in asparagus in the field but is typically a problem in stored asparagus and may be related to inadequate cooling and careless handling (Ramsay and Wiant 1941).

Tip rot is a major problem in export asparagus, severely reducing its shelf life, particularly after it is subjected to 2 weeks transportation in cool storage. Once 50% of a shipment has tip rot, the product would be unsaleable at a price which adequately recompensed both grower and exporter. The aim of tip rot control must be to produce a product that has a low incidence of the syndrome after a journey of 3-4 weeks from packhouse to market. However, the cause of the tip rot needs to be determined before control measures can be investigated.

There are two possible causes of the disorder. One is that it is a disease or, secondly, it could be primarily physiological with a secondary infection produced by associated microflora. By testing a wide range of therapeutants, active against a broad spectrum of micro-organisms, both in the field and laboratory, and by identifying bacteria and fungi associated with tip rot it ought to be possible to determine whether or not tip rot is microbiological in origin. Postharvest handling and storage parameters may also affect the development of the problem. The aim of the experiments described in this paper was to broadly test a range of possible factors in order to identify one as a major cause of tip rot.

MATERIALS AND METHODS

The research was carried out on asparagus cv 'N.Z. Beacon' grown on Levin silt loam at Levin Horticultural Research Centre. The plants were 450 mm apart and covered with 200 mm of soil. In the laboratory tests product was picked fresh as needed at a length between 180 and 230 mm. All spears were trimmed to 180 mm length for experimental use. Tip rot was defined as any discolouration of the tip, associated with a softening of the tip tissue.

Field Trial

The trial was split plot, with one 20 m row in each of four replicates being irrigated and one not irrigated. Within each row there were five 4 m subplots with the following treatments: streptomycin (Agrimycin) 100 ppm; cupric hydroxide (Kocide 101) 125 ppm; propiconazole (Tilt) 625 ppm with metalaxyl 200 ppm and mancozeb 1600 ppm

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(Ridomil MZ 72 WP): an untreated control; and a further treatment which was all three chemical treatments combined. The rates applied were derived by back calculation to ppm from the label information. Chemicals were mixed in 40 litres of water. The soil over the crowns was lightly scraped back to expose the top surface of the crowns. The asparagus was cut to ground level and treatments were applied on 16.11.87. When the liquid had drained into the soil, the soil was scraped back over the crowns.

Irrigation was via home garden soak hose which ran for 4 hours every day. Non-irrigated plots were sheltered with plastic sheets 700 mm wide, supported 800 mm above the soil. Asparagus spears 150 mm and longer were cut and counted three times per week from 18.11.87-16.12.87. Spears were placed in a coolroom at 0°C for 2 weeks. They were assessed for tip rot and then held at 20°C. Tip rot was then assessed daily until all spears were affected or had extreme dehydration.

Laboratory Tests

1. The effect of storage time on the development of tip rot.

Spears were washed in chlorinated water, plain water, or not washed. Lots of 20 spears were then held at 0°C for periods of 0, 0.5, 1, 2 and 3 weeks. Spears were then held at 20°C and assessed for tip rot.

2. Chemical tests

(a) Spears were held at 20°C standing in solutions of: 100 ppm streptomycin; 125 ppm of cupric hydroxide; 625 ppm propiconazole, 200 ppm metalaxyl, and 1600 ppm mancozeb; all chemical treatments mixed together; and a plain water control. Tip rot was assessed daily. There were two replicates of 10 spears in each treatment.

(b) Spears were immersed totally in the solutions listed in (a) for 5 minutes, drained and then held at 20°C and tip rot assessed daily. There were two replicates of 10 spears in each treatment.

(c) Spears which had been held at 0°C for 1 week, or freshly harvested spears, were held at 20°C with their butts in solutions of: 100 ppm streptomycin; 100 ppm streptomycin and 100 ppm benomyl; 100 ppm streptomycin and 625 ppm propiconazole; 100 ppm benomyl; 625 ppm propiconazole; 100 ppm benomyl and 625 ppm propiconazole; and a plain water control. Each treatment was replicated twice, with 10 spears in each replicate.

3. Effect of water on the development of tip rot.

One hundred spears were held dry and 100 with their butts in water. They were stored for 1 week at 0°C and then held at 20°C and tip rot assessed daily.

4. The effect of rhizome extract on the development of tip rot.

An asparagus crown was dug up, washed and sections of rhizome cut off. Sections of rhizome weighing 200 grams were taken. One section was coarsely chopped and two were homogenized in 200 ml of water in a Waring blender. One lot of homogenate was then filtered. Asparagus spears were held with their butts in the following treatments: 200 ml water, 200 ml water with coarsely chopped rhizome, 200 ml water plus homogenized rhizome, 200 ml of filtrate from homogenized rhizome.

5. Microbiological assessments

Spears with and without tip rot taken from the field and laboratory experiments using biocides were tested for the presence of bacteria and fungi. For every treatment tested two spears were surface sterilised for 2 hours in 1% sodium hypochlorite and two spears left unsterilised. Samples from the field trial were not surface sterilised.

Tissue segments were taken from primordia (lateral buds) or stem tip tissue. Surface sterilised spears were split longitudinally to expose internal tissue. Segments of primordia and stem tips were plated to test for internal infections.

Fungal isolations were carried out on prune agar medium amended with antibiotics (streptomycin 50 ppm + penicillin 50 ppm). The plates were incubated at 21°C under 12 hours light/12 hours dark for 5 days.

Bacterial isolations were carried out on Kings medium B amended with a fungicide (propiconazole 10 ppm) incubated at 25°C in the dark for 5 days. Bacteria were tested for pectolytic activity on crystal violet pectate medium.

RESULTS

Field Trial

No chemical treatment affected the development of tip rot. Irrigation and shelter from rain had no effect on the level of tip rot or on the time taken to develop tip rot. Tip rot occurred in 89-97% of all the spears harvested. This incidence developed in 3-7 days.

Laboratory Tests

1. Storage and pre-storage handling

Pre-storage handling had no consistent effects on tip rot development. After 1 week's storage the dry spears were much slower to develop the syndrome than were the wetted spears but this did not occur in other treatments.

The time taken to reach 100% tip rot ranged from 10-12 days with no storage or half a week's storage, to only 5 days after 3 weeks storage (Figure 1). Asparagus from the intermediate storage regimes of 1 and 2 weeks took 8-10 days to reach 100% tip rot. There was, thus, a strong indication of acceleration in the development rate of tip rot after between 2 and 3 weeks storage at 0°C. Storage duration did not affect the final level of tip rot. Almost all spears developed tip rot regardless of treatment.

Fig. 1: Mean number of days to maximum asparagus tip rot as function of weeks in storage.

2. Chemical control

The development of tip rot was as rapid in those spears either washed or standing in streptomycin, cupric hydroxide, propiconazole, mancozeb, and metalaxyl as it was in the water controls. Within 8 days all spears had tip rot. No other treatment affected the development of tip rot.

3. The effect of water

Onset of tip rot was delayed by 3-4 days in spears held in water compared with those kept dry (Figure 2). After 6 days proportion of tip rot in both treatments increased dramatically. After 9 days the differences between the two treatments were minimal.

4. The effect of rhizome material

No treatment had any effect on the development of tip rot.

5. Microbiological assessments

A diverse range of micro-organisms were isolated (Tables 1 and 2). The predominant bacteria were *Bacillus* spp., including *Bacillus mycoides* and *B. subtilis*. Some *Pseudomonas* spp. were isolated. The only fungus was *Fusarium* spp. The spears that had been immersed in the biocides (Table 1) had much higher levels of *Pseudomonas* and *Bacillus* bacteria than those from the field trial, but immersion did

suppress fungal populations. The range of bacteria isolated from surface sterilised spears was much lower than for unsterilised spears, and the surface sterilisation completely removed fungi. None of the *Bacillus* spp. tested showed any proteolytic activity indicating that they were not pathological. Some slight proteolytic activity was found amongst the *Pseudomonas* spp.

Fig. 2: The development of asparagus tip rot in spears stored dry or with their butts in water.

TABLE 1: Microflora associated with asparagus spears

Organisms isolated	Source			
	Field trial	Tip immersion (expt 2a)	Storage trials	
<i>Bacillus</i> spp	p	++	+	++
	s	++	+	++
<i>Pseudomonas</i> spp	p	—	++	—
	s	+	++	—
<i>Fusarium</i>	p	++	+	+
	s	++	+	+
<i>Penicillium</i>	p	—	—	+
	s	—	—	+
<i>Alternaria</i>	p + s	—	—	+
<i>Trichoderma</i>	p + s	—	—	+
<i>Phomopsis</i>	p + s	—	—	+
<i>Yeasts</i>	p + s	—	+	+
<i>Mucor</i>	p + s	—	+	+

++ common, + present, — absent, p = primordium, s = stem tip.

TABLE 2: Microflora associated with various grades of tip rot from stored asparagus.

Infection grade		<i>Bacillus</i> spp	<i>Bacillus mycoides</i>	<i>Pseudomonas</i>	<i>Penicillium</i>	<i>Fusarium</i>	<i>Alternaria</i>
no tip rot	ext	+	+	—	+	—	—
	int	—	—	—	—	—	—
slight tip rot	ext	+	+	—	—	—	—
	int	+	—	—	—	—	—
some softening	ext	+	+	—	+	+	+
	int	+	—	—	—	—	—
1-2cm of tip soft	ext	+	+	—	+	+	—
	int	+	—	—	—	—	—
tip decayed	ext	+	+	—	+	+	+
	int	+	—	—	—	—	—

— absent, + present, ++ common, int = internal, ext = external.

DISCUSSION

The data presented here indicate that the primary cause of tip rot is not microbiological. None of the biocides used in the field or the laboratory affected the development of the syndrome. No microbiological populations were consistently associated with the occurrence of the syndrome. *Penicillium* can be the cause of storage problems, and is soil borne but was not always present on spears with tip rot. The bacteria commonly associated with soft rots of vegetables, *Erwinia* spp and *Xanthomonas* spp, were not isolated. The gram positive bacteria isolated are common soil organisms and have not been implicated in the soft rot decay of vegetables.

The high incidence of tip rot, which affected nearly all spears, and the fact that no treatment caused any reduction in the incidence of tip rot indicates that the problem is due to physiological deterioration. Work by others (King *et al* 1986, 1988a, 1988b; Lill pers. comm.) supports this conclusion. Bacteria stimulated by cell exudates produced by tissue breakdown may be a secondary factor causing an acceleration of the breakdown process. Standing asparagus spears in water appears to partially protect asparagus against the early development of tip rot. However, tip rot rapidly increases after removal from storage at 0°C, particularly in asparagus stored for 1 week or more. This would suggest that physiological decline is occurring even at this temperature, albeit at a reduced rate.

Tip rot appears to be primarily a storage and handling problem. Further work is required on these factors to help understand how to alleviate the problem.

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