and 1 pint; and Pipron-Parnon at 4 ounces each. Four ounces of B-1956 spreader sticker per 100 gallons of water were used in all plots. Sisthane treatments were applied approximately every 14 days and were done on May 13 and 27 and June 10. Pipron-Parnon treatments were applied approximately every 7 days and were done on May 13, 20, and 27 and June 3, 10, 17, and 24. Plots were sprayed with a handgun at 200 psi, using a John Bean piston pump sprayer. Results are shown in table 5. Sisthane used at 1 or 2 quarts applied every 14 days was significantly better for control of powdery mildew of rose than the standard Pipron-Parnon sprayed every 7 days. Sisthane at 1 pint sprayed every 14 days gave intermediate control.

Darker colored foliage and shortened internodes were consistently noted in all trials where CG 64251 was applied.

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TABLE 2. Comparison of Fungicides for the Control of Rose Powdery Mildew, 1977—Variety-Samantha

Treatment	Rate 100/gal	Disease Rating July 15
Sisthane (RH 2161), 2 lb/gal	1 qt	0.7*a
CG 64251, 10W	8.4 oz	0.9 a
Nimrod, 2 lb/gal	28 oz	1.1 a
Nimrod	20 oz	1.2 a
DuPont 4423, 2 lb/gal	1 qt/1 pt	2.1 b
No treatment	—	2.7 c

*Sign. 5%

TABLE 3. Comparison of Fungicides for the Control of Rose Powdery Mildew in Commercial Size Plots, 1977—Variety-Samantha

Treatment	Rate 100/gal	Disease Rating Aug 19
Sisthane (RH 2161)	1 qt	0.7*a
Nimrod	20 oz	0.8 a
Pipron + Parnon	4 + 4 oz	1.5 b
No treatment	—	3.0 c

*Sign. 5%

TABLE 4. Comparison of Fungicides for the Control of Rose Powdery Mildew, 1978—Variety-Volare

Treatment	Rate 100/gal	Disease Rating June 8	Disease Rating June 15
CG 64251, 10W	10 oz	1.7*a	1.3 a
Sisthane, 2 lb/gal	0.75 qt	2.2 ab	1.3 a
Boots 7789, 25%	25 oz	2.7 b	1.5 a
Bayleton, 25W	8 oz	2.7 b	2.2 b
Pipron + Parnon	4 + 4 oz	3.5 c	2.7 b
No treatment	—	3.5 c	2.4 b

*Sign. 5%

TABLE 5. Comparison of Fungicides for the Control of Rose Powdery Mildew in Commercial Size Plots, 1978—Variety-Forever Yours

Treatment	Rate 100/gal	Disease Rating June 15	Disease Rating June 29
Sisthane, 2 lb/gal	2 qt	0.28*a	0.25a
Sisthane, 2 lb/gal	1 qt	0.4 a	0.5 a
Sisthane, 2 lb/gal	1 pt	1.0 b	1.5 b
Pipron + Parnon	4 + 4 oz	1.7 c	2.2 c

*Sign. 5%

Stem lesion of Easter lilies—a complex disease

John Bald □ John Lenz □ Albert O. Paulus

Every year, lesions appear on the stems of field-grown Easter lilies; but the serious effects of the disease known as "stem lesion" are very erratic. The lesions are most frequently superficial and one-sided, and reduce yield and quality very slightly or not at all. In some seasons and in some fields the lesions deepen and expand around the stem, interfering with transport of nutrients and reducing the yield and quality of the bulbs. Conditions promoting the intensification of symptoms are not understood; this fact and the erratic incidence of the disease in its serious form make experiments on control of stem lesion very difficult. Unfortunately, field experiments so far have been done only during seasons and in fields where the disease has been evident but has not become serious.

Cause

Stem lesion has been associated with another symptom, rotting on the tips and sides of bulb scales, known as scale tip rot. The two symptoms may reasonably be considered due to one disease. The same organisms have been isolated from both types of lesion. These are, (1) a fungus, *Fusarium oxysporum*, isolates of which can cause basal rot of lilies, and (2) a bacterium, *Pseudomonas* sp. Both organisms have been isolated many times from single lesions. They have also been inoculated to lilies singly and in combination, causing lesions, and have been recovered by subinoculation.

Inoculation of *Fusarium* causes different symptoms according to the severity of the isolate applied. Some isolates cause surface yellowing due to penetration between the surface cells only. Others cause various types of lesions of bulb stems and roots. The most severe syndrome is rotting of the basal plate of the bulb and the bases of scales, so that the bulb falls apart and the plant is destroyed.

In a susceptible cultivar, 'Croft,' inoculation of bulb scales with even a mild isolate of *Fusarium*, plus the bacterium, *Pseudomonas*, caused an expanding and destructive rot. *Pseudomonas* alone caused definite but restricted lesions. The combined damage was much more severe than the sum of the damage caused singly by each organism.

Pseudomonas gains entry to the tissues through wounds and natural openings, but it seems capable also of unaided entry into the tips of bulb scales, particularly the paper-thin tips of young scales. Thus penetration by both *Fusarium* and *Pseudomonas* may be independent. Each appears capable of establishing itself in lily bulb tissues in the soil. There is also sufficient superficial wounding of bulbs between digging and planting and sufficient movement and mixing of bulbs to allow many infections to occur when bulbs are out of the ground and in the packing shed.

Opportunities for infection of stems are more confined. The stem apex is hidden in the bulb, and the stem is exposed only by growth of the apex up through the soil from between the tips of the bulb scales. Also, the tissues are harder, and not so easily wounded. Wound inoculations with *Pseudomonas* do produce small lesions on immature stems, and the bacterium may be recovered by isolation procedures.

Consideration of these and similar observations suggests that by itself *Pseudomonas* is unlikely to act as a serious pathogen on lily stems. However, it has been recovered with *Fusarium* from many severe stem lesions. From other stem lesions, particularly when they have not been very damaging, only *Fusarium* has been recovered. It is assumed, though not fully proven, that the more severe forms of stem lesion are due to the combined effects of *Fusarium* and *Pseudomonas.* Presumably, *Pseudomonas* may enter stem tissues with *Fusarium,* and enhance its pathogenicity.

Field experiments with 'Croft'

During 1959-62 and 1966-68, field trials were made in northern California with Easter lilies of the cultivars 'Croft' and 'Ace' to test various materials as preplanting dips. Some of the fungicides tested were PCNB, ferbam, folpet, and fenaminosulf (Dexon and Leson). A bactericidal material, Agrimycin 100, was also tested. Agrimycin 100 was included after evidence appeared that *Pseudomonas* was involved in the production of stem and bulb lesions. Agrimycin 100 was composed of two antibiotics, Streptomycin sulfate mixed with a smaller proportion of oxytetracycline. This combination is no longer available for use against plant diseases, and, therefore, the results with Agrimycin 100 may have no application in farming practice. They are recorded here because they and the supporting laboratory and greenhouse work provide evidence on the nature of stem lesion and scale tip rot. This evidence is still relevant because efforts to find a bactericide to help control stem lesion are being renewed.

A 1962 field experiment with 'Croft' lilies failed to show any significant reduction of scale tip rot symptoms from dipping with the fungicides applied, or with various combinations of these fungicides. Treatment with Agrimycin 100 alone, or in the presence of PCNB and ferbam, gave reductions of scale tip rot that were almost statistically significant.

Greenhouse and laboratory work with bulbs from the field trial gave information that influenced diagnosis and evaluation of scale tip rot. Culturing from many slightly damaged scale tips gave more colonies of soil inhabiting fungi of the genera *Chaetomium, Alternaria, Trichoderma* and others, than of *Fusarium* and *Pseudomonas.* Apparently, slight damage to scale tips and penetration of damaged tissues by soil fungi had been confused with early stages of lesions due to the *Fusarium-Pseudomonas* complex. In later estimates of scale tip rot, bulb scales with slightly damaged tips were classified as healthy.

Trials with 'Ace'

Agrimycin 100 was tested again in field and greenhouse experiments during 1966-68 with the cultivar 'Ace.' By then 'Ace' had become the dominant cultivar of Easter lily. 'Ace' bulblet stocks from two growers were dipped (pretreated) in the standard PCNB-ferbam mixture. One grower had also hot-water treated the bulblets. Both provided equivalent samples of bulblets for the trial that were not pretreated. An early and a final harvest of bulbs gave a variety of data on yield and disease incidence. The final harvest provided bulbs for a forcing trial in the greenhouse, and for a second field trial during 1967-68.

During 1966-67, Agrimycin 100 was tested at two concentrations, 100 and 200 parts per million of the combined antibiotic. Also Bordeaux mixture at 10-10-100 was tried as a dip on the premise that it would kill bacteria as well as fungi. Like Agrimycin 100, it was applied both to untreated and pretreated bulblets. It was quite effective, but was deleted from the 1967-68 trial because it depressed growth and yield. Also deleted was the treatment with Agrimycin 100, at 100 ppm. The number of treatments was made the same as in the first trial by dipping half of each remaining lot of bulbs a second time in Agrimycin 100, at 200 ppm, and leaving half untreated.

In both field trials, Agrimycin 100 caused a consistent and statistically significant reduction in bulb scale lesions, including scale tip rot. The effects on stem lesions were more complex. These are illustrated in the table by the final harvest results from the 1966-67 field trial. Results from the first harvest were similar. Numbers of stems with visible lesions were reduced by the fungicidal pretreatments to about 3 percent. On the bulb stocks without pretreatment there was a decrease of stems with lesions from 48 percent of those growing from untreated bulbs, through 34 and 19 percent of stems from Agromycin 100 treatments, to 11 percent of those from bulbs treated only with Bordeaux mixture. The decrease from 48 to 19 percent, due presumably to the bactericidal action of Agrimycin 100, was statistically significant. Bordeaux apparently acted as both fungicide and bactericide.

Percentages of Easter Lily Stems with Lesions. Final Harvest from a Field Trial, 1966-67.*

	Not pretreated	Pretreated
Check	44.4	2.9
Agrimycin 100 (100 ppm)	34.3	2.9
Agrimycin 100 (200 ppm)	19.3	3.0
Bordeaux mixture (10-10-100)	11.8	3.1

* Treatments were a preplanting fungicidal dip with PCNB-ferbam (pretreatment) followed by the bactericide, Agrimycin 100, or Bordeaux mixture used as a bactericide.

These results are consistent with the ability of *Pseudomonas* to become established in bulb tissue and its probable dependence on *Fusarium* for establishment in stems. If establishment of *Pseudomonas* on stems without *Fusarium* is rare, recognizable stem lesions will be few when the *Fusarium* component is repressed by a fungicidal dip. If the expansion of incipient or inconspicuous *Fusarium* lesions to visible size is encouraged by association with *Pseudomonas,* recognizable lesions will be reduced progressively as a bactericide reduces the *Pseudomonas* population. If there is no bactericidal treatment, a residue of *Pseudomonas* is always likely to remain in the bulb, and ultimately, with the aid of what *Fusarium* remains, infect the stems. This explanation of the results is consistent with the results of laboratory and greenhouse experiments.

Conclusions

In this series of trials, Agrimycin 100 had no effect on bulb weight or yield. Stem lesions were relatively superficial and apparently had no effect on the passage of nutrients either from the roots to foliage or from foliage to bulbs and bulblets. On the other hand, dipping in PCNB-ferbam (pretreatment) increased bulb weight significantly during both seasons, although it was applied only once, before the first trial was planted.

If *Pseudomonas* on Easter lilies can be checked cheaply and conveniently by adding to or altering the bulb dip, the unpredictable but occasionally severe effects of stem lesion may be contained. Hence the continued search for an effective bactericidal dip for lily bulbs.

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