Ground Pearl Damage to Tifgreen:

Ground Pearls shown in enlarged picture.

A Research Report

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The ground pearl, *Margarodes miridonalis* Morr., is a subterranean scale insect which feeds on the roots of bermudagrass. It is a serious problem on lawns and golf greens throughout the southern United States, especially those planted to Tifgreen bermudagrass.

This scale was first described in 1927, nine years after specimens had been collected at Fort Myers, Fla., and in Georgia (Morrison, 1927). No mention was made of the scale's host, or whether its feeding was injurious. However, since nine years had elapsed between the original collection and the published description, one can assume that it originally was more of a collector's curiosity than an economic pest. Ground pearls are now causing extensive damage to centipede grass lawns in Georgia (Tippins and Bashear, 1968). In California, ground pearls were causing injury to grapes in 1954 and were also reported on irrigated bermudagrass pastures and other areas where bermudagrass was growing (Barnes, et al., 1955).

Ground pearls were first observed in Arizona during 1949 at Glendale, where they destroyed two small areas of a bermudagrass lawn. This early damage was overcome by adequate fertilization and watering. A survey conducted in 1954 showed that ground pearls were injuring lawns and golf courses in the Phoenix area (Werner, 1955). In 1958, Tifgreen was introduced in Phoenix, and because of its desirable qualities for both lawns and golf greens, its use was greatly expanded in the succeeding years. Shortly after the introduction of Tifgreen, ground pearls were found in injurious numbers. Damaging infestations appeared to spread along with the expanding use of Tifgreen, which isn't surprising since most of the common bermudagrass turf had noninjurious infestations.

In 1968, ground pearls were found infesting sorghum near Phoenix. In 1970, this insect was found infesting grape roots in the Chandler Heights area.

What is a Ground Pearl?

A ground pearl is the immature stage of an insect which develops to an adult inside a pearl-like shell. This shell is hard and protects the developing insect from predatory insects, diseases and prolonged periods of drought and excessive moisture. Because of the pearl-like covering, the immature insect is able to survive when grass is dormant.

Actually, very little is known about the life history of this insect. After the ground pearl has reached maturity and is about 1/8 inch in size, the adult leaves the ground-pearl shell. Only female adults have been reported (Morrison, 1927). The adult female is called a crawler because it has a small head, short legs and no wings. The crawler is slightly larger than the ground pearl from which it emerged, and it can only crawl short distances. Each crawler lays about 100 eggs which hatch into nymphs (Almand and Thomas, no date). These nymphs have legs, no wings, and are so small that it is impossible to see them unless they are placed under a microscope.

Shortly after hatching, the nymphs crawl a short distance, and with their mouth parts, attach themselves to bermudagrass roots. Immediately after attachment the nymphs lose their legs and develop pearl-like coverings. During this change, their mouth parts develop into tubes used for sucking plant juices. Newly formed pearls are difficult to see, but, as the immature insects inside the pearl-like shells grow, their shells also increase in size. The immature insects or nymphs slowly grow to adulthood within a year inside their shells. When nymphal maturity is reached, the adults emerge as crawlers from the ground pearl around June 1.

These crawlers are slightly larger than mature ground pearls. Their legs are short, and when they were placed on filter papers in petri dishes they moved very slowly, about an inch or so in a 24-hour period. This apparent lack of movement is supported by population studies which showed very few ground pearls six inches away from half-dead Tifgreen spots known to be infested for at least three years.

Injury

Excessive ground pearl populations usually kill Tifgreen in irregular areas ranging from six inches to three feet in diameter. Such areas will be bare when the turf commences growth in the spring. In early July when temperatures are 100°F. or over, and especially when the turf is stressed for water, previously healthy looking turf may be killed by ground pearls in areas ranging from 6 to 12 inches in diameter. Ground pearls can be found in these areas during the mid-summer, the fall and the succeeding spring. If the area has been destroyed for over a year, ground pearls will be absent in the dead areas but present in large numbers on live grass roots in a 3- to 4-inch border surrounding the dead area. Within a year or so, the border area will be killed.

The damage by ground pearls to Tifgreen turf often is overlooked because common bermudagrass can tolerate ground pearl activity. Common bermuda will migrate in and develop a healthy-looking turf in spots of Tifgreen that have been weakened or killed by ground pearls.

Ecological Studies

During the last two years in Arizona, it has been observed that ground pearls developed to their maximum size during April and May. Shortly before June 1, crawlers (adults) start emerging from mature pearls. Soil samples showed that the highest populations of crawlers were on June 15. A few were observed on July 1. On June 1 only mature ground pearls were observed, whereas on June 15 only immature ground pearls were found. These ground pearls grew in size so that by fall, 25 per cent were

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ABOUT THE AUTHOR

The late George P. Wene was raised on a farm in northeastern Ohio. He received his A.B. degree from Park College in 1934 and his M.S. degree from Ohio State University in 1939. He then worked for the Virginia Agricultural Experiment Station on tobacco insect control, completing his Ph.D. work at Cornell University in 1946. He was employed as a vegetable entomologist for the Texas Agricultural Experiment Station until 1957 when he moved to Arizona to do cotton insect research. In 1967 the Arizona Agricultural Experiment Station transferred him to a newly created position as an urban entomologist. In this position, Dr. Wene did research on the control of turf, ornamental and household insects.

Dr. Wene died in a dust-caused multiple-vehicle collision near Casa Grande, Ariz., on May 12. He was returning home from research work on certain grasses in the Phoenix area.

At the time of his death, Dr. Wene was serving his second term as a member of the Arizona Pesticide Control Board. He was Southwestern regional member of the Executive Committee of the American Entomological Society, and in 1968 received a special award from Arizona Aerial Applicators Association for his contributions to Arizona agriculture. As a research scientist, Dr. Wene published extensively and the above article is his most recent contribution to the science of turfgrass culture.

approximately 1/16 inch in size and the other 75 per cent slightly larger. In spring, these ground pearls grew to their maximum size of 1/8 inch.

The life cycle of this insect is only one year. This is shown by the lack of mature ground pearls on June 15 and the presence of crawlers and immature ground pearls instead.

Grass becomes dormant in October and remains so until early March. Large ground pearls were collected on November 5 and placed in dry soil. A number of these larger pearls were opened on April 20 and eight of them had live crawlers (adults) in them. This shows that large ground pearls can survive for prolonged periods without being attached to grass roots.

Studies conducted in the greenhouse indicate that ground pearls spread a distance of only about four inches per generation, or per year, since there is only one generation annually. This explains why injury to Tifgreen spreads so slowly in the field.

Populations in yards and golf greens were determined by taking half-inch soil cores to a depth of six inches. In spots where the Tifgreen recently had been killed, the population averaged 31 ground pearls per sample. Although as many as 150 were found in some of the samples, samples taken three inches away from the dead area averaged only 20 and none were found 12 inches away.

The vertical distribution of ground pearls is influenced by available moisture and soil type. On most golf greens, water is applied often and in small amounts. In a sandy soil on one Phoenix golf course, the majority of the root development was in the top two inches of the soil. The highest concentration of ground pearls was in the second inch of soil, similar to the root concentration. Below this two-inch soil level, the root concentration declined as did the ground pearl population. A few ground pearls were found as deep as nine inches in sandy soil, but this was in an area which received sufficient water thereby promoting root development.

Clay soils have a greater water holding capacity than sandy soils. As a result, bermudagrass roots were numerous to a depth of four inches. The ground pearl population was well distributed throughout the top three inches of soil. However, a few ground pearls were found at a depth of nine inches.

Ground pearl population records were taken from a golf course maintained on an adobe soil. The greens had from 1 to 1.5 inches of sand above an impermeable adobe layer. The Tifgreen roots were found only in the sandy layer, as were the ground pearls. Therefore, vertical distribution of ground pearl populations is determined to a large extent by the factors influencing root distribution in the soil.

Surveys show that populations of 25 ground pearls per 0.5 inch core sample (taken to a depth of 4 inches) killed Tifgreen. Populations of 25 or more per core sample caused no injury

Table 1.
Summary of 1969 and 1970 ground pearl control experiments conducted in Encanto Park, Phoenix

Insecticide granules	Year	Applications No.	Lbs./1000 sq. ft.	No. ground pearls in 25 0.5 x 4 in. soil cores Before	After
Aldicarb, 10%	1970	4	2.3	859	11
Bay 68138, 15%[a]	1970	1	4.6	626	216
		4	1.6	857	39
Diazinon, 14%	1969	4	2.3	30	401
	1970	4	4.6	711	311
Di-Syston, 10%	1969	1	6.9	266	57
		4	2.3	245	55
Di-Syston, 15%	1970	1	4.6	87	43
		4	1.6	515	27
Phorate, 10%	1970	1	6.9	621	67
		4	2.3	405	148
		4	2.3	667	259
Untreated	1969			882	701
	1970			11	110
				415	188

[a]Ethyl 4 — (methylthio-tolyl isosprophylphosphoramidate)

to common bermudagrass.

Control Experiments

In the laboratory, crawlers were immersed in various concentrations of insecticides. Such organic phosphates as diazinon, Dursban, Azodrin, and Gardona proved highly toxic to the adult crawlers. Chlordane had no effect on the crawlers. Although toxic to crawlers, the organic phosphate had no effect on large pearls when they were immersed in various concentrations.

Controlled experiments were conducted in 1969 on the temporary greens at Encanto Golf Course, Phoenix. The greens were approximately 1,000 square feet in area. Each green was divided into two areas. The treatments used are shown in Table 1. Due to the limited number of plots, it was impossible to replicate, but this was partially overcome by repeating the treatments in 1970. Previous work shows that the crawler stage was the most vulnerable, and treatments were started before they appeared. The first treatment was applied on May 15. Those plots receiving multiple applications were treated at two-week intervals after the first application. Immediately after treatment the plots were irrigated. Population data was taken before the first treatment and again in October.

The data in Table 1 show that systemic insecticides can reduce ground pearl population greatly. Aldicarb proved to be the best, but this was one year's data and should be repeated. Di-Syston reduced populations significantly in both years. Phorate and Bay 68138 effectively reduced populations. Diazinon at a high rate of application also reduced the population. Four applications of 1.6 pounds each of Di-Syston (15% granules) per 1,000 square feet appeared to be slightly more effective than one large treatment (4.6 pounds) at the beginning of the season.

The population in the untreated plot remained constant throughout 1969. In 1970 two untreated plots were observed. The first had been treated in 1969 with Di-Syston. The data show that there was no carryover effect since the population doubled. The second untreated plot had been severely injured by ground pearls and very little grass survived.

The data indicate that ground pearl populations can be reduced greatly by applying 10% granule formulations of Aldicarb, Di-Syston, Phorate and Bay 68138 applied at the rate of 2.3 pounds per 1,000 square feet. Four applications should be made at 14-day intervals, the first being applied 14 days before the adult crawlers emerge.

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