virus of sun blotch disease. Those which displayed obvious symptoms of sun blotch could be avoided, but there remained the possibility that some Duke trees might be symptomless carriers of sun blotch virus. Since it has been shown that seedlings grown from symptomless carrier avocado trees are infected with sun blotch virus through seed transmission and should not be used as rootstocks, it became necessary to insure that no symptomless carrier Duke trees be used as rootstock seed sources. Results presented here are from the first tests completed in the program to select suitable Duke trees for rootstock sources. The photo shows extreme sunblotch symptoms on Hass fruit. The sunken, yellow-colored areas on the surface and distortion of the fruit can make it unmarketable.

Inoculation

One method of determining whether an avocado tree without sun blotch symptoms is healthy, or is a symptomless carrier of sun blotch virus, is to inoculate from it to known healthy avocado seedlings.

In these studies, the seedlings used for indicators were derived from Hass Tree 19B-15-3 Citrus Research Center, which was known to be healthy. Seeds were planted individually in 1-gallon cans in virgin soil (Vista sandy loam) taken from noncultivated land of the University of California campus at Riverside. Seeds were planted in May 1962 and the containers and plants were maintained in a lathhouse throughout the experiment.

In May and June, 1963, when the Hass indicator seedlings were 30 to 36 inches high, each was "inoculated" by inserting four shield buds, each from a different budstick of a given Duke tree. A total of 10 Hass seedlings were inoculated from each of 12 Duke trees under test, using from 16 to 20 budsticks taken at random from each tree being tested. To speed up movement of the virus (if present) from the buds into the seedlings, the test plants were topped just above the upper inoculation bud and new shoots were permitted to form a top.

Test plants

All test plants were transferred to three-gallon cans in April 1965. All seedlings which had not developed symptoms by that time were again topped to encourage infection and development of symptoms if the virus was present but had not yet caused symptoms. This is necessary because there is a delay in infection and production of symptoms of sun blotch in some plants. The first symptoms to appear on infected seedlings are small yellow spots on the green bark of the main stem. Later these spots along the stems enlarge, becoming yellow, colorless or sometimes pinkish streaks, which may be slightly sunken.

Evaluation

All test seedlings in this study were carefully examined for symptoms six times between September 1964 and October 1967. Infection results are summarized in the table. Duke test trees 1 to 10 proved to be sun blotch free since no infections were obtained from them. However, results obtained from Duke trees 11 and 12 showed that both were infected; all 10 test seedlings inoculated from each, developed sun blotch symptoms. Inasmuch as no symptoms were found on these two Duke trees the chances are good that they are the symptomless carrier types which would produce diseased seedling progenies unsuitable for use as rootstocks. At least it is certain that they are infected.

Duke trees 13 and 14 were known to be infected with sun blotch virus; tree 13 showed symptoms while tree 14 was a previously identified symptomless carrier. Tree 15 was a symptomless carrier, Topa Topa. It should be noted that 100 per cent of the Hass seedlings developed sun blotch after inoculation from the known infected trees used as controls in this experiment.

Infections

Infections from symptomless carrier trees have been reported to require a long time before symptoms appear on the test seedlings. This apparently results from the presence of a very low concentration of the virus in infected, symptomless trees. Two of the four trees inoculated from Riverside Duke 13 which showed sun blotch symptoms, developed symptoms within 10 months after inoculation. Although there was 100 per cent infection of seedlings inoculated from the two symptomless-carrier Duke trees numbers 11 and 12, symptoms did not appear on any test seedlings until two years or more after inoculation.

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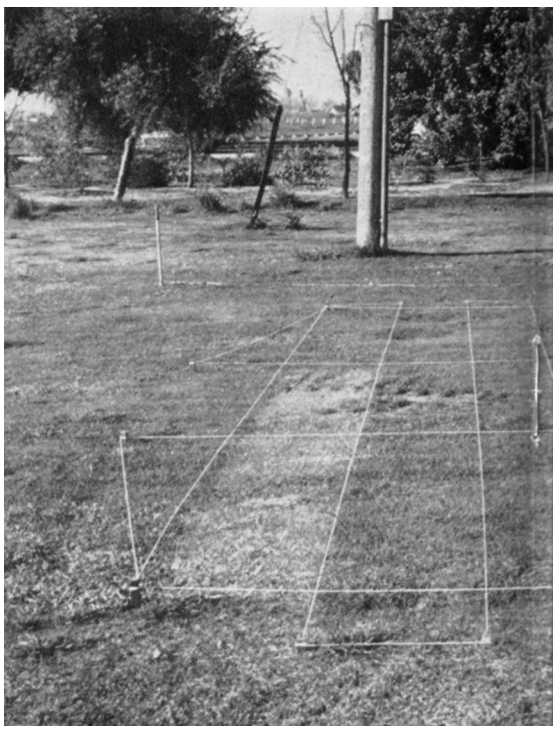
On the basis of present evidence, morphactins, regulatory effects on turfgrass growth—stimula ing tillering and degree of culm elongation. morphactins, do not indicate specific growth phytotoxicity. Such poisoning generally leads recover from wear, insect, and disease attacks, and insects; therefore, the continuing recomme mudagrasses when used for purposes to which is not objectionable, a considerable reduction by withholding irrigation and fertilizer.

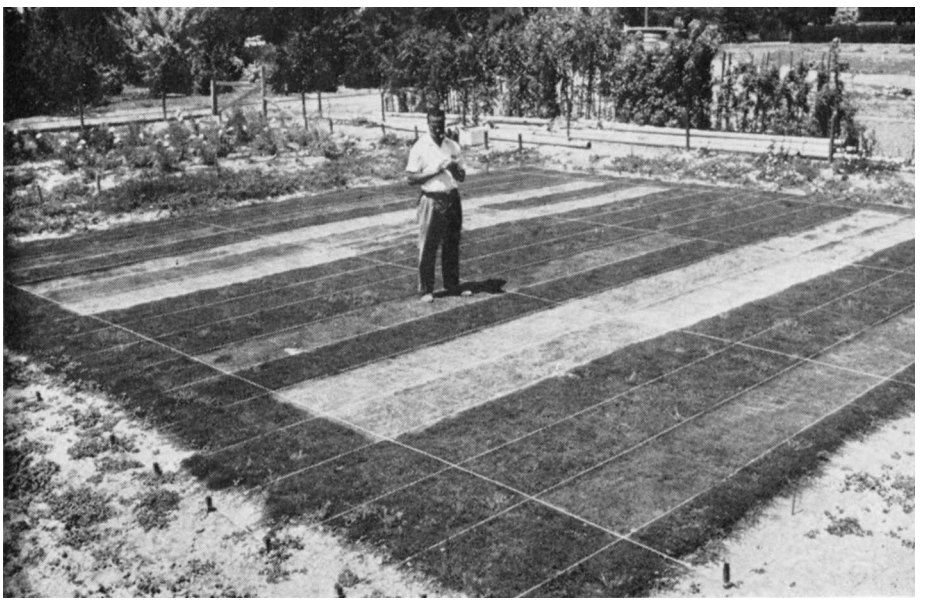
Testing fluorine

CHEM

JOHN H



actins, used at low rates, appear to have some timulating seed yield and flowering, and affect- tion. However, reductions in leaf growth from owth regulation but appear to be caused by leads to lowered vigor and reduced ability to acks, and may increase susceptibility to disease ommendation is for replacement of hybrid ber- which they are not suited. When a brown color uction of thatch and clippings can be obtained



Experimental plot of Tifgreen hybrid bermudagrass (above). Light strips show phytotoxicity at the higher application rates. The technician is standing in a strip that received a medium application rate. Photo below shows experimental plot of Penncross creeping bentgrass.

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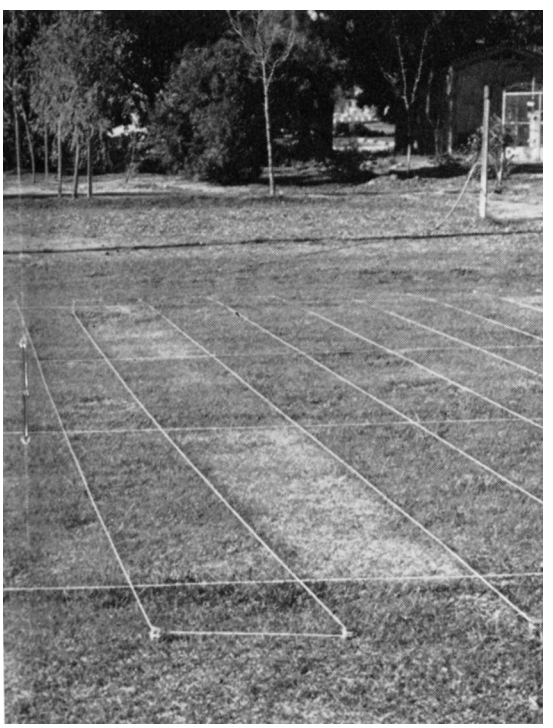
MICAL MOWING OF TURFGRASS

IN H. MADISON · JAMES M. JOHNSON · WILLIAM B. DAVIS · ROY M. SACHS



Cynodon transvaalensis is a fine-leafed, low growing, African bermudagrass. It throws many seedheads, requires large amounts of nitrogen fertilizer to stay green, and builds a dense thatch. *C. transvaalensis* is a diploid (2n = 20); it is crossed with common bermudagrass, a tetraploid (2n = 40), to produce hybrids which may have many sterile flower heads. Several hybrids have been selected for special high-maintenance turf uses. Success of the variety Tifgreen as a putting green grass has led to its use anywhere it would be difficult to maintain a vigorous grass requiring frequent attention, such as along highways or in parks. Unsuitable plantings should be fumigated and replaced. Because replanting is expensive, there has been a desire for a growth-retarding chemical that would reduce maintenance costs of mowing and thatch removal.

Some fluorine chemicals (*sic morphactins*) have been found to affect plant growth. One of these (methyl-2-chloro-9-hydroxyfluorene- (9) -carboxylate) was proposed by the manufacturer as a chemical to retard bermudagrass growth and was tested on turfgrasses at Davis in 1968. Vigorously growing grasses were treated on one or both of two dates, and yield, population density, reflectance, seed head development, and response to drought stress were examined. Kentucky bluegrass, Penncross creeping bentgrass, and Tifgreen bermudagrass were studied. Grass was fertilized and regularly mowed and irrigated. Blue and bent grasses were treated either Feb. 28th or March 21st or both. Tifgreen was treated April 10th and May 1st or both. Treatments consisted of spraying until wet with morphactin at concentrations from 0 to 10,000 ppm. The plots were not mowed for three weeks after treatment. Clippings were then collected for yield measurement. Water was withheld for six weeks beginning April 24th for bent and blue grasses, and June 7th for bermudagrass. Plots wilted evenly which suggests no important chemical root damage.

TABLE 1. YIELD AS GRAMS PER SQUARE METER DRY WEIGHT OF CLIPPINGS PRODUCED DURING THREE WEEKS OF TURFGRASS GROWTH FOLLOWING TREATMENT OF TURF WITH MORPHACTIN

1-a: PENNCROSS CREEPING BENTGRASS

Morphactin spray to wet	Treatment date, 1968			
	Feb. 28	Mar. 21	Feb. 28 and Mar. 21	Means** LD .05 = 6.3
ppm	gms per sq meter	gms per sq meter	gms per sq meter	gms per sq meter
0	26.1	25.5	27.0	26.2
100	28.4	31.5	29.6	29.8
1,000	29.7	31.6	28.2	29.8
10,000	12.9	19.1	5.1	12.4
Means NS	24.3	26.9	22.5	24.5

1-b: KENTUCKY BLUEGRASS

				Means* LD .05 = 6.7
0	15.9	16.2	11.9	14.7
100	18.0	18.8	23.3	20.0
1,000	12.9	10.9	8.1	10.6
10,000	7.6	9.5	1.4	6.2
Means NS	13.6	13.8	11.2	12.9

1-c: TIFGREEN HYBRID BERMUDAGRASS

	Apr. 10	May 1	Apr. & May	Means* LD .05 = 16.0
0	39.0	26.2	30.6	31.9
100	38.1	33.0	37.6	36.2
1,000	35.2	11.1	8.2	18.2
10,000	6.2	7.1	4.6	6.0
Means NS	29.6	19.4	20.2	23.1

* Probability of chance results less than 5%
** Probability of chance results less than 1%

TABLE 2. DENSITY OF TURFGRASSES AS INNOVATIONS PER SQUARE DECIMETER. COUNTS MADE APRIL 18, APRIL 19, AND MAY 29 FOR TABLES 1a, b, AND c

TABLE 2a: PENNCROSS CREEPING BENTGRASS

Morphactin spray to wet	Treatment date 1968			
	Feb. 28	Mar. 21	Feb. 28 and Mar. 21	Means** LD .05 = 44
ppm	no per sq dm	no per sq dm	no per sq dm	no per sq dm
0	993	682	1110	928
100	986	753	1140	960
1,000	552	921	784	752
10,000	249	484	118	284
Means NS	695	710	788	284

TABLE 2b: KENTUCKY BLUEGRASS

				Means* LD .05 = 53
0	341	303	320	321
100	341	282	359	327
1,000	273	351	414	346
10,000	400	253	154	269
Means NS	339	297	312	316

TABLE 2c: TIFGREEN HYBRID BERMUDAGRASS

	Treatment date 1968			
	Apr. 10	May 1	Apr. & May	Means** LD .05 = 121
0	985	941	883	936
100	774	677	1170	874
1,000	821	810	1472	1034
10,000	1537	1495	529	1187
Means NS	1029	981	1013	1008

* Probability of chance results less than 5%
** Probability of chance results less than 1%

TABLE 3. EFFECT OF MORPHACTIN ON INFLORESCENCE NUMBERS OF TIFGREEN HYBRID BERMUDAGRASS. CULMS PER SQUARE DECIMETER COUNTED JULY 9–12 1968

Morphactin spray to wet	Treatment date			
	April. 10	May 1	Apr. & May	Means** LD .05 = 29.1
ppm	no per sq dm	no per sq dm	no per sq dm	no per sq dm
0	52.0	75.8	57.5	61.8
100	111.7	89.4	123.2	108.1
1,000	189.7	191.0	168.4	183.0
10,000	32.3	27.1	1.8	20.4
Means NS	96.4	95.8	87.7	93.3

** Probability of chance results less than 1%

Yield data are given in table 1. All three grasses show stimulation by 100 ppm morphactin. Bent was stimulated by 1,000 ppm, blue and bermudagrass yield was depressed. Yield of all grasses was depressed at 10,000 ppm. Results were accentuated by two sprays. Since yield data do not show effects on appearance it is important to note that there *was no reduction in growth without accompanying injury to the grass.* Injury was noted as yellowing or browning of the turf and a browning of tips and margins of treated leaves (photo).

Population data are presented in table 2. Population density of bent turf was reduced at the two highest rates of morphactin; bluegrass density was reduced at the highest rate; but morphactin increased density of bermudagrass except when the highest rate was repeated. In effect more bermudagrass plants yielded less, suggesting that some energy was diverted to tiller production while leaf extension was reduced.

Bermudagrass seed head production was affected by morphactin. Inflorescence counts are given in table 3. Culms were increased by 100 and 1,000 ppm morphactin. There was a dwarfing of culms at 100 ppm with about 70 per cent of the inflorescenses produced at or below the turf height. At 1,000 ppm inflorescenses appeared normal and were held above the turf at normal height. At 10,000 ppm the number of inflorescenses was sharply reduced and those produced showed distorted growth.

These results suggest that the morphactin stimulated the grass until phytotoxic levels were reached. *Growth was then reduced by toxicity, not by physiological growth regulating effects.* If morphactin did act as a growth regulator it was in the range between the two highest rates used. Consequently an additional study was made on Tifgreen bermudagrass with morphactin at 0, 2,000, 4,000, and 6,000 ppm. Within this range there was a steady reduction in yield accompanied by a proportionate increase in injury. Injury was estimated visually and by measuring reflectance from the turf. This measures efficiency of sunlight use by turf. Stressed turf reflects more radiation. Reflectance vs. yield was a straight-line relationship in treated plots (photo) showing that decreased yield was related to increased injury.

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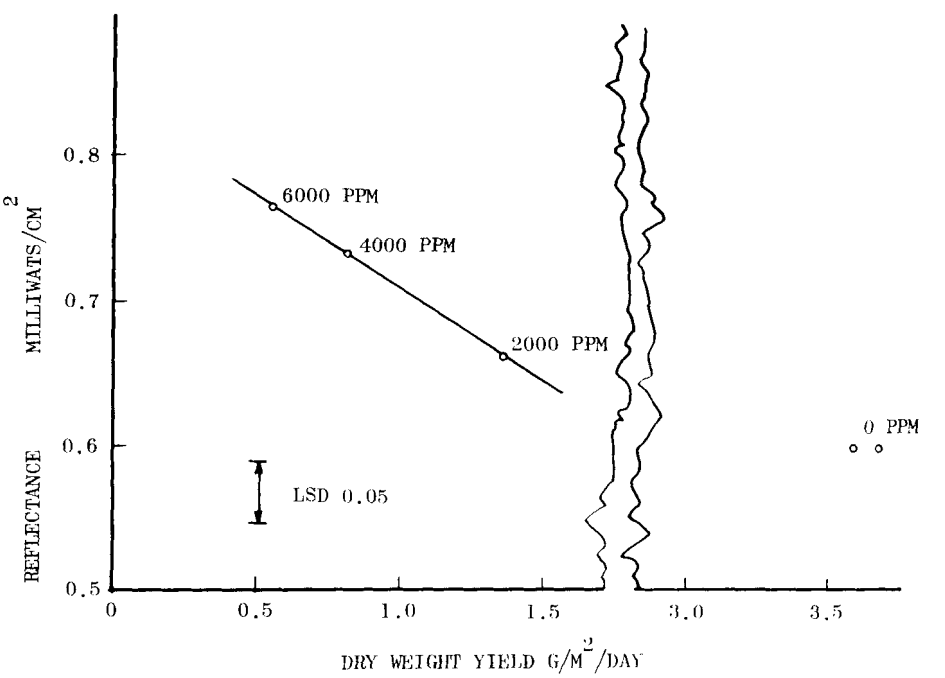
REFLECTANCE VS. YIELD GRAPH SHOWING INCREASING INJURY AND DECREASING YIELD AS FLUORINE TREATMENT RATES INCREASE IN CHEMICAL MOWING TESTS IN TURFGRASS