and 70° F) on stored Hopmans Glory and Valeria jumbo corms and subsequent flower and corm production were investigated.

Both harvest dates and varieties greatly affected the percentage of corms recovered from storage as well as subsequent flower production. In general the most satisfactory storage treatments were (1) 40° F for 5 months, (2) 55° F for 1 month plus 40° F for 4 months or (3) 70° F for 1 month plus 40° F for 4 months

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CHEMICAL GROWTH SUBSTANCES AS SUBSTITUTES FOR HIGH LIGHT INTENSITIES ON 'TIFGREEN' BERMUDAGRASS

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The problems in growing turf grasses in shady locations are well known to golf course superintendents and other workers in turf management. Difficulties arise because grasses grow abnormally tall and density is decreased under low light intensities or in light with certain spectral portions removed. Continued mowing and wear cause the grass to decline and die. Growth of plants in the shade after treatment with 2-chloroethyltrimethyl ammonium chloride (CCC) and 2,4-dichlorobenzyltributyl phosphonium chloride (Phosfon) is similar in appearance to growth in full sunlight (1). Cabler (1) showed that CCC and Phosfon will slow down the growth rate of *Cynodon dactylon* 'Tifgreen' and 'Ormond' bermudagrasses without injury to the plants. The morphological growth response of treated grasses was similar to that of high light intensity, i.e., reduction of internodal elongation, increase in stem diameter and development of dark-green leaf color.

Purpose of this experiment was to determine if Phosfon, CCC and B995 (N-dimethylamino succinamic acid) could substitute for high light intensity and increase shade tolerance of 'Tifgreen' bermudagrass.

MATERIAL AND METHODS

A factorial experiment in split plot design was started November 4, 1962 and continued for 16 weeks to test effect of 4 light intensities and 3 growth regulator chemicals on growth of 'Tifgreen' bermudagrass. Whole plot treatments consisted of 4 light intensities—100, 80, 60 and 20 percent full sunlight. Sub-plot treatments were check and growth regulator chemicals CCC, Phosfon and B995. There were 3 replications with 8 pots of grass in main plots with 2 pots given each sub-plot treatment.

This experiment was conducted in a clear glass greenhouse with shade covers that reduced light intensity to 80, 60 and 20 percent of full sunlight constructed from saran cloth. The grass obtained from University of Florida turf research area had been maintained under high

fertilization. Experimental grass was taken with a 4 inch cup-cutter and put into a 4 inch plastic pot. Color and density were uniform on all pots when treatments were applied.

Growth regulators were applied to plant top as a drench on November 4, 1962, and January 7, 1963 (after eighth week) at rates of Phosfon —0.136 grams per pot; CCC—2.18 grams per pot; B995—0.131 grams per pot; and a check treatment. All rates are for a single application.

All pots were treated periodically with a fungicide, nematicide and insecticide. The pots were fertilized with a chemical fertilizer (2-1-2) initially and 5, 9 and 11 weeks later (based on Table 1) at rate of one-half pound of N (ammonium nitrate) per 1000 square feet.

The grass was clipped weekly to one-half inch and the clippings dried and weighed. Pots were rated weekly for density and color. A rating of 9 was given to all pots at start of the experiment. A rating of 10 was needed since the density and color improved after treatment with the growth retardants.

Density Rating

1. Bare ground
2. 2 or 3 green sprigs
3. 76-95% bare ground
4. 60-75% bare ground
5. 50-59% bare ground
6. 20-49% bare ground
7. 10-19% bare ground
8. Slightly sparse
9. Grass under heavy fertilization and normal sunlight
10. Grass after treatment with CCC or phosfon very dense

Color Rating

1. All grass brown
2. Mostly brown
3. Yellow with brown spots
4. Yellow
5. Yellow-green
6. Very light green
7. Light green
8. Green
9. Dark green
10. Very dark green

Results

Improved varieties of bermudagrass do not grow satisfactorily under low light intensity. Data (Fig. 1) show that density of 'Tifgreen' bermudagrass decreased as light intensity decreased. Even when 80 percent sunlight was present the grass thinned out with time. When

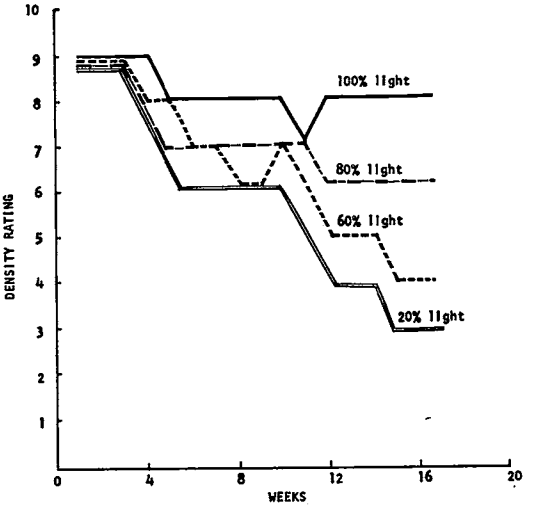

FIG. 1 EFFECT OF FOUR LIGHT INTENSITIES ON DENSITY RATING OF 'TIFGREEN' BERMUDAGRASS

60 and 20 percent of the light intensity was present the grass did not produce satisfactory cover and after 16 weeks this grass was too sparse to be commercially acceptable. The same picture is true for the dry weight measurement (Table 1), that is, as light intensity decreased, dry weight decreased.

Data presented (Fig. 2) show that when 'Tifgreen' bermudagrass was treated with CCC or Phosfon under 100 percent light intensity its density increased over that of the check. Also, 'Tifgreen' bermudagrass treated with Phosfon or CCC remained dense at all light intensities tested. Check plots under similar conditions of low light intensities declined to the extent very little grass was left in the pots.

Characteristic growth pattern of bermudagrass treated with Phosfon or CCC in full sunlight is a low, spreading type of growth with shorter internodes and wider leaf blades than those on untreated grasses. This same type of morphological growth response was observed on grass treated with CCC or Phosfon even under lower light intensities and the etiolated response characteristic of grasses grown under conditions of reduced light intensity was absent on the grasses treated with these two chemical growth substances.

The dry weights of treated and untreated plants are given in Table 1. It was anticipated that dry weight of 'Tifgreen' bermudagrass would be less for grass treated with Phosfon and CCC since a previous experiment had shown

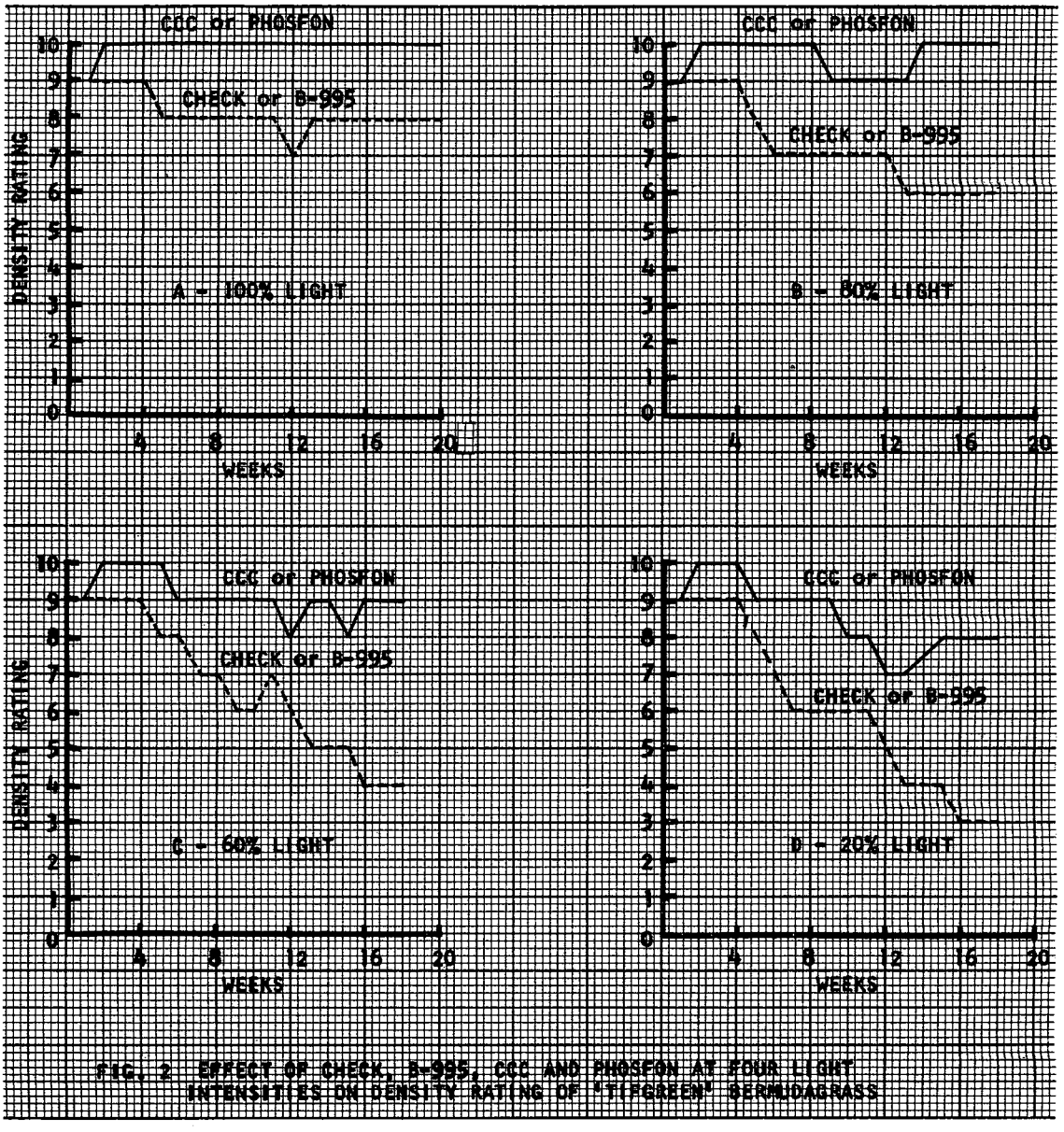

FIG. 2 EFFECT OF CHECK, B-995, CCC AND PHOSFON AT FOUR LIGHT INTENSITIES ON DENSITY RATING OF 'TIFGREEN' BERMUDAGRASS

this to be true (1). However, it had been observed earlier that applying ammonium nitrate at the rate of one pound of nitrogen per 1,000 square feet reduced effect of the CCC growth substance in 'Tifgreen' bermudagrass due to CCC(1). Dry weights from grass under 100 and 80 percent light intensity (Table 1) indicated that the retarding effect of CCC was reduced when nitrogen was added. The grass was fertilized after and fifth, ninth and eleventh weeks and increased in dry weight in each case. It is important that growth retarding properties of CCC can be offset at any time with applications of fertilizer. It is also important that CCC increased shade tolerance of the grass even when it was acting as a growth retardant.

Dry weight of grass treated with Phosfon decreased initially as did CCC treated plants

TABLE 1. EFFECT OF CHECK, B995, PHOSFON AND CCC GROWTH SUBSTANCES ON AVERAGE DRY WEIGHT (mg/per pot) AT 4 LIGHT INTENSITIES OF 'TIFGREEN' BERMUDAGRASS OVER 13 WEEKS PERIOD.

LIGHT	CHECK													
INTENSITY	1	2	3	4	5	6	7	8	9	10	11	12	13	Totals
100%	242	523	554	369	224	467	249	319	184	287	207	287	267	4179
80%	233	490	597	231	212	364	181	259	176	185	152	262	261	3603
60%	254	461	441	183	161	231	141	149	163	122	96	181	139	2772
20%	257	408	503	193	169	241	108	145	139	112	76	115	100	2566
TOTALS	986	1882	2095	976	768	1303	679	872	662	706	531	845	767	
LIGHT	CCC													
INTENSITY	1	2	3	4	5	6	7	8	9	10	11	12	13	Totals
100%	178	349	369	178	163	484	283	292	251	301	210	240	121	3419
80%	157	379	514	218	235	403	232	238	195	232	213	318	263	3597
60%	162	323	321	181	166	272	161	136	178	144	117	211	154	2526
20%	177	312	256	195	191	279	147	165	131	100	83	196	168	2400
TOTALS	674	1363	1460	772	755	1438	823	831	755	777	623	965	706	
LIGHT	PHOSFON													
INTENSITY	1	2	3	4	5	6	7	8	9	10	11	12	13	Totals
100%	275	456	462	185	188	461	277	277	206	190	96	104	72	3249
80%	244	452	409	184	184	361	210	251	196	119	74	125	69	2878
60%	236	406	312	174	174	248	153	141	194	64	40	72	41	2255
20%	228	343	365	157	143	181	113	165	172	34	30	45	47	2023
TOTALS	983	1657	1548	700	689	1251	753	834	768	407	240	346	229	
LIGHT	B995													
INTENSITY	1	2	3	4	5	6	7	8	9	10	11	12	13	Totals
100%	306	528	432	253	222	556	312	344	279	332	230	313	237	4344
80%	241	429	601	195	214	379	192	287	187	222	171	276	229	3623
60%	224	407	365	171	147	203	109	104	150	065	045	098	068	2156
20%	261	361	428	186	171	236	127	191	147	121	091	162	131	2609
TOTALS	1032	1725	1826	801	754	1374	740	926	763	740	537	949	765	

(Table 1). Fertilizer applications increased the dry weight after the fifth week. Retreatment with Phosfon after the eighth week caused a decrease in dry weight and subsequent addition of fertilizer could not overcome the growth retarding properties of Phosfon. This substantiated earlier observations and is in contrast to the effect of CCC.

The data of Table 2 show the improved color of the grasses treated with Phosfon or CCC. The color improvement occurred under all light intensities.

The density and color of grass treated with B995 was not significantly different than the checks.

DISCUSSION

This experiment showed that CCC and Phosfon acted as "substitutes" for high light intensities. They substituted in the sense that the treated grass remained in a dense-type growth and the etiolated condition that is common under conditions of reduced light intensity did not occur. This is important both from a practical and physiological standpoint.

It was found that fertilizer applications can offset the growth retarding effect of CCC regardless of when it is applied, but this was not true for Phosfon. It was observed that the effect of Phosfon is long-lasting and work by the writer (unpublished data) has shown that the effect of Phosfon on 'Ormond' and 'Tifgreen' bermudagrasses will last for 14 months or more with one heavy application. This suggests that Phosfon or its product may accumulate in the plant or soil. If the Phosfon content is low enough it can be overcome with applications of fertilizer. However, once the level of Phosfon is increased to a certain point, fertilizer has no effect.

The difference found in the growth retarding properties of Phosfon and CCC in this experiment suggests that these compounds may be affecting different biochemical pathways. The mode of action of these growth retarding chemicals has not been determined. The most obvious place to look for a mechanism would be in relation to IAA and Gibberellins. Gibberellin is known to be similar to some light responses (3) and the level of IAA in plants can be related to light intensity (2). This experiment has shown that there is a relationship between the plant's response to light intensity and Phosfon and CCC. Recently Kuraishi and Muir (4) have shown that an effect of CCC is to lower the auxin level in the plant. Other workers have described CCC

TABLE 2. EFFECT OF CHECK, B995, CCC AND PHOSFON GROWTH SUBSTANCES AT FOUR LIGHT INTENSITIES ON COLOR RATING OF 'TIFGREEN' BERMUDAGRASS OVER 16 WEEKS PERIOD.

LIGHT	CHECK OR B995															
INTENSITY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
100%	9	9	9	9	8	7	9	9	8	9	7	8	7	7	6	7
80%	9	9	9	8	8	7	7	8	7	7	6	6	6	6	6	6
60%	9	9	9	8	8	7	8	7	6	7	7	7	7	6	6	6
20%	9	9	8	8	7	7	8	7	6	8	8	7	7	7	7	6
LIGHT	CCC															
INTENSITY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
100%	9	10	10	10	10	10	10	10	9	10	10	10	10	10	10	9
80%	9	10	10	10	10	10	10	10	9	9	9	10	9	9	9	9
60%	9	10	10	10	9	9	9	9	9	9	9	10	9	9	9	10
20%	9	10	10	9	9	9	9	9	9	9	8	9	9	9	9	9
LIGHT	PHOSFON															
INTENSITY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
100%	9	10	10	10	10	10	10	9	9	10	9	9	10	10	10	10
80%	9	9	9	9	9	8	9	9	9	10	9	10	10	10	10	10
60%	9	9	9	9	9	9	9	9	9	9	9	10	10	10	10	10
20%	9	9	9	9	8	8	8	8	9	9	9	9	10	10	10	10

and Phosfon as anti-gibberellins (5, 6). Thus it is probable that there is a strong relationship between light, growth promoters and growth retardants.

SUMMARY

The results of this experiment indicate that 'Tifgreen' bermudagrass cannot grow satisfactorily under conditions of low light intensity. Also this grass will produce a dense growth under low light intensity if the growth substances CCC and Phosfon are applied. Differences between these two chemical compounds are discussed. The growth retardant B995 had no effect on density of 'Tifgreen' bermudagrass.

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EFFECTS OF GIBBERELLIC ACID AND 2-CHLOROETHYL TRIMETHYLAMMONIUM CHLORIDE ON GROWTH AND FLOWERING OF GARDENIA JAMINOIDES 'VEITCHII'

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Many commercial growers in the South are interested in producing flowering gardenias in pots for sale during the holiday seasons. To produce a satisfactory flowering plant, problems of flower bud set and flower bud drop must be overcome. Gardenias lose many flower buds if environmental conditions are not satisfactory. One cause of flower bud drop is reported to be high minimum night temperature.

Laurie *et al.* (5) suggest a temperature of 55° F. for flower bud formation and 62° F. for

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