is used directly (or after multiplication in vitro) for several evaluations (chemical contents, disease resistance, DNA markers, etc.). Feedback seedlings (Fig. 1.) are selected and targeted for the next field trials. This procedure can save several years on the present breeding span (usually 15 to 25 years). A brief outline of our new protocol is illustrated in Figure 1.

Table 1. Results of inoculation trials of tea anthracnose disease resistance on the half-cotyledons of three cultivars of different degree of resistance.

Cultivar	No. cotyledons examined	No. diseased cotyledons	Diseased (%)
Yamatomidori	341	124	36
Sayamakaori	101	66	65
Miya-A—5	183	67	37

Effects of an Anti-Auxin-Like Substance Containing Fluorines and Chlorinated Indole Auxin on the Seed and Vegetative Propagation of Two Turf Species

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The effects of 4,4,4-trifluoro-3-(indole-3-)butyric acid (TFIBA) and 4-chloroindole-3-acetic acid (4-Cl-IAA) on the seed and vegetative propagation of two turf species were investigated. As a result, TFIBA was seen to promote noticeable root growth on turf seedlings and sod.

INTRODUCTION

Turf is often utilized for the creation of green amenity areas and the prevention of soil erosion (Eguchi, 1988). It is also utilized as a ground cover in parks and sports facilities. Among turf species, bentgrass is multiplied by seed, whereas the multiplication of manilagrass *(Zoysia matrella)* is usually by vegetative propagation (Crockett, 1975). In this study, a number of treatments including a new chemical, an anti-auxin-like substance containing fluorines and chlorinated indole auxin, were applied to both turf taxa at the propagation stage, to find a more efficient method of multiplication.

MATERIALS AND METHODS

'Penncross' bentgrass seeds were sown in a petri dish containing 0.01, 0.1, 1, and 10 ppm aqueous solution of each chemical: indolebutyric acid (IBA), 4,4,4-trifluoro-3-(indole-3-)butyric acid (TFIBA) (Fig. 1), 4-chloro-indole-3-acetic acid and its methyl ester (4-Cl-IAA and 4-Cl-IAA-Me), and water as the control. Treated seeds were subsequently incubated under 25±1C, 4000 lx and 16-h day length with various germination and growth responses observed.

In the case of Manilagrass, 10 cm × 20 cm sod pieces were submerged in the IBA, TFIBA, and 4-Cl-IAA solutions at concentrations of 0.1, 1, and 10

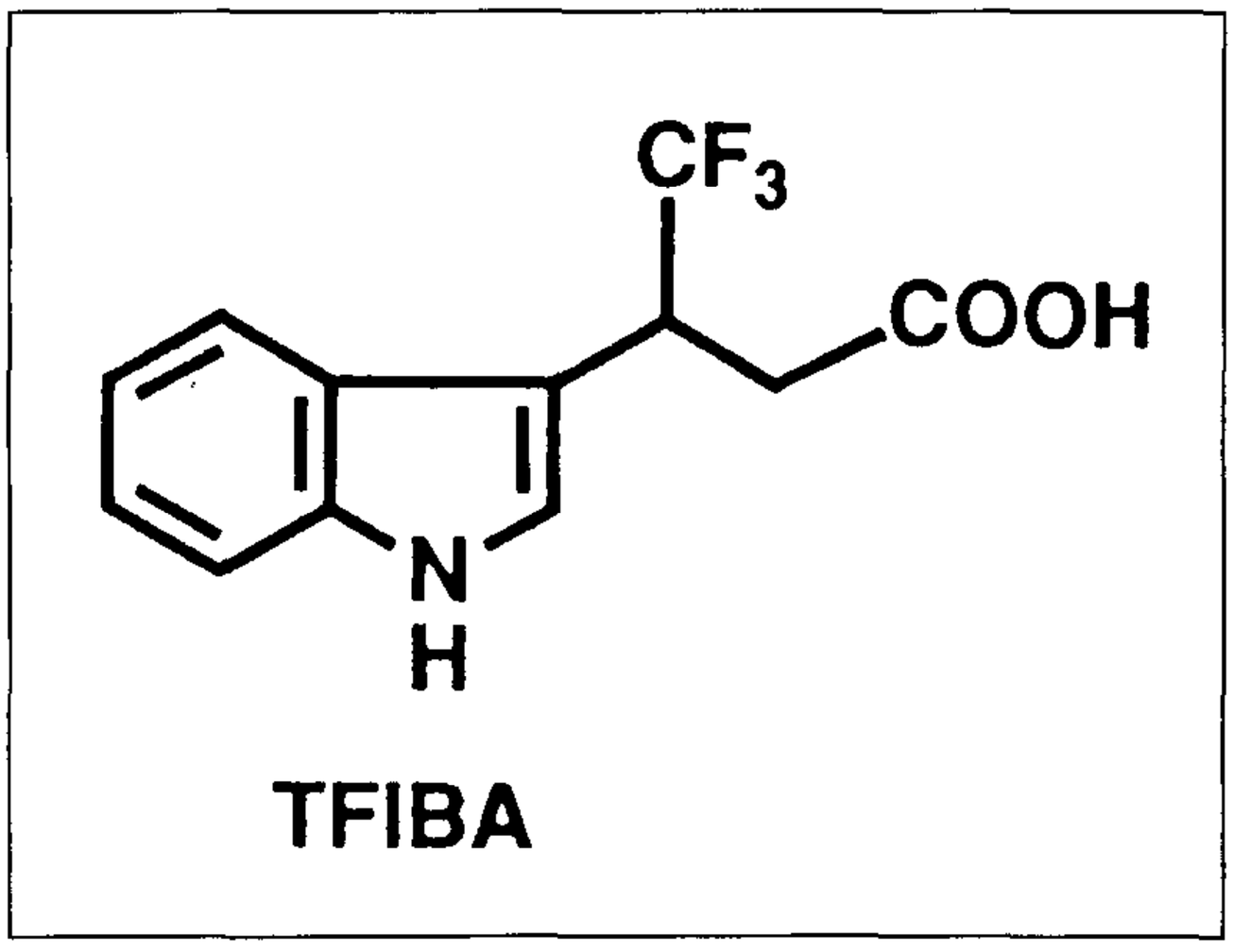

Figure 1. Structure of 4,4,4-triflouoro-3-(indole-3-) butyric acid (TFIBA).

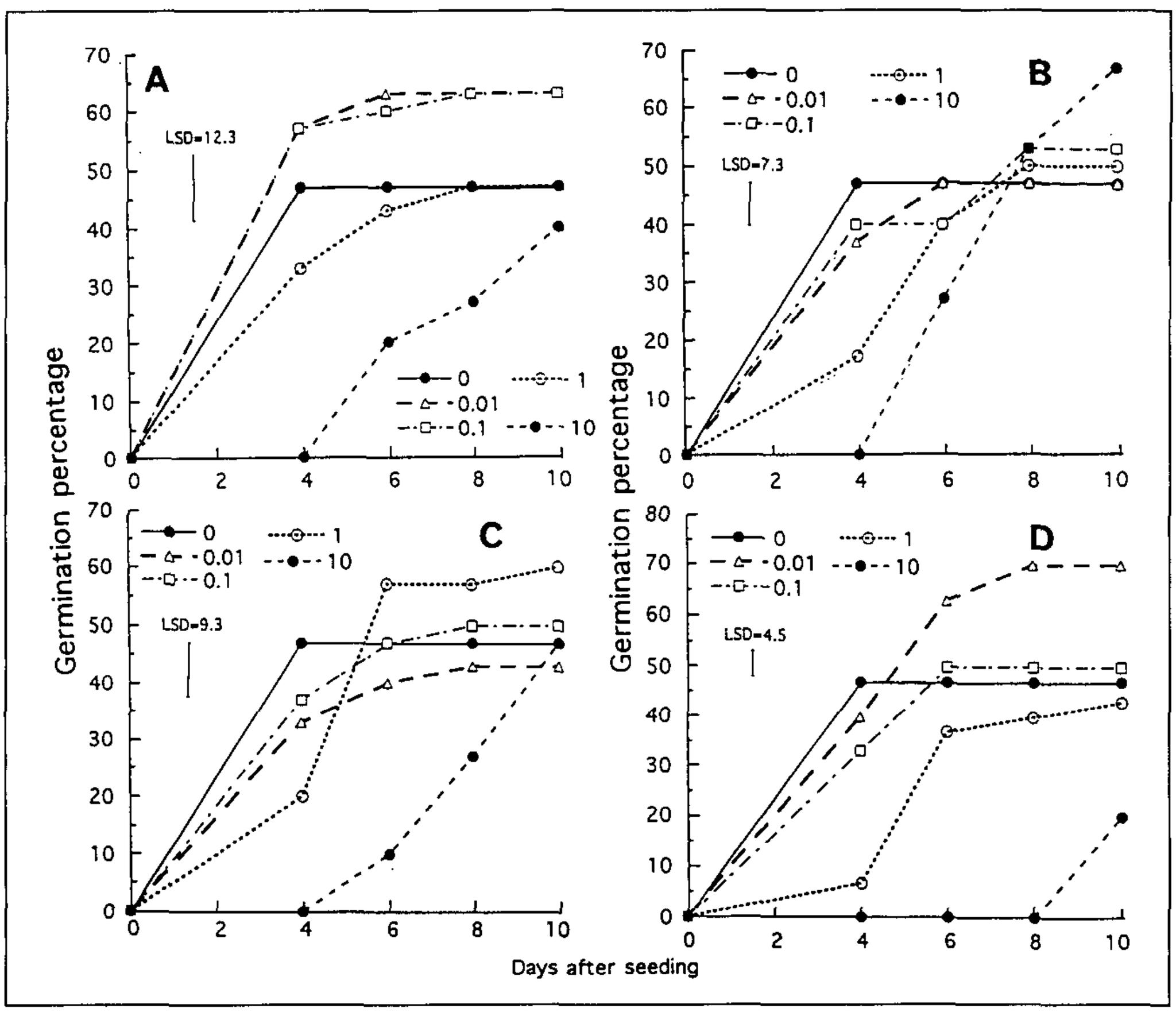

Figure 2. Effects of IBA (A), TFIBA (4,4,4-triflouoro-3-(indole-3-)butyric acid) (B), 4-Cl-IAA (4-chloroindole-3-acetic acid) (C), and 4-Cl-IAA-Me (D) treatment (ppm) on germination rate of turf.

ppm each for 1 h, and then grown in a plastic house from 22 March for 1 month.

RESULTS AND DISCUSSION

Low concentrations (0.01 and 0.1 ppm) of IBA promoted germination but high concentrations (1 and 10 ppm) inhibited it. On the other hand, TFIBA, 4-Cl-IAA, and 4-Cl-IAA-Me increased the ratio of germination 10 days after the seed was sown at the concentrations of 10, 1, and 0.01 ppm, respectively, although the TFIBA showed a tendency to delay germination (Fig. 2). Also, root growth was promoted by the low concentration treatments of IBA and TFIBA (Table 1).

Table 1. Effect of chemical treatments on growth of bentgrass.

Treatments	ppm	Stem length (mm)	Root length (mm)	Ratio of S/R
Control (H_2O)	-	20.2 ab[Z]	35.7 abcd	0.57
IBA[Y]	0.01	19.0 abc	38.8 ab	0.49
	0.1	17.5 cd	40.2 a	0.44
	1	14.3 ef	39.6 ab	0.36
	10	10.9 g	8.3 gh	1.31
TFIBA	0.01	20.4 a	37.3 abc	0.55
	0.1	19.3 abc	38.8 ab	0.50
	1	16.7 cde	32.1 cd	0.52
	10	15.5 de	20.3 f	0.76
4-Cl-IAA	0.01	21.2 a	35.6 abcd	0.60
	0.1	17.8 bcd	30.9 de	0.58
	1	15.8 de	11.3 g	1.40
	10	10.8 g	2.8 i	3.86
4-Cl-IAA-Me	0.01	19.0 abc	33.8 bcd	0.56
	0.1	18.8 abc	26.5 e	0.71
	1	12.3 fg	3.9 hi	3.15
	10	3.0 g	0.4 i	7.50

[Z] Mean separation within columns by Duncan's multiple range test at 5% level.
[Y] Abbreviations: IBA, indole-3-butyric acid; TFIBA, 4,4,4-triflouoro-3-(indol-3-) butyric acid; 4-Cl-IAA, 4-chloroindole-3-acetic acid; 4-Cl-IAA-Me, methyl ester of 4-Cl-IAA.

The results in Table 2 show that root number was enhanced markedly by IBA and TFIBA treatments, and their sods became much greener in colour, suggesting that the chlorophyll content of the leaves might have been increased as a result of these chemical treatments.

Table 2. Effect of chemical treatments on rooting, leaf growth, and viability of sod of manilagrass.

Treatments	ppm	No. of roots	Viability[Z]	Leaf growth[Z]	Greenish color of leaf[Y]
Control (H_2O)	-	66 cd[x]	4.3 ab	3.7 a	-7.5 b
IBA[W]	0.1	102 a	5.0 a	4.7 a	-9.6 a
	1	83 abc	4.1 bc	4.3 a	-8.2 b
	10	97 ab	3.3 c	4.7 a	-8.1 b
TFIBA	0.1	82 bc	3.7 bc	4.7 a	-8.1 b
	1	61 de	3.3 c	4.3 a	-8.2 b
	10	91 ab	3.3 c	4.1 a	-7.5 b
4-CI-IAA	0.1	45 ef	1.7 d	2.3 b	-5.3 c
	1	38 f	1.3 d	2.7 b	-5.4 c
	10	35 f	1.3 d	2.7 b	-5.7 c

[Z] Rating of the degree of each item; from 5 (excellent) to 1 (poor).
[Y] Severity as expressed by Hunter value (a).
[X] Mean separation within columns by Duncan's multiple range test at 5% level.
[W] Abbreviations: IBA, indole-3-butyric acid; TFIBA, 4,4,4-triflouoro-3-(indol-3-)butyric acid; 4-Cl-IAA, 4-chloroindole-3-acetic acid.

The positive effect of TFIBA on root growth in this study agrees with the findings of Katayama et al. (1995) and Kato et al. (1993). They observed that this anti-auxin-like substance promoted the root growth of rice, Chinese cabbage, and lettuce after the treatment of seeds or germinated seeds. Enhanced effect on root growth was not shown with 4-Cl-IAA whereas Ahmad et al. (1987) indicated root promotion on pea cuttings with an application of 10^{-3} M of 4-Cl-IAA compared to the control. The contrary result in this study is possibly attributable to the different concentrations used—Ahmad et al. used about 20 times the concentration used in this study.

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