

# Enhancement products tested on experimental putting green

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During the summer of 1990, the Florida Golf Course Superintendents Association (in cooperation with the University of Florida) built a golf course putting green (20,000 sq. ft.) at the Fort Lauderdale Research and Education Center.

The purpose was to develop a field laboratory to be used by turf researchers for their research projects and to conduct independent field testing of products that the superintendents wished to evaluate on bermudagrass maintained as a putting green. The first project initiated in May 1991 for the FGCSA was an evaluation

## Acknowledgments

This project was supported by the following companies: Sinnamon Brothers/Eco, Inc.; Ringer Corporation; Milorganite Division - MMSD; Sustane Corporation; Emerald Isle, Ltd. (PanaSea Plus); Environmental Supplies, Ltd./Arbor Groves, Inc. (Kelpak); and American Colloid (Enersol).

We would also like to take this opportunity to thank the following suppliers for their donations of equipment and materials for the basic maintenance of the FGCSA Research Green in 1993. Without their generosity, we would be unable to conduct research!

- **Golf Agronomics** (topdressing material)
- **Googe Trucking** (trucking services)
- **Harrell's Inc.** (fertilizer)
- **La Gorce Country Club** (used triplex mower)
- **NuCrane Machinery** (equipment)
- **Regal Chemical Company** (weather station)
- **RSI Holdings of Florida, Inc.** (equipment)
- **Vigoro Industries** (fertilizer)

### Table 1

Natural organic fertilizers and cytokinin-like products evaluated on the FGCSA Research Green from May 1992 through April 1993.

Treatment Number	Treatment	Rate per 1000 sq. ft.*	Application Application Interval
1	Enersol**	16 fl oz	Once per week for 3 weeks with 8 weeks between the multiple applications
	IBDU mix***	0.5 lb N	2 weeks
2	PanaSea Plus	4 fl oz	2 weeks
	IBDU mix	0.5 lb N	2 weeks
3	PanaSea Plus	4 fl oz	4 weeks
	IBDU mix	0.5 lb N	2 weeks
4	Kelpak	4.5 fl oz	First application only
		1 fl oz	6 weeks
	IBDU mix	0.5 lb N	2 weeks
5	Eco 7-1-5	0.5 lb N	2 weeks
6	Sustane 5-2-4	0.5 lb N	2 weeks
7	Ringer 8-2-8	0.5 lb N	2 weeks
8	Milorganite 6-2-0	0.5 lb N	2 weeks
	sulpomag (0-0-22)	0.5 lb K	2 weeks
9	Eco 7-1-5	0.25 lb N	2 weeks
	IBDU mix	0.25 lb N	2 weeks
10	Sustane 5-2-4	0.25 lb N	2 weeks
	IBDU mix	0.25 lb N	2 weeks
11	Ringer 8-2-8	0.25 lb N	2 weeks
	IBDU mix	0.25 lb N	2 weeks
12	Milorganite 6-2-0	0.25 lb N	2 weeks
	IBDU mix	0.25 lb N	2 weeks
13	IBDU <sup>™</sup> mix only	0.5 lb N	2 weeks

\*Fertilizer rate was increased 2X from November 1992 through April 1993 to a total of 1.0 pounds N per 1000 sq. ft. every 2 weeks.

\*\*Treatment was terminated November 1992, but area continued to be fertilized.

\*\*\*The IBDU mix is a blend of 8% N (as IBDU<sup>™</sup>), 8% K (potassium magnesium sulfate=sulpomag), 4% Mg, 0.5% Fe (iron oxide and iron sulfate), and 0.4% manganese sulfate.

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tion of nitrogen sources, primarily slow-release nitrogen sources.

A major concern of the golf course superintendents, however, is the root loss that seems to occur during the long summer season in southern Florida. Part of this root loss may be due to soilborne pathogens. However, most bermudagrass putting greens are maintained at a cut-

ting height of  $\frac{3}{16}$  inch or less. This places a natural stress on the root system by virtue of the fact that there is very little leaf tissue to support photosynthesis. Thus, a second project was initiated in May 1992 to evaluate natural organic fertilizers and cytokinin-like hormonal products derived from sea plants (kelp) as potential products to help minimize

Table 2

Pesticides applied to research study area on the FGCSA Research Green from May 1992 through April 1993.

Pesticide	Application Date	Application Area
<b>Herbicides</b>		
MSMA	12 January 1993	Spot Treatment
Basagran	28 January 1993	Entire Green
MSMA	9 February 1993	Spot Treatment
Basagran	9 February 1993	Spot Treatment
<b>Insecticides</b>		
Amdro Bait	8 May 1992	Spot Treatment
Dursban Bait	10 July 1992	Spot Treatment
Dursban Bait	25 July 1992	Spot Treatment
Dursban Bait	12 August 1992	Spot Treatment
Amdro Bait	12 August 1992	Spot Treatment
Di-Pel	22 September 1992	Entire Green
Oftanol	15 January 1993	Spot Treatment
Dursban Bait	22 February 1993	Spot Treatment
Dursban Bait	10 March 1993	Spot Treatment
Oftanol	29 March 1993	Spot Treatment
Oftanol	14 April 1993	Spot Treatment
<b>Fungicides</b>		
Daconil 2787	22 January 1993	Entire Green
Daconil 2787	13 February 1993	Entire Green

this root loss. The following is a summary report of the first year of the study. The products evaluated are listed in Table 1.

The Eco, Sustane, Ringer and Milorganite products are described as natural organic fertilizers because they conform to the Association of American Plant Fertilizer Control Officials definition of "materials derived from either plant or animal products containing one or more elements (other than carbon, hydrogen and oxygen) that are essential for plant growth." In other words, they are derived from natural organic materials such as turkey litter, sewage sludge, alfalfa, bloodmeal, wheat germ, etc. This

is in contrast to the synthetic organic fertilizers which are composed of urea. Urea is also an organic material but the slow-release urea fertilizers commonly used in the golf industry are derived via a chemical process. For more information, please refer to an article on "Natural Organic Nitrogen Sources" in the March 1992 issue of *Golf Course Management*.

The natural organic fertilizers were evaluated two ways. First, they were used as the only source of fertilizer. For Eco, Sustane and Ringer, these fertilizers were the only products applied to those particular treatment plots. All plots would receive the same amount of nitrogen, but

**IBDU™ was used as the standard for synthetic organic nitrogen sources. Therefore, this treatment is considered the "check" treatment in this study. We formulated a fertilizer using IBDU, sulphomag, iron sulfate and manganese sulfate to obtain a blend containing 8% nitrogen and 8% potassium. We did not use Vigoro Industries standard 8-0-8 blend because part of the nitrogen in that blend is derived from sewage sludge.**

Table 3

Quality scores resulting from evaluation of natural organic fertilizers on the FGCSA Research Green from May through October 1992 at the summerfertility rate. \*

Treatment	June 2	July 17	July 30	Aug. 13	Aug. 28	Sept. 11	Oct. 12	Oct. 22
Eco	6.5 a	6.0 a	6.5 a	7.0 a	7.5 a	7.0 a	5.7 a	5.6 a
Sustane	6.5 a	6.0 a	6.5 a	7.0 a	7.5 a	7.0 a	6.1 a	6.1 a
Ringer	6.5 a	6.0 a	6.5 a	7.0 a	7.5 a	7.0 a	6.1 a	6.0 a
Milorganite	6.5 a	6.0 a	6.5 a	7.0 a	7.5 a	7.0 a	5.8 a	5.5 a
Eco + IBDU	6.5 a	6.0 a	6.5 a	7.0 a	7.5 a	7.0 a	5.9 a	5.9 a
Sustane + IBDU	6.5 a	6.0 a	6.5 a	7.0 a	7.5 a	7.0 a	5.9 a	5.9 a
Ringer + IBDU	6.5 a	6.0 a	6.5 a	7.0 a	7.5 a	7.0 a	6.0 a	5.9 a
Milorganite + IBDU	6.5 a	6.0 a	6.5 a	7.0 a	7.5 a	7.0 a	5.9 a	5.9 a
IBDU™ only	6.5 a	6.0 a	6.5 a	7.0 a	7.5 a	7.0 a	6.0 a	6.1 a
F Value	0	0	0	0	0	0	1.03	1.19
MSD	----	----	----	----	----	----	----	0.8

\* Quality scores (color and density) are based on a scale of 1 to 10 with 10 equal to a perfect score. Values are means of four replicate plots. Means within a column followed by the same letter are not significantly different (P=0.05), according to Waller-Duncan k-ratio t test.

\*\* F value too small to determine mean significant difference (MSD).

**Table 4**

Quality scores resulting from evaluation of natural organic fertilizers on the FGCSA Research Green from November 1992 through April 1993 at the winter fertility rate.\*

Treatment	Nov. 3	Dec. 18	Dec. 30	Jan. 12	Jan. 27	Feb. 10	Feb. 24	Mar. 20	Mar. 24	Apr. 7	Apr. 21
Eco	5.3 b	5.0 a	5.6 b	4.0 a	5.5 a	4.9 a	6.0 a	6.5 a	7.5 a	7.5 a	7.5 a
Sustane	6.1 a	5.0 a	5.6 b	4.0 a	5.5 a	5.0 a	6.0 a	6.5 a	7.5 a	7.5 a	7.4 b
Ringer	5.8 ab	5.0 a	5.6 b	4.0 a	5.5 a	5.0 a	6.0 a	6.5 a	7.5 a	7.5 a	7.5 a
Milorganite	5.0 ab	5.0 a	5.8 ab	4.0 a	5.5 a	5.4 a	6.0 a	6.5 a	7.5 a	7.0 b	6.5 c
Eco + IBDU	5.5 ab	5.0 a	5.8 ab	4.0 a	5.5 a	5.2 a	6.0 a	6.5 a	7.5 a	7.5 a	7.5 a
Sustane + IBDU	6.1 a	5.0 a	6.0 a	4.0 a	5.5 a	5.4 a	6.0 a	6.5 a	7.5 a	7.5 a	7.5 a
Ringer + IBDU	5.4 ab	5.0 a	6.0 a	4.0 a	5.5 a	5.6 a	6.0 a	6.5 a	7.5 a	7.5 a	7.5 a
Milorganite + IBDU	5.8 ab	5.0 a	6.0 a	4.0 a	5.5 a	5.6 a	6.0 a	6.5 a	7.5 a	7.5 a	7.5 a
IBDU_TMi only	6.1 a	5.0 a	6.0 a	4.0 a	5.5 a	5.2 a	6.0 a	6.5 a	7.5 a	7.5 a	7.5 a
F Value	2.46	0	3.22	0	0	0.74	0	0	0	999.99	253.0
MSD	0.9	----**	0.3	----	----	----	----	----	----	0	0.05

\* Quality scores (color and density) are based on scale of 1 to 10 with 10 equal to a perfect score. Values are means of four replicate plots. Means within a column followed by the same letter are not significantly different (P=0.05) according to Waller-Duncan k-ratio t test.

\*\* F value too small to determine mean significant difference (MSD).

The natural organic fertilizers were also evaluated as individual mixtures with the synthetic organic nitrogen source IBDU™. For these treatments, one half of the nitrogen was derived from the natural organic fertilizer and one half from the IBDU blend.

the amount of phosphorus, potassium and other nutrients would vary depending on the fertilizer source. Milorganite contains no potassium. Since potassium is essential for turfgrass growth, plots fertilized with Milorganite as the sole nitrogen source were supplemented with potassium magnesium sulfate (sulpomag) (0-0-22). However, the

amount of Milorganite applied provided an equivalent amount of nitrogen as for the other natural organic fertilizers.

IBDU™ was used as the standard for synthetic organic nitrogen sources. Therefore, this treatment is considered the "check" treatment in this study. We formulated a fertilizer using IBDU, sulpomag, iron sulfate and manganese

sulfate to obtain a blend containing 8% nitrogen and 8% potassium. We did not use Vigoro Industries standard 8-0-8 blend because part of the nitrogen in that blend is derived from sewage sludge.

The natural organic fertilizers were also evaluated as individual mixtures with the synthetic organic nitrogen source IBDU™. For these treatments, one half

**Table 5**

Quality scores resulting from evaluation of cytokinin-like products on the FGCSA Research Green from May through October 1992 at the summer fertility rate. \*

Treatment	June 2	July 17	July 30	Aug. 13	Aug. 28	Sept. 11	Oct. 12	Oct. 22
Enerzol	6.5 a	6.0 a	6.5 a	7.0 a	7.5 a	7.0 a	6.1 a	6.1 a
PanaSea Plus @ 2 weeks	6.5 a	6.0 a	6.5 a	7.0 a	7.5 a	7.0 a	5.9 a	5.8 a
PanaSea Plus @ 4 weeks	6.5 a	6.0 a	6.5 a	7.0 a	7.5 a	7.0 a	6.1 a	6.1 a
Kelpak	6.5 a	6.0 a	6.5 a	7.0 a	7.5 a	7.0 a	6.1 a	6.3 a
IBDU™ only	6.5 a	6.0 a	6.5 a	7.0 a	7.5 a	7.0 a	6.0 a	6.1 a
F Value	0	0	0	0	0	0	0.61	0.77
MSD	----**	----	----	----	----	----	0.3	0.6

\* Quality scores (color and density) are based on a scale of 1 to 10 with 10 equal to a perfect score. Values are means of four replicate plots. Means within a column followed by the same letter are not significantly different (P=0.05) according to Waller-Duncan k-ratio t test.

\*\*\_F value too small to determine mean significant difference (MSD).

The cytokinin-like... products are not intended to be used as fertilizers but rather as biostimulants for plant growth.

of the nitrogen was derived from the natural organic fertilizer and one half from the IBDU blend. Phosphorus was applied twice each year at 2.5 pounds P per 1000 sq. ft. to all plots, except those receiving only the Eco, Sustane, Ringer and Milorganite fertilizers.

The cytokinin-like products were evaluated as supplements to the normal

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Table 6

Quality scores resulting from evaluation of cytokinin-like products on the FGCSA Research Green from November 1992 through April 1993 at the winter fertility rate. \*

Treatment	Nov. 3	Dec. 18	Dec. 30	Jan. 12	Jan. 27	Feb. 10	Feb. 24	Mar. 20	Mar. 24	Apr. 7	Apr. 21
Enersol	6.1 a	5.0 a	6.0 a	4.0 a	5.5 a	5.4 a	6.0 a	6.5 a	7.5 a	7.5 a	7.5 a
Pana Sea Plus @ 2 weeks	5.8 a	5.0 a	6.0 a	4.0 a	5.5 a	5.4 a	6.0 a	6.5 a	7.5 a	7.5 a	7.5 a
Pana Sea Plus @ 4 weeks	6.3 a	5.0 a	5.9 a	4.0 a	5.5 a	5.6 a	6.0 a	6.5 a	7.5 a	7.5 a	7.5 a
Kelpak	6.2 a	5.0 a	6.0 a	4.0 a	5.5 a	5.1 a	6.0 a	6.5 a	7.5 a	7.5 a	7.5 a
IBDU™ only	6.1 a	5.0 a	6.0 a	4.0 a	5.5 a	5.2 a	6.0 a	6.5 a	7.5 a	7.5 a	7.5 a
F Value	0.55	0	1.00	0	0	0.40	0	0	0	0	0
MSD	----*	----	----	----	----	----	----	----	----	----	----

\* Quality scores (color and density) are based on a scale of 1 to 10 with 10 equal to a perfect score. Values are means of four replicate plots. Means within a column followed by the same letter are not significantly different (P=0.05) according to Waller-Duncan k-ratio t test.

\*\* F value too small to determine mean significant difference (MSD).

Table 7

Clipping weights (grams) resulting from evaluation of natural organic fertilizers on the FGCSA Research Green from May through October 1992 at the summer fertility rate and November 1992 through April 1993 at the winter fertility rate. \*

Treatment	July 29	Aug. 27	Sept. 23	Oct. 28	Nov. 27	Dec. 30	Jan. 27	Feb. 24	Apr. 7	
Eco	6.811 a	3.307 b	4.237 a	1.330 a	2.888 ef	2.941 c	2.094 b	2.369 a	5.042 b	3.310 bc
Sustane	6.277 a	4.293 ab	4.846 a	1.505 a	3.285 cde	3.251 c	2.013 b	2.540 a	4.868 b	3.104 bc
Ringer	7.736 a	4.930 ab	5.297 a	1.457 a	3.028 def	2.868 c	2.001 b	2.647 a	4.430 b	2.817 cd
Milorganite	7.740 a	3.724 b	4.185 a	1.404 a	2.535 f	2.954 c	2.855 a	2.895 a	5.120 b	2.081 d
Eco + IBDU	7.337 a	4.703 ab	5.092 a	1.503 a	3.532 bcd	3.488 abc	2.564 ab	3.126 a	5.754 ab	3.459 bc
Sustane + IBDU	7.311 a	4.566 ab	5.621 a	1.729 a	3.988 ab	3.844 ab	2.297 ab	2.678 a	5.752 ab	3.460 bc
Ringer + IBDU	7.641 a	5.463 a	5.315 a	1.565 a	3.659 abc	4.078 a	2.976 a	2.707 a	5.875 ab	3.970 ab
Milorganite + IBDU	6.883 a	4.217 ab	5.495 a	1.661 a	3.766 abc	3.920 ab	2.895 a	2.812 a	6.896 a	3.562 bc
IBDU™ only	7.276 a	5.466 a	5.228 a	1.591 a	4.192 a	3.960 ab	2.647 ab	3.278 a	6.620 a	4.580 a
F Value	0.61	2.42	1.45	0.45	7.56	4.20	2.94	1.11	3.19	5.30
MSD	----**	1.633	1.735	----	0.557	0.728	0.756	---	1.476	0.893

\* Values are means of four replicate plots. Means within a column followed by the same letter are not significantly different (P=0.05) according to Waller-Duncan k-ratio t test.

\*\* F value too small to determine mean significant difference (MSD).

**Studies on cool-season turfgrass sod in Virginia have indicated a potential role for these products to enhance root growth and strength and, more importantly, to enhance the plant's ability to survive during stress periods.**

Table 8

Clipping weights (grams) resulting from evaluation of cytokinin-like products on the FGCSA Research Green from May through October 1992 at the summer fertility rate and November 1992 through April 1993 at the winter fertility rate. \*

Treatment	July 29	Aug. 27	Sept. 23	Oct. 28	Nov. 27	Dec. 30	Jan. 27	Feb. 24	Apr. 7	Apr. 21
Enersol	9.268 a	6.316 a	5.434 a	2.044 a	5.014 a	3.651 a	2.537 a	3.305 a	6.556 a	4.206 a
PanaSea Plus @ 2 weeks	7.471 a	5.201 a	5.070 a	1.837 a	4.095 a	4.249 a	2.707 a	3.179 a	6.419 a	4.650 a
PanaSea Plus @ 4 weeks	8.091 a	5.445 a	4.996 a	1.713 a	4.217 a	3.474 a	2.741 a	3.173 a	6.051 a	4.079 a
Kelpak	7.585 a	6.182 a	5.793 a	1.633 a	4.000 a	3.777 a	2.280 a	2.836 a	6.267 a	4.304 a
IBDU™ only	7.276 a	5.466 a	5.228 a	1.591 a	4.192 a	3.960 a	2.647 a	3.278 a	6.620 a	4.580 a
F Value	1.19	1.52	0.70	0.86	0.93	1.52	1.52	0.26	0.20	0.27
MSD	----**	----	----	----	----	----	----	----	----	----

\* Values are means of four replicate plots. Means within a column followed by the same letter are not significantly different (P=0.05) according to Waller-Duncan k-ratio t test.

\*\* F value too small to calculate mean significant difference (MSD).

Table 9

Percentage of disease (*Bipolaris* leaf spot), soil pH and root weights resulting from evaluation of natural organic fertilizers on the FGCSA Research Green from May 1992 through April 1993. \*

Treatment	% Disease			pH			Root Weight (grams)		
	10 Feb 93	6 Nov 92	3 May 93	16 Aug 92	30 Nov 93	1 Mar 93	16 Aug 92	30 Nov 93	1 Mar 93
Eco	16.25 a	6.84 a	6.86 ab	14.733 a	12.433 a	16.885 a			
Sustane	23.75 a	6.80 a	6.91 a	22.272 a	14.284 a	29.030 a			
Ringer	16.25 a	6.73 a	6.81 ab	19.478 a	14.926 a	24.151 a			
Milorganite	7.50 a	6.82 a	6.63 ab	17.393 a	14.093 a	22.830 a			
Eco + IBDU	16.25 a	6.66 a	6.49 ab	23.869 a	15.058 a	23.721 a			
Sustane + IBDU	10.00 a	6.78 a	6.55 ab	20.075 a	17.539 a	24.809 a			
Ringer + IBDU	8.75 a	6.81 a	6.85 ab	21.419 a	14.481 a	28.128 a			
Milorganite + IBDU	8.75 a	6.56 a	6.67 ab	14.454 a	13.631 a	28.171 a			
IBDU™ only	7.50 a	6.71 a	6.40 b	20.700 a	13.834 a	24.038 a			
F Value	1.74	1.11	1.88	0.92	0.61	0.89			
MSD	16.37	----**	0.50	----	----	----			

\* Values are means of four replicate plots. Means within a column followed by the same letter are not significantly different ( $P=0.05$ ) according to Waller-Duncan k-ratio t test.

\*\* F value too small to determine mean significant difference (MSD).

**The root zone mix was 80% sand and 20% Canadian peat moss, as has been all material used for topdressing. The area was planted with Tifdwarf hybrid bermudagrass and has never been overseeded.**

fertility program which used the IBDU™ blend described previously. These products are not intended to be used as fertilizers but rather as biostimulants for plant growth. Studies on cool-season turfgrass sod in Virginia have indicated a potential role for these products to enhance root growth and strength and, more importantly, to enhance the plant's ability to survive during stress periods.

## Materials and methods

### Study area and general maintenance:

The putting green section used for this study was the area built without the coarse sand choke layer. The root zone mix was 80% sand and 20% Canadian peat moss, as has been all material used for topdressing. The area was planted with 'Tifdwarf' hybrid bermudagrass and has never been overseeded. It is maintained at  $\frac{3}{16}$  inch height of cut using a walk-behind greens mower with groomer attachments. The area is verticut and topdressed approximately once per month, with depth of verticutting de-

pendent on thatch layer thickness. Pesticides used, date of application and application area are listed in Table 2. Every effort is made to spot treat pest problems rather than use a blanket treatment in order to minimize any potential damaging effects to the soil microbial populations by the pesticides.

**Experimental plan:** Each plot was 6.5 feet by 10 feet (65 sq. ft.) with four replicate plots per treatment. The experimental design was a randomized complete block. The treatments are listed in

Table 12

Soil analyses of bulk samples from natural organic fertilizer plots (15 June 1993) as conducted by the University of Florida Analytical Research Laboratory. \*

Treatment	pH	Ca	Mg	K	P	Zn	Cu	Mn	Fe	Na	Cl
Eco	7.2	322	24.4	14.1	24.0	7.76	1.09	9.12	18.98	7.3	0.0
Sustane	7.0	392	31.1	14.4	47.5	9.26	1.22	12.54	24.59	7.4	0.0
Ringer	7.1	334	19.6	12.4	34.6	5.64	1.02	10.13	24.72	7.3	0.0
Milorganite	6.9	236	50.5	16.9	19.6	9.61	2.26	10.27	19.81	6.7	0.0
Eco + IBDU™	6.9	356	54.2	19.7	43.3	7.55	1.24	13.13	22.84	7.9	0.0
Sustane + IBDU™	7.1	398	53.2	16.0	49.7	10.14	2.44	14.07	22.58	7.0	0.0
Ringer + IBDU™	7.0	309	41.3	15.9	33.9	7.77	1.09	11.36	19.14	6.2	0.0
Milorganite + IBDU™	6.9	295	40.5	12.8	34.9	9.13	1.44	10.51	24.78	7.0	0.0
IBDU™ only	6.9	225	40.9	9.7	26.2	5.06	0.93	7.24	18.72	6.5	2.0

\* The water extractable ions and Mehlich-I extractable elements were determined according to standard laboratory procedures. Elements are listed as mg per kg soil (ppm).

**Table 10**

Percentage of disease (Bipolaris leaf spot), soil pH and root weights resulting from evaluation of cytokinin-like products on the FGCSA Research Green from May 1992 through April 1993. \*

Treatment	% Disease		pH		Root Weight (grams)		
	10 Feb 93	6 Nov 92	3 May 93	16 Aug 92	30 Nov 92	1 Mar 93	
Enersol	5.00 b	6.65 a	6.66 ab	18.577 a	12.635 a	27.435 a	
Pana Sea Plus @ 2 weeks	8.75 b	6.61 a	6.43 ab	21.987 a	15.559 a	26.129 a	
Pana Sea Plus @ 4 weeks	5.00 b	6.61 a	6.71 a	21.873 a	16.162 a	25.971 a	
Kelpak	17.50 a	6.64 a	6.25 b	22.164 a	14.264 a	33.026 a	
IBDU™ only	7.50 b	6.71 a	6.40 ab	20.700 a	13.834 a	24.038 a	
F Value	3.81	0.26	2.40	0.22	0.56	1.21	
MSD	8.67	----**	0.44	----	----	----	

\* Values are means of four replicate plots. Means within a column followed by the same letter are not significantly different (P=0.05) according to Waller-Duncan k-ratio t test.

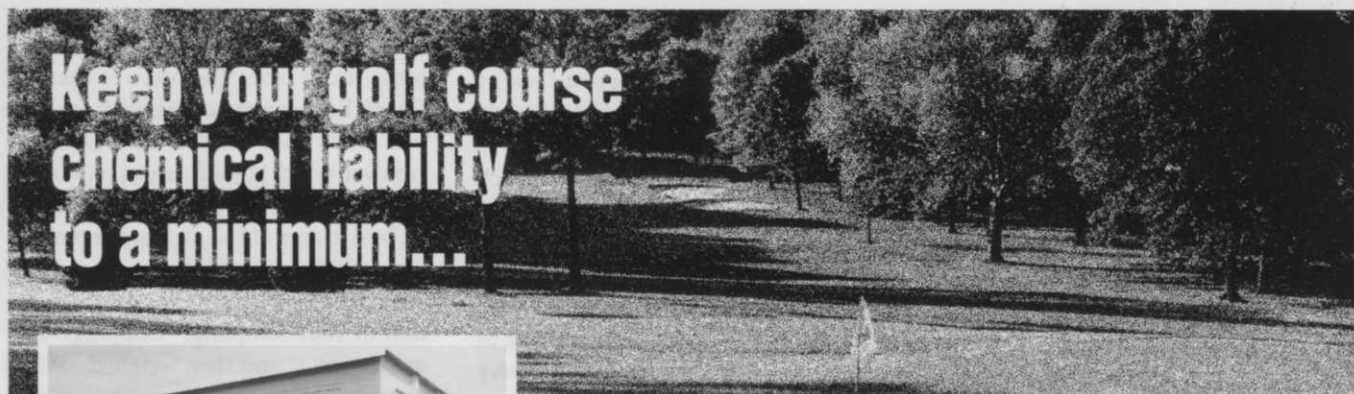
\*\* F value too small to determine mean significant difference (MSD).

**For each application date, the fertilizers were applied first, by hand, and then immediately irrigated with . . . water.**

Table 1. Nitrogen was applied at the rate of 18 pounds per 1000 sq. ft. per year, with 1 pound per month applied during the summer (May through October) and 2 pounds applied per month during the winter (November through April). This is the average nitrogen rate used in south-eastern Florida (see July/August 1992 issue of *The Florida Green*). The summer nitrogen rate was applied at 0.5 pound

every two weeks and the winter nitrogen rate at 1.0 pound every two weeks. For each application date, the fertilizers were applied first, by hand, and then immediately irrigated with 0.12 to 0.14 inches of water. Those treatments that were mixtures of natural and synthetic fertilizers were mixed in the laboratory before applying to the field plots.

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Table 11

Soil analyses, from check plots, conducted by University of Florida Analytical Research Laboratory in Gainesville. \*

Sample	pH	Ca	Mg	K	P	Zn	Cu	Mn	Fe	Na	Cl
<b>1 May 1992</b>											
1-3 inches	7.2	288	64.9	37.1	27.6	6.88	0.86	21.52	16.89	9.4	NT
4-6 inches	7.3	118	36.8	16.3	12.0	0.90	0.20	1.92	12.12	4.1	NT
<b>22 July 1992</b>											
1-4 inches	6.6	214	29.0	11.4	27.9	1.64	0.47	3.94	7.39	4.3	4.0
<b>30 October 1992</b>											
1-4 inches	7.2	246	38.5	14.6	24.9	4.16	0.76	6.48	20.67	4.7	2.0
<b>15 June 1993</b>											
1-4 inches	6.9	225	40.9	9.7	26.2	5.06	0.93	7.24	18.72	6.5	2.0

\* The water extractable ions and Mehlich-I extractable elements were determined according to standard laboratory procedures. Elements are listed as mg per kg soil (ppm).

During the first year of this project, the only disease observed was a leaf spot caused by a *Bipolaris* species which is one of the "Helminthosporium" group of fungi. Percentage of each plot affected by the leaf spot was determined. Blue-green algae were also prevalent during the winter months. The quality scores during the 1992-93 winter reflect the presence of algae. Symptoms of the root rot disease Bermudagrass Decline, caused by the fungus *Gaeumannomyces graminis* var. *graminis*, were not observed during this twelve-month period.

products were applied according to schedule (see Table 1) using a backpack CO<sub>2</sub> boom sprayer with 40 p.s.i. at the handle. These products were applied in an appropriate amount of deionized water. If a product was scheduled to be applied the same day as the fertilizers, they were instead applied the following day so they would not be affected by the irrigation cycle. These treatment plots and the check plots were fertilized with the IBDU fertilizer blend at the same nitrogen rate and using the same schedule as the natu-

ral organic fertilizer treatments.

**Evaluation - quality scores:** Quality scores were determined based on grass color and density using a scale of 1 to 10 with 10 being a perfect score. On each date, two persons rated the plots. Those scores were then averaged together for statistical analysis. The plots were rated one week after each nitrogen application. Some scores are missing, usually due to cultural practices (for example, heavy topdressing) that interfered with the rating procedure.

**Evaluation - clipping weights:** Clippings, from plots that had not been cut for 48 hours, were collected from each plot once each month from a 22 in. (mower-width) by 9 ft. area (16.5 sq. ft.) for July and August 1992 and from a 22 in. by 6 ft. area (11 sq. ft.) for the remaining months. Sample size was reduced beginning September 1992 due to initiation of root sampling. Clippings were dried at 60 C and then weighed. When possible, we tried to rate and collect clippings on the same day or subsequent days.

Quality scores were determined based on grass color and density using a scale of 1 to 10 with 10 being a perfect score. On each date, two persons rated the plots. Those scores were then averaged together for statistical analysis. The plots were rated one week after each nitrogen application. Some scores are missing, usually due to cultural practices (for example, heavy topdressing) that interfered with the rating procedure.



## Quality Scores for All Products at the Winter Fertility Rate

Treatment	Nov. 3	Dec. 30	Jan. 12	Jan. 27	Feb. 10	Feb. 24	Mar. 20	Mar. 24	Apr. 7	Apr. 21
Enersol	6.1 a-d	6.0 a	4.0 a	5.5 a	5.4 a	6.0 a	6.5 a	7.5 a	7.5 a	7.5 a
Pana Sea Plus @ 2 weeks	5.8 a-e	6.0 a	4.0 a	5.5 a	5.4 a	6.0 a	6.5 a	7.5 a	7.5 a	7.5 a
Pana Sea Plus @ 4 weeks	6.3 ab	5.9 ab	4.0 a	5.5 a	5.6 a	6.0 a	6.5 a	7.5 a	7.5 a	7.5 a
Kelpak	6.2 abc	6.0 a	4.0 a	5.5 a	5.1 a	6.0 a	6.5 a	7.5 a	7.5 a	7.5 a
Eco	5.3 de	5.6 b	4.0 a	5.5 a	4.9 a	6.0 a	6.5 a	7.5 a	7.5 a	7.5 a
Sustane	6.1 a-d	5.6 b	4.0 a	5.5 a	5.0 a	6.0 a	6.5 a	7.5 a	7.5 a	7.4 b
Ringer	5.8 a-e	5.6 b	4.0 a	5.5 a	5.0 a	6.0 a	6.5 a	7.5 a	7.5 a	7.5 a
Milorganite	5.0 e	5.8 ab	4.0 a	5.5 a	5.4 a	6.0 a	6.5 a	7.5 a	7.0 b	6.5 c
Eco + IBDU™	5.5 b-e	5.8 ab	4.0 a	5.5 a	5.2 a	6.0 a	6.5 a	7.5 a	7.5 a	7.5 a
Sustane + IBDU™	6.1 a-d	6.0 a	4.0 a	5.5 a	5.4 a	6.0 a	6.5 a	7.5 a	7.5 a	7.5 a
Ringer + IBDU™	5.4 cde	6.0 a	4.0 a	5.5 a	5.6 a	6.0 a	6.5 a	7.5 a	7.5 a	7.5 a
Milorganite + IBDU™	5.8 a-e	6.0 a	4.0 a	5.5 a	5.6 a	6.0 a	6.5 a	7.5 a	7.5 a	7.5 a
IBDU™ only	6.1 a-d	6.0 a	4.0 a	5.5 a	5.2 a	6.0 a	6.5 a	7.5 a	7.5 a	7.5 a
IBDU™ only	6.6 a	6.0 a	4.0 a	5.5 a	5.3 a	6.0 a	6.5 a	7.5 a	7.5 a	7.5 a

**Evaluation - root weights:** Root weights were obtained every three months beginning in August 1992. At each sampling date, two 6-inch diameter by 4-inch deep samples were obtained from each end of each plot for a total of four sub-samples per plot. A 0.5 inch cap was cut from the top to remove leaf tissue and the majority of the thatch layer. Samples were then processed with the Gillison Hydropneumatic Elutriation System.

The accumulated material was dried at 80 C for 36-48 hours and then weighed. Weights from the four sub-samples of each plot are added together to obtain the total weight per plot. Resulting "holes" from sampling were filled with the 80/20 mix used for topdressing.

**Evaluation - disease ratings and soil pH:** During the first year of this project, the only disease observed was a leaf spot caused by a *Bipolaris* species which is one

of the "Helminthosporium" group of fungi. Percentage of each plot affected by the leaf spot was determined. Blue-green algae were also prevalent during the winter months. The quality scores during the 1992-93 winter reflect the presence of algae. Symptoms of the root rot disease Bermudagrass Decline, caused by the fungus *Gaeumannomyces graminis* var. *graminis*, were not observed during this twelve-month period.

Soil pH values were determined for all plots at six month intervals to determine if the products were affecting bulk soil pH, especially the natural organic fertilizers. The average pH of the Eco, Sustane and Ringer products was 9.0-9.5, whereas the Milorganite product was 4.0. Soil pH was determined by obtaining cores that were 4-inches deep and 1-inch in diameter. The top 0.5 inch was removed. A 1:1 (v:v) suspension of soil and deionized water was made and shaken for 30 minutes. After filtering, the pH of the resulting solution was determined.

**Soil analyses:** A complete soil analysis was conducted by the University of Florida Analytical Research Laboratory at 6-month intervals. These analyses were conducted on soil obtained from the check IBDU fertilizer blend treatment plots. Results are presented in Table 11. A complete soil analysis was also conducted in June 1993 on the natural organic fertilizer treatment plots and the plots receiving a mixture of natural and synthetic fertilizers. These results are presented in Table 12. For each treatment, soil samples from each replicate



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Some  
significant  
differences  
in  
clipping  
weights  
were  
observed  
for the  
natural  
organic  
fertilizers  
but not  
the  
cytokinin-  
like  
products.

Few differences were observed in quality, the characteristic of most concern to golf course superintendents, for either the natural organic fertilizers or the cytokinin-like products. For the natural organic fertilizers, differences were observed on seven of the nineteen rating dates but only four of those dates resulted in significant differences between treatments.

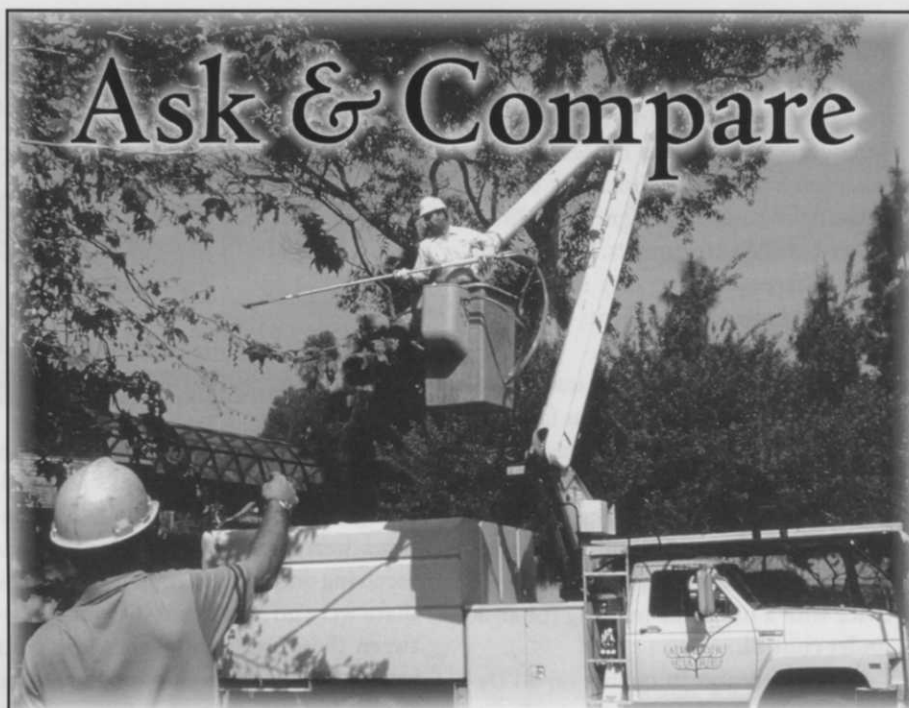
plot were bulked for analysis. Therefore, no statistical analysis was performed on the data obtained.

### Results and discussion

Tables 3 and 4 list the quality scores obtained for the natural organic fertilizer treatments. Tables 5 and 6 list the quality scores obtained for the cytokinin-like hormonal products. Table 7 lists the clipping weights and Table 9 lists the disease rating, root weights and soil pH values obtained for the natural organic fertilizers. Tables 8 and 10 list the same for the cytokinin-like products.

Few differences were observed in quality, the characteristic of most concern to

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## Clipping Weights for All Products at the Winter Fertility Rates

Treatment	Nov. 27	Dec. 30	Jan. 27	Feb. 24	Apr. 7	Apr. 21
Enersol	5.014 a	3.651 a-d	2.537 abc	3.305 a	6.556 ab	4.206 abc
Pana Sea Plus @ 2 weeks	4.095 abc	4.249 a	2.707 abc	3.179 ab	6.419 ab	4.650 a
Pana Sea Plus @ 4 weeks	4.217 abc	3.474 a-d	2.741 ab	3.173 ab	6.051 abc	4.079 abc
Kelpak	4.000 a-d	3.777 abc	2.280 abc	2.836 ab	6.267 ab	4.304 ab
Eco	2.888 ef	2.941 d	2.094 bc	2.369 b	5.042 bc	3.310 bcd
Sustane	3.285 c-f	3.251 cd	2.013 c	2.540 ab	4.868 bc	3.104 cde
Ringer	3.028 def	2.868 d	2.001 c	2.647 ab	4.430 c	2.817 de
Milorganite	2.535 f	2.954 d	2.855 a	2.895 ab	5.120 abc	2.081 e
Eco + IBDU™	3.532 b-f	3.488 a-d	2.564 abc	3.126 ab	5.754 abc	3.459 bcd
Sustane + IBDU™	3.988 bcd	3.844	abc 2.297 abc	2.678 ab	5.752 abc	3.460 bcd
Ringer + IBDU™	3.659 b-e	4.078 ab	2.976 a	2.707 ab	5.875 abc	3.970 abc
Milorganite + IBDU™	3.766 b-e	3.920 abc	2.895 a	2.812 ab	6.896 a	3.562 a-d
IBDU™ only	4.192 abd	3.960 abc	2.647 abc	3.278 a	6.620 ab	4.580 a
IBDU™ only	4.427 ab	3.415 bcd	2.411 abc	2.990 ab	5.746 abc	3.818 a-d

golf course superintendents, for either the natural organic fertilizers or the cytokinin-like products.

For the natural organic fertilizers, differences were observed on seven of the nineteen rating dates but only four of those dates resulted in significant differences between treatments. No significant differences in quality scores were observed between treatments for the cytokinin-like products.

The primary reason for quality decline in the winter months was from development of blue-green algae as a result of the unusually rainy 1992-93 winter we experienced in southern Florida. In fact, it was so severe and uniform by mid-January, that the entire green was sprayed twice with a fungicide to bring the algae under control.

The differences in quality on 30 December 1992 for the natural organic fertilizers were due to differences in the amount of algae on the plots. In general, the algae was initiated first on the plots treated with natural organic fertilizers, but the algae built up so quickly across

**Some significant differences in clipping weights were observed for the natural organic fertilizers but not the cytokinin-like products. In general, the largest clipping weights were associated with the IBDU check treatment or mixtures of the natural organic fertilizers with the IBDU blend.**

the remaining plots that these differences were not apparent two weeks later. Although the initial *Bipolaris* leaf symptoms were first observed on the plots receiving only natural organic fertilizers, there were no significant differences between these treatments when the plots were evaluated for disease incidence. There were significant differences between the cytokinin-like product treatments. However, since disease incidence was low, there was minimal effect on quality.

Some significant differences in clip-

ping weights were observed for the natural organic fertilizers but not the cytokinin-like products. In general, the largest clipping weights were associated with the IBDU check treatment or mixtures of the natural organic fertilizers with the IBDU blend. There did not appear to be a consistent correlation between clipping weights and quality scores.

While there appears to be a large difference between treatments for root weights, none are significantly different from each other - primarily due to the variability between replicates within a

**While there appears to be a large difference between treatments for root weights, none are significantly different from each other - primarily due to the variability between replicates within a treatment. This was not totally unexpected. The primary reason for obtaining so many sub-samples from each plot was in an effort to reduce variability. However, it is important to note the substantial difference between root weights over time across all treatments.**

treatment. This was not totally unexpected. The primary reason for obtaining so many sub-samples from each plot was in an effort to reduce variability. However, it is important to note the substantial difference between root weights over time across all treatments. Over the two year study period, this could confirm the general opinion that turfgrass on putting greens in southern Florida, especially those that have not been overseeded, is at its optimum health and quality in the late spring and early summer. This is primarily due to the substantial root system that is present during this time period. The root system then declines as the summer progresses. This would be in contrast to the spring root die-off observed in Texas.

This study will be continued for another year at which time a final report will be presented. In addition to the above evaluations, we are also conducting a microbial ecology study to determine the effects of the fertilizer treatments on the bacterial and fungal populations present in the top 3-4 inches of soil. That information will also be presented after the study has been completed.

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