1993

The Effects of Turf Compression on Plants Growth Regulator Efficacy

William Lyle Petersen

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The Effects of Turf Compression

On Plants Growth Regulator Efficacy

BY

William Lyle Petersen

THESIS

SUBMITTED IN PARTAIL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF

Master of Science

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I HEREBY RECOMMEND THIS THESIS BE ACCEPTED AS FULFILLING
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ABSTRACT:

A 150kg lawn roller was used in combination with various Plant Growth Regulators (PGR) (Embark & Event, Event & Oust, Embark & Oust, Escort & Oust, Telar & Oust, Event & Balan, Oust & Balan, and Balan) to evaluate its affects on the growth rate of rough turf at the Coles County Airport. The rolled plots were evaluated for height, reduction of seedheads, phytotoxicity, and weed control. Rolling was of no significance to treated or untreated turf. PGR combinations containing Oust were significantly better at reducing turf height than combinations lacking Oust. PGR combinations lacking Oust discolored turf significantly less than the PGR combinations containing Oust. Escort & Oust proved to be significantly better at controlling weeds than the other combinations. However by the end of the experiment, most of the weeds had recovered. Oust combinations were significantly better at inhibition of seedheads than those combinations without.

ACKNOWLEDGMENTS

I would like to extend special thanks to my advisor, Dr. Roger Darding for his assistance in conducting this research and in writing the thesis.

I would also like to thank my committee members Dr. William Weiler for his aid in correcting this document and Dr. John Ebinger for his support and for driving me nuts!

Mostly I wish to thank my parents for their support and therefore I would like to dedicate this thesis to them.

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INTRODUCTION

The primary objective of this project was to investigate the effects of turf compression prior to spraying on the efficacy of plant growth regulators. Observations from tractor tire tracks of previous years indicated that turf compression may increase PGR efficacy. It is thought that rolling the turf compresses the soil particles together. Observable affects include destruction of soil structure, and increase in soil density which reduces aeration and increases CO_2 and other gases that are toxic to the root system, which in turn causes a reduction in plant growth (7).

Plant growth regulators (PGR's) are organic compounds which in small concentrations can increase, decrease, or otherwise alter physiological processes in plants (31). These compounds can be both synthetic or naturally occurring. The majority of plant growth regulators injure and discolor turf grass while reducing growth and suppressing seedhead production (20). Injuries caused by PGR's are only temporary and plants will recover normally each spring. Desirable characteristics of PGR's include slower growth rate, low seedhead production and the retention of natural turf color. The combinations of PGR's used in this experiment were Embark (3M Corporation) & Event (American Cyanamid Company), Event & Oust (DuPont) , Embark & Oust, Escort (DuPont) & Oust, Telar (DuPont) & Oust, Event & Balan (Elanco Products Company), Oust & Balan, and Balan. Three replications were made of these various combinations of PGR's after 100% turf greenup.

The species of turf grass that were subjected to the rolling and the PGR's were tall fescue (*Festuca arundinacea* Schreb.), bluegrass (*Poa pratensis* L.), and a few species of *Panicum* (19). Broadleaf weeds such as plantain, dandelion and red clover were also present.

LITERATURE REVIEW

Plant growth regulators (PGR's) are organic compounds which in small concentrations can increase, decrease, or otherwise alter physiological processes in plants (32). These compounds can be both synthetic or naturally occurring. The American Cyanamid Company developed a class of inhibitors called imidazolinones, which inhibit the production of acetohydroxy acid synthase, the enzyme responsible for the synthesis of the amino acids valine, leucine, and isoleucine (6,9,29). Research indicates these amino acid deficiencies can inhibit growth (6).

The majority of plant growth regulators injure and discolor turf grass while reducing growth and suppressing seedhead production (20). Injuries caused by PGR's are only temporary and plants will recover normally by the next spring. PGR's also inhibit root and rhizome development as well as shoot growth. Desirable characteristics of PGR's include slower growth rate, low seedhead production and the retention of natural turf color.

Tolerance to PGR's is thought to be in part due to the plants ability to metabolize them. Kentucky bluegrass, which tolerates the PGR chorsulfuron may be able to metabolize it, while tall fescue, which is sensitive to chlorsulfuron can not (22). A PGR must come in contact with living plant cells before it can have any regulator affect on the plant (32). How fast and how much a PGR penetrates plants cells may also affect its efficacy (32).

Plant growth regulators can be applied as an aqueous or oil based spray and must be retained on a leaf before penetration can occur. Surfactant can be added to the spray to reduce surface tension and improve surface wetting (33). The surface of the leaf can affect

the absorption of PGR's. Plants with smooth cuticular surfaces retain more of the PGR's on their leaves then those plants with crystalline epicuticular waxes (12, 28). The presence of a crystalline surface with epicuticular waxes, creates a hydrophobic surface on the leaf, thus leading to large contact angles, as air becomes trapped between the surface and the liquid. A large contact angle inhibits the adhesion of drops of solutions, which could explain why such plants as winter wheat and quackgrass have low retention capacities (28).

The primary purpose for turf rolling is to correct minor defects in the turfgrass surface, the majority of which is caused by winter freezing and thawing. This also presses turfgrass plants back into the soil after they have been heaved upward during the winter (7). Rolling should only be done when the soil is not overly moist, with a roller that is not too heavy to avoid soil compaction, and only once a year. Any more than once a year will compact the soil. Observable effects include destruction of soil structure and increases in soil density which reduces aeration and increases CO_2 and other gases toxic to the root system (7).

The following is a list of the PGR's used in this experiment. Each is accompanied by a brief description of the active ingredients, when they should be applied, how they affect the turf, and who manufactures it.

EVENT

Event is an imidazolinone plant growth regulator manufactured by American Cyanamid Company. The active compounds in Event are imazethapyr ((+)-2-[4,5-dihydro-4-methyl-4- (methylethyl)-5- oxo-1-H-imidazol-2-yl]-5-ethyl-3- pyridine carboxylic acid)

and imazapry (2-[4-5-dihydro-4- methyl-4-(methylethyl)-5-oxo-1-H- imidazol-2-yl]-3-pyridine carboxylic acid), which comprises 16.3% and 0.6% respectively, of the composition of Event.

Vegetation treated with Event show decreased height, with minor or no physical damage to plants or decreases in plant density (3, 4). One application is affective in reducing growth and control of seedheads for 60-90 days.

Event is effective for controlling the height and seedhead production in tall fescue, perennial ryegrass, bluegrass, and bahiagrass. It is recommend in areas such as roadsides, airports, golf courses and industrial grounds (2, 5).

Event is absorbed through the root and leaves and accumulates in the meristematic regions (30). It inhibits the production of valine, leucine, and isoleucine by inhibiting the enzyme acetohydroxy acid synthetase. The inhibition of the enzyme also interferes with DNA synthesis which in turn causes reduction in cell division and elongation (14). By interrupting these pathways, Event reduces the growth of turf grasses.

EMBARK

Embark is manufactured by 3M Corporation. The active ingredient is mefluidide (N-2,4dimethyl-5-(trifluromethyl)-sulfonylamino phenyl acetamide), which comprises 28% of the of the mixture (31).

For best control Embark should be applied postemergent after 100% greenup, but prior to mowing. The effects of an application may last up to six weeks (31). However, Moore and Tautyvdas at Purdue University found one application of mefluidide in

combination with, chlorsulfuron, 2,4-D and a surfactant will control bluegrass and tall fescue for an entire season (24).

Embark is absorbed through the foliage and controls the height of a wide variety of grasses (13). It also inhibits seedhead production and prevents rooting decline (10, 11). It is recommended for improving annual bluegrass turf and to reduce mowing frequency.

OUST

Oust is manufactured by DuPont Agricultural Chemicals. The active compound which comprises 75% of Oust is sulfometuron methyl (methyl-2-[[[[(4,6-dimethyl-2-pyrimidinyl)amino] carbonyl] amino] sulfonyl] benzoate) (5).

Oust can be used as both a postemergent and preemergent regulator. As a postemergent regulator, Oust is absorbed by the foliage. Plant growth is inhibited by stopping meristematic activity of the roots and shoots (16). As a preemergent regulator regular rainfall is essential for Oust to be absorbed by the roots of germinating plants (25).

Oust is used in controlling many grasses and broadleaf weeds. It is not recommended for use in crop land areas, since some crop plants may be susceptible. Symptoms such as chlorosis and necrosis first appear about two weeks after application and are most severe after four to six weeks (15).

ESCORT

Escort is manufactured by DuPont Agricultural Chemicals. The active compound that comprises 60% of Escort is metsulfuron methyl (methyl 2-[[[[(4-methoxy-6-methyl -1,3,5-triazin-2-yl) amino] carbonyl] sulfonyl] benzoate) (14).

Escort can be used as both a postemergent and preemergent plant growth regulator.As a postemergent regulator, it is absorbed through both the roots and foliage. As a preemergent regulator it is absorbed through the roots. Timely rainfall is essential for good weed control of resistant perennials (14).

Escort is recommend for use in controlling woody plants and annual and perennial broadleaf weeds. It is recommend for areas such as airports, highways, storage areas and roadside turf. Symptoms are similar as those found in Oust.

TELAR

Telar is produced by DuPont Agricultural Chemicals. The active ingredient that comprises 75% is chorsulfuron (2-chloro-N-[(4-methyl-1,3,5,-triazin-2-yl) aminocarbonyl) benzenesulfonamide).

Telar can be used as both a preemergence and postemergence regulator PGR. As a preemegent regulator, Telar is absorbed by the root system of the developing young plants. As a postemergent regulator, Telar is absorbed by the roots as well as the foliage. Telar is most effective when applied to young actively growing plants.

Telar may cause chlorosis and necrosis in treated vegetation. Symptoms usually begin to appear two weeks after treatment and become most pronounced at about 4 to 6 weeks after application.

Telar is recommended for use along fence rows, right of ways, roadsides, storage areas, railroads, and airports. It has been shown to regulate growth in at least 65 species, including foxtail and sweet clover (17).

BALAN

Balan is manufactured by Elanco Products Company, a division of Eli Lilly and Company. The active ingredient which comprises 2.5% of Balan is N-butyl-N-ethyl-,-trifluoro-2, 6-dinitro-p-toluidine.

Balan is a preemergence herbicide used for control of annual grasses. Balan must be applied one to two weeks before the germination of annual grasses, as it does not control established plants. The effects can be enhanced if treated areas are irrigated soon after treatment (18).

MATERIALS AND METHODS

Research area

The research area is located 11 km west of Charleston, Illinois at the Coles County Memorial Airport (Figure 1). This area was subdivided into three blocks, each block served as a replicate and contained 18 plots. These plots measured 1.8 m wide by 9.2 m long with 0.6 m alleys. These plots were mowed to an average height of 7.6 cm and all clippings were removed from the plots. Half of the plots in each block were rolled with a 150 kg lawn roller prior to being sprayed. One rolled and one non-rolled plot were sprayed in each block using each of the combinations listed in the appendix.

Preparation & application of chemical

Event, Embark, Escort, Oust, and Telar were the five plant growth regulators (PGR's) that were used in this study, Balan was the only herbicide used in the research. The combinations, concentrations and rates of application are listed in the appendix.

All PGR's were applied with a tractor CO_2 mounted rear pressurized spray boom, containing four Teejet standard flat spray nozzles model 1103, at a total rate of 274 Kg/ha. The height of the nozzles was approximately 61 cm and the tractor was traveling at speed of 4.8km/hour (29).

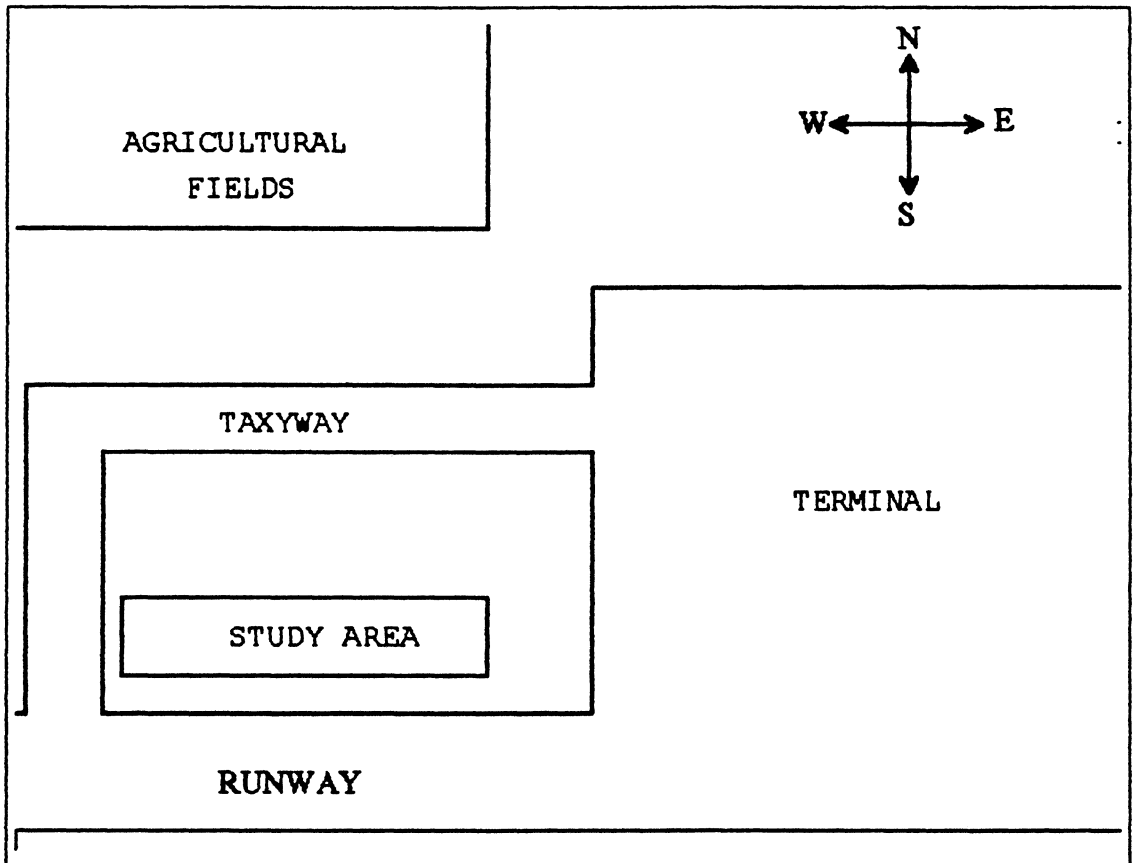

Figure 1. Location and orientation of the study area at Coles County Memorail Airport. Not Drawn to scale.

The sprayer was calibrated prior to spraying using the following calculations:

$$LPM = \frac{LPha \times KmH \times W}{Con}$$

LPM = Liters per minute
LPha = Liters per Hectare
KmH = Kilometers per hour
W = spray width of nozzle (cm)
Con = Conversion constant

$$LPM = \frac{286.3 \times 4.8 \times 50.8}{225606} = 0.309 \text{ LPM}$$

All four Teejet nozzles were calibrated within 10% error of each other prior to spraying. This was done by measuring the total amount of H_2O the nozzle was putting out in 20 second intervals.

Enough chemical was mixed to spray four plots even thought three plots were sprayed. The extra chemical was needed to purge the system when changing chemicals and to allow enough chemical to over run the ends of the plots. The following is a list of formulas that were used to determine how much of each solution would be needed. To find the total area of each plot the following formula was used:

$$\frac{1.8 \times 9.1 \text{ m (plot size)}}{10000 \text{ m}^2 \text{ per ha}} = .00164 \text{ ha per plot}$$

The following formula was used to calculate the area for the four plots.

$$0.00164 \text{ ha} \times 4 \text{ plots} = 0.00656 \text{ ha for 4 plots}$$

To find the total amount of solution needed to spray four plots the following formula was used:

L/ha (Standard rate) x ha (per treatment) = L
286.3 L/ ha x 0.00656 ha = 1.878 L

For PGR's that were in liquid form such as Embark the following formula was used to determine how much of the solution would be PGR:

assume a concentration of 0.739 L/ha
0.739 L/ha x 0.00656 ha = 0.00485L

For PGR's that are solid such as Oust the following formula was used to determine how many grams of the PGR would be added to the final solution:

assume concentration of 0.036 kg/ha
36 g/ha x 0.00656 ha = 0.236 g of PGR

The solutions were mixed and stored in two liter plastic bottles for six days before being sprayed. For a complete listing of the amount of each PGR used for each treatment see Appendix.

Chemical effects on height and appearance of vegetation

Plots were examined every two weeks for height, weed control, seedhead suppression, and phytotoxicity. Height was measured with the use of a Robel pole (26). Weed control was evaluated by using a scale of one to ten, one being no signs of weed control, progressing up to ten which indicated no weeds. Seedhead suppression was measured using the same scale one being no signs of seedhead suppression progressing up to ten indicating total seedhead suppression. Phytotoxity was also measured using a scale of one to ten. However in this case a rating of ten meant no discoloration progressing down to one which indicated complete browning .The plots were examined 4/9/92, 4/23/92, 5/7/92, 5/22/92, 6/5/92, and 6/19/92 for all four parameters. Twelve weeks after

the spraying the regulatory effects of the PGR's were disappearing and the study was terminated.

All data were analyzed with CoStat using analysis of variance with a complete randomized block design. Significant differences between the rolled and non-rolled plots were determined by using Duncan's Multiple Range test at $p=0.05$, and significant differences between the plant growth regulators were also determined by using Duncan's Multiple Range test at $p=0.05$.

RESULTS

Rolling the turf had no significant effects on height, color, weed control, or seedhead production (Tables 1 through 9). At no part in the experiment was there more than a 3% difference between the rolled turf and the non-rolled turf with any of the PGR's used.

Balan showed no significant effects on height, color, weed control, or seedhead production. The rate of growth paralleled that of the control (Figure 2), and there were no visible signs Balan had any effect on the color of the turf (Figure 3). Balan also had no affect on the weeds that were growing in the plots (Figure 4) and in no way inhibited the production of seedheads (Figure 5).

All combinations of PGR's showed a significant reduction in turfgrass height (Table 10). Event & Oust exhibited the greatest reduction in height followed by Escort & Oust, Oust & Balan, Embark & Oust, Telar & Oust, Embark & Event, and Event & Balan respectively (Figure 1). By week 14 mean vegetation heights for these combinations were 13.8cm, 14.3cm, 15.6cm, 16.9cm, 21.1cm, 23.7cm and 26.0cm, respectively (Table 10). All plots that were sprayed with PGR combinations containing Oust were significantly shorter than those plots that were not sprayed with Oust (Table 10).

A significant discoloration in all of the plots treated was observed during the entire fourteen week period (Table 11). Plots sprayed with combinations of PGR's containing Oust showed a greater degree of discoloration. (Figure 2). Those plots sprayed with these PGR's never recovered more than 53% of their natural color when compared to the control,

while those plots not sprayed with these PGR's recovered 80% of their natural color by the end of the experiment.

Starting at week four, plots were evaluated for weed control. After four weeks all combinations of PGR's showed significant control of weeds when compared to the control (Table 13). The weeds in the plots that were not sprayed with the PGR Oust recovered quicker than those plots that were sprayed with it. By week six these plots were no longer significantly different than the control plots (Table 13). However by fourteen week the efficacy of the PGR's had dropped off to the point where there were very few observable affects of the PGR's on the weeds (Figure 3).

Starting at six weeks the plots were also evaluated for the production of seedheads. At weeks two and four there were no seedheads being produced on any of the plots and therefore the plots were not evaluated during this time. Significant reduction of seedheads was found with all combinations of PGR's (Table 13). Oust combinations were more effective in seedhead suppression than the other PGR's (Table 13). By week 14 Oust combinations were at least 20% better at suppressing seedhead production than PGR combinations lacking Oust.

Table 1. A comparison of height, color, seedhead production and weed control of rolled turf as a percentage of the non-rolled control using the PGR's Embark & Event.

	WEEKS AFTER TREATMENT						
	week 2	week 4	week 6	week 8	week 10	week 12	week 14
height	98%	99%	100%	99%	100%	101%	100%
color	99%	98%	99%	98%	99%	100%	100%
seedhead	100%	100%	100%	100%	100%	100%	100%
weed con.	100%	99%	99%	99%	98%	99%	98%

Table 2. A comparison of height, color, seedhead production and weed control of rolled turf as a percentage of the non-rolled control using the PGR's Event & Oust.

	WEEKS AFTER TREATMENT						
	week 2	week 4	week 6	week 8	week 10	week 12	week 14
height	100%	101%	101%	100%	100%	101%	100%
color	99%	99%	100%	101%	100%	100%	99%
seedhead	100%	100%	98%	99%	99%	100%	100%
weed con.	100%	100%	99%	100%	100%	100%	100%

Table 3. A comparison of height, color, seedhead production and weed control of rolled turf as a percentage of the non-rolled control using the PGR's Embark & Oust.

	WEEKS AFTER TREATMENT						
	week 2	week 4	week 6	week 8	week 10	week 12	week 14
height	99%	99%	100%	100%	100%	100%	100%
color	100%	100%	101%	102%	101%	101%	100%
seedhead	100%	100%	99%	99%	98%	99%	100%
weed con.	100%	99%	99%	100%	101%	100%	100%

Table 4. A comparison of height, color, seedhead production and weed control of rolled turf as a percentage of the non-rolled control using the PGR's Escort & Oust.

	WEEKS AFTER TREATMENT						
	week 2	week 4	week 6	week 8	week 10	week 12	week 14
height	100%	99%	100%	99%	100%	101%	100%
color	100%	100%	100%	100%	100%	100%	100%
seedhead	100%	100%	99%	99%	100%	100%	101%
weed con.	100%	100%	99%	99%	100%	100%	100%

Table 5. A comparison of height, color, seedhead production and weed control of rolled turf as a percentage of the non-rolled control using the PGR's Telar & Oust.

	WEEKS AFTER TREATMENT						
	week 2	week 4	week 6	week 8	week 10	week 12	week 14
height	100%	99%	100%	99%	100%	101%	100%
color	100%	100%	100%	100%	100%	100%	100%
seedhead	100%	100%	99%	99%	100%	100%	101%
weed con.	100%	100%	99%	99%	100%	100%	100%

Table 6. A comparison of height, color, seedhead production and weed control of rolled turf as a percentage of the control non-rolled using the PGR's Event & Balan.

	WEEKS AFTER TREATMENT						
	week 2	week 4	week 6	week 8	week 10	week 12	week 14
height	98%	99%	100%	99%	100%	101%	100%
color	100%	100%	100%	100%	100%	100%	100%
seedhead	100%	100%	99%	99%	100%	100%	101%
weed con.	100%	100%	99%	99%	100%	100%	100%

Table 7. A comparison of height, color, seedhead production and weed control of rolled turf as a percentage of the non-rolled control using the PGR's Oust & Balan.

	WEEKS AFTER TREATMENT						
	week 2	week 4	week 6	week 8	week 10	week 12	week 14
height	98%	99%	100%	99%	100%	101%	100%
color	100%	99%	100%	100%	100%	99%	100%
seedhead	100%	100%	99%	99%	100%	100%	101%
weed con.	100%	100%	98%	99%	101%	100%	100%

Table 8. A comparison of height, color, seedhead production and weed control of rolled turf as a percentage of the non-rolled control using the PGR Balan.

	WEEKS AFTER TREATMENT						
	week 2	week 4	week 6	week 8	week 10	week 12	week 14
height	98%	99%	100%	99%	100%	101%	100%
color	100%	99%	100%	100%	100%	100%	100%
seedhead	100%	100%	99%	99%	100%	100%	101%
weed con.	100%	100%	99%	99%	100%	100%	100%

Table 9. A comparison of height, color, seedhead production and weed control of rolled turf as a percentage of the non-rolled control using no PGR's.

	WEEKS AFTER TREATMENT						
	week 2	week 4	week 6	week 8	week 10	week 12	week 14
height	98%	99%	100%	99%	100%	101%	100%
color	100%	99%	100%	100%	100%	100%	100%
seedhead	100%	100%	99%	99%	100%	100%	101%
weed con.	100%	100%	99%	99%	100%	100%	100%

Table 10. Mean vegetation heights (cm) of all combinations of PGR's at 2, 4, 6, 8, 10, 12, and 14 weeks after treatment.

	WEEKS AFTER TREATMENT						
	Week 2	Week 4	Week 6	Week 8	Week10	Week12	Week14
Embark & Event	5.9b[x]	6.7b	5.9b	12.7b	17.7b	24.5bcd	23.7bc
Event & Oust	5.0b	5.9b	2.1c	4.6c	4.6d	14.3ef	13.8c
Embark & Oust	5.9b	7.1b	3.3c	7.1c	10.5cd	17.7de	16.9bc
Escort & Oust	6.3b	5.9b	3.3c	3.3c	5.5d	10.5f	14.3c
Telar & Oust	5.2b	6.3b	2.9c	5.0c	7.1d	19.0cde	21.1bc
Event & Balan	5.5b	6.7b	5.9b	14.4b	16.9b	25.8bc	26.0b
Oust & Balan	5.5b	5.5b	4.2bc	2.9c	5.9d	16.9ef	15.6c
Balan	11.1a	16.9a	17.3a	42.7a	60.3a	75.3a	66.4a
Control	10.1a	17.7a	17.7a	43.1a	65.6a	81.7a	66.0a

x mean separation within the column based on Duncan's Multiple Range Test at P=0.05

Numbers in columns followed by the same letter are not significantly different

Table 11. Phytotoxic effects[z] of all combinations of PGR's at 2, 4, 6, 8, 10, 12, and 14 weeks after treatment.

	WEEKS AFTER TREATMENT						
	Week 2	Week 4	Week 6	Week 8	Week10	Week12	Week14
Embark & Event	4.6b [x]	4.5bc	4.6b	6.3b	7.3b	6.5b	8.0ab
Event & Oust	4.1b	2.6e	1.8d	1.8cd	1.8c	1.8e	2.6f
Embark & Oust	4.5b	3.3cde	2.8cd	3.1c	3.5c	5.1bcd	5.5cde
Escort & Oust	4.3b	2.5e	2.2d	1.6d	1.3c	1.8e	3.8def
Telar & Oust	4.5b	3.0de	2.6cd	2.1cd	2.8c	3.3de	5.3cde
Event & Balan	4.8b	5.0b	5.3b	6.6b	7.8b	6.0bc	8.0ab
Oust & Balan	4.6b	3.0d	2.3cd	1.3d	2.1c	2.0e	3.3ef
Balan	10.0a	10.0a	10.0a	10.0a	10.0a	10.0a	10.0a
Control	10.0a	10.0a	10.0a	10.0a	10.0a	10.0a	10.0a

z each treatment was assigned a number from 1-10 with 10 being equal to the control and showing no signs of discoloration progressing down to 1 which was equal to dead grass.

x mean separation within the column based on Duncan's Multiple Range Test at P=0.05

Numbers in columns followed by the same letter are not significantly different

Table 12. Control of weeds[z] for all combinations of PGR's at 4, 6, 8, 10, 12, and 14 weeks after treatment.

	WEEKS AFTER TREATMENT					
	Week 4	Week 6	Week 8	Week 10	Week 12	Week 14
Embark & Event	3.8c [x]	2.0def	1.5cd	1.8cd	1.5de	1.0b
Event & Oust	6.0a	4.0ab	4.6b	4.6b	2.3bcd	1.6a
Embark & Oust	5.5ab	3.6bc	3.8bc	2.8bc	1.6cde	1.0b
Escort & Oust	5.3ab	5.5a	7.5a	7.0a	4.8a	1.6a
Telar & Oust	5.5ab	3.3bcd	4.3b	2.8bc	1.3e	1.0b
Event & Balan	4.1bc	2.1cdef	1.6cd	1.5cd	1.8bcde	1.0b
Oust & Balan	5.8c	4.1ab	1.5cd	3.1bc	2.5bc	1.0b
Balan	1.0d	1.0d	1.0d	1.0d	1.0e	1.0b
Control	1.0d	1.0d	1.0d	1.0d	1.0e	1.0b

z each treatment was assigned a number from 1-10 with 1 being equal to the control, showing no weed control progression up to 10 which was equal to total weed control.

x mean separation within the column based on Duncan's Multiple Range Test at P=0.05

Numbers in columns followed by the same letter are not significantly different

Table 13. Inhibition of seedheads[x] for all combinations of PGR's at 6, 8, 10, 12, and 14 weeks after treatment.

	WEEKS AFTER TREATMENT				
	Week 6	Week 8	Week 10	Week 12	Week 14
Embark & Event	5.3bcd[y]	5.6cd	5.3cd	3.0de	3.6cd
Event & Oust	9.5a	8.3ab	9.0a	8.3a	9.1a
Embark & Oust	7.6abc	8.0ab	6.6bc	4.5d	5.5bc
Escort & Oust	4.3cd	8.1ab	8.0ab	7.8a	7. 0 b
Telar & Oust	5.5bcd	7.0bc	7.0bc	6.8ab	6.5b
Event & Balan	3.6d	4.8d	3.1e	3.0de	3.1d
Oust & Balan	8.5ab	9.0a	7.8ab	7.5ab	7.3ab
Balan	1.0e	1.0e	1.0f	1.0f	1.0e
Control	1.0e	1.0e	1.0f	1.0f	1.0e

x each treatment was assigned a number from 1-10 with 1 being equal to the control, showing no inhibition of seedhead progressing up 10 which was equal to total inhibition of seedheads

y mean separation within the column based on Duncan's Multiple Range Test at P=0.05

Numbers in columns followed by the same letter are not significantly different

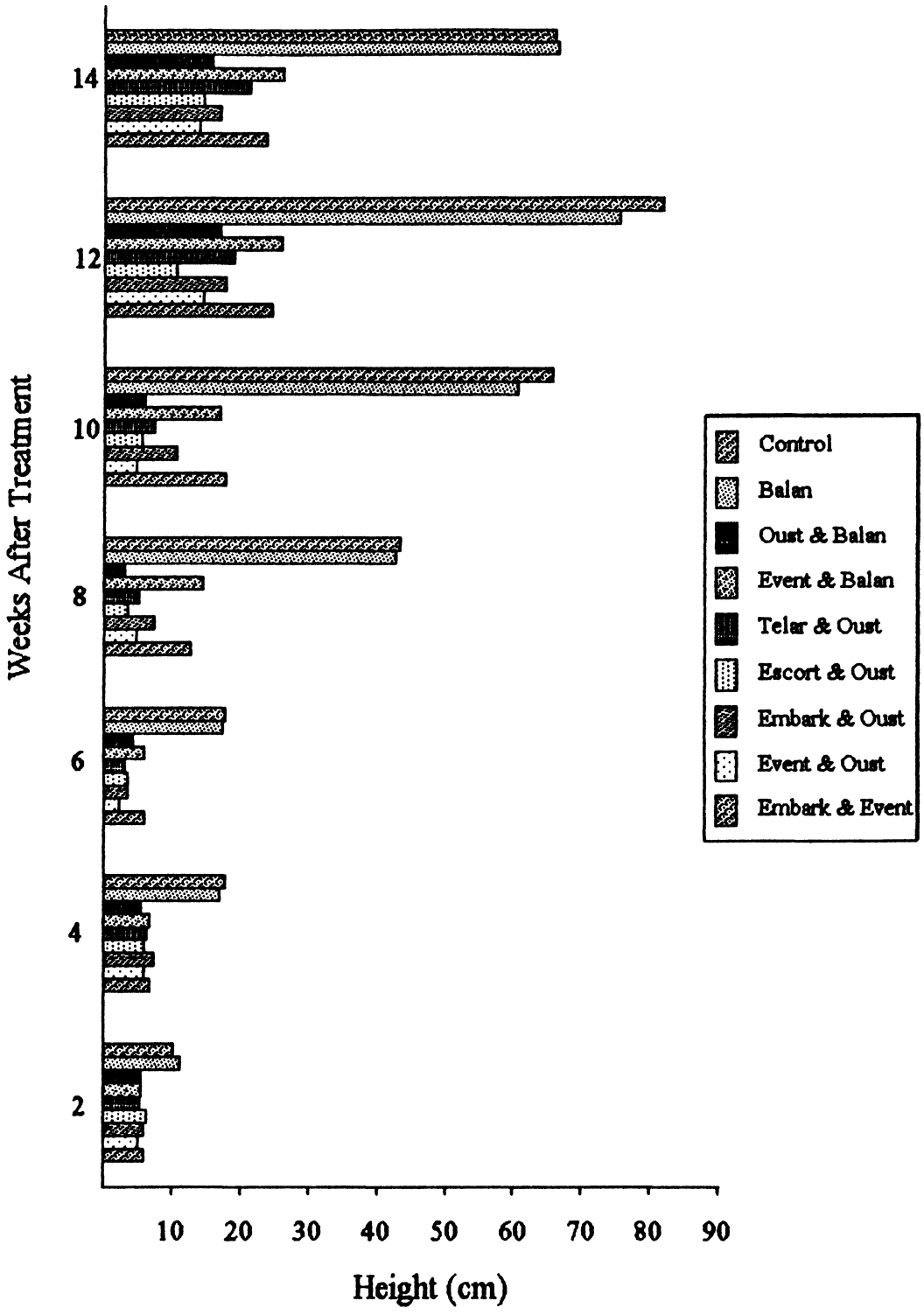

Figure 2. Mean vegetation height (cm) for all combinations of PGR's at 2, 4, 6, 8, 10, 12, and 14 weeks after treatment.

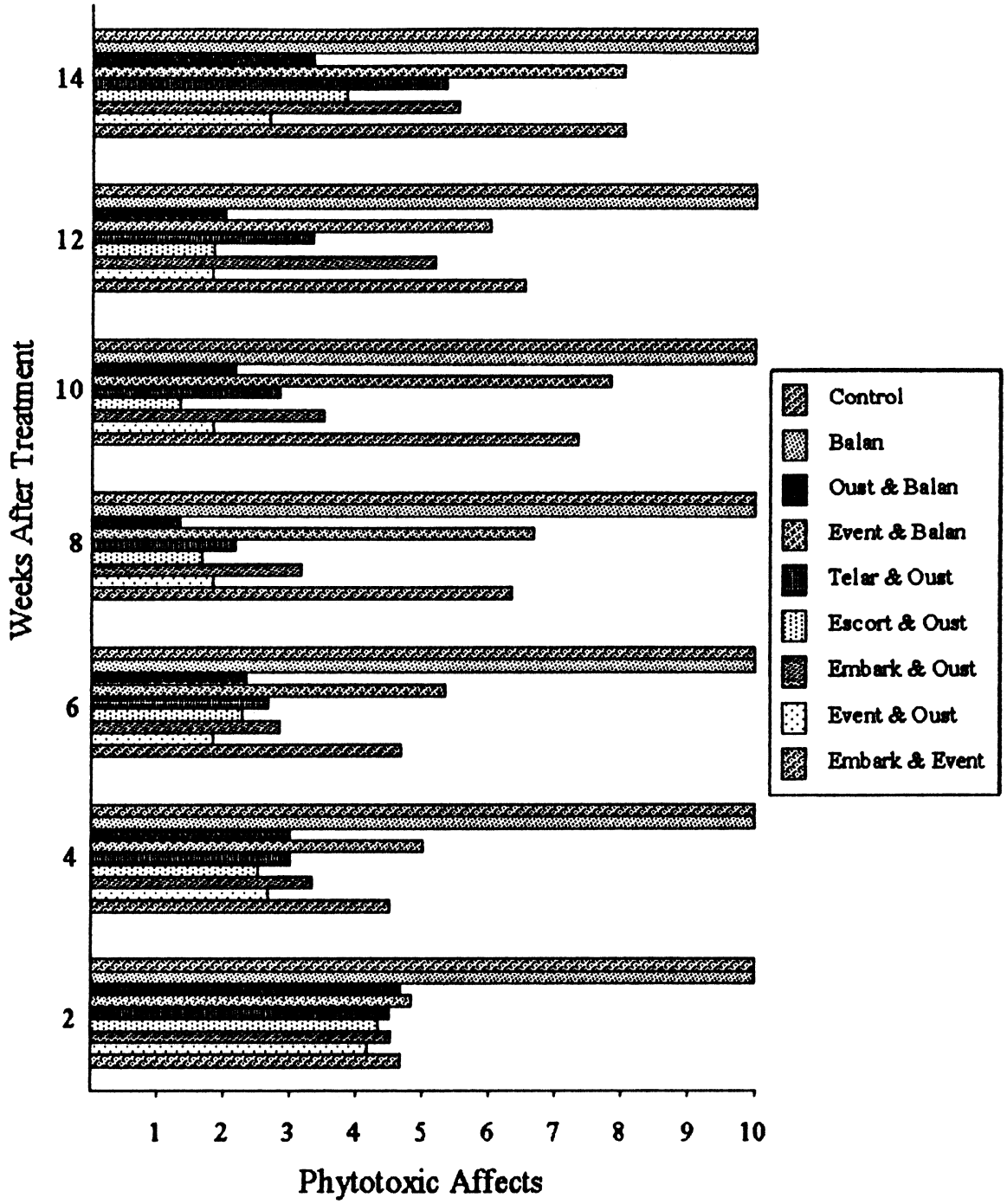

Figure 3. Phytotoxic affects for all combinations of PGR's at 2, 4, 6, 8, 10, 12, and 14 weeks after treatment (with 10 being equal to no discoloration and 1 being equal to total discoloration)..

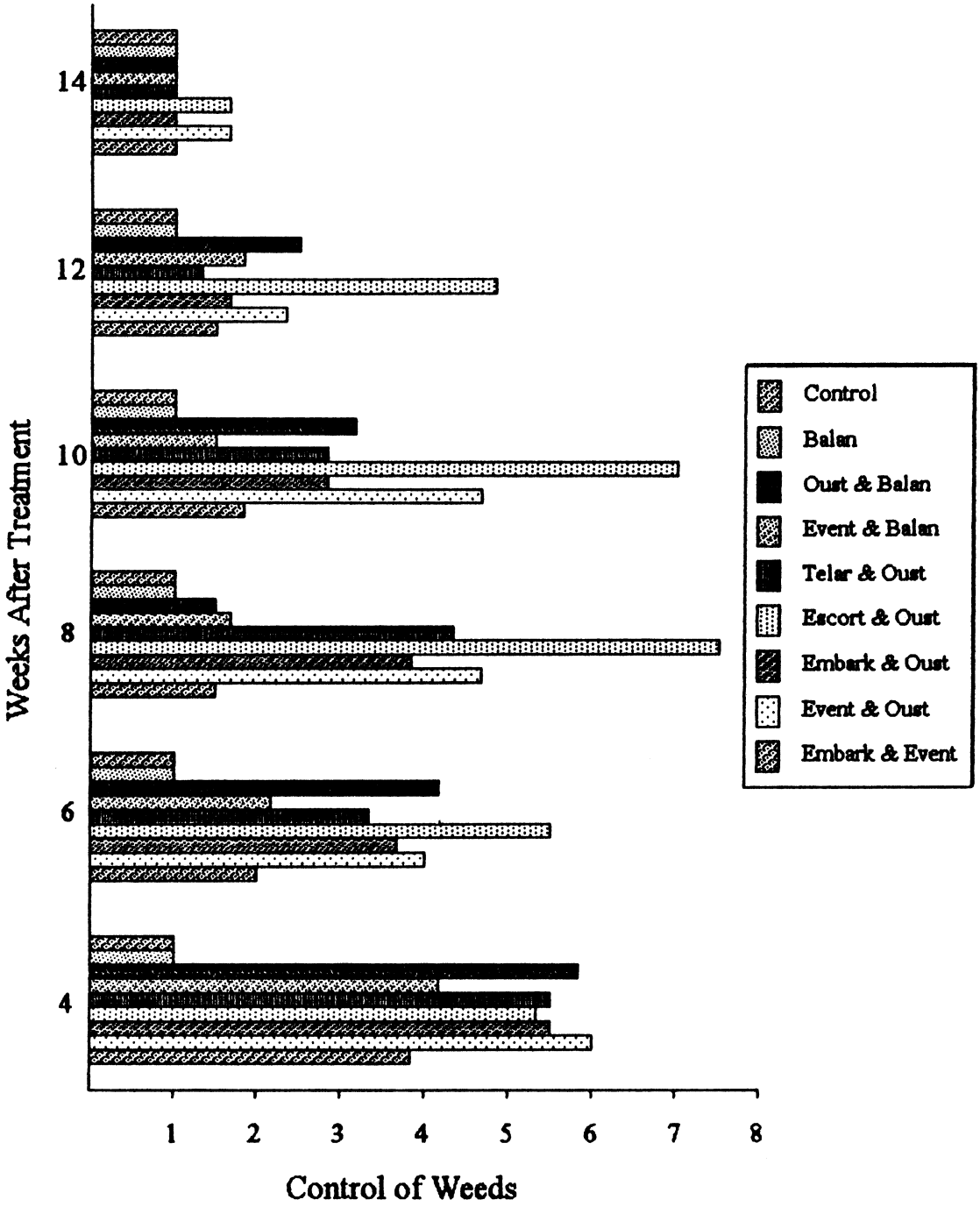

Figure 4. Control of weeds for all combinations of PGR's at 4, 6, 8, 10, 12, and 14 weeks after treatment (with 1 being equal to no control of weeds and 10 being eqaul to total control of weeds).

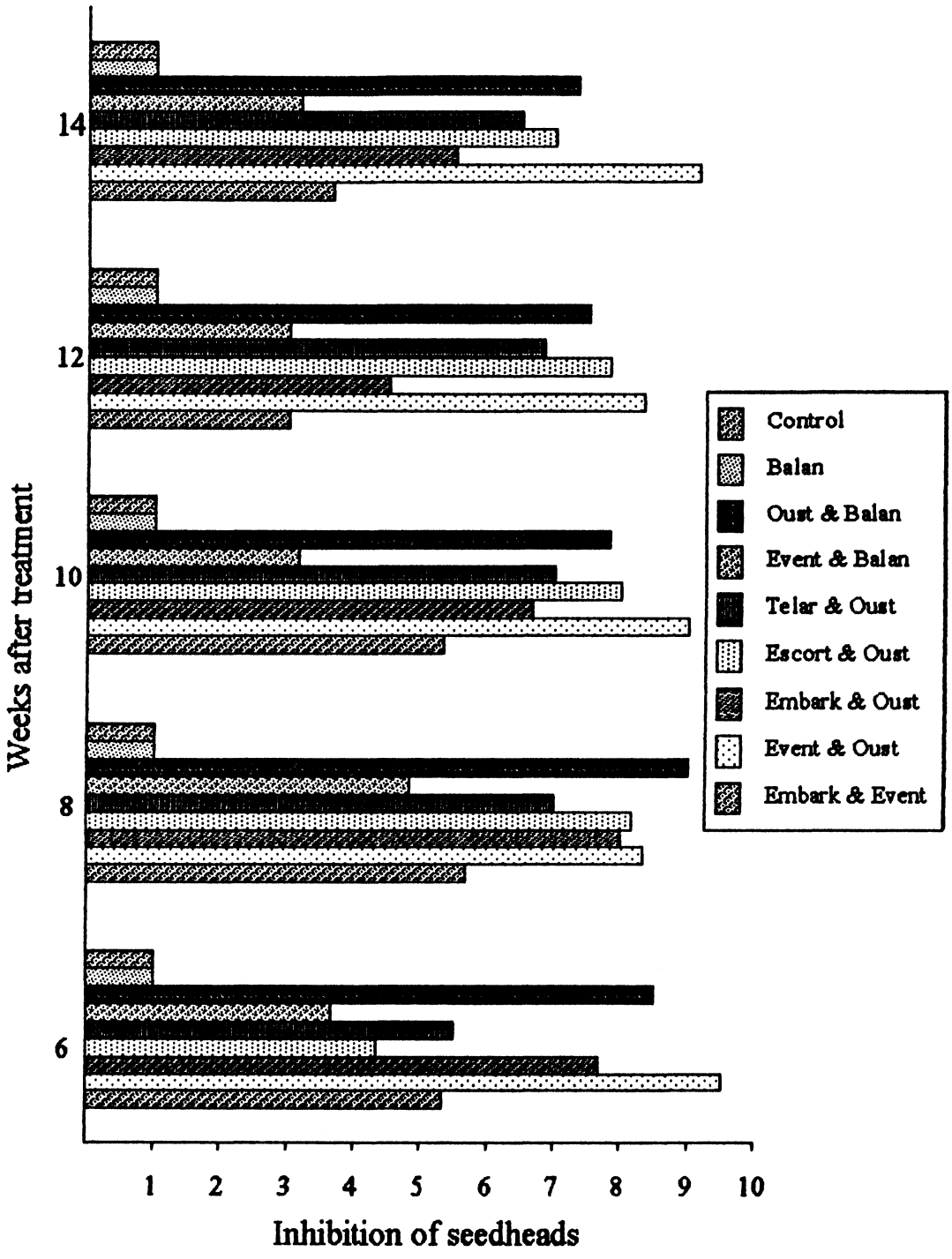

Figure 5. Inhibition of seedheads for all combination of PGR's at 6, 8, 10, 12, and 14 weeks after treatment (with 1 being no affect on seedhead production progressing up to 10 indicating no seedheads being produced).

DISCUSSION

Rolling the turf had no effect on height, color, weed control, or seedhead production. This was unexpected since in prior years compression due to tractor wheels left observable tracks through the entire experiment. No wheel tracks were observed during this experiment. This might be caused by varying soil moisture conditions. Soils with high moisture content are more easily compressed then are drier soils, and it has been shown that rolling in very wet conditions does affect the quality of turf (7).

Balan, a preemergent herbicide, had no effect on height, color, seedhead production, or weed control (Tables 11 through 14). It is primarily used for controlling annual weeds that have not germinated and will not inhibit growth of already growing plants (18). The majority of the plants that were measured in the experiment were perennials and thus Balan had no effect on these plants. In treated plots, annual grass control was very effective relative to the control (Tables 11 through 14, Figures 2 through 5).

From week 2 on all combinations of PGR's showed significant reduction in height as compared to the control (Table 10). By week 6 plots treated with combination of PGR's containing Oust were at least 76% shorter than the control, while those plots not treated with combinations containing Oust were at most 67% shorter. The trend of plots treated with Oust being significantly shorter than those plots not treated with Oust continued until week 12 (Table 10). By week 14 the effects of the PGR's were beginning to wear off and many of the plots treated with Oust were no longer significantly different from those plots that were not treated with Oust (Table 10).

One major problem with the use of PGR's is the browning of foliage. By week 2 all PGR combinations showed significant discoloration (Table 11). By week 4 Oust combinations showed significantly more discoloration than PGR combinations without Oust (Table 11). Oust combinations at best had only 33% of the natural color by week 6 and only 55% of their natural color by week 14. Those plots sprayed with combinations lacking Oust had 46% of their natural color by week 6 and had 80% by week 14 and were no longer significantly different from the control (Table 11).

Significant control of weeds was observed starting at week 4 . By week 6 the PGR combinations lacking Oust were no longer significantly different from the control (Table 12). By week 8 Escort & Oust was significantly better at controlling weeds than any other combination. By week 14 the majority of the combinations of PGR's used no longer had any effect on the weeds growing in the plots and only the PGR combinations of Escort & Oust and Event and Oust showed any sign of affecting weeds (Table 12).

Significant inhibition of seedheads was seen at week 6 of the experiment which was when seedheads were starting to be produced. All PGR's tested significantly reduced seedhead production when commpared to the control (Table 13). Those combinations lacking Oust inhibited seed head production significantly less than those combinations containing Oust (Table 13). By week 14 none of the plots showed signs of recovery in the form of increased seedhead production and were in the same shape as they were in week 8 (Table 13).

CONCLUSIONS

The primary objective of this experiment was to determine if compressing the turf before applications of PGR's would have any affect on their performance. The second objective was to determine which combinations of plant growth regulators were most affective.

Rolling the turf once prior to spraying had no significant affect relative to height, color, seedhead production, and weed control.

Oust in combination with Event, Balan, or Escort proved to be the most affective in reducing turf height and seedhead production and in weed control. However, these combinations also proved to cause the greatest amount of discoloration. PGR combinations lacking Oust proved to be least effective in reducing turf height, seedhead production and in weed control but reduced the natural turf color the least. (Tables 10 through 13).

It is recommend that Oust be used on areas were height rather than color is an important factor, such as airports and roadsides. For areas were color of turf is important (golf courses and parks), it is recommended that Oust not be used rather Embark & Event should be used instead.

APPENDIX

Table 14a. The amount of each PGR used (a total of 1878 ml) in spraying the test plots on March 26, 1992. These concentrations were used for both rolled and non-rolled plots

1. Embark & Event at 739 ml/ha rate
   4.85 ml Embark + 4.85 ml Event + 1868 ml H_2O

2. Event at 739 ml/ha & Oust at 17.5 g/ha rate
   4.85 ml Event + 0.115 g Oust + 1873 ml H_2O

3. Embark at 739 ml/ha & Oust at 17.5 g/ha rate
   4.85 ml Embark + 0.115 g Oust + 1873 ml H_2O

4. Escort at 36 g/ha & Oust at 17.5 g/ha rate
   0.236 g Escort + 0.115 g Oust + 1878 ml H_2O

5. Telar at 17.5 g/ha rate & Oust at 17.5 g/ha rate
   0.115 g Telar + 0.115 g Oust + 1878 ml H_2O

6. Event at 664 ml/ha & Balan at 89000 g/ha rate
   4.36 ml Event + 1874 ml H_2O
   146 g Balan applied in granular form

7. Oust at 36 g/ha & Balan at 89000 g/ha rate
   0.236 g Oust + 1878 ml H_2O
   146 g Balan applied in granular form

8. Balan at 89000 g/ha rate
   146 g Balan applied in granular form

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