USE OF PLANT GROWTH REGULATORS ON HIGHWAY TURFS

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In May 1982 Michigan State University began a research project in cooperation with and funding provided by the Michigan Department of Transportation. This project is entitled "Using Plant Growth Regulators to Develop a Cost Efficient Management System for Roadside Vegetation". Plant Growth Regulators will herein be referred to as "PGRs". Several further improved PGR compounds are being studied to evaluate their potential for use in highway roadside vegetation management systems.

Utility turfs were found to be most suited to PGR vegetation management systems in the early years of PGR development. Inconsistant growth suppression, phytotoxicity, reduced resistance to traffic and weed encroachment were a few of the reasons that PGR research had been directed toward the rough and utility turf areas (i.e. roadsides, industrial grounds, rights of way, around trees, buildings and in fence rows).

Today we have PGR compounds which provide more consistant responses over a wider range of vegetation mangement situations. By incorporating appropriate herbicides we can overcome the weed encroachment problems. Safer formulations and accurate application rates have reduced the severity of the phytotoxic responses to acceptable levels.

Both seedheads and vegetative growth can be controlled with a few of the modern PGRs. Seedhead suppression is in most cases the primary form of growth regulation desired. Seedheads grow more upright than the vegetative portion of the grass plants. This vertical seedhead growth is responsible for the objectionable appearance of utility turf areas. Many PGRs effectively suppress seedhead production but each species responds differently to some degree. In most utility turf situations there are several grasses in a mixed stand. Each grass is stimulated to produce seedheads at different times throughout the spring which vary according to the weather conditions. Therefore, the question of accurate application timing for seedhead suppression is very dependent upon the primary species to be controlled at an individual site.

Embark^R from 3M Company and Cutlass^R manufactured by Elanco are the only two PGR compounds available commercially. A new product from Monsanto Company (MON-4621) is in its final development stage and should be released for sale within two years. The remaining PGR compounds used in our studies are available for experimental use only.

PGR compounds can be roughly grouped into either of two categories. Foliarly absorbed compounds are those which enter the grass plant by absorption through living foliage. PGRs of this type must be allowed to lay on the leaf for a minimum of several hours. Embark^R is a foliarly absorbed compound. Crown and/or root absorbed PGRs form the second category. These compounds must reach the crown or root portions of the grass plant to be absorbed. It is necessary that chemicals of this type be "washed in" following treatment. Granular PGR formulations must also be washed in. The chemical in the granules needs to be dissolved in order to distribute the active ingredients to the crown/root zone in the surface layer of soil. Cutless^R and the Monsanto product fit into the second category.

"Chemical Mowing" is a term used when referring to PGR vegetation management systems. With proper use, PGRs can reduce mowing requirements dramatically. All mowing operations cannot be replaced by PGR treatments but actual mechanical mowing will be required much less frequently. Both vegetation and seedhead production can be reduced so that when mowing is necessary fewer man hours and less fuel will be needed. Seedhead supression is the most important factor when trying to reduce the mowing frequency. When subjected to standard mowing operations, seedhead seedstalks are more difficult to cut cleanly than the succulent green vegetation. The seedstalks have a much more upright growth habit and when mature are very tough.

There is considerable potential for cost savings by the use of PGRs. Mowing frequency can be reduced by one half in some situations. Additionally, turf quality may actually be enhanced even with less frequent mowing.

Research with PGRs on high quality grasses (i.e. home lawns and golf courses) is also ongoing. Several of the problems found in utility turf situations are common to the finer turfs. Insect and disease pressure along with phytotoxicity and weed encroachment continue to limit the use of PGRs on high quality turfs. Because of the higher aesthetic qualities required for ornamental turfs, fewer of the deleterious side effects can be tolerated. Constant improvements are being made and PGRs for use on high quality grasses are sure to be developed.

The ultimate goal is to reduce the cost of routine maintenance by the elimination of frequent and expensive mowing operations without sacrificing turf quality. Current products and techniques provide good results on utility turfs and the potential for effective use on high quality turf is very real.

The studies reported here are part of the ongoing research program initially reported at the 1982 Turfgrass Conference (1). A summary of the results will be presented in these proceedings. The support of the MDOT for this project is gratefully acknowledged.

Research Results to Date

DOT-1 PGR Application Timing Study Sp. 83

Embark (0.14 kg ai/ha) and MON-4621 (2.2 kg ai/ha) were applied on four dates - 4/22/83; 5/4/83; 5/15/83; and 5/27/83. This study is located at highway site 4 (U.S. 127 north of Lansing) which is predominantly Kentucky bluegrass and fine fescue.

Relative seedhead density and actual seedhead height are being reported. Additional evaluations include: relative vegetative density, vertical vegetative height, visual color response, overall quality of control and clipping yields.

The 4/22/83 and 5/4/83 treatments gave the best seedhead suppression for both Embark and MON-4621. MON-4621 plots treated 4/22 and 5/4/83 exhibited slightly lower and more consistent relative seedhead densities (see figure 1). Embark and MON-4621 plots treated 5/15 and 5/27/83 did not provide any practical amount of seedhead suppression. Our data suggests that the timing of PGR applications is critical for effective seedhead suppression as well as for other vegetation management factors.

Actual seedhead heights of Kentucky bluegrass were measured on 7/22/83. Seedhead production was almost completely inhibited by MON-4621 treatments at the first two application dates. Embark plots treated 4/22/83 limited Kentucky bluegrass seedhead elongation to less than one half that of the control and the 5/4/83 application reduced seedhead production by nearly 100 percent (see figure 2). These data suggest that the "window of activity" (which is the time span in calendar weeks during which any particular PGR compound must be applied for maximum effectiveness) was shorter in duration for Embark than for MON-4621 in 1983. However, it is likely that the "window of activity" for any PGR compound will fluctuate from year to year depending on weather variations.

DOT-2 Roadside PGR Compounds Evalaution Study Sp 83

Chemicals applied were: Embark (0.14 ai/ha), Eptam (6.7 kg ai/ha), EL-500 (Cutless, 1.7 kg ai/ha), Glean (0.14 kg ai/ha), MON-4621 (2.2 kg ai/ha) and PP-333 (1.7 kg ai/ha). All compounds were applied 5/6/83. This study is located at highway site 2 (U.S. 127 north of Lansing) which is primarily Kentucky bluegrass and fine fescue with some coarser grasses (i.e. orchardgrass, redtop, tall fescue and quackgrass) randomly mixed throughout.

Relative seedhead density and actual seedhead height will be reported. Other evaluations included relative vegetative density, vertical vegetative height, visual color response, and overall quality of control.

Relative seedhead density was evaluated 7/19/83 (74 days after treatment). MON-4621 and Eptam gave the only significant seedhead density reductions. All other compounds performed inadequately within this evaluation parameter (see figure 3). It is interesting to note the difference in response when comparing Embark treatments from this study to study DOT-1 in 1983. The treatment dates were 5/4/83 for DOT 1 and 5/6/83 for DOT 2 yet there is a large difference in the respective responses (compare Figure 1 and Figure 3 for Embark response). Rainfall records reveal that the DOT 1 applications (5/4/83) remained on the grass leaves for at least two full days before being washed off by rain. The DOT 2 treatments (5/6/83) were rained on later that same day and throughout the following day. Therefore, the absorption time had been much less than one day for the DOT 2 treatments. Embark is absorbed through the foliage so this response differential can likely be attributed to the difference in leaf contact time.

Actual seedhead height was measured on 7/26/83 (81 days after treatment) for Kentucky bluegrass and fine fescue. Kentucky bluegrass seedhead height was reduced more than one half by MON-4621 treatments and Eptam inhibited nearly all bluegrass seedhead production. PP-333 reduced bluegrass seedhead height but not by a practical amount. Glean, EL-500 (Cutless), and Embark had no effect on bluegrass seedhead height (figure 4).

Fine fescue seedhead production was almost entirely eliminated by MON-4621 and Eptam treatments. PP-333, EL-500 (Cutless) and Glean inhibited seedhead elongation by a statistically significant amount. However, the differences as compared to the control, were not sufficient to claim as successful results. Embark had no effect on fine fescue seedhead production for this study in 1983.

DOT 4 - PGR Compound-Species Interaction Study Sp 83

Eight species blocks were established at the Hancock Turfgrass Research Center in 1982: Kentucky bluegrass, smooth bromegrass, timothy, orchardgrass, perennial ryegrass, fine fescue, redtop, and tall fescue.

The compounds and rates applied wre: Embark (0.28 and 0.42 kg ai/ha), EL-500 (Cutless, 1.12 and 2.2 kg ai/ha), Eptam (5.6 and 11.2 kg ai/ha), MON-4621 (1.68 and 2.8 kg ai/ha), PP-333 (1.12 and 2.2 kg ai/ha) and Embark + Glean (0.14 and 0.14 kg ai/ha, respectively). All plots were treated 5/17/83 and 5/18/83.

Evaluation parameters included: degree of discoloration or thinning, vertical vegetative height, actual seedhead height, relative seedhead density, overall quality of control, visual color response and seedhead suppression index (which is computed by multiplying actual seedhead height times relative seedhead density). Only the seedhead suppression index will be reported here.

Calculation of the seedhead suppression index for a PGR compounds enables us to make more comprehensive comparisons among chemicals.

Figure 5 shows graphically the seedhead suppression index of each compound and rate for fine fescue. Both rates of Eptam and MON-4621 provided the best responses, which means the lowest index values. The high rates of EL-500, Embark, PP-333 and the Embark + Glean combination each resulted in index values close to one half that of the control. The low rates of EL-500, Embark and PP-333 showed insignificant responses.

Figure 6 reports the seedhead suppression index for each PGR rate or combination on perennial ryegrass. Again both rates of Eptam and MON-4621 had very low seedhead suppression indices as compared to the control. The high rate of PP-333 and the Embark + Glean combination showed the only other excellent responses. EL-500 and Embark at both low and high rates were essentially ineffective seedhead inhibitors in this study. The low rate of PP-333 was likewise ineffective.

DOT 5- Mowing Energy Study Sp 83

Kentucky bluegrass plots four feet by thirty feet were located at the Soils Research Center on campus. All plots for this study were treated on 5/11/83. The PGR compounds and rates used in this study were: Embark (0.14 and 0.28 kg ai/ha), Eptam (5.6 and 11.2 kg ai/ha), MON-4621 (1.12 and 2.2 kg ai/ha) and two Embark + Glean combinations (Embark at 0.07 and 0.14 plus Glean at 0.014 and 0.014 kg ai/ha).

Evaluation parameters were: relative seedhead density, relative vegetative density, relative vegetative growth, relative weed population, visual color response, vertical vegetative height, overall quality of control, and watts of electricity used to mow a strip of each plot using a specially adapted electric mower. Watts used and relative weed population will be reported.

Both Embark + Glean combinations provided greater weed population reductions than any other PGR compound. Glean is known for its superior broadleaf weed control characteristics so this response would be considered typical. Weed populations for all rates of the remaining compound were not different than the control. With the high rate of Eptam the weed population was actually greater than the control, although the increase was not significant statistically.

The energy required to mow each plot with the electric mower was recorded as watts of electricity used per plot. Mowing evaluations were made on 7/8/83 (58 days after treatment). Figure 7 diagrams the results as watts used. Neither rate of MON-4621 provided a reduction in energy use as compared to the control. This is not an unusual response, nor is it undesirable. Previous experience has shown us that MON-4621 is an excellent seedhead inhibitor and that its vegetative growth inhibition is much less severe than many other PGR compounds. In many cases this might be advantageous given that with slower yet continued growth, the grass may be able to better withstand traffic than if all vegetative growth had been completely inhibited.

Each of the other compounds at low and high rates required significantly less mowing energy. Both rates of Eptam, the high rate of Embark and the heavy Embark + Glean Combination provided the greatest mowing energy reductions.

Seedhead supression and vegetative inhibition are the primary factors responsible for mowing energy reductions. Seedstalks, due to their toughness are more difficult to cut while mowing, therefore it follows that a good seedhead inhibitor would reduce the energy required to mow a utility turf area. Similarly, less vegetation will translate to lower mowing energy requirements.

DOT 6-PGR Compound Rate and Mixture Study Sp 83

This study is located at highway site 5 (U.S. 127 north of Lansing) which is predominantly Kentucky bluegrass and fine fescue with some quackgrass mixed throughout. The chemical treatments were: EL-500 (Cutless, 1.12 and 2.2 kg ai/ha), Embark (0.28 and 0.42 kg ai/ha), Eptam (5.6 and 11.2 kg ai/ha), MON-4621 (1.12 and 2.2 kg ai/ha), PP-333 (1.12 and 2.2 kg ai/ha), Embark + Glean at two rates (0.07 and 0.14 for Embark and 0.014 for Glean) and MON 4621 + Glean at two rates (0.84 and 1.68 for MON 4621 and 0.014 for Glean). All plots were treated 5/9/83.

Parameters evaluated for this study were: relative seedhead density, relative vegetative density, visual color response, overall quality of control, actual seedhead height and clipping yields. Relative seedhead density will be reported here.

Superior seedhead suppression was found with both rates of Embark and for both rates of the Embark + Glean combination. Excellent responses were recorded for both rates of Eptam. Moderate seedhead suppression was observed on plots treated with MON-4621 at low and high rates and with both MON-4621 + Glean combinations. EL-500 (Cutless) and PP-333 treatments had no effect on seedhead production in this study. For graphical representation of all relative seedhead density responses, see figure 8.

Interestingly the Embark treatments provided superior seedhead suppression in this study (DOT 6, figure 8) while in study DOT 2 (figure 3) seedhead suppression was quite ineffective. As in the comparison of studies DOT 1 and DOT 2 discussed earlier, the explanation of this differential efficacy lies in the weather record. The DOT 2 plots were rained on soon after treatment which reduced the leaf contact time and the foliar uptake of the Embark. On the other hand, the DOT 6 plots did not receive rain for at least five days which allowed for much greater plant absorption of the Embark, and in turn produced more dramatic growth regulation effects. Hot dry weather following treatments with crown and/or root absorbed PGR compounds will negatively affect their efficacy. These compounds need to be washed into the crown/root zone for uptake, if not they are subject to photodecomposition and microbial attack which reduces their effectiveness dramatically. The results from study DOT 6 demonstrate this variation due to weather quite well.

Conclusions

1. The timing of seedhead initiation varies among grass species, therefore, the timing of PGR compound application is critical for seedhead suppressions of specific grasses.
2. When uncontrolled, seedhead height and seedhead density are the primary factors responsible for the low aesthetic quality of highway roadsides, along with objectionable weedy species.
3. Michigan roadsides are populated with coarse and fine textured grass species. The responses of Kentucky bluegrass and fine fescue treated with the selected PGRs were more consistent than the responses of the coarser species.

4. Appropriate herbicides must be used in combination with PGRs where weed encroachment pressure is high.
5. PGR treatments can reduce mowing energy requirements through the suppression of vegetative growth and seedhead production of desired species, but PGRs cannot eliminate all mowing needs.
6. The most beneficial growth suppression effects are found with early spring PGR applications. Spring treatments should be made after green up for improved aesthetic quality and enhanced plant uptake.
7. Prevailing weather conditions affect the efficacy of the PGRs evaluated. Treatment with foliarly absorbed compounds followed by a lack of rainfall produces a more dramatic response. Responses from crown and root absorbed compounds are enhanced if rainfall occurs soon after treatment.

LITERATURE CITED

1. McElroy, M.T., P.E. Rieke, and S.L. McBurney. 1983. Plant growth regulator efficacy on utility turfs. 53rd Ann. Mich. Turfgrass Conf. Proc. 12:27-31.

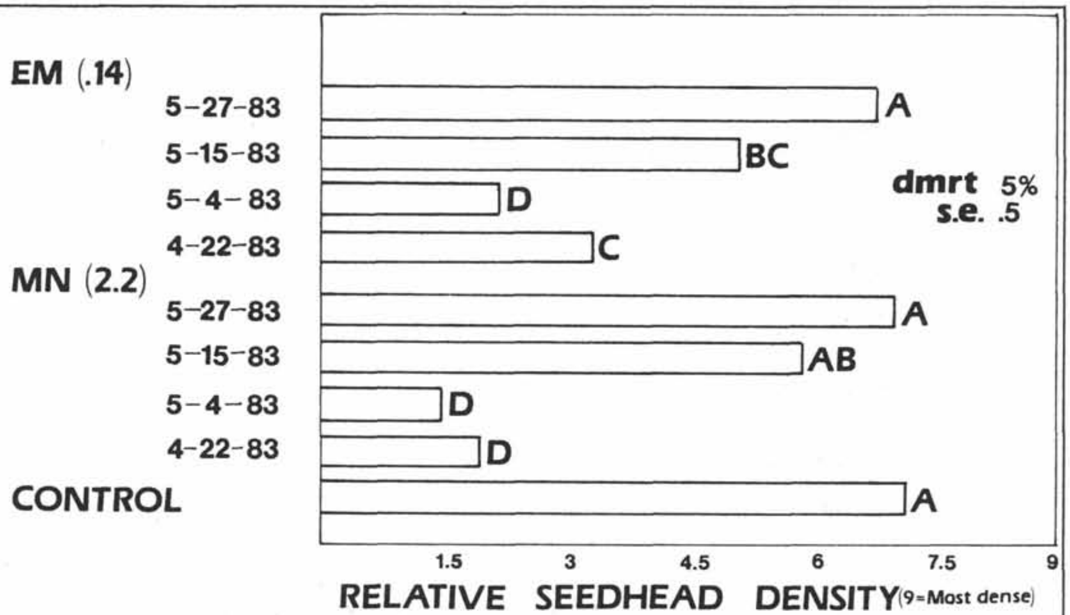

FIGURE 1.
1983 DOT 1. RELATIVE SEEDHEAD DENSITY, all species combined. Evaluated 7-18-83.

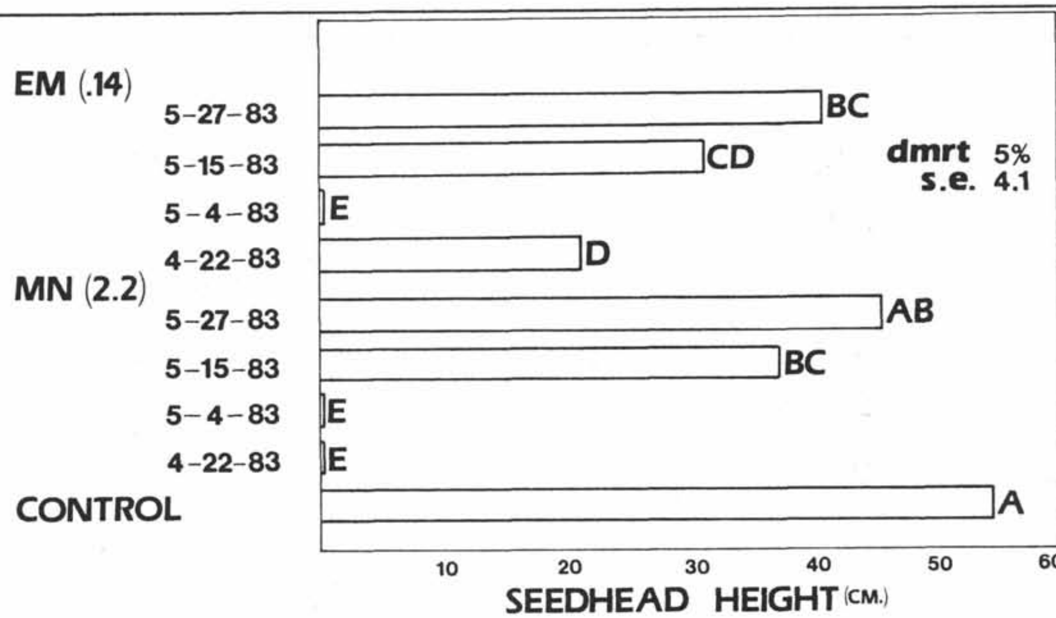

FIGURE 2.
1983 DOT 1. *Poa pratensis*. SEEDHEAD HEIGHT. Evaluated 7-22-83.

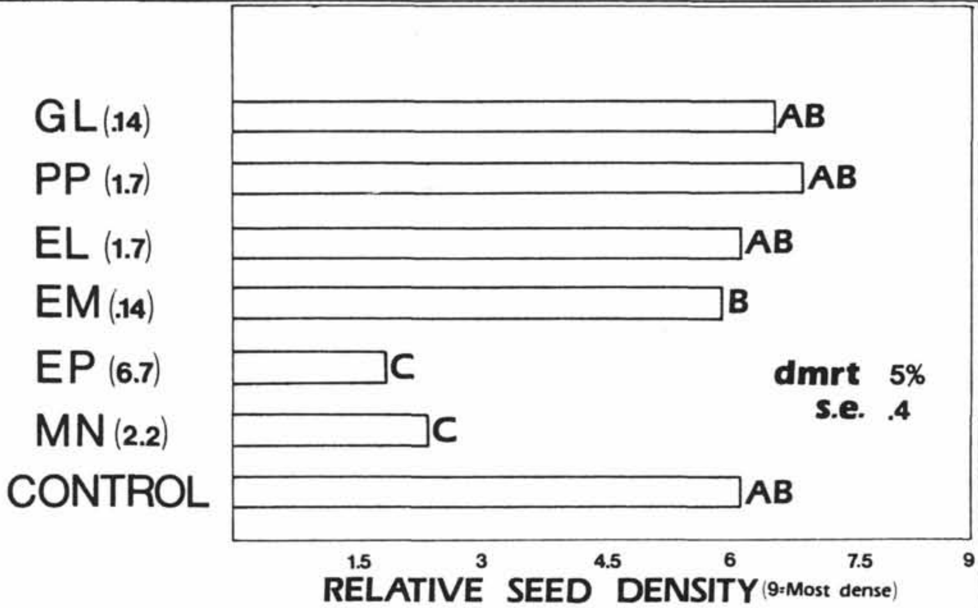

FIGURE 3.

1983 DOT 2. Treated 5-6-83. RELATIVE SEEDHEAD DENSITY, all species combined. Evaluated 7-19-83.

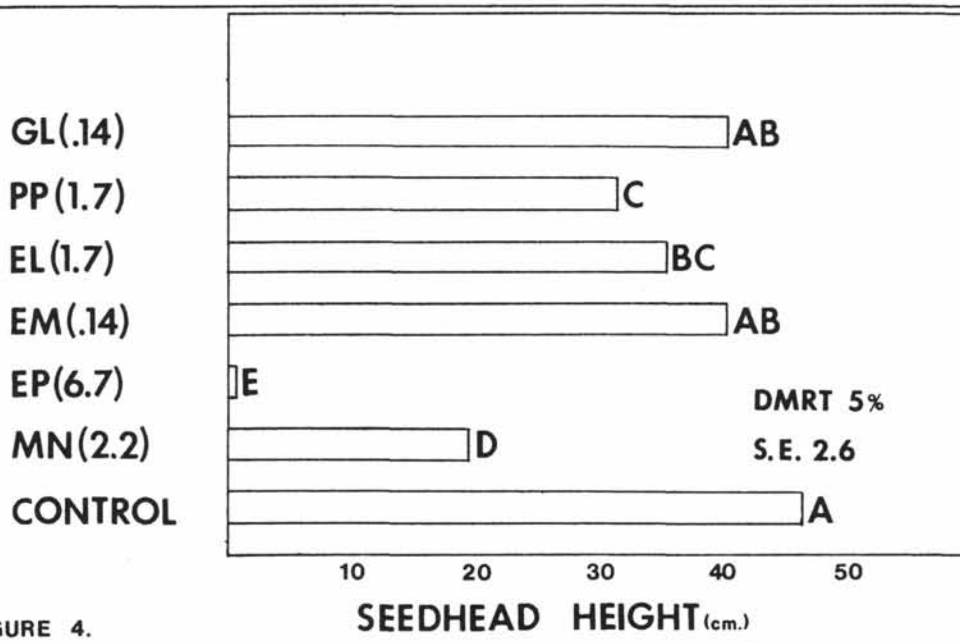

FIGURE 4.

1983 DOT 2. Treated 5-6-83. Poa pratensis SEEDHEAD HEIGHT. Evaluated 7-26-83.

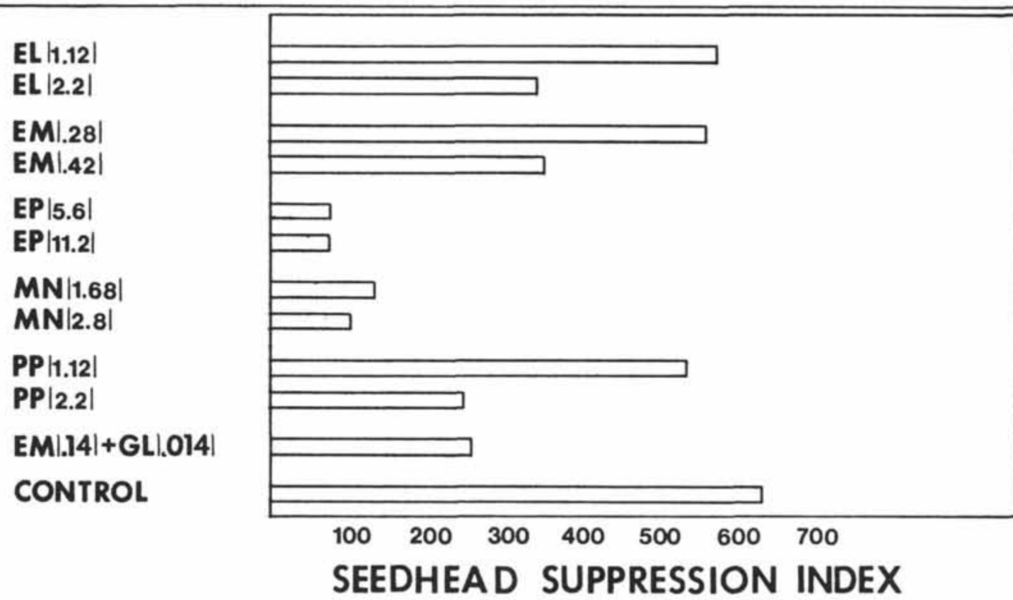

FIGURE 5.
1983 DOT 4. Relative seedhead density times Seedhead height equals SEEDHEAD SUPPRESSION INDEX. Treated 5/18/83. Fine fescue.

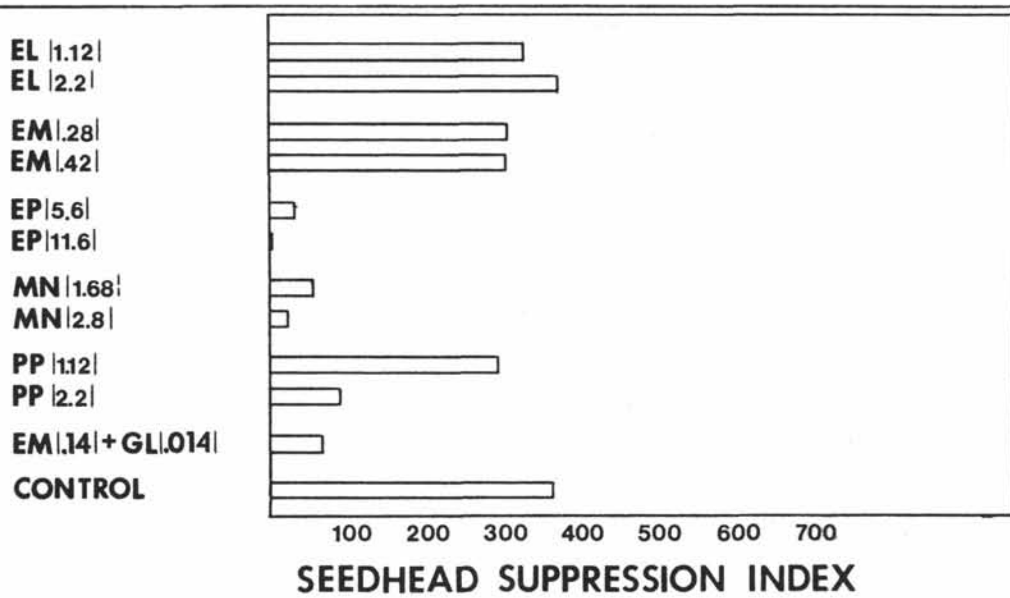

FIGURE 6.
1983 DOT 4. Relative seedhead density times Seedhead height equals SEEDHEAD SUPPRESSION INDEX. Treated 5/18/83. Perennial ryegrass.

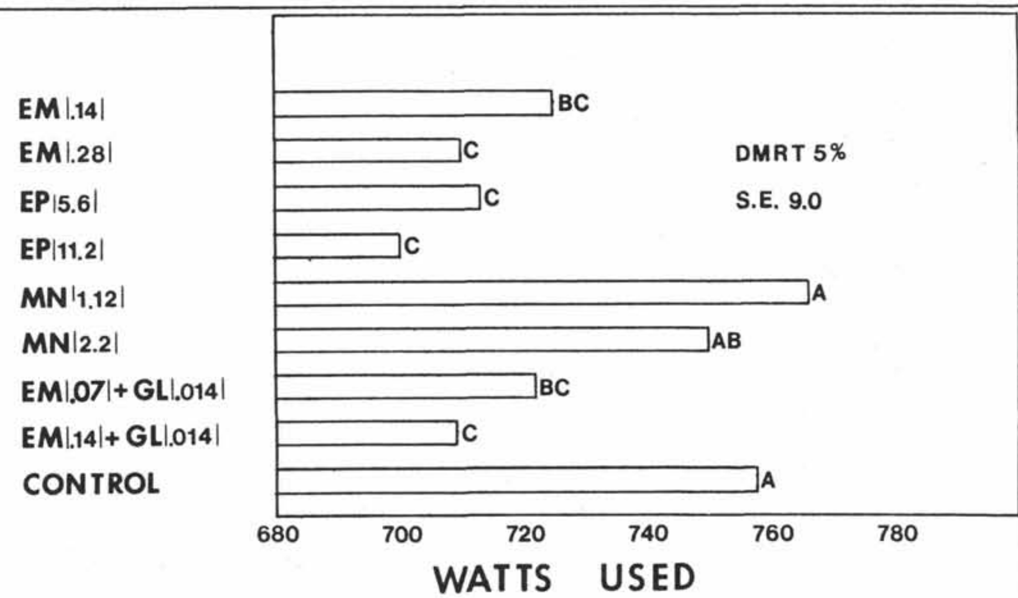

FIGURE 7.
1983 DOT5. Electrical energy as WATTS USED per plot. Treated 5/11/83. Evaluated 7/8/83.

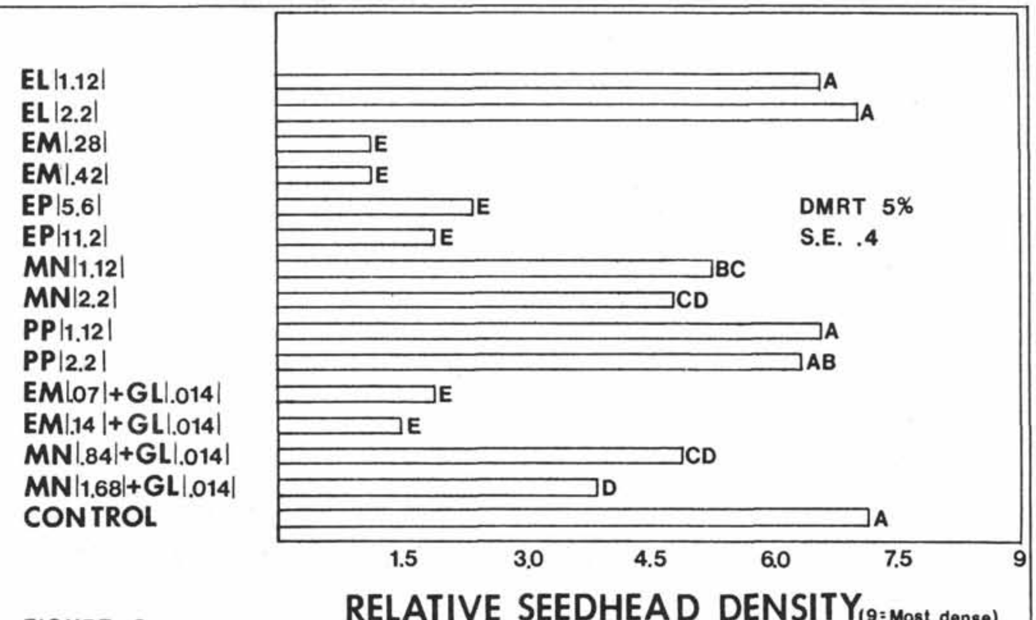

FIGURE 8.
1983 DOT6. RELATIVE SEEDHEAD DENSITY, all species combined. Treated 5/9/83. Evaluated 7/19/83.