PLANT GROWTH REGULATOR RESEARCH ON MICHIGAN ROADSIDES--FINAL REPORT

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In the spring of 1982 Michigan State University received funding approval for the research project entitled "Using Plant Growth Regulators to Develop a Cost Efficient Management System for Roadside Vegetation". Grateful acknowledgement is given to the Federal Highway Administration and the Michigan Department of Transportation for funding the orginial two year grant (for 1982 and 1983) and extending the funding for additional research through the 1984 growing season.

Our studies were designed to evaluate the performance of some commercially available and experimental Plant Growth Regulators (PGRs) on highway roadside grass and weed species. Figure 1 lists the basic objectives for all studies.

Deleterious side effects are sometimes found when using many of the PGRs evaluated in our studies. Therefore, utility turfs (i.e. roadsides, industrial grounds, rights of way, fence rows, etc.) with their "distant landscape" visual perception and lower demand for aesthetic beauty are well suited for PGR application. It should be noted however, that any long lasting side effects (severe phytotoxic injury and/or discoloration) would not normally be acceptable even on low maintenance utility turfs. In addition to plant injury we observed some degree of variability in the effectiveness of individual compounds depending on the site, the weather conditions before and after application, and the species of grass (or weed) being treated. Despite this, the beneficial effects by far outweigh the limitations for PGR use in the future at all levels of turfgrass maintenance.

Careful attention must be paid to application technique and timing. Most PGRs require precise dosage for optimum effectiveness. Overtreatment can be herbicidal with some compounds or a waste of money with others. Under treatment is essentially not effective for nearly all compounds. Application techniques for PGRs depend on the nature of the compound being used. Foliarly absorbed compounds must be applied to living foliage when environmental conditions are favorable for their uptake. Temperatures need to be warm enough for active plant growth and there must be a period without rain of at least 12 hours following application. Crown and/or root absorbed compounds must also be applied while the plant is actively growing, however, the PGR compound must be delivered to the site of uptake (below the soil surface). To accomplish this, very high application gallonage is necessary or treatments can be made during or just prior to significant rainfall (0.05 inches or more as long as flooding does not occur).

Proper timing will help to provide the most effective plant growth inhibition while keeping the negative side effects to a minimum. Optimal PGR timing is very closely related to the seasonal weather of each site, particularly to the accumulated Growing Degree Days (GDD). GDD are calculated

by subtracting the preselected base temperature (most commonly 50 °F) from the average daily temperature (see Table 1 for an example of this calculation). If a positive number results then it is added to the previous days total accumulated GDD and becomes the new total. If the daily average temperature is less than the base, no GDD are lost or gained.

Seedhead suppression is the primary concern of utility turfgrass maintenance programs. This is due to the height to which they grow and to the poor aesthetic appearance of the site once the seadheads mature. Vegetative suppression can be simultaneously achieved if the timing of application is correct but this is usually a secondary consideration for utility turfs.

SUMMARY OF RESULTS

DOT 1-PGR Application Timing Study, Spring 82, 83 and 84

Embark^{R} and Limit^{R} (formerly MON-4621) were applied on four dates for each year of study (see Figure 2 for dates and rates of application). Three separate sites were used. All three were located on highway medians adjacent to Highway U.S. 127 north of Lansing, Michigan. Kentucky bluegrass and fine fescue were the predominant species with small percentages of other grasses throughout the plots.

Relative seedhead density is being reported. Additional evaluation factors included: seedhead height, relative vegetative density, vertical vegetative height, visual color response, overall quality of control and clipping yields.

The two earliest dates of application provided the best seedhead suppression for both Embark and Limit for all three years of study (Figure 2). Each year, Limit treatments provided slightly better seedhead suppression on the first two application dates than did Embark treatments on the same dates. The later dates of application were essentially not effective for practical purposes. The data shows that the timing of PGR applications is critical for optimum effectiveness. Seedhead suppression requires the most exact timing because PGR effectiveness depends on the stage of plant development at the time of application. This is largely determined by the daily temperatures and the accumulation of temperature effects which are quantified through the calculation of accumulated growing degree days (GDD). For 1983 and 1984 the "window of activity" (defined as the time span in calendar weeks during which any particular PGR compound must be applied for maximum effectiveness) appears to have been greater in duration for Limit than for Embark. This is exhibited best by 1984 relative seedhead density ratings (Figure 2) and by 1983 seedhead heights (not shown).

Figure 3 gives a graphic representation of plot ratings versus calendar date and growing degree days (GDD) for 1983 and 1984. For 1983 the highest quality ratings (taken on 7-18-84) were given to the first two treatment dates with the later treatments receiving lower overall quality marks. Again in 1984 the same trend is found as of 6-25-84, the earliest treatments (more so DOT 1 than DOT 1B) are judged to be superior in quality of control with later treatments showing some to poor control. Treating prior to 25 GDD is not

recommended at all and applications after approximately 150 to 175 GDD may provide varying amounts of vegetative control but the potential for seedhead suppression is greatly diminished.

DOT 1B-PGR Herbicide Experimental Application Timing Study, Spring 1984

Embark (0.125 lb ai/A) and Limit (1.5 lb ai/A) were combined with Telar^{R}(0.5 oz ai/A), a broad spectrum broadleaf herbicide and applied on five different dates (see Figure 4) for dates). This study was undertaken only during 1984 to evaluate the interactive effects of these two PGRs and Telar, a commercially available herbicide. The study was located on a highway median strip adjacent to highway U.S. 127, north of Lansing Michigan. The predominant grasses were Kentucky Bluegrass and fine fescue with some quackgrass, smooth bromegrass and tall fescue mixed throughout the plot area.

Figure 4 shows relative seedhead density and overall quality of control (both evaluations taken 7-24-85). Overall quality of control ratings were highest and relative seedhead densities lowest for the 5/2 and 5/10 applications of the Limit-Telar combination. These were also the most effective treatment dates for Embark-Telar, however, the ratings were not as good as those of Limit. The earliest treatment date (4/20/84) did not provide good control, in fact for the Embark-Telar treatments it was as ineffective as the last treatment (5/31/84). This shows that it is possible to treat too early as well as too late. The timing of Limit-Telar application did not appear to be as critical in this study. Embark-Telar treatments severely injured tall fescue in these plots especially those plots treated at the earlier dates.

DOT 2-Roadside PGR Compound Evaluation Study, Spring 1982, 1983 and 1984

Six PGR compounds were used in the 1982 and 1983 studies. They were: Embark EM), Limit (MN), Eptam (EP), EL-500 (EL), PP-333 (PP) and Glean (GL, same as Telar). For 1984 Glean (Telar) treatments were dropped from the study for lack of significant inhibition of grass growth. All treatments were applied on single dates each year of the study (see Figure 5 for treatment rates and dates of application). The site was located on a highway roadside and backslope adjacent to U.S. 127 north of Lansing, Michigan. Again the predominant grasses were Kentucky bluegrass, fine fescue with some smooth bromegrass, orchardgrass, quackgrass and bunches of tall fescue. The same site was used for each year of study with each plot treated the same as the year before. The only significant carry-over effect observed was the long term activity of Glean (Telar). Glean at two ounces ai/A had been applied in 1982; nearly 100% weed control still existed in 1984.

Relative seedhead density is reported here; several other factors were evaluated, the data are not shown.

Limit and Eptam (now called Shortstop^{R}) consistently reduced seedhead density by more than half over the entire range of grass species for all three years of study. For the most part the other treatments did not provide seedhead suppression of practical magnitude. Other studies showed similar lack of activity with these other PGR compounds, however, it is unusual to

have such poor response from Embark treatments. Embark gave excellent results on other very similar highway sites, so it is not known how this study or location may have been different causing these contradictory results. Tall fescue was also significantly injured by the Telar treatments in this study.

CONCLUSIONS

1. Applications before 25 Growing Degree Days (GDD) based on 50 ^{o}F have accumulated can inhibit normal spring green up and result in a greater duration of poor aesthetic quality. Applications following the peak period for seedhead initiation (approximately 150 to 175 GDD), reduced effects for the improvement of turf quality.

2. The timing of seedhead initiation varies among grass species, therefore, the timing of PGR compound application is critical for seedhead suppression of specific grasses. The "window of activity" for PGR treatment of a mixed stand can, therefore, be difficult to determine.

3. Prevailing weather conditions affected the efficacy of the PGRs evaluated in these studies. The duration of leaf contact time is very important for foliar absorbed compounds such as Embark. Rainfall soon after treatment with foliarly absorbed PGRs will dramatically reduce the efficacy of these compounds. On the other hand, the efficacy of crown and/or root absorbed compounds such as Limit, Cutless and Telar is enhanced if rainfall occurs soon after application.

4. When uncontrolled, seedhead height and seedhead density are the primary factors responsible for the low aesthetic quality of highway roadsides. Seedhead suppression of cool season grasses was the only form of season long control produced by the PGR treatments used in these studies. Season long vegetative control was not observed for any PGR treatment.

5. Most PGRs tested were somewhat species specific. On fine-textured species such as Kentucky bluegrass and fine fescue excellent seedhead suppression was found, while on coarser-textured grasses such as bromegrass, tall fescue, and orchardgrass, much less consistent seedhead control was observed. Telar when combined with Embark caused severe injury to tall fescue at very low rates.

6. Embark treatments must be carefully applied because over application can cause severe injury while under application may provide unsatisfactory vegetative and seedhead control for practical use. Some discoloration was observed on plots treated with Eptam with higher rates being more severely injured. Over treatment with Limit (MON-4621) did not result in severe discoloration but under treatment was significantly less effective than optimum rates.

7. Currently available PGRs will not likely eliminate all mowing needs. Necessary mowings will however be more economically accomplished due to reduced vegetative growth and seedhead density.

8. Several PGR treatments produced color enhancement of the treated turf.

Improved green color is considered to be a positive aesthetic effect at any level of turfgrass maintenance. In general the PGRs given superior overall ratings also resulted in improved green color. Reduced seedhead production and delayed senescence of leaf tissue contributed to the perception of color enhancement of the treated plots by reducing the accumulation of straw or brown colored tissue. Other research has suggested that some PGRs cause increased chlorophyll production and accumulation of carbohydrates in living turf foliage which would also result in color enhancement.

9. Many utility turf sites are subject to significant weed encroachment pressure. PGR treatments which cause excessive turf thinning and greatly reduced turf vigor will increase the potential for weed encroachment. Also, PGR treated turfs may have increased disease susceptibility and on sloped sites the potential for soil erosion is increased. These problems must be addressed while planning to begin a PGR vegetation management program.

Table 1. An example of the method used to calculate accumulated Growing Degree Days (GDD). Use 50 degrees Fahrenheit as the base temperature in calculations.

EXAMPLE

DATE	TEMPERATURE(°F) Minimum	Maximum	Average	DAILY Accumulation	TOTAL Accumulation
1 May	40	52	46	0.0	0.0
2 May	45	55	50	0.0	0.0
3 May	45	65	55	5.0	5.0
4 May	50	62	56	6.0	11.0
5 May	53	58	55.5	5.5	16.5
6 May	41	50	45.5	0.0	16.5

CALCULATIONS

$$\frac{\text{Minimum + Maximum (Temp)}}{2} = \text{Average Temperature}$$

Average Temp - Base Temp = Daily GDD accumulated (negative numbers = 0)

Previous total accum + Daily accum = New total GDD accumulated

SAMPLE

3 May Minimum temp = 45°F
Maximum temp = 65°F

$$\frac{45°F + 65°F}{2} = 55°F \text{ Average temp}$$

Average temp = 55°F
Base temp = 50°F

55°F - 50°F = 5.0 GDD accumulated

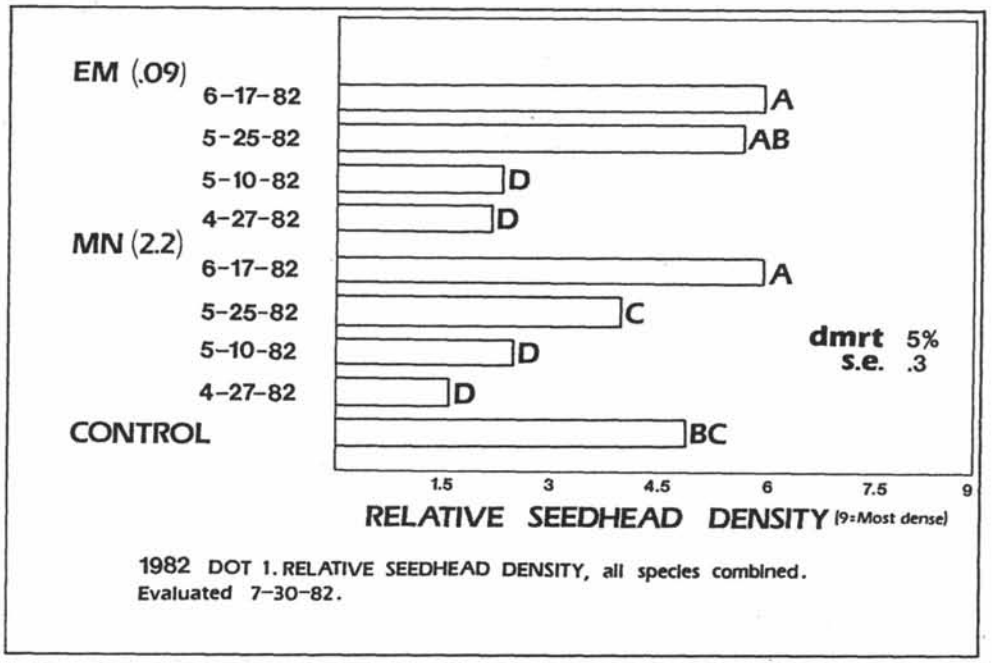
Previous total accumulation = 0.0 GDD
3 May GDD accumulated = 5.0 GDD

0.0 GDD + 5.0 GDD = 5.0 Total GDD

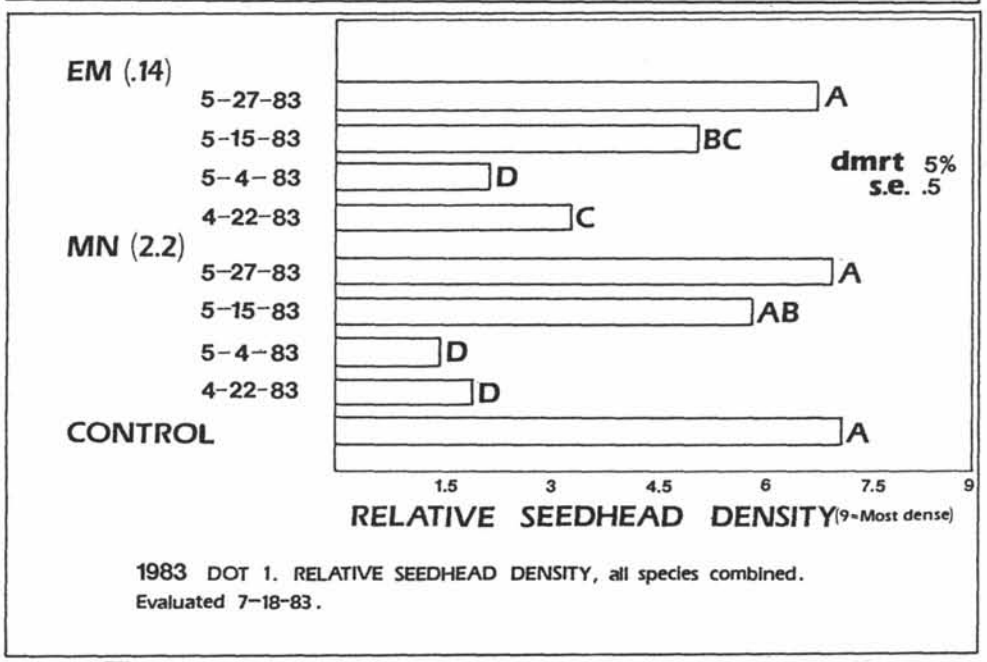
OBJECTIVES

1) To determine the "window of activity" of selected PGRs on roadside grasses.
2) To determine the activity of specific PGRs over a range of grasses and weed species.
3) To evaluate selected PGR–Herbicide combinations for vegetative and seed–head suppression of roadside grasses.
4) To evaluate the potential to reduce energy consumption when mowing.
5) To evaluate different rates of application for selected PGRs and PGR–Herbicide combinations.
6) To compare the cost:benefit ratio of PGR application versus mowing.

FIGURE 1

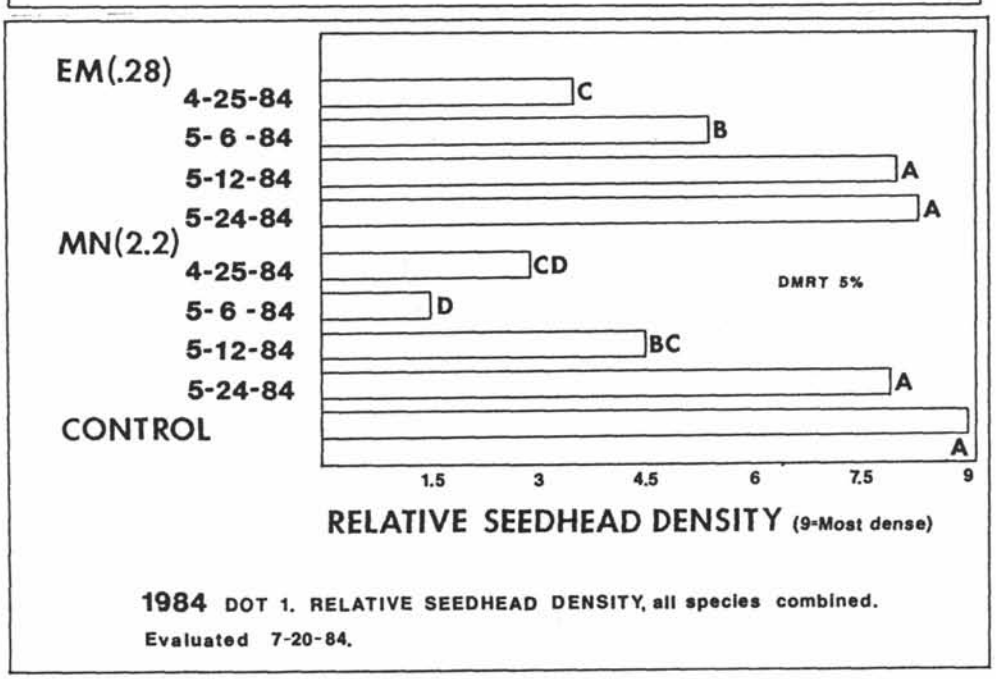


1982 DOT 1. RELATIVE SEEDHEAD DENSITY, all species combined.
Evaluated 7-30-82.

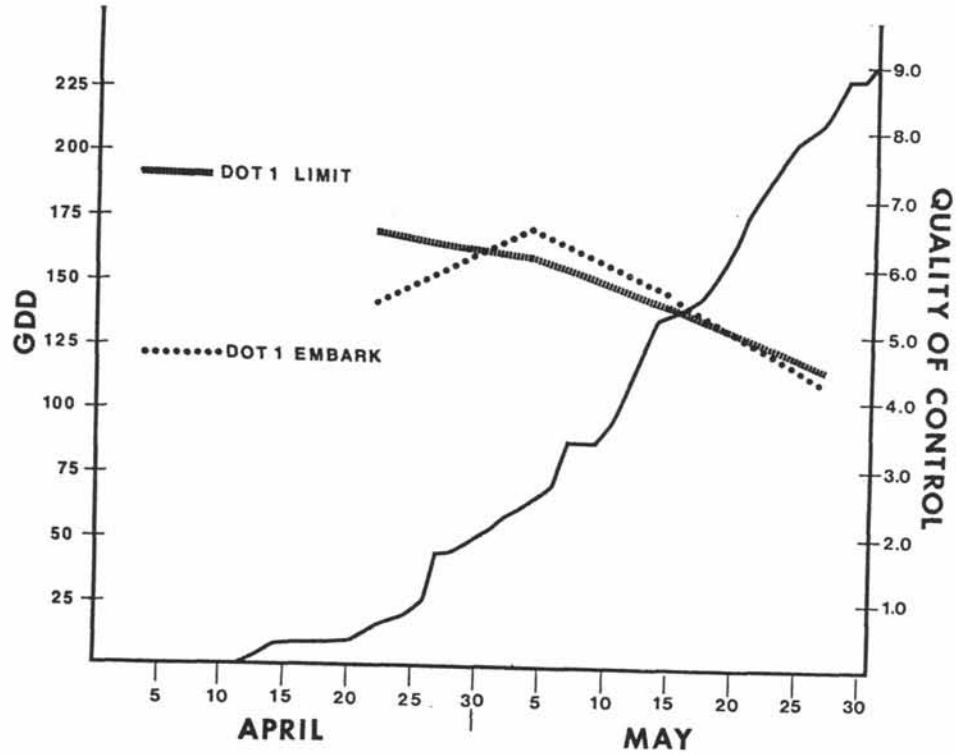


1983 DOT 1. RELATIVE SEEDHEAD DENSITY, all species combined.
Evaluated 7-18-83.

FIGURE 2

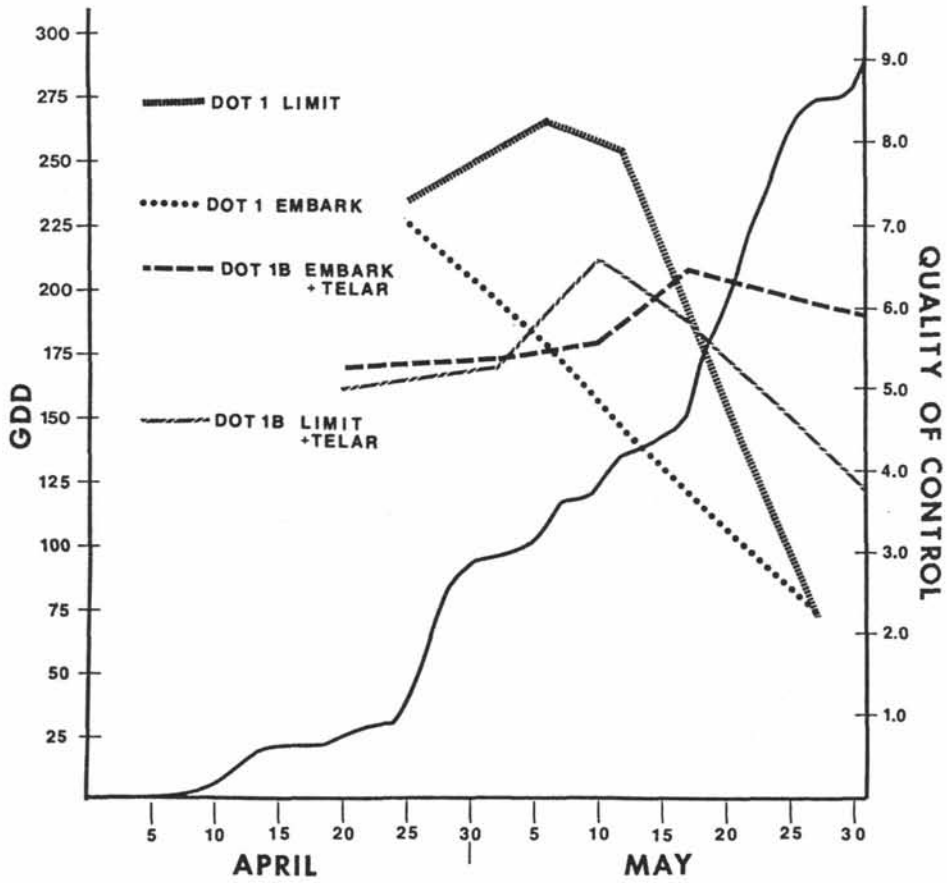


1984 DOT 1. RELATIVE SEEDHEAD DENSITY, all species combined.
Evaluated 7-20-84.

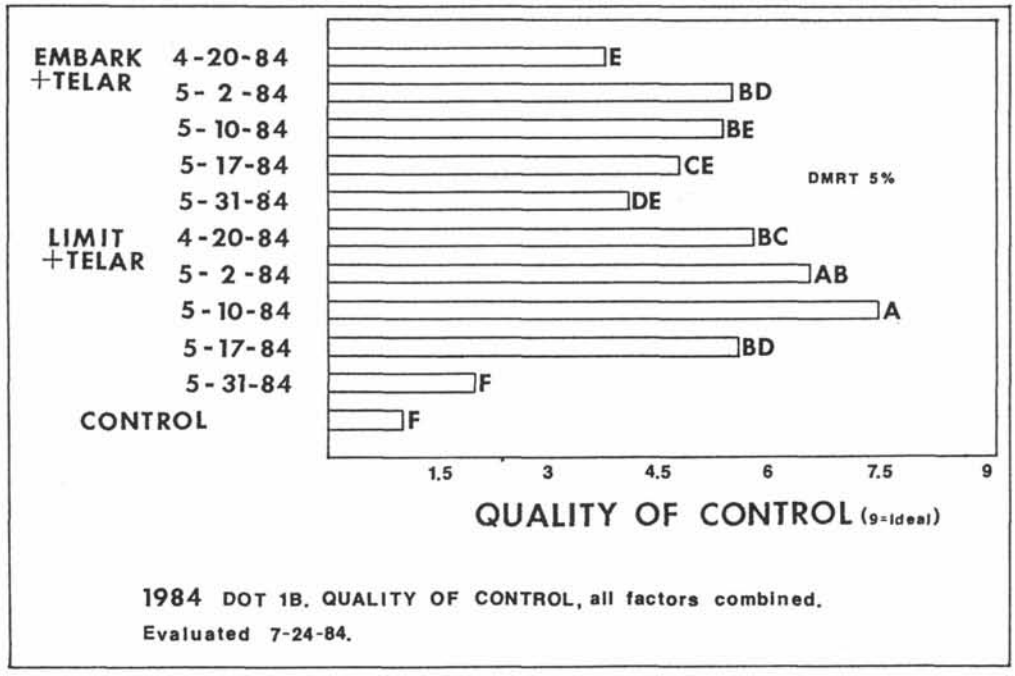


1983 DOT 1. QUALITY OF CONTROL versus Growing Degree Days (GDD) for each date of application. Evaluated 7-18-83.

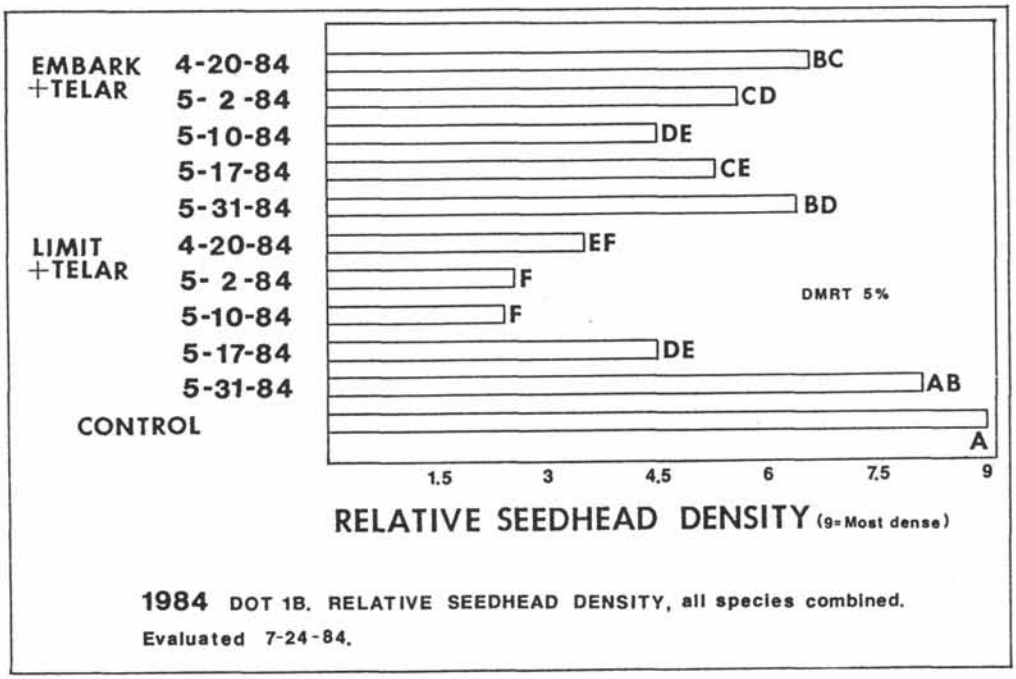
FIGURE 3



1984 DOT 1 and DOT 1B. QUALITY OF CONTROL versus Growing Degree Days (GDD) for each date of application. Evaluated 6-25-84.



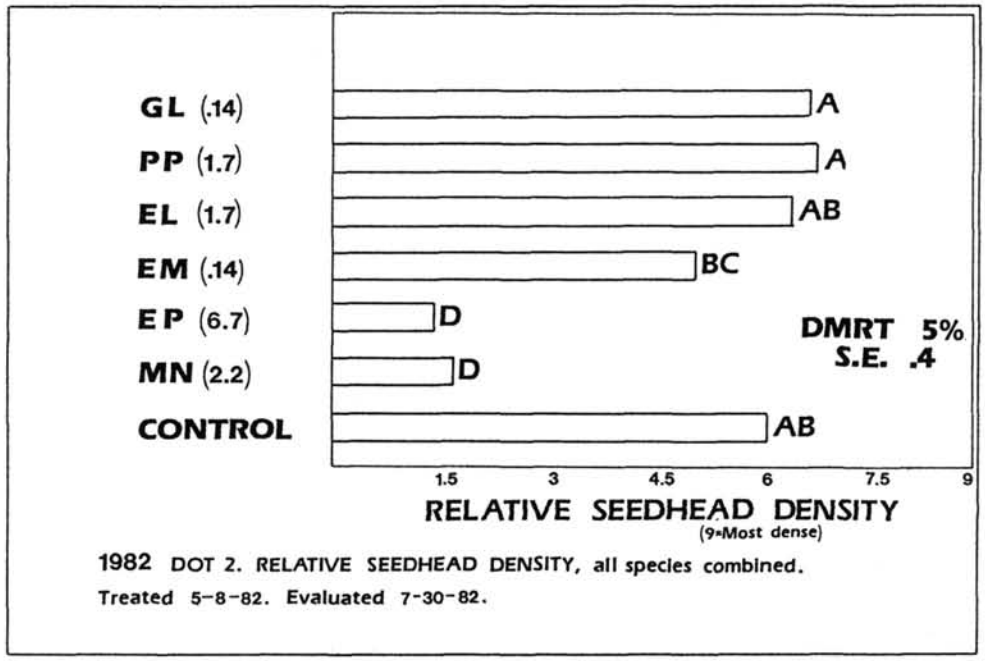
1984 DOT 1B. QUALITY OF CONTROL, all factors combined.
Evaluated 7-24-84.



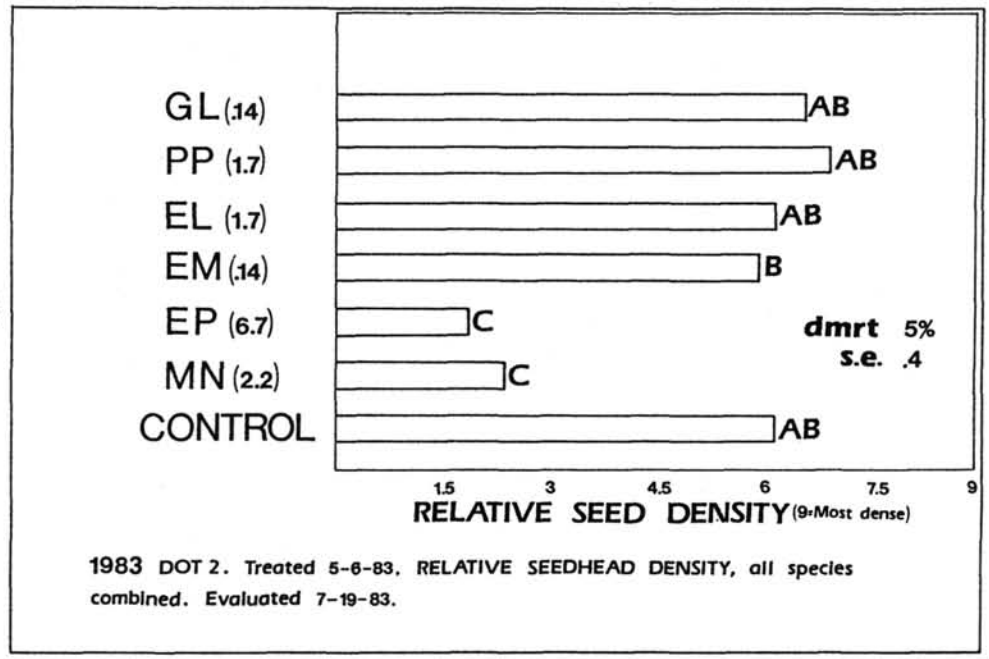
1984 DOT 1B. RELATIVE SEEDHEAD DENSITY, all species combined.
Evaluated 7-24-84.

FIGURE 4

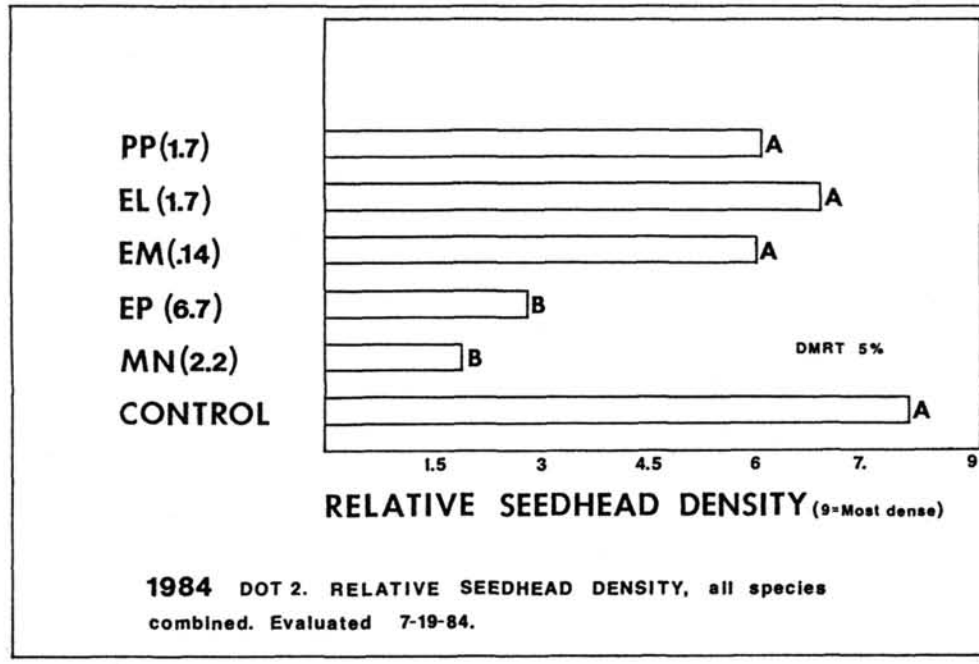
FIGURE 5



1982 DOT 2. RELATIVE SEEDHEAD DENSITY, all species combined. Treated 5-8-82. Evaluated 7-30-82.



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



1984 DOT 2. RELATIVE SEEDHEAD DENSITY, all species combined. Evaluated 7-19-84.