# Evaluation and Demonstration of Corn Gluten Meal as an Organic Herbicide

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***Summary***

Corn gluten meal (CGM), a plant-based product marketed to home gardeners for preemergent control of weeds as well as a nitrogen fertilizer, was tested for crabgrass and broadleaf weed control in turf in comparison to other organic materials and synthetic herbicides. We conducted two large studies; one without supplementing the study site with nitrogen fertilizer and one where the entire study site was fertilized with nitrogen in the form of calcium nitrate. We also conducted a smaller study comparing the effect on turf quality of CGM to that of an equivalent rate of nitrogen supplied by ammonium nitrate. We found that where the turf was not previously fertilized, there was an improvement in turf quality. However, no improvement was noted when the turf was adequately fertilized. It was difficult to assess weed control since overall weed pressure was low in all studies despite overseeding with crabgrass and broadleaf weeds.

***Introduction***

In recent years there has been increased public awareness of pesticides as they relate to environmental issues. While many people recognize that pesticides augment other methods of pest control, they are reluctant to use synthetic materials because of real or perceived health and environmental hazards. In 1991, researchers at the Iowa State University were granted a patent for the use of corn gluten meal (CGM) as a preemergence herbicide. CGM is a byproduct of the corn milling process and is 60% corn protein and 9.0% nitrogen. It is used as livestock feed material and in commercial pet food products. In 1996, CGM was classified by the USEPA as a material exempt from registration as a pesticide. Consequently, this material has become popular with the press and is currently being marketed (trade names Garden W.O.W. and Supressa) to home gardeners and organic growers as an alternative to synthetically derived herbicides.

The recommended rate for CGM as a preemergent herbicide is 20 lb/1000ft$^2$. In field studies conducted by Christians (1993) crabgrass was reduced by 58% when CGM was applied one week prior to crabgrass germination. In greenhouse studies, annual grasses and broadleaf weeds were reduced 0 to 97% (depending on the species) from that of the control at 324g/m$^2$ (equivalent to 66 lb/1000ft$^2$) which was the lowest rate tested (Bingaman and Christians, 1995). Root formation of susceptible species is reportedly inhibited by dipeptides found in CGM (Liu and Christians, 1996). However, the presence of the material alone at the high use rate (20 lb/1000ft$^2$) may also contribute to the reported weed control by acting as a mulch or by improving the competitiveness of the crop or turf due to nitrogen fertilizer effect.

In tests conducted by the University of California (Wilen, Elmore, unpublished), CGM was only marginally active as a herbicide, concurring with the 60% crabgrass reduction reported by Christians. Clearly, this product falls short when compared to commercially available synthetic herbicides, where greater than 80% control is expected. Nevertheless, there are no other products available that are sold as “natural” herbicides and there appears to be a market for such products regardless of their level of efficacy.

Cost and regulatory issues have also raised questions about the use of CGM. The cost of CGM when sold in bulk as a herbicide is $24 per 50lb. At the recommended rate, this is $9.60 per 1000ft$^2$ or $418/A, compared to synthetic herbicides which can be as inexpensive as $30/A. Nevertheless, cities where pesticide use is limited, e.g. San Francisco, have begun to use this material for controlling weeds on roadsides (Wilen, pers. comm.) because there are no other herbicidal options allowed.

There have been no studies comparing CGM to other organic amendments such as compost for weed control. In addition, combinations of synthetic herbicides and organic materials may result in more effective weed control at lower than label rates. Gardner et al. (1997) reported 75-85% crabgrass control could be achieved with reduced rates of pendimethalin when used in combination with CGM. Therefore, CGM may prove to be useful in reducing the amount of synthetic herbicide applied.

In these studies, we compared CGM to other organic materials (sawdust, compost) and synthetic herbicides and combinations of these materials in order to rank its herbicidal efficacy among these groups. We also report on the turf response to the fertilizer effect of CGM.

Table 1. Materials applied to turf in 1999.

| | Treatment | lb/1000ft$^2$ | | |
|---|---|---|---|---|
| 1 | Corn gluten meal[1] | 20 | | |
| 2 | Corn gluten meal | 10 | | |
| 3 | Corn gluten meal + compost[2] | 20 | + | 20 |
| 4 | Corn gluten meal + compost | 20 | + | 10 |
| 5 | Corn gluten meal + compost | 10 | + | 20 |
| 6 | Corn gluten meal + compost | 10 | + | 10 |
| 7 | Corn gluten meal + sawdust[3] | 20 | + | 20 |
| 8 | Corn gluten meal + sawdust | 20 | + | 10 |
| 9 | Corn gluten meal + sawdust | 10 | + | 20 |
| 10 | Corn gluten meal + sawdust | 10 | + | 10 |
| 11 | Weed Stop[4] | 0.21 | | |
| 12 | Weed Stop | 0.11 | | |
| 13 | Weed Stop + compost | 0.21 | + | 20 |
| 14 | Weed Stop + compost | 0.21 | + | 10 |
| 15 | Weed Stop + compost | 0.11 | + | 20 |
| 16 | Weed Stop + compost | 0.11 | + | 10 |
| 17 | Weed Stop + sawdust | 0.21 | + | 20 |
| 18 | Weed Stop + sawdust | 0.21 | + | 10 |
| 19 | Weed Stop + sawdust | 0.11 | + | 20 |
| 20 | Weed Stop + sawdust | 0.11 | + | 10 |
| 21 | Weed Stop + Corn gluten meal | 0.21 | + | 20 |
| 22 | Weed Stop + Corn gluten meal | 0.21 | + | 10 |
| 23 | Weed Stop + Corn gluten meal | 0.11 | + | 20 |
| 24 | Weed Stop + Corn gluten meal | 0.11 | + | 10 |
| 25 | compost | 20 | | |
| 26 | compost | 10 | | |
| 27 | sawdust | 20 | | |
| 28 | sawdust | 10 | | |
| 29 | none | 0 | | |

[1]granular formulation, 9%N, reapplied September 9, 1999
[2]humus, composted bark and greenwaste, approximately 2%N
[3]pine and fir, approximately 0.2%N
[4]granular formulation, 0.27% dithiopyr, Spectrum Group, St. Louis, MO, reapplied September 9, 1999, $12 (retail price) treats 1000ft$^2$ for 4 months

### *Materials and Methods*

The trials were conducted in 1999 and 2000 at Steele Canyon Golf Club in Jamul, California. The site was predominately bermudagrass, overseeded with perennial rye. In both years, the treatments were arranged in a completely randomized design with 5 replications. Plots were 5X10 ft. The study site was irrigated daily by sprinklers.

Study 1 (1999). Treatments (Table 1) were applied on July 7 and July 8, 1999 and reapplied on September 9, 1999. Materials were applied by shaking over each plot and raking in to spread. Large crabgrass (*Digitaria sanguinalis*), lambsquarters (*Chenopodium album*), and purslane (*Portulaca oleracea*) were overseeded over the entire site on July 15 at the rate of 0.2, 0.2, and 0.1 lb/1000 ft$^2$, respectively. Treatments were evaluated on August 31, September 21, and October 20 for turf quality (1-9 scale where 1=poor cover and color and 9=full cover and excellent green color) and weed cover (percent).

Study 2 (1999). CGM was applied on July 15 at the rate of 10 and 20 lb/1000 ft$^2$. This supplied the equivalent of 1 and 2 lb N/1000 ft$^2$, respectively. An equivalent amount of N, in the form of ammonium nitrate was applied to another set of plots to compare the fertilizer effect of CGM. Treatments were evaluated for turf quality as above.

Study 3 (2000). Treatments (Table 2) were applied on February 3, 2000. All materials except CGM were applied by shaking over each plot and raking in to spread. CGM was applied using a drop spreader. The entire site was fertilized with 50 lb calcium nitrate (equivalent to 1 lb N/1000 ft$^2$). Large crabgrass and lambsquarters were overseeded over the entire site on March 6 at the rate of 1.8 and 0.2 lb/1000 ft$^2$, respectively. Treatments were evaluated on May 15 and June 30 for weed cover (percent).

### *Results and Discussion*

Study 1. Because overall weed pressure was low over the entire study site it was difficult to elucidate differences among treatments; differences may be more evident if the weed population were higher. There were too few broadleaf weeds to evaluate, therefore, only the percent crabgrass cover was recorded. Main effects on turf quality and crabgrass control due to herbicide treatment are shown in Table 3. There were no differences in crabgrass control due to any of the treatments, either singly or in combination (data not shown). There was a significant difference in turf quality at the first evaluation date where CGM at the 20 lb.1000ft$^2$ rate had significantly better turf quality than the untreated control or the plots treated only with Weed Stop. However, this response did not carry over into the later evaluation dates. There was also no difference in weed control or turf quality when CGM or Weed Stop was reapplied 2 months after the initial application (data not shown).

Study 2. There were no significant differences between CGM and ammonium nitrate for turf quality at any of the evaluation dates (Figure 1). All treatments were adequate in maintaining turf quality.

Study 3. As in the Study 2, weed pressure was low despite overseeding with a large quantity of weed seed. This may have been due to the additional N added prior to oveseeding. Elmore (pers. comm.) found that crabgrass is not competitive if it germinates in less than 3”

Table 2. Materials applied to turf in 2000.

| | Treatment | lb/1000ft[2] | | |
|---|---|---|---|---|
| 1 | Corn gluten meal[1] | 20 | | |
| 2 | Corn gluten meal | 10 | | |
| 3 | Corn gluten meal+compost[2] | 20 | + | 20 |
| 4 | Corn gluten meal+compost | 20 | + | 10 |
| 5 | Corn gluten meal+compost | 10 | + | 20 |
| 6 | Corn gluten meal+compost | 10 | + | 10 |
| 7 | Corn gluten meal+sawdust[3] | 20 | + | 20 |
| 8 | Corn gluten meal+sawdust | 20 | + | 10 |
| 9 | Corn gluten meal+sawdust | 10 | + | 20 |
| 10 | Corn gluten meal+sawdust | 10 | + | 10 |
| 11 | Amaze[4] | 3 | | |
| 12 | Amaze | 1.5 | | |
| 13 | Amaze+compost | 3 | + | 20 |
| 14 | Amaze+compost | 3 | + | 10 |
| 15 | Amaze+compost | 1.5 | + | 20 |
| 16 | Amaze+compost | 1.5 | + | 10 |
| 17 | Amaze+sawdust | 3 | + | 20 |
| 18 | Amaze+sawdust | 3 | + | 10 |
| 19 | Amaze+sawdust | 1.5 | + | 20 |
| 20 | Amaze+sawdust | 1.5 | + | 10 |
| 21 | Amaze+Corn gluten meal | 3 | + | 20 |
| 22 | Amaze+Corn gluten meal | 3 | + | 10 |
| 23 | Amaze+Corn gluten meal | 1.5 | + | 20 |
| 24 | Amaze+Corn gluten meal | 1.5 | + | 10 |
| 25 | compost | 20 | | |
| 26 | compost | 10 | | |
| 27 | sawdust | 20 | | |
| 28 | sawdust | 10 | | |
| 29 | none | 0 | | |

[1]powder formulation, 9%N
[2]humus, composted bark and greenwaste, approximately 2%N
[3]pine and fir, approximately 0.2%N
[4]granular formulation, 1% benefin, 1% oryzalin, Green Light Co., San Antonio, TX, $4.50 treats (retail price) 1000ft[2] for 4 months

of open space. The turf may have become more closed and therefore more competitive when additional fertilizer was applied. We noted that in open spaces, such as where we had sprayed the corners of the plots with a non-residual postemergence herbicide or where tire tracks had disturbed the turf, that crabgrass grew abundantly. There was insufficient weed pressure to evaluate on May 15 therefore only the June 30 results are reported here.

There were no significant differences among treatments in this test. Results were too variable to make conclusions whether the addition of CGM to a reduced rate of synthetic herbicide (Amaze) would achieve adequate weed control (data not shown) or whether CGM or other organic materials provide adequate weed control in relation to a synthetic herbicide (Figures 2 and 3). Again, if the weed pressure were higher we may have been able to see differences among the treatments.

### *Conclusions*

Applications of CGM to nitrogen deficient turf can improve the appearance of turf by providing nitrogen as CGM decomposes. This may result in a more competitive turf that can better resist weed invasion. In well-fertilized turf, this response may not be as apparent. The results from this test were inconclusive regarding the overall weed control that may be imparted by CGM. All treatments, including combinations, were statistically equivalent. Cost comparisons of CGM to synthetic herbicides or fertilizer commonly available for residential use may make the use of this material prohibitive for most areas and uses (Table 4). Nevertheless, in areas where synthetic herbicides or fertilizers are not desired, this may be an alternative. Additional work should be done to examine the herbicidal effects of CGM with and without the interacting effects of turf competition.

### *Literature cited*


Bingaman, B.R. and N.E. Christians. 1995. Greenhouse screening of corn gluten meal as a natural control product for broadleaf and grass weeds. Hortscience 30:1256-1259.

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Gardner, D S, Christians, N E, Bingaman, B. R. 1997. Pendimethalin and corn gluten meal combinations to control turf weeds. Crop Science 37:1875-1877.

Liu, D.L. and N.E. Christians. 1996. Bioactivity of a


Table 3. Mean turf rating and percent crabgrass cover as affected by herbicide.

| | | Turf rating | | | | % Crabgrass cover | | |
|---|---|---|---|---|---|---|---|---|
| Herbicide | lb/1000ft[2] | Aug. 31 | | Sept. 21 | Oct. 20 | Aug. 31 | Sept. 21 | Oct. 20 |
| none | — | 4.52 | b[z] | 5.50 | 4.08 | 4.20 | 5.52 | 8.24 |
| CGM | 20 | 5.67 | a | 6.32 | 4.87 | 4.05 | 5.05 | 3.92 |
| CGM | 10 | 4.77 | ab | 5.46 | 4.57 | 1.50 | 2.62 | 2.30 |
| Weed Stop | 0.2 | 4.36 | b | 5.20 | 3.98 | 1.32 | 1.44 | 2.92 |
| Weed Stop | 0.1 | 4.68 | b | 5.74 | 4.30 | 2.60 | 4.84 | 6.08 |
| | | | | n.s. | n.s. | n.s. | n.s. | n.s. |

[z]numbers in a column folled by different letters are significantly different at the p=0.05 level by Fishers LSD test, "n.s." is "not significant".

pentapeptide isolated from corn gluten hydrolysate on *Lolium perenne* L. J. Plant Growth Regul. 15:13-17.

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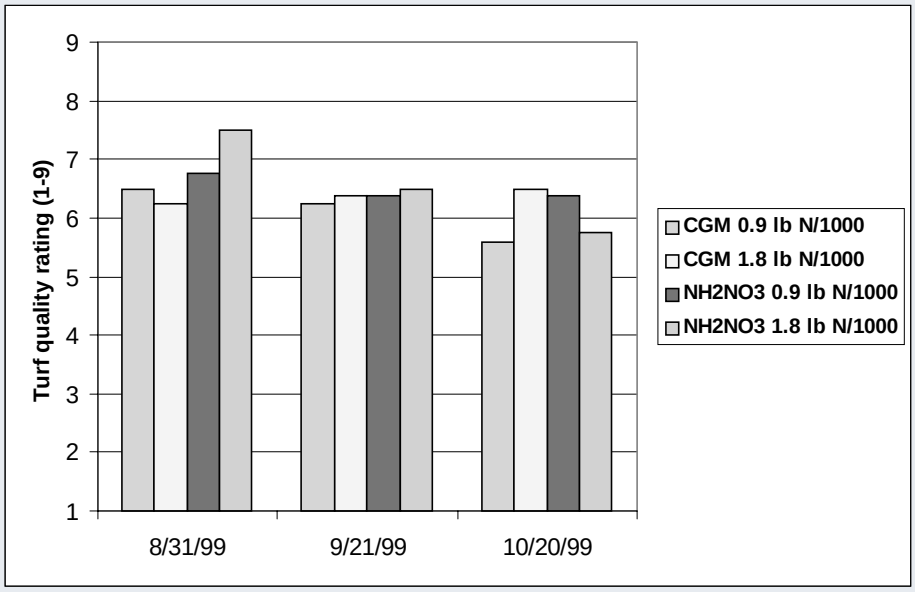
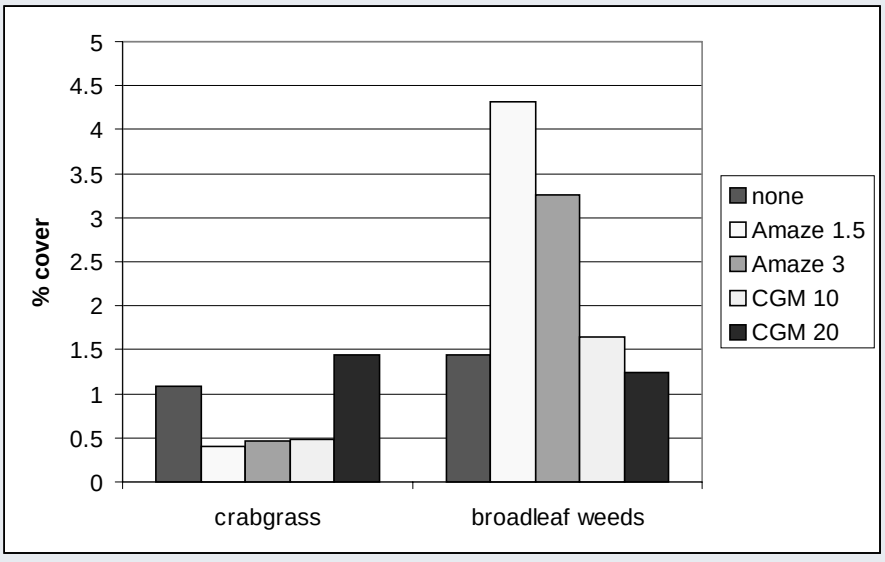



***Figure 1. Turf quality rating, 1999. (1-9 where 1=poor color and turf uniformity and 9=excellent green color and turf uniformity).***

***Figure 2. Percent crabgrass and broadleaf weed cover in turf as affected by herbicide. Number following herbicide name is rate in lb/A.***



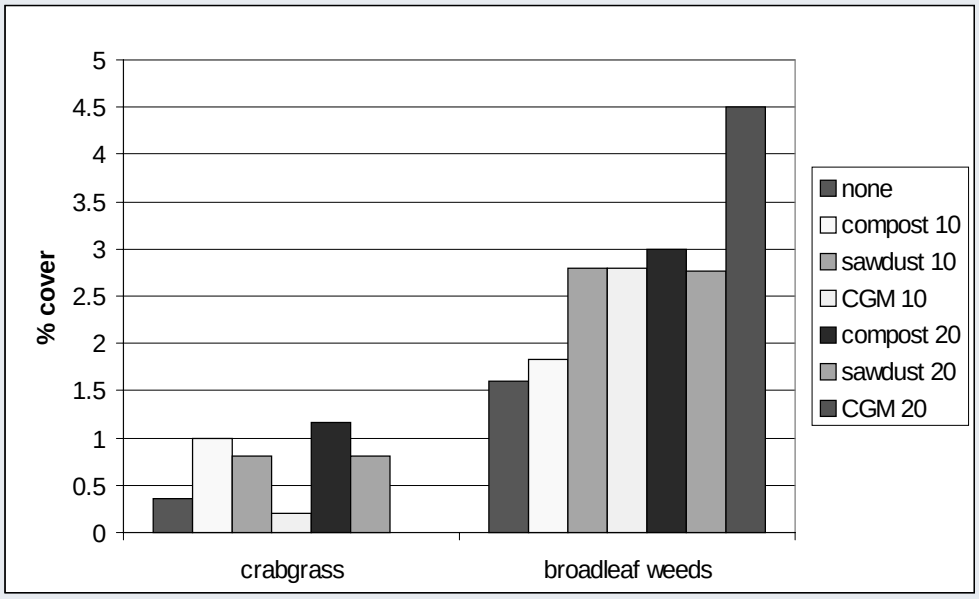



***Figure 3. Percent crabgrass and broadleaf weed cover in turf as affected by organic amendments. Number following amendment name is rate in lb/A.***

Table 4. Cost comparison of corn gluten meal, residential use herbicides, and nitrogen fertilizers.

| Material | Type | Rate to treat 1000 ft$^2$ (lb) [1,2] | Cost to treat 1000 ft$^2$ ($)[3] |
|---|---|---|---|
| Corn gluten meal | herbicide/fertilizer | 20 | ~20.00 (when purchased in 50 lb bag) |
| Amaze | herbicide | 3.00 | 4.50 |
| Weed Stop | herbicide | 4.25 | 12.00 |
| Calcium nitrate | fertilizer | 11.30 | 1.13 |
| Ammonium nitrate | fertilizer | 5.30 | 0.93 |
| Ammonium sulfate | fertilizer | 8.60 | 1.72 |

[1]Amount of herbicide needed to provide 4 months control of weeds listed on label.
[2]Amount of fertilizer needed to provide 1.8 lb N.
[3]Cost based on approximate retail price if purchased from home supply store.