2-BUTENAL, TRANS-2-PENTENAL AND RELATED ENAL COMPOUNDS FOR CONTROLLING PLANT PESTS AND WEEDS IN SOIL

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Field of Classification Search ............... 504/348; 514/703

See application file for complete search history.

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6,294,584 B1* 9/2001 Bockowski et al. ........ 514/693

FOREIGN PATENT DOCUMENTS
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English translation of JP 55002616 (Jan. 1980).*

* cited by examiner

Primary Examiner—John Pak

ABSTRACT

A method for controlling pests and weeds on or around plants, especially crop plants is disclosed. The method includes admixing 2-butenal, trans-2-pentenal or other related enal compounds to form an aqueous solution, and applying the aqueous solution to plants, plant seeds, weeds, or soil around the area in which the plants grow.

7 Claims, 10 Drawing Sheets
FIGURE 1. EFFECT OF APPLICATIONS 2-PROPENAL [ACROLEIN] ON POPULATIONS OF RENIFORM AND MICROBIVOROUS NEMATODES IN A SOIL FROM A COTTON FIELD

PREPLANT

RENIFORM
ROTYLENCHULUS RENIFORMIS
FLSD [p<0.05] = 106

MICROBIVOROUS
FLSD [p<0.05] = 11

2-PROPENAL APPLIED [MGS/KG SOIL]

Figure 1A
Figure 2. Growth response of 'Young' soybean to pre-plant applications of 2-propanal (acrolein) in an experiment with soil from a cotton field infested with the reniform nematode (Rotylenchulus reniformis).
ROOT CONDITION INDEX

2-PROPENAL APPLIED [MG/KG SOIL]

ROOT WEIGHT [GR] 0 25 50 75 100 125 150 175 200 225 250 275 300

ROOT CONDITION SCALE: 1 = BEST TO 5 = WORST

*ROOT CONDITION INDEX: 5 = 0

23 22 21 20 19 18 17 16

ROOT WEIGHT IN GMS
FIGURE 3. EFFECT OF 2-BUTENAL \textit{(CROTONALDEHYDE)} ON THE RENIFORM AND MICROBIVOROUS NEMATODES IN A SOIL FROM A COTTON FIELD.

\begin{figure}
\centering
\includegraphics[width=\textwidth]{figure3}
\caption{Microbivorous per 100 MLS Soil}
\end{figure}
FIGURE 4. CONTROL OF YELLOW NUTSEDEGE WITH POST-EMERGENCE APPLICATIONS OF 2-PROPENAL IN AN EXPERIMENT WITH SOIL FROM A COTTON FIELD ARTIFICIALLY INFESTED WITH THE WEED.
NEMATODES IN ROOT SYSTEM

Figure 6B

2-PENTENAL RATE [MG/ML SOIL]

NEMATODES PER 100 MLS SOIL
1
2-BUTENAL, TRANS-2-PENTENAL AND RELATED ENAL COMPOUNDS FOR CONTROLLING PLANT PESTS AND WEEDS IN SOIL

CROSS REFERENCE TO RELATED APPLICATION(S)

This application claims priority to U.S. Provisional Application No. 60/622,460, filed Oct. 27, 2004.

BACKGROUND OF THE INVENTION

The present invention relates to pesticides and herbicides, and more particularly to the use of 2-propanal and related enal compounds for controlling pests and weeds on or around plants, especially crop plants.

A variety of herbicides are well known and have been long used to kill unwanted weeds in crop fields. Typically, these herbicides are sprayed onto the soil (pre-emergence), or onto the plants themselves (post-emergence). Pesticides are also well known, and are necessary for reducing the level of pest infestation in the soil around the area in which the plants grow or on the plants themselves. One such pesticide is methyl bromide. Methyl bromide is an odorless, colorless gas that has been used as an agricultural soil fumigant to control a wide variety of pests. However, because it has been discovered that methyl bromide depletes the stratospheric ozone layer, its use is being phased out. It is therefore desirable to find a replacement for methyl bromide.

It is well known that many herbicides and pesticides are expensive, quite toxic to the environment, and often times result in unintended consequences such as soil and groundwater contamination, crop damage, spray drift on non-targeted plant species, and other health concerns. It is therefore desirable to provide an active compound that is relatively inexpensive, is less toxic to the environment, and minimizes the unintended consequences noted above, yet remains effective against weeds and pests.

Herbicides and pesticides also have a further disadvantage in that the active ingredient, as well as being quite toxic, has no function other than killing weeds or pests. In other words, the active ingredient typically does not have any beneficial effect on the soil or for the plant. Thus, it would also be desirable to provide an active ingredient that is not only herbicidal and pesticidally effective, but also may have some beneficial effect on plant growth.

SUMMARY OF THE INVENTION

The present invention is directed toward the use of 2-propanal and related enal compounds for controlling pests and weeds on or around plants, particularly crop plants. In one embodiment, the invention is directed toward a method for controlling pests and weeds on or around plants comprising the steps of providing an active compound an olefinically unsaturated lower alkyl aldehyde having the formula

```
\[ \text{R} = \text{H or straight chain alkyl radical having 1 to 5 carbon atoms, admixing an effective amount of}
```

the active compound with water to form an aqueous solution, and applying the aqueous solution to plants, plant seeds, weeds or soil around the area in which the plants grow. The preferred compounds are 2-propanal (acrolein), 2-butenal (crotonaldehyde) and trans-2-pentenal.

Although the application of these enal compounds are herbicidally and pesticidally effective with all types of plants, they are particularly effective when used to control pests and weeds on or around crop plants. Typical crop plants include corn, wheat, barley, oats, rice, sorghum, cotton, soybeans, potatoes, strawberries, tomatoes, sunflowers, sugar beets, oilseeds, peppers, turnips, turf, and cabbage. The above list is not all-inclusive, and only represents but a few of the crop plants with which the active enal compounds disclosed herein can be used.

The active enal compound is admixed with water in an amount of from about 1 to about 1350 parts of the active compound per million parts of water. Typically, the water will comprise irrigation water for the above crop plants. Typical application rates are from about 75 pounds to about 800 pounds of the active compound per acre of soil, and preferably the active is drenched in the soil to a depth of about 10 to about 12 inches to provide effective and long lasting herbicidal and pesticidal activity.

In another embodiment of the invention, it has been unexpectedly found that in low doses, the enal compounds disclosed herein provide a method of enhancing growth of the plants, especially crop plants. It has been discovered that the application of the active compound to soil around the area in which the plants grow in an amount of from about 1 pound to about 600 pounds of said active compound per acre of soil (lbs/A), preferably from about 100 to about 400 lbs/A, results in increased growth of plants as compared to plants growing in untreated soils.

In yet another embodiment of the present invention, it has further been unexpectedly found that the application of the active ingredient to soil around the area in which tomato plants grow results in reduced transplant shock of the tomato plants.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. 1A is a graph illustrating the effect of 2-propanal on reniform and microvirobas nematodes in soil at various pre-emergent application rates.

FIG. 1B is a graph illustrating the effect of 2-propanal on reniform and microvirobas nematodes in soil at termination of experiment.

FIG. 1C is a graph illustrating the effect of 2-propanal on reniform and microvirobas populations in plant root systems at termination of experiment.

FIG. 2A is a graph illustrating the effect of 2-propanal on the growth response of young soybean plants at various pre-emergent application rates.

FIG. 2B is a graph illustrating the effect of 2-propanal on the growth response of soybean plants at various pre-emergent application rates on root weight and root condition of the plant.

FIG. 3 is a graph illustrating the effect of 2-butenal on reniform and microvirobas nematodes in soil at various pre-emergent application rates.

FIG. 4 is a graph illustrating the effect of 2-propanal on yellow nutsedge in response to various post-emergent application rates.
FIG. 5 is a graph illustrating the effect of 2-butenal (crotonaldehyde) on yellow nutsedge in response to various post emergent application rates.

FIG. 6A is a graph illustrating the effect of 2-pentenal on reniform nematodes in soil and roots.

FIG. 6B is a graph illustrating the effective of 2-pentenal on microbivorous nematodes in soil and roots.

DETAILED DESCRIPTION OF THE INVENTION

It has now been discovered that the addition of olefinically unsaturated lower alkyl aldehydes to water, particularly irrigation water, employed in the agricultural industry for growing plants, especially crop plants, destroys and kills, or at least effectively inhibits, and therefore controls pests and weeds on or around such plants, without adversely affecting the plants themselves. Thus, the use of these olefinically unsaturated lower alkyl aldehydes in the amounts hereinafter described, kills, destroys and/or inhibits the growth of pests and weeds for substantial periods of time without affecting to any material degree the plant itself. These aldehydes thus provide an effective replacement for methyl bromide.

The olefinically unsaturated lower alkyl aldehydes contemplated by the present invention for use as the pesticidally and herbicidally effective active compound are those represented by the following general formula

\[
\begin{align*}
\text{R} & - \text{C} = \text{C} - \text{C} - \text{O} \\
\end{align*}
\]

where R may be hydrogen or a straight chain alkyl radical having 1 to 5 carbon atoms. The preferred active compounds are 2-propenal (acrolein) having the structure

\[
\begin{align*}
\text{H} & - \text{C} = \text{C} - \text{C} - \text{O} - \text{H} \\
\end{align*}
\]

or 2-butenal (crotonaldehyde) having the structure

\[
\begin{align*}
\text{H} & - \text{C} = \text{C} - \text{C} - \text{O} - \text{H} \\
\end{align*}
\]

or trans-2-pentenal having the structure

\[
\begin{align*}
\text{H} & - \text{C} = \text{C} - \text{C} - \text{O} - \text{H} \\
\end{align*}
\]

The most preferred active compound is 2-propenal which, as noted above, is commonly referred to as acrolein.

The above aldehydes are commercially available or can be synthesized by methods well known in the art. For example, 2-propenal is available under the trade name "MAGNACIDE H" from Baker Petroliet. It may be commercially prepared by vapor phase oxidation of propylene with air or oxygen in the presence of a catalyst. Reference should be made to Shell Oil Company's U.S. Patent No. 2,042,220 for a description of the synthesis. 2-butenal is available under the trade name "crotonaldehyde" from Richmond Chemical, Inc. Trans-2-pentenal is available from Nanyang Chemicals and China Aroma Chemicals Co., Ltd.

The rate of application of the active ingredient will depend on a number of factors including, for example, the extent of the herbicidal and pesticidal activity of the active ingredient, the plant species with which the active ingredient is to be used, the growth stage of the plant, the method of application, the weed and/or pest to be eliminated, and the time period of effectiveness desired, among other factors. As a general guide, however, the application rate of the active ingredient is from about 75 pounds to about 800 pounds of the active compound per acre of soil. For weed control, typical application rates will be about 75 pounds to about 300 pounds per acre of soil, and most preferably about 100 to about 200 pounds of active per acre of soil. For weed control, the application rate is preferably about 200 to about 800 pounds of active per acre of soil, and most preferably about 200 to about 400 pounds of active per acre of soil.

The preferred method of application is addition of the active ingredient to irrigation water. This is typically accomplished by attaching a container of the active ingredient to an irrigation line through a control valve. As irrigation water moves through the irrigation pipe, it draws the active ingredient from its container to be admixed therewith to form the aqueous solution to be applied to the plants, plant seeds, weeds or soil around the area in which the plants grow. The amount of active ingredient is metered by the control valve, or other conventional means. Preferably, to be most effective, the aqueous solution containing the active ingredient should be allowed to drench the soil on which it is applied to a depth of about 10 to about 12 inches. Drenching to this depth will enable the active compound to be herbicidally and pesticidally effective for a longer period of time. However, drenching is not required, but is only preferred. The effective amount of the active ingredient admixed with the irrigation water to form the aqueous solution will typically be from about 1 to about 1350 parts of the active compound per million parts of water. Preferably, the concentration of active in the aqueous solution is from about 300 parts to about 1300 parts of the active compound per million parts of water.

Spraying of the aqueous solution containing one or more active ingredient(s) is not recommended. The enal compounds disclosed herein are very volatile and hydrophobic. As such, attempting to apply these active ingredients via spraying would result in high evaporation rates of the active compound to the extent that spraying reduces the amount of active ingredient actually applied to the plant, plant seeds, weeds or soil so that this technique is substantially ineffective in controlling pests and weeds.

The aqueous solution containing the active ingredient applied to plants, plant seeds, weeds or soil around the area in which the plants grow, may also contain other adjuvants commonly utilized in agricultural compositions. Such adjuvants include compatibilizing agents, anti-foam agents, sequestering agents, neutralizing agents, buffers, corrosion inhibitors, dyes, odorants, spreading agents, penetration aids, sticking agents, dispersing agents, thickening agents, freezing point depressants, antimicrobial agents, ultraviolet (UV)
light absorbers, and the like. The compositions may also contain other compatible components, for example, other herbicides or pesticides, plant growth regulators, fungicides, insecticides, and the like. The active ingredients can also be formulated together with liquid or solid fertilizers such as ammonium nitrate, urea, and the like.

Representative plant species that may be treated with the active enal compounds of the present invention include domestic and agricultural plants, especially crop plants such as corn, wheat, barley, oats, rice, sorghum, cotton, soybeans, potatoes, strawberries, tomatoes, sunflowers, sugar beets, oilseeds, peppers, turnips, turf and cabbage. It should be particularly noted that it is not intended that the use of these active enal compounds and the methods of the present invention be limited to the above listed plant species. The active ingredient and the method disclosed herein is effective for controlling pests and weeds on or around all plant species.

It will be understood by one skilled in the art that the adjuvants listed above are not essential to the activity of the active enal compounds. Their proportions, therefore, are not critical and may be optimized for the purpose and method of application by one skilled in the art. It should also be apparent to one skilled in the art that the adjuvants listed above may be used alone or in combination with one or more of the active enal compounds of the present invention.

In addition, it will also be apparent to one skilled in the art that the active enal compounds of the present invention may be used singly (alone), in combination with one or more other active enal compounds, or with one or more other auxiliary herbicides and/or pesticides. Such auxiliary pesticides may be a chemical pesticide, a fungal insecticide, a viral insecticide or a biopesticide such as a Bacillus-based insecticide.

The chemical pesticide may be selected from carbamates, avermectins, insect growth regulators, pyroles, organophosphates, pyrazoles, chlorinated arganies or pyrethroids. The viral insecticide may be a poliovirus or a granulosis virus.

Examples of biopesticides include but are not limited to baculoviruses, such as nuclear polyhedrosis virus (NPV), e.g., Autographa californica NPV, Syngrapha falcifer NPV, Heliothis zeae NPV, Lymantria dispar NPV, Spodoptera exigua NPV, Neodiprion lecontei NPV, Neodiprion serifer NPV, Harrisina brinllis NPV, Endopiza viteana Clemens NPV; granulosis viruses, e.g., Cydia pomonella granulosis virus (GV), Pieris brassicae GV, Piers rapae GV; entomopathogenic fungi, such as Beauveria bassiana, Metarhizium anisopliae, Verticillium lecanii, and Paecilomyces spp. and various Bacillus-based products. Examples of Bacillus-related pesticides include but are not limited to pesticides produced by Bacillus thuringiensis subsp. kurstaki, Bacillus thuringiensis subsp. israelesiensis, Bacillus thuringiensis subsp. tenebrionis, Bacillus sphaericus, Bacillus cerus, Bacillus thuringiensis kurstaki/tenereini, Bacillus thuringiensis aizawai/kurstaki, and Bacillus thuringiensis kurstaki/kurstaki.

example Ceratophyllus spp. and Xenopsylla cheopis; from the order Thysanura, for example Lepisma saccharina and from the order Acarina, for example Acarus siro, Acrea sheldoni; Aculus spp., especially A. schlechtendali; Amblyomma spp., Argas spp., Boophilus spp., Brevipalpus spp., especially B. californicus and B. phoenicis; Bryobia pratensis, Calioptrinus spp., Chorioptes spp., Dermatophagoides spp., Eotetranychus spp., especially E. carpini and E. orientalis; Eriophyes spp., especially E. vitis; Hylommena spp., Ixodes spp., Olygonychus pratensis, Ommatolothrus spp., Panonychus spp., especially P. ulmi and P. citri; Phylocoptidae spp., especially P. oleivora; Polyphagotarsonemus spp., especially P. latus; Psoroptes spp., Rhipicephalus spp., Rhizoglyphus spp., Sarcoptes spp., Tarsenomes spp. and Tetranychus spp., in particular T. urticae, T. cinnabarinus and T. Kanzawai; representatives of the class Nematoda; (1) nematodes selected from the group consisting of root knot nematodes, cyst-forming nematodes, stem eelworms and foliar nema-
todes; (2) nematodes selected from the group consisting of Anguina spp.; Apelenchoides spp.; Ditylenchus spp.; Globo-
dera spp., for example Globodera rostochiensis; Heter-
erodera spp., for example Heterodera avenae, Heteroder-
a glycines, Heteroderia schachtii or Heterodera trifolii; Longi-
dorus spp.; Meloidogyne spp., for example Meloidogyne incognita or Meloidogyne javanica; Pratylenchus, for example Pratylenchus neglectus or Pratylenchus penetrans; Radopholus spp., for example Radopholus similis; Tri-
choderus spp.; Tylencehus, for example Tylencehus semi-
penetrans; and Xiphinema spp.; or (3) nematodes selected from the group consisting of Heterodera spp., for example Heterodera glycines; and Meloidogyne spp., for example Meloidogyne incognita.

The method according to the invention allows pests of the abovementioned type to be controlled, i.e. contained or destroyed, which occur, in particular, on plants, mainly useful crop plants and ornamentals in agriculture, in horticulture and in forests, or on parts, such as fruits, flowers, foliage, stalks, tubers or roots, of such plants. The protection against these pests in some cases even extends to plant parts which form at a later point in time.

The above-mentioned weeds which can be controlled by the method according to the present invention include, for example, the following:

yellow nutsedge (Cyperus esculentus)
purple nutsedge (Cyperus rotundus)
bermudagrass (Cynodon dactylon)
torpedograss ( Panicum repens)
morning glory (Ipomoea spp.)
pigweed (Amaranthus spp.)
crabgrass (Digitaria spp.)
goosegrass (Eleusine indica)
jungerlecke (Echinochloa colonum)
broadleaf signalgrass (Urochloa platyphylla)
Texas panicum (Panicum texanum)
sicklepod (Senna obtusifolia)
jimson weed (Datura stramonium)
foxtail (Setaria spp.)
prickly sida (Sida Spinosa)
small-flower morning glory Jacquemontia tannifolia)
henbit (Lamium amplexicaule)
wild radish (Raphanus raphanistrum)

The above list is not all-inclusive but only provides many of the more common weeds against which the active end compounds are effective.
Nematicidal Activity, 2-propanal. Data obtained from the experiment with 2-propanal are presented in FIGS. 1A-1E and 2A-2E. The compound reduced exponentially populations of reniform and microvorous nematodes in pre-plant samples (FIGS. 1A-1B). A dose of 50 mg/kg soil equivalent to 100 lbs/A resulted in >90% reduction in these populations. Soil and root samples at the end of the pre-plant samples; however, microvorous populations had recovered in response to applications of ≥100 mg/kg soil and were even stimulated by the 75 mg rate.

Sharp increases in shoot height and weights were observed in response to dosages ≥50 mg/kg (FIGS. 2A-2C); this was followed by gradual decline in values for the two variables. The overall response was typical of a log-normal model. Root weights increased gradually (FIGS. 2D-2E) in response to rates up to 175 mg/kg and declined with higher dosages in a typical Gaussian symmetrical pattern. Root condition was improved by all but the highest dose of 2-propanal (FIG. 2D).

2-butanal. Response patterns of nematodes to applications of 2-butanal were very similar to those described for 2-propanal. FIG. 3 serve to illustrate the similarity of response between the two compounds.

2-pentenal. Response patterns of nematodes to applications of 2-pentenal were very similar to those described for 2-propanal. FIGS. 6A-6B serve to illustrate the similarity of responses between the two compounds.

Herbicidal Activity. Application of 2-propanal resulted in sharp declines in the number of yellow nutseed weevils in response to increasing doses of the chemical (FIG. 4). The relation between dose and weed population adjusted well to an inverse cubic model (FIG. 4) indicating that doses ≥200 mg/kg soil applied post-emergence resulted in practical elimination of the weed.

Application of 2-butanal also resulted in sharp declines in the number of yellow nutseed weevils in response to increasing dose of the chemical (FIG. 5). FIG. 5 thus illustrates the similarity of responses between the two compounds.

Application of 2-pentenal is likewise expected to result in sharp declines in the number of yellow nutseed weevils in response to increasing doses of the chemical (data not shown).

Conclusions

While 2-propanal, 2-butanal and 2-pentenal are powerful nematicidal and herbicidal compounds with long-term effects against plant pathogenic nematodes but with no long lasting negative effects on beneficial microbensores nema-todes, Application rates of 50-100 mg/kg soil which are equivalent to 100-200 lbs/acre (lbs/A) on a broadcast basis eliminate planthopping nematode, retain microbensores nema-todes and increase growth of plants. Yellow nutseed, a hard-to-kill species, and other weeds were practically eliminated with rates ≥200 mg/kg soil; the 200 (mg/kg) rate is equivalent to 400 lbs/A on a broadcast basis. These rates are very practical and are considerably below those used with methyl bromide (400-1000 lbs/A) for soil fumigation. The fact that 2-propanal and 2-butanal are precursors for the synthesis of many other organic compounds makes these chemicals available in large quantities and at a very reasonable price compared with current prices for methyl bromide.

This example together with the data in Table 1 includes results of a study conducted to test the effects of acrolein on tomato plant growth. The first column in Table 1 includes, from left to right the treatment number, the treatment name, the rate of application, and the unit for that rate. The treatment name includes two separate treatment ingredients for each treatment number. The top name of each treatment name lists the test additive, and the bottom listing of the treatment name lists any additional herbicide applied in that particular treatment number. For example, in treatment number 5, methyl bromide was applied with a sandia herbicide. The rate and the rate unit headings, for this study, lists the amount of application of the treatment ingredients in pounds of active ingredients per acre (lb ai/a). Column 2 of Table 1 lists a vigor rating for each tomato plant on a scale of 1 to 5, wherein a 1 rating indicates a tomato plant with very little vigor, and a 5 rating indicates a very vigorous tomato plant. Column 2 lists vigor scale ratings for each treatment number taken on Aug. 17, 2005, and column 3 lists a vigor rating for each treatment taken on Aug. 25, 2005. Comparing column 2 to column 3 will illustrate whether any given treatment had a positive or negative effect on the vigor of the tomato plant.

Still referring to Table 1, treatment number 1 shows a “check” treatment with no additional herbicide. This treatment is merely a “check” treatment, meaning that neither methyl bromide, nor acrolein were applied to the tomato plant. In treatment 1, the vigor of the tomato plant decreased from 3.5 to 3.0 over the duration of the test. Treatment 4 shows that 350 pounds of active ingredient per acre of methyl bromide 1 was applied to the tomato plant with no additional herbicide, which resulted in no change in vigor scale rating over the term of the test. Treatment numbers 7 and 13 illustrate acrolein injected into the soil with no additional herbicides at relatively low rates of 200 pounds of active ingredient per acre and 400 pounds of active ingredient per acre, respectively. In treatment number 7, the vigor of the tomato plant increased an increase of 4.25 to 4.75, and in test 13, the tomato plant enjoyed an increase in vigor of 4.0 to 5.0. The results included in Table 1 support the conclusion that relatively small amounts of acrolein applied to the soil around tomato plants increase the vigor and stimulates growth of the tomato plants, while applying methyl bromide to the soil around tomato plants results in no significant improvement in vigor and/or growth of tomato plants. At the same time, the untreated tomato plants showed a decrease in vigor scale.

<table>
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<tr>
<th>Trt No.</th>
<th>Treatment Name</th>
<th>Rate Unit</th>
<th>TOMATO VIGOR</th>
<th>TOMATO VIGOR 1-SCALE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CHECK 1</td>
<td></td>
<td>3.500</td>
<td>3.000</td>
</tr>
<tr>
<td>2</td>
<td>CHECK 1</td>
<td></td>
<td>3.250</td>
<td>3.250</td>
</tr>
<tr>
<td>3</td>
<td>SANDEA</td>
<td>0.25 lb ai/a</td>
<td>3.000</td>
<td>3.500</td>
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<tr>
<td>4</td>
<td>V101/42</td>
<td>0.25 lb ai/a</td>
<td>2.500</td>
<td>2.500</td>
</tr>
<tr>
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<td>350 lb ai/a</td>
<td>2.750</td>
<td></td>
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<tr>
<td>6</td>
<td>METHYL BROMIDE 2</td>
<td>350 lb ai/a</td>
<td>2.750</td>
<td></td>
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### TABLE 1-continued

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<th>Trt No.</th>
<th>Treatment Name</th>
<th>Rate</th>
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<th>TOMATO VIGOR 1-5 SCALE</th>
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<td></td>
<td>25/Aug/05</td>
<td></td>
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<td>lb a/a</td>
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<td>2.650</td>
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<td>lb a/a</td>
<td>2.250</td>
<td>2.900</td>
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<td>ACROLEIN INJECT</td>
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<td>lb a/a</td>
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<td>lb a/a</td>
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<tr>
<td>15</td>
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We claim:
1. A method for controlling pests and weeds on or around plants, comprising the steps of:
   providing as an active compound trans-2-pentenol having the structure
   
   ![Structure Image]

   admixing an effective amount of said active compound with water to form an aqueous solution; and
   applying the aqueous solution to plants, plant seeds, weeds or soil around the area in which the plants grow at a rate that is effective for controlling pests and weeds on or around said plants.

2. The method of claim 1, comprising applying the solution at a rate of about 200 pounds to about 800 pounds of said active compound per acre of soil.

3. The method of claim 1, comprising applying the solution at a rate that is greater than about 400 pounds of said active compound per acre of soil.

4. A method for controlling pests and weeds on or around plants, comprising the steps of:
   providing as an active compound 2-butenal having the structure
   
   ![Structure Image]

   admixing an effective amount of said active compound with water to form an aqueous solution; and
   applying the aqueous solution to plants, plant seeds, weeds or soil around the area in which the plants grow at a rate that is effective for controlling pests and weeds on or around said plants.

5. A method for controlling pests and weeds on or around plants, comprising the steps of:
   providing as an active compound 2-butenal or trans-2-pentenol:
   admixing an effective amount of said active compound with water to form an aqueous solution; and
   applying the aqueous solution to plants, plant seeds, weeds or soil around the area in which the plants grow at a rate.
of about 200 pounds to about 800 pounds of said active compound per acre of soil.

6. A method for controlling pests and weeds on or around plants, comprising the steps of:
   providing as an active compound 2-butenal or trans-2-pentenal;
   admixing an effective amount of said active compound with water to form an aqueous solution; and
   applying the aqueous solution to plants, plant seeds, weeds or soil around the area in which the plants grow at a rate that is greater than about 400 pounds of said active compound per acre of soil.

7. The method of claim 6, wherein the active compound is 2-butenal.