The invention relates to low VOC plant growth regulator compositions comprising less than about 25% of volatile organic compounds (VOCs). The compositions preferably comprise 6-benzyladenine (6-BA) or forchlorfenuron (CPPU). Also provided are methods of using the compositions.
LOW VOC AND STABLE PLANT GROWTH
REGULATOR LIQUID AND GRANULE COMPOSITIONS

The present invention relates to stable and water-soluble plant growth regulator compositions with low amounts of volatile organic compounds (VOCs).

Background of the Invention

The present invention generally relates to stable and water-soluble plant growth regulator compositions with low amounts of volatile organic compounds (VOCs).

Plant growth regulators are useful for influencing a range of plant developmental processes including stem elongation, germination, dormancy, flowering, sex expression, enzyme induction, fruit size and quality, as well as leaf and fruit senescence. Plant growth regulators may be formulated in at least five different types of formulations: 1) solutions, 2) wettable powders, 3) soluble powders, 4) tablets and 5) water-soluble or dispersible granules.

Cytokinins are a class of plant growth regulators which are generally defined as N6- substituted adenine derivatives such as trans-zeatin, 6-benzyladenine (6-BA) and kinetin. Recently, a new class of cytokinins has been identified which possess N-phenylurea substituted structure such as forchlorfenuron (CPPU) and thidiazuron (TDZ). Cytokinins are of extreme importance in regulating plant growth and development, especially cell division. They are marketed under various trade names and are commercially used in fruit
thinning and sizing as well as pre- and post-harvest treatments of ornamental plants and flowers.

6-BA and CPPU have very low water solubility of 44 and 39 ppm at 25°C, respectively. Alcoholic solvents such as IPA, THFA and propylene glycol are being employed in conventional liquid plant growth formulations. For example, US Patent Application US 2008/0039322 A1 discloses cytokinin solution formulations comprising propylene glycol. However, one of the disadvantages of alcoholic solvents is that they are considered volatile organic compounds (VOCs) having relatively high photochemical reactivity for ground level ozone formation and, therefore, may be harmful to the environment. The United States Environmental Protection Agency (EPA) estimates the maximum incremental reactivity (MIR) of volatile organic compounds or solvents which can participate in atmospheric photochemical reactions (MiR measures grams ozone produced per grams VOC).

Various regulatory agencies, such as the EPA, the California Department of Pesticide Regulation (DPR) and Air Resources Board (CARB) seek to lower the VOC content in various agricultural products and fumigants.

There is a significant formulation challenge to meet the requirements of lowering the VOC content while preserving product stability and effectiveness.

There is, therefore, a need to develop effective plant growth regulator compositions that contain low amounts of VOCs.
Brief Summary of the Invention

The present invention is generally directed to stable, water-soluble, low VOC plant growth regulator compositions. The compositions of the present invention comprise less than about 25.0% by weight of volatile organic compounds (VOCs) measured by Thermogravimetric Analysis (TGA).

In one embodiment, an aqueous composition of the present invention comprises from about 1.0% to about 5.0% by weight of a plant growth regulator, a base, a surfactant and water, wherein the weight percentages are based on the total weight of the plant growth regulator composition.

In another embodiment, an aqueous composition of the present invention comprises from about 0.1% to about 5.0% by weight of a plant growth regulator, an acid, a surfactant and water, wherein the weight percentages are based on the total weight of the plant growth regulator composition.

In yet another embodiment, an aqueous composition of the present invention comprises from about 0.5% to about 2.0% by weight of a plant growth regulator, an acid, a surfactant and water, wherein the weight percentages are based on the total weight of the plant growth regulator composition.

In one embodiment, a soluble granule composition of present invention comprises from about 3.0% to about 6.0% by weight of a plant growth regulator, an acid, an anionic surfactant wetter, a nonionic surfactant binder in conjunction with maltodextrin and iactose fillers.

In another embodiment, a soluble granule composition of present invention comprises about 5.0% cytokinin plant growth regulator in combination
with 5% gibberellin plant growth regulator, an acid, an anionic surfactant wetting agent, a nonionic surfactant binder, a block copolymer surfactant solubilizer in conjunction with maitodextrin and lactose fillers.

Preferably, the plant growth regulator is selected from the group consisting of gibberelins, auxins, cytokinins, ethylene biosynthesis inhibitors, and combinations thereof. More preferably, the plant growth regulator is a cytokinin and/or a gibberellin.

In a preferred embodiment, the base is potassium hydroxide.

In another preferred embodiment, the acid is lactic acid.

In yet another preferred embodiment, the surfactant is selected from the group consisting of ethoxylated alkyl alcohols, sodium dioctyl sulfosuccinates, ethoxylated fatty acids, ethoxylated vegetable oils, glycol esters, sorbitan fatty acid esters, ethoxylated sorbitan fatty acid esters, ethylene oxide/propylene oxide block copolymer and combinations thereof. Most preferably, the surfactant is an ethoxylated alkyl alcohol, block copolymer and sodium dioctylsulfosuccinate.

In one preferred embodiment, a low VOC composition of the present invention comprises about 2.0% by weight of 6-benzyladenine, about 1.13% by weight of potassium hydroxide, about 5% ethoxylated alkyl alcohol and about 91.87% by weight of water, wherein the weight percentages are based on the total weight of the plant growth regulator composition.

In another preferred embodiment, a low VOC composition of the present invention comprises about 2.0% by weight of 6-benzyladenine, about 20.0% by weight of lactic acid, about 5.0% by weight of an ethoxyiated alkyl alcohol and
about 73.0% by weight of water, wherein the weight percentages are based on the total weight of the plant growth regulator composition.

In yet another preferred embodiment, a low VOC composition of the present invention comprises about 1.0% by weight of forchlorfenuron, about 20.0% by weight of lactic acid, about 10.0% by weight of an ethoxylated alkyl alcohol and about 69.0% by weight of water, wherein the weight percentages are based on the total weight of the plant growth regulator composition.

In one preferred embodiment, a soluble granular composition of the present invention comprises about 5% by weight of 6-benzyladenine, about 10% by weight of lactic acid, about 1% by weight of sodium dioctylsulfosuccinate, about 1% by weight of an ethoxylated alkyl alcohol, about 10% by weight of maltodextrin and about 73% by weight of lactose.

In another preferred embodiment, a soluble granular composition of the present invention comprises about 5% by weight of 6-benzyladenine, about 5% by weight of gibberellin A4A7, about 1% by weight of sodium dioctylsulfosuccinate, about 1% by weight of an ethoxylated alkyl alcohol, about 5% by weight of a block copolymer, about 10% by weight of maltodextrin and about 63% by weight of lactose.

Additionally, the compositions of the present invention may further comprise an antioxidant. The antioxidant may be propyl gallocate, ethoxyquin, butylated hydroxyanisole, butylated hydroxytoluene, tertiary butylhydroquinone and combinations thereof.
The compositions may also contain at least one additional component such as a sticker, a spreader sticker, a systemic acquired resistance inducer, an anti-foaming agent, a preservative, a humectant, a dye, a U.V. protectant, a buffer, a carrier or a combination thereof.

In another embodiment, the invention relates to a ready-to-use product prepared from the compositions of the present invention. The ready-to-use products may be spray-applied to plants in order to improve plant growth, yield, fruit thinning, fruit sizing, flowering and quality.

The invention is also directed to a method of regulating plant growth comprising the step of treating soil, a seed or a plant with an effective growth-regulating amount of the compositions described above.

These and other features, aspects, advantages of the present invention will become better understood with reference to the following description and appended claims.

**Detailed Description of the invention**

The present invention generally relates to stable, water-soluble and low VOC plant growth regulator compositions. All compositions of the present invention comprise less than about 25.0% by weight of volatile organic compounds (VOCs).

We have surprisingly discovered that water-insoluble 6-benzyladenine or forchlorfenuron can be dissolved in lactic acid or a potassium hydroxide solution in conjunction with a surfactant. Therefore, soluble aqueous or granular
formulations of plant growth regulators that comprise less than about 25.0% by weight of VOCs can be prepared.

The phrase "plant growth regulator" as used herein connotes a product which serves to modify the growth and the development of a treated plant to agricultural maturity without killing the plant. Such modification may result from the effect of the material on the physiological processes of the plant, or from the effect of said material on the morphology of the plant. These modifications may also result from any combination or sequence of physiological or morphological factors.

The plant growth regulator may be a gibberellin, an auxin, a cytokinin, an ethylene biosynthesis inhibitor, or a combination thereof. Suitable ethylene biosynthesis inhibitors include aminoethoxyvinylglycine; suitable auxins include indole-3-acetic acid, indole butyric acid and 1-naphthalene acetic acid and suitable cytokinins include 6-benzyladenine or 6-benzylaminopurine (6-BA), forchlorfenuron (CPPU), thidiazuron (TDZ) and 6-furfurylaminopurine (kinetin).

Most preferable plant growth regulators are 6-BA, CPPU and GA4A7.

In one embodiment, a composition of the present invention comprises from about 1.0% to about 5.0% by weight of a plant growth regulator, a base and water, wherein the weight percentages are based on the total weight of the plant growth regulator composition.

In another embodiment, a composition of the present invention comprises from about 0.1% to about 5.0% by weight of a plant growth regulator, an acid, a
surfactant and water, wherein the weight percentages are based on the total weight of the plant growth regulator composition.

In yet another embodiment, a composition of the present invention comprises from about 0.5% to about 2.0% by weight of a plant growth regulator, an acid, a surfactant and water, wherein the weight percentages are based on the total weight of the plant growth regulator composition.

In another embodiment, a solid granular composition of the present invention comprises about 5% by weight of 6-benzyladenine, about 10% by weight of lactic acid, about 1% by weight of sodium dioctylsulfosuccinate, about 1% by weight of an ethoxylated alkyl alcohol, about 10% by weight of maltodextrin and about 73% by weight of lactose.

In yet another embodiment, a solid granular composition of the present invention comprises about 5% by weight of 6-benzyladenine, about 5% by weight of giberellin A4A7, about 1% by weight of sodium dioctylsulfosuccinate, about 1% by weight of an ethoxylated alkyl alcohol, about 5% by weight of a block copolymer, about 10% by weight of maltodextrin and about 63% by weight of lactose.

In compositions which comprise a base, the preferred base is potassium hydroxide.

In compositions which comprise an acid, the preferred acid is lactic acid.

In the compositions of the present invention, a surfactant may be used as a wetting, solubilizing, binding and penetrating agent for certain plant growth regulators. Suitable surfactants include non-ionic surfactants, anionic surfactants...
and amphoteric surfactants. Non-ionic surfactants include ethoxylated alkyl alcohols such as TOMADOLS®, ethoxylated vegetable oils such as AGNIQUE S80® (soybean), CSO (castor) and RSO (rapeseed), ethoxylated sorbitan esters such as EMSORB®, TWEEN®, and T-MAZE®; sorbitan fatty acid esters such as SPAN® and ALKAMUL®; sucrose and glucose esters and derivatives thereof such as MAZON®, RHEOZAN® and GLUCOPON®; ethoxylated alcohols such as TRYCOL®, BRIJ®, ARMIX®, TERTITOL® and PLURAFAC®; ethoxylated alkylphenols such as IGEPAL®, IvlACOL® and TRITON®; ethoxylated fatty amines such as TRYMEEN® and ETHOMEEN®; ethoxylated fatty acids such as EMEREST®, ALKAMUL® and TRYDET®; ethoxylated fatty esters such as ALKAMUL® and ATLAS G®; fatty acids such as ATLAS G-1556®; glycerol esters such as MAZOL GMO®; glycol esters such as GLYCOL SEG®; lanolin-based derivatives such as AMERCHOL CAB®; methyl esters such as OLEOCAL ME®; monoglycerides and derivatives such as ETHOSPERSE G-26®; propoxylated and ethoxylated fatty acids such as ANTAROX AA-60®; block copolymers of ethylene oxide and propylene oxide such as PLURONIC® or SURFONIC®; silicone-based surfactants such as SILWET®, BREAKTHRU® and mixtures of organosilicon surfactant with non-ionic or ionic surfactants; polysaccharides, copolymers of acrylamide and acrylic acid; and acetylenic diol derivatives such as SURFYNOL 104® or tristyrylphenols such as SOPROPHOR® among others.

A presently preferred nonionic surfactant family is the ethoxylated alkyl alcohols of C9 to C15 chains (TOMADOL 25-7, 1-7 or 91-6®) or block copolymer
of ethylene oxide and propylene oxide (Pluronic F127). Non-ionic surfactants such as natural ethoxylated alcohols (BRIJ®) and vegetable oils (AGNiQUE®) are presently also preferred. Suitable anionic surfactants include phosphate esters such as EMPHOS® and RHODAFAC®; sodium dialkyl sulfosuccinates such as MONAWET®, N-acyl ED3A chelating surfactant (Hampshire) and N-Acyl Sarcosines (Hamposyl) among others.

The surfactants’ tradenames are often common to a class or series of surfactants. Therefore, where a tradename is mentioned, any surfactant in the family including that tradename will be suitable.

Other components of the compositions may include additional surface active agents, dyes, stickers, spreader stickers, U.V. (ultra-violet) protectants, systemic acquired resistance inducers, preservatives, humectants, antioxidants, antifoams, buffers, carriers, or other components or combinations thereof which facilitate product handling and application. The antioxidant may be propyl gallate, ethoxyquin, butyilated hydroxyanisole, butylated hydroxytoluene, tertiary butylhydroquinone and combinations thereof.

In one preferred embodiment, a low VOC composition of the present invention comprises about 2.0% by weight of 6-benzyladenine, about 1.13% by weight of potassium hydroxide, about 5% by weight of an ethoxylated alkyl alcohol and about 91.87% by weight of water, wherein the weight percentages are based on the total weight of the plant growth regulator composition.

In another preferred embodiment, a low VOC composition of the present invention comprises about 2.0% by weight of 6-benzyladenine, about 20.0% by
weight of lactic acid, about 5.0% by weight of an ethoxylated alkyl alcohol and about 73.0% by weight of water, wherein the weight percentages are based on the total weight of the plant growth regulator composition.

In yet another preferred embodiment, a low VOC composition of the present invention comprises about 1.0% by weight of forchlorfenuron, about 20.0% by weight of lactic acid, about 10.0% by weight of the ethoxylated alkyl alcohol and about 69.0% by weight of water, wherein the weight percentages are based on the total weight of the plant growth regulator composition.

In another preferred embodiment, a low VOC solid granular composition of the present invention comprises about 5% by weight of 6-benzyladenine, about 10% by weight of lactic acid, about 1% by weight of sodium dioctylsulfosuccinate, about 1% by weight of an ethoxylated alkyl alcohol, about 10% by weight of maltodextrin and about 73% by weight of lactose.

In another preferred embodiment, a low VOC solid granular composition of the present invention comprises about 5% by weight of 6-benzyladenine, about 5% by weight of gibberellins A4A7, about 1% by weight of sodium dioctylsulfosuccinate, about 1% by weight of an ethoxylated alkyl alcohol, about 5% by weight of a block copolymer, about 10% maltodextrin and about 63% lactose.

In another embodiment, the invention relates to a ready-to-use product prepared from the compositions of the present invention. It is well within a skill of the art to prepare such ready-to-use products using well-known techniques, such as dilutions. The dilutions may be made in water and spray-applied in order to
improve plant growth, yield, fruit thinning, fruit sizing, flowering and quality. In one embodiment, the compositions of the present invention are themselves ready-to-use products. It is also contemplated that the ready-to-use compositions of this invention may be used in other active ingredients, such as herbicides, fungicides, insecticides, nematodes, biochemical pesticides, plant produced pesticides (botanicals) or plant nutrients.

The compositions described above may be used to regulate plant growth of fruit-producing plants, vegetable-producing plants, row crops, vegetable crops, grasses or trees. The benefits of using the compositions of the present invention vary according to the type of plant treated. For example, in grapes, treatment with the compositions can lead to cluster elongation, thinning and larger grapes. In oranges, lemons, limes and tangerines, the formulation can lead to a delay in the aging of the rind and reduce disorders such as rind staining, water spotting, sticky or tacky surface, puffy rind or rupture under pressure. In cherries, the compositions may advantageously be used to produce larger, brighter colored and/or firmer fruit.

The compositions of the present invention are preferably diluted in water and sprayed on the plant or tree to be treated. The spraying may be by conventional ground or aerial application equipment. Spray volumes are variable depending upon the orchard or crop, growth stage and climatic conditions. The range may be 5 gallons to 300 gallons/acre or higher. A presently preferred range is between 100 to 250 gallons per acre by pressurized spray application equipment. To prepare a composition for application, a tank is naif-filled with
water, followed by spray addition of adjuvant, and then addition of the plant growth regulator composition, followed by addition of more water and mixing for at least 15 minutes prior to actual spraying.

Alternatively, the compositions of the present invention may be directly applied to the soil (in which the plant will be grown or is growing) with or without granular fertilizers for the improved growth and maintenance of crops.

Moreover, the compositions of the present invention may be applied to seeds to achieve the same effect. The seed may be rice or paddy, alfalfa, cotton, sorghum, soybeans, corn or other vegetables, ornamental or turf and pasture grass seed, among others.

The concentration of the plant growth regulator will vary depending upon the type of fruit is to be treated, the peculiarities of the locale, and the desired result. In general, the composition may be applied at a field rate of from about 0.01 to about 1.0 lb per acre; preferably at a rate of from about 0.02 to about .5lbs per acre and most preferably at a rate of from about 0.02 to about .2 lbs/acre. For example, the field spray rates for apples using 6-BA can be about 38-75 g/100 gallons per acre and for grapes using CPPU can be about 4-8 g/250 gallons per acre.

A single application may be enough, though depending upon the particular fruit and desired results, multiple applications may be made.

As used herein the term "plant" includes fruit-producing plants, vegetable-producing plants, row crops, vegetable crops, grasses and trees.
The fruit may be grapes, cherries, lemons, limes, oranges, grapefruit, strawberries, pineapples, stone fruits, apples, pears, peaches, blueberries, pistachio or tangerines. The row crop may be cotton, soybeans, corn, sugar cane or rice, among others. The vegetable crops may be lettuce, artichokes, celery or peppers among others. The grasses may be Bahia grass (Paspalum notatum Flugge), Bentgrass (Agrostis L), Bermudagrass (Cynodon dactylon L), Carpetgrass (Axonopus affinis Chase), Kentucky bluegrass (Poa pratensis L.), Canada Blugrass (Poa compressa L), Buffalograss (Buchloe dactyloides (Nutt.) Englem.), Fescue grasses (Festuca), annual Rye grass (Lolium L multiflorum Lam.), perennial Rye grass (Lolium perenne L), Saint augustine grass (Stenotaphrum secundatum Kuntze), Japanese lawn grass (Zoysia japonica Steucl.), Centipede grass (Eremochloa ophiuroides (Munro) Hacck, other turf grasses for residential or commercial establishments, among others.

As used herein, all numerical values relating to amounts, weight percentages and the like, are defined as "about" or "approximately" each particular value, plus or minus 10%. For example, the phrase "at least 5.0% by weight" is to be understood as "at least 4.5% to 5.5% by weight." Therefore, amounts within 10% of the claimed values are encompassed by the scope of the claims.

The invention will be understood more clearly from the following non-limiting representative examples. Of course, the present invention is not limited to the particular embodiments and modes of operation described herein and it is possible to imagine a number of variations in the details without
departing from the scope of this invention.

The examples below are presented to describe preferred embodiments and utilities of the invention and are not meant to limit the invention unless otherwise stated in the claims appended hereto.

**EXAMPLES**

**EXAMPLE 1 - Low VOC 2% δ-BA compositions**

Table 1a

<table>
<thead>
<tr>
<th>Components, Wt %</th>
<th>VBC-30075</th>
<th>VBC-30076</th>
</tr>
</thead>
<tbody>
<tr>
<td>6-Benzyladenine (99%)</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>KOH (45%)</td>
<td>2.5</td>
<td></td>
</tr>
<tr>
<td>Lactic Acid (80%)</td>
<td></td>
<td>25.0</td>
</tr>
<tr>
<td>Tomadol® 25-7</td>
<td>5.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Distilled Water</td>
<td>90.5</td>
<td>68.0</td>
</tr>
</tbody>
</table>

Tornado® 25-7 is an ethoxylated alkyl alcohol non-ionic surfactant marketed by Tomah Products.

Table 1a shows the percent weight of the components of two low VOC plant growth compositions, VBC-30075 and VBC-30076. VBC-30075 is a 2% 6-BA/Base composition, while VBC-30076 is a 2% 6-BA/Acid composition. The pH for VBC-30075 was measured at 13.33, while pH for VBC-30076 was measured at 1.96.

The compositions have low VOC content which was demonstrated by thermogravimetry analysis (TGA). According to TGA, VOC content in VBC-30075 was N/A, and VOC content in VBC-30076 was about 18.94%.
Briefly, the compositions were prepared as follows: 6-BA technical powder is dissolved in 45% potassium hydroxide or 80% lactic acid with mixing, and then diluted with water and Tornado! surfactant to complete the formulations.

The compositions were sprayed on greenhouse tomato plants and did not exhibit phototoxicity.

Table 1b

Storage Stability of Low VOC 6-BA Aqueous Compositions (HPLC Assay)

<table>
<thead>
<tr>
<th>Temperature and Time</th>
<th>VBC-30075</th>
<th>VBC-30076</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Value</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>54°C/2 weeks</td>
<td>1.97 (99%)</td>
<td>2.0 (100%)</td>
</tr>
<tr>
<td>13.5 mo/25°C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25°C/6 months</td>
<td>2.02 (101%)</td>
<td>2.0 (100%)</td>
</tr>
<tr>
<td>25°C/12 months</td>
<td>2.00 (100%)</td>
<td>2.0 (100%)</td>
</tr>
</tbody>
</table>

Table 1b shows that the low VOC compositions of Table 1a exhibit good storage stability after up to 12 months of storage at 25°C or accelerated 2 weeks at 54°C.
EXAMPLE 2 - Low VOC 1% CPPU aqueous composition

Table 2a

Low VOC CPPU Aqueous Compositions

<table>
<thead>
<tr>
<th>Components, Wt %</th>
<th>VBC-30077</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forchlorfenuron (98%)</td>
<td>1.0</td>
</tr>
<tr>
<td>Lactic Acid (80%)</td>
<td>25.0</td>
</tr>
<tr>
<td>Tomadol® 25-7</td>
<td>10.0</td>
</tr>
<tr>
<td>Distilled Water</td>
<td>64.0</td>
</tr>
</tbody>
</table>

Table 2a shows the percent weight of the components of another low VOC plant growth composition, VBC-30077. VBC-30077 is a 1% CPPU Microemulsion Concentrate (MEC) composition with 10% Tornado! surfactant. High surfactant levels are needed to prevent the crystallization of CPPU in cold storage and use dilution. The pH for VBC-30077 was measured at 1.72.

The composition has low VOC content which was demonstrated by TGA. According to TGA, VOC content in VBC-30077 was about 19.05%.

The compositions were prepared similarly to the compositions of Example 1.

The compositions were sprayed on greenhouse tomato plants and did not exhibit phytotoxicity.
Table 2b

Storage Stability of Low VOC CPPU MEC Composition
(HPLC Assay)

<table>
<thead>
<tr>
<th>Temperature and Time</th>
<th>VBC-30077</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Value</td>
<td>1.05</td>
</tr>
<tr>
<td>54°C/2 weeks 13.5 mo/25°C</td>
<td>1.03 (99%)</td>
</tr>
<tr>
<td>25°C/6 months</td>
<td>1.01 (96%)</td>
</tr>
<tr>
<td>25°C/12 months</td>
<td>1.01(96%)</td>
</tr>
</tbody>
</table>

Table 2b shows that the low VOC composition of Table 2a exhibits good storage stability after up to 12 months of storage at 25°C and 2 weeks at 54°C.

EXAMPLE 3 - 5% 6-Benzyladenine and 5% 6-Benzyiadenine + 5% GA4A7 soluble granule compositions.

Table 3a PGR Soluble Granule Formulations

<table>
<thead>
<tr>
<th>Components, Wt%</th>
<th>YW-43-3</th>
<th>YW-54-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>6-Benzyladenine (99%)</td>
<td>5.1</td>
<td>5.1</td>
</tr>
<tr>
<td>GA4A7 (91%)</td>
<td></td>
<td>5.5</td>
</tr>
<tr>
<td>Aerosol OT-B</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Pluronic F127</td>
<td></td>
<td>5.0</td>
</tr>
<tr>
<td>Maltrin M100</td>
<td>10.0</td>
<td>10.0</td>
</tr>
<tr>
<td>Lactose powder</td>
<td>72.9</td>
<td>62.4</td>
</tr>
<tr>
<td>Lactic acid</td>
<td>10.0</td>
<td>10.0</td>
</tr>
<tr>
<td>Brij 98</td>
<td>1.0</td>
<td>1.0</td>
</tr>
</tbody>
</table>

Table 3a shows the percent weight of the components of 5% 6-Benzyladenine soluble granule and 5% 6-Benzyladenine + 5% GA4A7 soluble granule
formulations. There are no VOCs in soluble granule formulations except potential TGA measurement of Brij 98 or Pluronic F127 nonionic surfactants.

The 6-Benzyladenine was dissolved in 80% lactic acid, and then mixed with Brij 98 surfactant and 1-2% deionized water to form a clear liquid binder solution. Lactose, Maltrin M100 and Aerosol OT-B powders were dry blended, and then mixed with the binder solution containing 6-Benzyladenine to form a homogeneous paste suitable for extrusion. The moist paste was extruded into 1 mm diameter cylindrical pellets of uniform size with a low pressure LCl Dome Extruder. The small pellets were pan or fluid-bed dried to less than 1% moisture and screened through -12/+50 screen to obtain final soluble granule products. For the δ-BA + GA4A7 SG formulation, the Gibberellin and Pluronic powders were added in a dry blend prior to paste preparation and extrusion.

Table 3b shows the accelerated stability studies on 5% 6-BA and 5% 6-BA + 5% GA4A7 SG formulation (HPLC Analysis):

<table>
<thead>
<tr>
<th>Initial Wt%</th>
<th>YW-43-3</th>
<th>YW-54-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>6-BA</td>
<td>5.2</td>
<td>5.16</td>
</tr>
<tr>
<td>GA4A7</td>
<td></td>
<td>5.18</td>
</tr>
<tr>
<td>54°C/2 weeks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6-BA</td>
<td>5.12</td>
<td>5.1</td>
</tr>
<tr>
<td>GA4A7</td>
<td></td>
<td>5.0</td>
</tr>
</tbody>
</table>

Good stability was shown after 2 weeks storage at 54°C. The soluble granules are easily dissolved in water with gentle mixing. The PH of 1% dilution in 200 ppm hard water is about 3 for both granules.
CLAIMS

We claim:

1. A low VOC plant growth regulator composition comprising:
   a. from about 1.0% to about 5.0% by weight of a plant growth regulator;
   b. a base; and
   c. water,

   wherein the weight percentages are based on the total weight of the plant growth regulator composition, and wherein said composition contains less than 25.0% of volatile organic compounds.

2. A low VOC plant growth regulator composition comprising:
   a. from about 0.1% to about 5.0% by weight of a plant growth regulator;
   b. an acid;
   c. a surfactant; and
   d. water,

   wherein the weight percentages are based on the total weight of the plant growth regulator composition, and wherein said composition contains less than 25.0% of volatile organic compounds.

3. The low VOC plant growth regulator composition of claim 2 which comprises:
   a. from about 0.5% to about 2.0% by weight of a plant growth regulator.
4. The composition of claims 1 or 2 wherein the plant growth regulator is a cytokinin.

5. The composition of claim 4 wherein the cytokinin is 6-benzyladenine.

6. The composition of claim 1 wherein the plant growth regulator is 6-benzyladenine and wherein the base is potassium hydroxide.

7. The composition of claim 6, wherein the amount of 6-benzyladenine is about 2.0% by weight, the amount of potassium hydroxide is about 1.13% by weight, and the amount of water is about 96.87% by weight.

8. The composition of claim 2 wherein the acid is lactic acid.

9. The composition of claim 2 wherein the surfactant is selected from the group consisting of ethoxylated alkyl alcohols, dioctyl sodium sulfosuccinates; ethoxylated fatty acids, ethoxylated vegetable oils, glycol esters, sorbitan fatty acid esters, ethoxylated sorbitan fatty acid esters, and combinations thereof.

10. The composition of claim 2 wherein the plant growth regulator is 6-benzyladenine, the acid is lactic acid and the surfactant is an ethoxylated alkyl alcohol.

11. The composition of claim 10 wherein the amount of 6-benzyladenine is about 2.0% by weight, the amount of lactic acid is about 20.0% by weight, the amount of the ethoxylated alkyl alcohol is about 5.0% by weight, and the amount of water is about 64.0% by weight.
12. The composition of claim 3 wherein the plant growth regulator is forchlorfenuron.

13. The composition of claim 2 wherein the plant growth regulator is forchlorfenuron, the acid is lactic acid and the surfactant is an ethoxylated alkyl alcohol.

14. The composition of claim 13, wherein the amount of forchlorfenuron is about 1.0% by weight, the amount of lactic acid is about 20.0% by weight, the amount of the ethoxylated alkyl alcohol is about 10.0% by weight, and the amount of water is about 64.0% by weight.

15. A solid granular composition comprising about 5% by weight of 6-benzyladenine, about 10% by weight of lactic acid, about 1% by weight of sodium dioctylsulfosuccinate, about 1% by weight of an ethoxylated alkyl alcohol, about 10% by weight of maltodextrin and about 73% by weight of lactose.

16. A solid granular composition comprising about 5% by weight of 6-benzyladenine, about 5% by weight of gibberellins A4A7, about 1% by weight of sodium dioctylsulfosuccinate, about 1% by weight of an ethoxylated alkyl alcohol, about 5% by weight of a block copolymer, about 10% by weight of maltodextrin and about 63% by weight of lactose.

17. A ready-to-use product prepared from the compositions of claims 1 or 2.

18. A method of treating plants comprising applying an effective amount of the compositions of claims 1, 2, 15 or 16 to said plants.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
   IPC(8) - A01 N 37/00 (2010.01)
   USPC - 504/142
   According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED
   Minimum documentation searched (classification system followed by classification symbols)
   IPC(8) - A01N 37/00 (2010.01)
   USPC - 504/142
   Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
   USPC - 504/142.1 18,320

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
   PubWEST (PGPB; USPT; EPAP; JPAB); Google; Google Scholar
   Search Terms Used: plant growth regulator, low VOC, volatile organic compounds, base, acid, water, lactic acid, surfactant, 6-benzyladenine, sodium dioctylsulfosuccinate, ethoxylated alkyl alcohol, maltodextrin, lactose, gibberellins, block copolymer

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
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<tr>
<th>Category*</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No</th>
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<tr>
<td>Y</td>
<td>US 2008/0213326 A1 (AMRHEIN, et al.) 04 September 2008 (04.09.2008) para [0008]-[0009], [0015], [0018], [0091], [0102],[0106]-[0108], [0161], [0162], [0167]-[0168], [0176], [0172], [0181], [0184], [0213];elm 19</td>
<td>1-14, 17-18</td>
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<td>Y</td>
<td>US 4,863,506 A (YOUNG) 05 September 1989 (05.09.1989) col 3, In 39-50; col 6, In 50-58; ab</td>
<td>8, 10-11, 13-15</td>
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Further documents are listed in the continuation of Box C

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08 APR 2010

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