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 (54) Title: PLANT GROWTH REGULANT

(57) **Abrégé/Abstract:**

An aqueous composition of citric acid or acetic acid and citric acid, in combination with a surfactant, for use as a plant growth regulant. In aspects, the regulant may be used to modify plant growth by giving more compact plants, as well as improvements in flowers, yield and general appearance.

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<p>(54) Title: PLANT GROWTH REGULANT</p> <p>(57) Abstract</p> <p>An aqueous composition of citric acid or acetic acid and citric acid, in combination with a surfactant, for use as a plant growth regulant. In aspects, the regulant may be used to modify plant growth by giving more compact plants, as well as improvements in flowers, yield and general appearance.</p>		

TITLE:**PLANT GROWTH REGULANT****5 Field of the Invention**

The present invention relates to aqueous compositions of acetic acid and citric acid in combination with a surfactant and to aqueous compositions of citric acid in combination with a surfactant, that may be used as a plant growth regulant.

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Background of the Invention

It is well known that certain chemicals can act as plant growth regulants. Such chemicals may modify plant growth, flowering, yield and/or general appearance. Some of these chemicals are natural plant hormones, whereas others have been synthesized. Examples of the latter chemicals are known in the trade, under a number of different trade names e.g. A-rest (Ancymidol), B-nine SP (Daminozide) and Cycocel (Chlormequant-Chloride). These chemicals are used on different plants to modify their height, since sturdy compact plants are easier to grow in the greenhouse and are preferred by most people. Cycocel is also used on cereals to produce shorter plants that are more resistant to lodging.

In order to be suitable for use on ornamental plants or with grains, growth regulants must be effective without causing visible damage to foliage. Damage to foliage would not be acceptable to either greenhouse growers or buyers. For instance, if a plant growth regulant caused damage such as leaf or stem burning, or twisting of leaves, it would be deemed to be unacceptable.

It is well known that dark green colour is associated with an indication of health and vigour of the plant. The green colour may be produced by feeding the plant with certain nutrients, such as nitrogen. However, this leads to rapid growth of the plant. Consequently, elongated

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-2-

plants are obtained, rather than compact sturdy plants, which is contrary to grower's objective with a plant growth regulant.

U.S. Patent No.5 705 455, which is directed to herbicidal compositions, discloses test results in which a combination of acetic acid and citric acid produced higher fresh weight in corn plants that were not damaged or killed by the herbicidal application. Higher fresh weight in corn usually means bigger plants, which is the reverse to what is needed to produce compact plants as would be obtained with a plant growth regulant.

10 Summary of the Invention

A plant growth regulant in the form of an aqueous composition of acetic acid and citric acid in combination with a surfactant has now been found. JP 4 363 338 is directed citric, itaconic or malic acid as a soil conditioning agent. JP 4 046 104 is directed to in particular citric acid in combination with inorganic fertilizer as a plant growth regulant. JP 2 178 203 is directed to use of mixture of citric and malic acid for increasing crops. JP 50 157 167 is directed to use of citric acid to promote growth of rice seedlings.

Aspects of the invention are as follows:

20 A method of effecting regulation of plant growth comprising spraying an aqueous composition comprising acetic acid and citric acid, in combination with surfactant, onto said plant, said composition having a ratio of acetic acid to citric acid in the range of 4:1 to 1:1 on a weight basis, the concentration of acetic acid being less than 4 g/l and the concentration of surfactant being in the range of 1-5 g/l.

25 Use an aqueous composition comprising acetic acid and citric acid, in combination with surfactant, as a plant growth regulant, said composition having a ratio of acetic acid to citric acid in the range of 4:1 to 1:1 on a weight basis, the concentration of acetic acid being less than 4 g/l and 30 the concentration of surfactant being in the range of 1-5 g/l.

A method of effecting regulation of plant growth comprising spraying an aqueous composition of citric acid and surfactant onto said plant,

-3-

the concentration of citric acid being in the range of 1-10 g/l, said composition being effective as a plant growth regulant.

5 **Detailed Description of the Invention**

In embodiments, the present invention relates to aqueous plant growth regulant compositions of acetic and citric acid in combination with surfactant. The combination of acetic and citric acids with surfactant exhibits synergistic effects as a plant growth regulant. In particular, the resulting
10 composition is more effective as a plant growth regulant than a corresponding composition of acetic acid, citric acid or surfactant alone at the same concentration or a combination of acetic acid and surfactant.

In other embodiments, the present invention provides compositions of citric acid and surfactant as a plant growth regulant. The
15 combination of citric acid with surfactant exhibits synergistic effects as a plant growth regulant. In particular, the resulting composition is more effective as a plant growth regulant than a corresponding composition of citric acid or surfactant alone at the same concentration.

In addition, the plant growth regulant compositions may be
20 formulated so that the concentration of the acid(s) is such that the compositions do not exhibit herbicidal properties with respect to a particular plant. In particular, the compositions may be formulated to not exhibit herbicidal properties with respect to cucumbers, tomatoes, cabbage, roses and peppers, broad leaf plants and/or other vegetation.

25 The present invention will be particularly described herein with respect to compositions of acetic acid, citric acid and surfactant, which is a preferred embodiment.

A composition of the invention comprises a synergistic combination of acetic acid and citric acid, with surfactant, in aqueous solution.

30 The acetic acid component is conveniently provided by domestic white vinegar while the citric acid is conveniently provided by lemon juice or juices of other citrus fruits. It is understood, however, that industrial sources

-4-

of either or both of these components may be used. For instance, the composition may be formulated using glacial acetic acid.

The weight ratio of acetic acid to citric acid in the plant growth regulant composition may vary over a wide range, for instance, in the range of
5 from about 4:1 to 1:1, on a weight basis. In embodiments, the weight ratio of acetic acid to citric acid is in the range of 4:1 to about 2:1.

The plant growth regulant composition in use may contain up to 4 g/l of acetic acid. The composition should contain at least 1 g/l of acetic acid and 0.5 g/l of citric acid. Preferred compositions contain about 4 g/l of
10 acetic acid and 2 g/l of citric acid.

The plant growth regulant activity requires the combination of acetic acid and citric acid with at least one surfactant. The amount of surfactant should be at least equal to the amount of citric acid.

It is believed that a wide variety of surfactants may be used.
15 However, it is known that some surfactants exhibit herbicidal activity when used alone and such surfactants should not be used in the compositions of the invention.

A particularly preferred composition contains acetic acid, citric acid and a surfactant available as SpontoTM 300T. Sponto 300T is
20 understood to be an anionic/non-ionic surfactant blend, and is available from Witco. Other surfactants may be used. The amount of surfactant should be in the range of 1-5 g/l.

A further composition of the present invention comprises a combination of citric acid with surfactant, in aqueous solution. Sources of
25 citric acid have been discussed above. A preferred surfactant is SpontoTM 300T. In preferred embodiments, the concentration of citric acid is in the range of 1-10 g/litre, and especially 3-10 g/litre. However, as noted above, the concentration of citric acid and surfactant should be such that the

- 5 -

composition does not cause plant damage for the particular plant that is to be treated.

The plant growth regulant composition may be formulated so as to be effective on one or more of a variety of plants, and different
5 compositions and concentrations may be preferred with some plants.

The present invention may be used on a wide variety of plants, especially flowering and fruit-bearing plants. In particular, the present invention may be used to increase flower-set in the plants, which would lead to increased fruit-set in plants that bear fruit. Examples include peppers,
10 tomatoes, and other fruit bearing vegetables; impatiens, begonias, zinnias, dianthus, marigolds and other flowering plants; corn and other fruit or seed producing plants of the grass family; and other plants that produce flowers or fruit. In addition, the present invention may be used on tropical fruit-bearing plants or trees e.g. citrus trees, pineapples or the like.

15 In other embodiments, the compositions are used as plant growth regulants on a variety of vegetation.

The present invention is illustrated by the following examples:

EXAMPLE I

20

Materials and Methods:

All plant material was purchased as young seedlings in plug trays typical of the bedding plant industry. The seedlings were transplanted into individual plastic cell packs containing four cells per pack. The
25 exceptions were the tuberous begonias, which were planted into four inch plastic pots. The growing media consisted of typical peat moss-based soil commonly used in the greenhouse industry. All experiments with flowering plants were conducted in a greenhouse maintained at 70°F night temperature.

30 Untreated plants i.e. control plants, in all experiments were sprayed with water only.

- 6 -

Non-Stop Tuberous Root Begonia:

Transplanted plants were placed on a greenhouse bench and were watered with water containing a water-soluble fertilizer that is commonly used in a greenhouse. After one week, the plants were sprayed with a
5 composition of 2 g acetic acid plus 1 g citric acid plus 5 g Sponto 300T surfactant in 1000 ml of water. All plants were sprayed to runoff. After a further week, the plants were sprayed again with the same composition. The plants were then allowed to grow for three weeks before evaluation. Each experiment was replicated four times.

10 The results obtained are given in Table 1.

Impatiens "Accent Red":

Seedlings were planted in cell packs. Twelve-cell packs were placed on a plastic tray standard in the bedding plant industry. The plants
15 were sprayed in similar fashion to tuberous root begonias.

The colour of the foliage and the appearance of the leaves were evaluated by several people. The results obtained are given in Table 2.

Zinnia:

20 Plants were placed in four-inch plastic pots and allowed to grow for two weeks. Each plant was sprayed once with the composition noted above.

The treated and untreated plants were measured three weeks after spraying.

25

Dianthus Telstar F1 Hybrid:

Seedlings were transplanted into cell packs and allowed to grow for two days. The seedlings were then sprayed once. After a further two weeks, the height of treated and untreated plants was measured. The colour
30 of the plants was noted at the same time.

The results obtained are given in Table 4.

- 7 -

Pepper var. Enterprise:

Individual plants were planted in six-inch plastic pots and allowed to grow for two weeks. Plants were sprayed twice, at an interval of one week, and the height of the plants was recorded four weeks later.

5 Blooms were counted after a further three weeks.

The results obtained are given in Table 5.

Results:

10

Table 1: Non-Stop Tuberous Root Begonia

	<u>Treatment</u>	<u>Number of Branches</u>
	Unsprayed	7
	Sprayed once	13
15	Sprayed twice	13

Table 2: Impatiens Accent Red

	<u>Treatment</u>	<u>Height</u>	<u>Number of Branches</u>	<u>Colour</u>
20	Control	10.4 cm	11	Light green
	Sprayed twice	9.3 cm	18	Dark green

Table 3: Zinnia

	<u>Treatment</u>	<u>Height</u>
25	Unsprayed	12.0 cm
	Sprayed once	10.0 cm

- 8 -

Table 4: Dianthus Telstar F1 Hybrid

	<u>Treatment</u>	<u>Height</u>	<u>Colour</u>
	Unsprayed	3.8 cm	Light green
5	Sprayed once	2.8 cm	Dark green

Table 5: Pepper var. Enterprise

	<u>Treatment</u>	<u>Height</u>	<u>Number of Blooms</u>	<u>Colour</u>
10	Unsprayed	30.0 cm	20	Light green
	Sprayed once	20.0 cm	35	Dark green

The results clearly demonstrate that the application of the combination of acetic and citric acid to young plants results in shorter, more branched and greener plants. This produces several benefits to growers, without any foliar damage. The increase in number of blooms will result in the setting of more fruit, which will result to yield improvements, which would be especially beneficial in agriculturally-important crops.

20

EXAMPLE II

To determine whether citric acid alone could produce a reduction in height and be a plant growth regulant, several flowering plants were sprayed with different concentrations of citric acid plus surfactant. Details of the compositions are given in Table 6.

The height and condition of the plants was measured four weeks after application of the composition. The results are summarized in Table 6 below.

- 9 -

Table 6

	Fuchsia	Calceolaria	Sunscape Daisy	Petunia
5 g ca + 3 g Sponto/litre	7.0 cm	5.0 cm	8.0 cm	5.0 cm
20 g ca + 3 g Sponto/litre	5.0 cm	4.0 cm	7.0 cm	4.0 cm
Control	10.0cm	7.0 cm	12.0 cm	7.0 cm

ca = citric acid

5 Sponto = Sponto 300T surfactant

The same experimental procedure was repeated using tomato plants var. Emanuelle. The results are summarized in Table 7.

10

Table 7

	Tomato
5 g ca + 3 g Sponto/litre	5.0 cm no damage
20 g ca + 3 g Sponto/litre	4.0 cm damaged leaves
60 g ca + 3 g Sponto/litre	Dead
Control	8.0cm

ca = citric acid

Sponto = Sponto 300T surfactant

15

The results on flowers and vegetables showed that citric acid reduced plant height and caused an increase in lateral branching. The best

- 10 -

results were obtained with compositions having 5 g/l of citric acid. At this rate of application, no plant injury occurred.

Stunting of plants increased with increasing concentration of citric acid. At an application rate of 20 g per litre or higher, plant injury or total
5 kill of the plant became evident, especially with tomatoes, thereby showing variations in concentration that are effective.

EXAMPLE III

10 Experiments were conducted to show that the nature of the surfactant had an impact on the plant.

Using a concentration of 20 g/l citric acid, use of 3 g Witconol SN-90 surfactant resulted in severe damage on petunia stems. However, this damage was not evident when the same concentration of Sponto 300T was
15 used as the surfactant.

Witconol SN-90 surfactant is an ethoxylated alcohol.

Table 8

	% Injury on Petunia
20 g ca + 3 g Sponto 300T	0
20 g ca + 3 Witconol SN-90	70
Control	0

20

ca = citric acid

EXAMPLE IV

25 The effect of citric acid on plant branching was determined, by spraying three plants of Fuchsia (6.0 cm tall) with 5 g citric acid per litre of water. Control plants were sprayed with water only. The plants were planted in 10 inch plastic pots.

- 11 -

The plants were allowed to grow for three months, and then were evaluated for the number of side branches. The results obtained are shown in Table 9. Each experiment was replicated three times.

5

Table 9

	Average No. of Branches
Control	82
5 g ca + 3 g Sponto 300T	115

ca = citric acid

10

The results show that the citric acid/surfactant solution induced more branching in plants, thus producing more bushy and valuable plants.

- 12 -

CLAIMS:

1. A method of effecting regulation of plant growth comprising spraying an aqueous composition comprising acetic acid and citric acid, in combination with surfactant, onto said plant, said composition having a ratio of acetic acid to citric acid in the range of 4:1 to 1:1 on a weight basis, the concentration of acetic acid being less than 4 g/l and the concentration of surfactant being in the range of 1-5 g/l.
2. The method of Claim 1 in which the regulation in plant growth is an increase in flower-set in a flowering plant.
3. The method of Claim 1 in which the regulation in plant growth is an increase in fruit-set in a fruit-bearing plant.
4. The method of Claim 1 in which the regulation in plant growth is an increase in fruit-set of a tropical plant or tree.
5. The method of any one of Claims 1-4 in which the spraying of the composition is more effective in regulation of plant growth than spraying of any combination of one or two of acetic acid, citric acid and surfactant at the same concentration.
6. The method of any one of Claims 1-5 in which the concentration of acetic and citric acids and surfactant is such that the composition does not exhibit herbicidal properties on tomatoes.
7. The method of any one of Claims 1-6 in which the surfactant is a blend of nonionic and anionic surfactants.
8. Use an aqueous composition comprising acetic acid and citric acid, in combination with surfactant, as a plant growth regulant, said

- 13 -

composition having a ratio of acetic acid to citric acid in the range of 4:1 to 1:1 on a weight basis, the concentration of acetic acid being less than 4 g/l and the concentration of surfactant being in the range of 1-5 g/l.

5 9. The use of Claim 8 in which the composition effects an increase in flower-set in a flowering plant.

 10. The use of Claim 8 in which the composition effects an increase in fruit-set in a fruit-bearing plant.

10

 11. The use of Claim 8 in which the composition effects an increase in fruit-set of a tropical plant or tree.

15 12. The use of any one of Claims 8-11 in which the spraying of the composition is more effective in regulation plant growth of than spraying of any combination of one or two of acetic acid, citric acid and surfactant at the same concentration.

20 13. The use of any one of Claims 8-12 in which the concentration of acetic and citric acids and surfactant is such that the composition does not exhibit herbicidal properties on tomatoes.

 14. The use of any one of Claims 8-13 in which the surfactant is a blend of nonionic and anionic surfactants.

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 15. A method of effecting regulation of plant growth comprising spraying an aqueous composition of citric acid and surfactant onto said plant, the concentration of citric acid being in the range of 1-10 g/l, said composition being effective as a plant growth regulant.

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 16. The method of Claim 15 in which the surfactant is a blend of nonionic and anionic surfactants.