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(54) Title: PLANT DORMANCY CONTROL SYSTEM

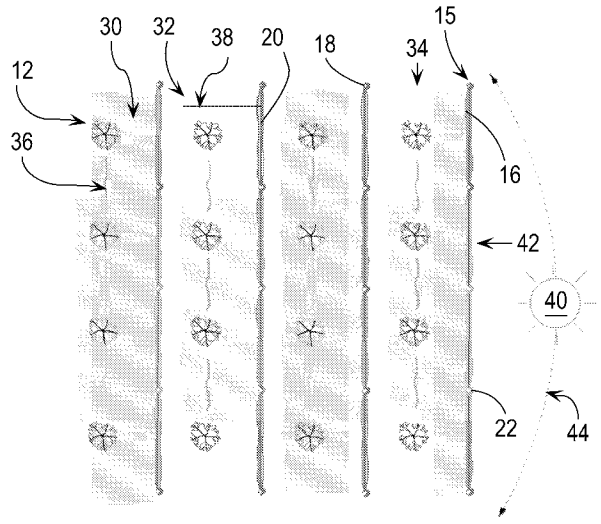


FIG. 5

(57) Abstract: A dormancy control system for use with plants such as fruit trees, nut trees, and perennial berry bushes planted in commercial settings. The dormancy control system employs vertical shade structures to control the dormancy of plants such as fruit trees, nut trees, and perennial berry bush crops. The dormancy control system results in dramatic increases in crop yield, and may be coupled with orchard planting directional orientation, evaporative cooling systems, and chemical and hormone based spray applications.

PLANT DORMANCY CONTROL SYSTEM

TECHNICAL FIELD

The invention relates to a dormancy control system for use with plants such as fruit trees, nut trees, and perennial berry bushes planted in commercial settings. More particularly, the invention pertains to the use of vertical shade structures to control the dormancy of plants such as fruit trees, nut trees, and perennial berry bush crops, optionally coupled with orchard planting directional orientation, the use of evaporative cooling systems, and the use of various chemical and hormone based spray applications.

BACKGROUND OF THE INVENTION

Many plants, including stone and pome fruit trees, nut trees, and perennial berry bushes, develop next year's buds during the summer each year. In the autumn of each year, these new buds go through a multi-stage process resulting in a dormant state. The nature and quality of the dormancy of these buds has been understood to be primarily controlled by the temperature to which the buds are exposed. Each species (or in many cases each variety) of fruit tree, nut tree, and perennial berry bush has specific dormancy requirements, which are typically expressed as minimum chilling units. Each chill unit is roughly equivalent to 1 hour of bud exposure to the required chilling temperature, or a lower temperature, for that variety. There are several different accepted methods for calculating chill units, and depending on the plant species or

varieties involved some of these methods take into account the greater or lesser chilling effect of specific temperatures by assigning higher or lower chill units to each hour spent within specific temperature ranges. Depending on the amount of chilling units required by each variety of plant for a healthy dormancy, various plant varieties are referred to as "high chill" varieties (meaning that they require a large number of chilling units) or "low chill" varieties (meaning that they require a small number of chilling units.)

If plant buds do not annually receive the minimum required chilling units, or if plant buds do not otherwise annually undergo a healthy dormancy period for that species or variety, then a number of problems arise. These problems include delayed or inadequate foliation and flowering, or delayed fruit production, or fruit production in non-commercial quantities or quality.

It has also been important to match the dormancy requirements of a particular variety with the location where that variety is planted. Even though a planting location may have ideal growing conditions during the main growing season for a particular variety, that same planting location may not naturally have the required dormancy conditions for that variety. A mismatch of dormancy requirements and planting location can cause serious problems. For example, planting a low chill variety in a cold area may result in trees flowering too early and being damaged by late frosts. As another example, planting a high chill variety in a warm area may result in little or no fruit production or low quality fruit production.

Cherries, in particular, present a good example of the effects of a mismatch between dormancy requirements and planting locations. Cherries grow very well in warm areas during

their main growing season. But, even with low-chill cherry varieties, it is difficult and sometimes impossible in those warm areas to obtain the minimum required chill units or to have a healthy dormancy period.

In early efforts to help control dormancy, commercial fruit growers tried to use overhead nets or shading, stretched horizontally on cables above the orchard, to protect their orchards from direct solar radiation during the autumn and winter months. This approach did not work, however, because the net/shade structures trapped heat and infrared light beneath the net/shade structure and actually caused the average plant bud temperature to increase during the autumn and winter – the opposite effect of what the growers were trying to achieve. These horizontal overhead net/shade structures actually exacerbated the dormancy problem the growers were trying to solve.

Currently, growers of fruit trees, nut trees, and perennial berries use evaporative cooling systems (including overhead water sprinklers as one example) in their orchards and fields to help keep plant bud temperatures at or below the required minimum chill temperature for the required number of hours (chill units). These growers also use several chemical or hormone based sprays to help induce, maintain, break, or otherwise affect plant bud dormancy. Some growers use both evaporative cooling and chemical/hormone sprays in their efforts to improve the quality and duration of plant bud dormancy in these warm areas. Despite all of these efforts, and despite use of low-chill plant varieties, there are still many years where commercial fruit growers do not get a commercial crop in warm growing areas, due to a failure of the plant buds to move into a healthy dormant state for the minimum required period of time. If the global climate continues

to warm, the insufficient dormancy issue may be an increasing problem for cherry growers as well as other stone fruit and pome fruit growers.

There are also situations where a grower wants to either induce early dormancy to produce an earlier crop, wants to extend dormancy to produce a later crop, or wants to create a dormancy period for an everbearing plant species or variety in an everbearing commercial planting location in order to concentrate or control the timing of harvest. In all three situations growers have attempted to use evaporative cooling coupled with chemical/hormone sprays, but without any significant success.

Cherries present a good example of the need to produce early or late crops. Producing early or late crops of cherries, for example, can be highly profitable for growers.

No-chill ever-bearing blueberry plants present a good example of the need to concentrate and control the time of harvest for ever-bearing plant varieties arises with commercial blueberry fields planted below a latitude of 34 degrees in either the northern or southern hemispheres. While everbearing blueberry plants are very productive on an annual basis, when planted in everbearing locations, only a small number of blueberries on each plant are ever ripe at any one time. This greatly increases the labor costs, because pickers may need to pass through and harvest those fields ten or more times during the year. Inducing a dormancy period in those no-chill ever-bearing blueberry plants would help to concentrate the entire annual production of blueberries into a much shorter and better defined harvest period, reducing the number of passes by pickers through the field while still maintaining a high annual yield.

Accordingly, there is a need for a system of controlling and improving dormancy

conditions for fruit trees, nut trees, and perennial berry plants, to allow these crops to be commercially grown in areas that otherwise do not naturally have optimal, or even adequate, dormancy conditions, and to control the date or duration of harvest.

The following is a disclosure of the present invention that will be understood by reference to the following detailed description taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF DRAWINGS

FIG. 1 is a perspective view of the plant dormancy control system, with the vertical shade fabric deployed, according to an embodiment of the invention;

FIG. 2 is a perspective view of the plant dormancy control system, with the vertical shade fabric retracted, according to an embodiment of the invention;

FIG. 3 is side view of the plant dormancy control system, with the vertical shade fabric retracted, according to an embodiment of the invention.

FIG. 4 is an overhead view of the plant dormancy control system, with the vertical shade structures directionally oriented in-line with E-W plant rows and the vertical shade fabric retracted, according to an embodiment of the invention;

FIG. 5 is an overhead view of the plant dormancy control system, with the vertical shade structures directionally oriented in-line with E-W plant rows and the vertical shade fabric deployed, according to an embodiment of the invention;

FIG. 6 is an overhead view of the plant dormancy control system, with the vertical shade structures directionally oriented transversely across N-S plant rows and the vertical shade fabric

retracted, according to an embodiment of the invention;

FIG. 7 is an overhead view of the plant dormancy control system, with the vertical shade structures directionally oriented transversely across N-S plant rows and the vertical shade fabric deployed, according to an embodiment of the invention.

DETAILED DESCRIPTION OF SPECIFIC EMBODIMENTS

The invention relates to a plant dormancy control system, employing vertical shade structures **15** that are installed in-line with plant rows **34** oriented in an East-West direction (E-W), or that are installed transversely across plant rows **34** oriented in a North-South direction (N-S). FIGs. 1 through 7 show the plant dormancy control system **10**, according to certain preferred embodiments of the present invention.

In one preferred embodiment, the plant dormancy control system of the present invention is for use in a commercial planting **11** of cherry trees, which may be referred to herein simply as the "orchard." The commercial planting includes a multiple of plants **12** that produce fruit **14**. For the purposes of the foregoing disclosure, the plants **12** can be referred to simply as "cherry trees," the fruit **14** can be referred to simply as 'cherries,' and the commercial planting of cherry trees can be referred to as a 'cherry orchard.'

In another preferred embodiment, the plant dormancy control system of the present invention is for use in a commercial planting **11** of blueberries, which may be referred to herein simply as the "blueberry field." The commercial planting includes a multiple of plants **12** that produce fruit **14**. For the purposes of the foregoing disclosure, the plants **12** can be referred to

simply as "blueberry bushes," the fruit **14** can be referred to simply as 'blueberries,' and the commercial planting of blueberry bushes can be referred to as a 'blueberry field.'

All of the preferred embodiments for plant dormancy control system **10** that are disclosed herein can be used alternatively with any variety of fruit tree, nut tree, or perennial berry bushes that requires dormancy, or that will tolerate extended or induced dormancy. All varieties of stone fruit varieties, pome fruit varieties, nut varieties, and many perennial berry varieties require dormancy periods and each have their own specific minimum chilling requirements. Additionally, there are no-chill ever-bearing varieties of plants that will nevertheless tolerate an induced dormant or semi-dormant period of time for the purpose of concentrating the harvest time period for those varieties.

The plant dormancy control system **10** of the present invention includes a vertical shade structure **15** which includes vertical supports **18** in the form of wood, metal, plastic, or concrete poles that support shade fabric **16,** which can be deployed (shown in FIGs 1, 5, and 7) or retracted (shown in FIGs 2, 3, 4, and 6), with the vertical shade structure **15** oriented in-line with plant rows **34** that run approximately in an East-West direction (E-W), as shown in FIGs 4 and 5, or a vertical shade structure **15** oriented transversely across plant rows **34** that run approximately in a North-South direction (N-S), as shown in FIGs 6 and 7.

A most preferred plant dormancy control system **10** consists of vertical shade structures **15** that are installed in a commercial planting **11** directionally oriented in-line with plant rows **34** that run approximately E-W, and includes vertical supports **18** and shade fabric **16** that is attached to an upper support cable **20** and a lower support cable **24**, with upper support cable **20**

attached to each vertical support **18** by upper support cable attachment **22**, and lower support cable **24** attached to each vertical support **18** by lower support cable attachment **26**, as shown in the perspective views of FIGs. 1 and 2, the side view of FIG. 3. When shade fabric **16** is vertically deployed, vertical shade structure **18** produces shade **32** during daylight hours by blocking direct solar radiation **42** produced by the sun **40** from reaching plants **12**, as shown in FIGs 1, 5, 7. Taking into consideration the latitude, orientation, and slope of the commercial planting **11** as a whole, vertical shade structures **15** are preferably placed to create a shaded area **30** during daylight hours in the form of a triangular prism that substantially encompasses plants **12** in each plant row **34**, and which substantially blocks direct solar radiation **42** from reaching plants **12**, as shown in FIGs 1, 5, and 7. The triangular prism of shaded area **30** consists of a triangular shaded area with three legs (ground leg **38**, vertical leg **37**, and shade leg **39**) created by vertical shade structure **18** and that extends the full length of plant row **34.** The ground leg **38** extends from the base of the vertical support structure **18** to shade edge **32**. The vertical leg **37** extends from the base of the vertical support structure **18** to top of shade fabric **16** where it is attached to upper support cable **20.** The shade leg **39** extends from the top of the shade fabric **16** where it is attached to upper support cable **20** down to shade edge **32**.

As shown in FIGs. 1 through 7, the vertical shade structure **15** for the plant dormancy control system **10** also includes a shade fabric **16** that extends vertically approximately four to six meters from the ground surface **36** for plants **12** that are fruit or nut trees, or that extends vertically approximately two to three meters from the ground surface **36** for plants **12** that are perennial berry bushes like blueberries. The shade fabric **16** is held in a substantially vertical

position by upper support cable **20** and a lower support cable **24**, as shown in FIGs. 1, 2, and 3, and held up by vertical shade structure **15**, and stretches along each plant row **34** (or transversely across all plant rows **34**) of commercial planting **11**. Most preferably, the shade fabric is made of EXTENDAY brand of nonreflective shade fabrics, as manufactured by Extenday Advanced Horticultural Fabrics, of Auckland, New Zealand. In a preferred embodiment, as shown in FIGs. 1, 5 and 7, the shade fabric **16** serves to absorb much of or substantially all of the direct solar radiation **42** from the orchard, while reflecting much of or substantially all of the direct solar radiation **42** from the orchard. Most preferably, the shade fabric serves to absorb approximately 90% or more of the direct solar radiation from the orchard, while reflecting approximately 10% or less of the direct solar radiation from the orchard. For the preferred embodiments, the substantially low reflectivity of shade fabric is necessary in order to substantially avoid reflecting part of the blocked direct solar radiation back onto the plants **12** that are located on the sun **40** side of each vertical shade structure **15**.

Because the shade fabric **16** is substantially nonreflective and has a large surface area, it disperses most of the absorbed heat generated from direct solar radiation **42** during the day, and then at night rapidly radiates any residual heat vertically up out of the commercial planting **11.**

The most preferred embodiment of the plant dormancy control system **10** also includes the ability to retract shade fabric **16** to stop creating shade for dormancy control, as shown in FIGs 2, 3, 4, and 6. Preferably, in order to retract shade fabric **16** the lower support cable attachments **26** on vertical supports **18** are opened or removed, and lower support cable **24** is used to lift shade fabric **16** to approximately the same height as upper support cable **20.** Then,

upper support cable **20**, shade fabric **16**, and lower support cable **24** are all temporarily bound together with shade fabric gathering tie **28** during the time that shade fabric **16** is retracted.

The plant dormancy control system **10** has been installed in cherry orchards to test the degree of plant dormancy control that can be achieved. In a test installation, the use of vertical shade structure **15** was evaluated in terms of controlling cherry bud temperatures during the cherry tree dormancy period, with a maximum ambient temperature of 25 °C during the dormancy period, on typical sunny days. This data was collected between the hours of 10am to 4pm. The results of that experiment are set forth in Table 1 below:

Table 1

Control Temp.	Vert. Shade Temp.	Vert. Shade + Evap. Cool. Temp
25.4 °C	16.9 °C	15.2 °C
26.4 °C	19.4 °C	15.3 °C
30.1 °C	22.5 °C	21.5 °C
32.0 °C	25.2 °C	21.2 °C
29.8 °C	22.5 °C	18.0 °C
31.3 °C	23.9 °C	22.2 °C
31.6 °C	24.3 °C	22.8 °C

Further experiments were performed using control trees, vertical shade structure **15** ("VS" in Table 2 below), evaporative cooling ("EC" in Table 2 below), and various chemical/hormone sprays. The results of those experiments are set forth in Table 2 below:

Table 2

Treatment	Production Increase	Harvest Timing
No Dormex®	0-5 cherries per tree	May 8
Early Dormex®	0-5 cherries per tree	
Late Dormex®	5-50 cherries per tree	
Thiadiazuron (TDZ)	0-50 cherries per tree	
Erger®	0-50 cherries per tree	
Evap. Cool. (EC) + Early Dormex®	3-5 ton/ha	April 28
Vertical Shade (VS) + Early Dormex®	15-20 ton/ha	
VS + EC + Early Dormex®	15-20 ton/ha	April 20
EC + TDZ	3-5 ton/ha	
VS + TDZ	25-30 ton/ha	
VS + EC + TDZ	25-30 ton/ha	April 28
EC + Erger®	4 ton/ha	
VS + Erger®	15 ton/ha	
VS + EC + Erger®	20 ton/ha	

The experimental results set forth in Table 2 demonstrate the relative ineffectiveness of the current dormancy control systems using chemical/hormone sprays, or sprays coupled with evaporative cooling. Using the current dormancy control systems, the best result was approximately 5 metric tons of cherries per hectare.

The experimental results set forth in Table 2 also demonstrate the surprising effectiveness of incorporating the use of vertical shade structures **15** with either evaporative cooling, or chemical/hormone sprays, or both. The addition of vertical shade structures **15** resulted in a cherry crop yield of between 15 and 30 metric tons per hectare – an improvement of at least

300% to 600% in crop yield. These results were entirely unexpected.

It was found that by absorbing the solar radiation from 550nm to 850nm in wavelength, the plant dormancy control system **10** prevented that range of radiation from striking the plant and activating the phytochromes of the plant, and apparently a high chill accumulation was induced resulting in a huge crop increase, even in the absence of temperature regimes that are commonly thought to be the only regulator of chill accumulation. It is observed that the incidental reduction in temperature on the buds of the plants had only a small secondary effect on increasing the level of dormancy.

In a preferred embodiment of the plant dormancy control system **10**, vertical shade structures **15** can be installed in commercial plantings **11** of plants **12** that are cherry trees to provide adequate dormancy in locations where there are not sufficient natural chilling units available. In this preferred embodiment, the plant dormancy control system is used to solve the problem presented by planting a low chill cherry variety in a warm location that does not naturally have adequate chilling units.

In an alternative preferred embodiment of the plant dormancy control system **10**, vertical shade structures **15** can be installed in commercial plantings **11** of plants **12** that are low chill cherry trees to induce early dormancy in a warm location before the natural climatic conditions would have naturally induced a dormant condition in the cherry trees. Because of the low minimum chilling units required by low chill cherry varieties, inducing early dormancy of those cherry trees in a warm location using the plant dormancy control system would result in cherries being available for harvest much earlier than the same variety of low chill cherries grown in the

same location under natural conditions. In this preferred embodiment, the dormancy requirements for those cherry trees would be met much earlier than under natural conditions without the use of the plant dormancy control system **10**. In this preferred embodiment, the plant dormancy control system is used to advance the harvest date of cherries, while still achieving adequate dormancy and thus maintaining commercial quantities and quality for the harvested cherries.

In another alternative preferred embodiment of the plant dormancy control system **10**, vertical shade structures **15** can be installed in commercial plantings **11** of plants **12** that are high chill cherry trees to extend dormancy in a cold location for longer than the natural climatic conditions would have naturally have maintained dormancy. Because high chill cherry varieties can tolerate higher numbers of chilling units, it is possible to extend dormancy of those cherry trees in a cold location using the plant dormancy control system in order to avoid the dangers of spring frost and to create cherry harvest dates much later than for the same variety of high chill cherries grown in the same location under natural conditions. In this preferred embodiment, the dormancy requirements for those cherry trees would be extended much longer than under natural conditions without the use of the plant dormancy control system **10**. In this preferred embodiment, the plant dormancy control system is used to delay both the bloom date and harvest date of cherry trees, thus protecting the cherry trees from the dangers of spring frost and still maintaining commercial quantities and quality for the harvested cherries.

In another alternative preferred embodiment of the plant dormancy control system **10**, vertical shade structures **15** can be installed in commercial plantings **11** of plants **12** that are

blueberry bushes to provide adequate dormancy in locations where there are not sufficient natural chilling units available. In this preferred embodiment, the plant dormancy control system is used to solve the problem presented by planting a low chill blueberry variety in a warm location that does not naturally have adequate chilling units.

In another alternative preferred embodiment of the plant dormancy control system **10**, vertical shade structures **15** can be installed in commercial plantings **11** of plants **12** that are low chill blueberry bushes to induce early dormancy in a warm location before the natural climatic conditions would have naturally induced a dormant condition in the blueberry bushes. Because of the low minimum chilling units required by low chill blueberry varieties, inducing early dormancy of those blueberry bushes in a warm location using the plant dormancy control system would result in blueberries being available for harvest much earlier than the same variety of low chill blueberries grown in the same location under natural conditions. In this preferred embodiment, the dormancy requirements for those blueberry bushes would be met much earlier than under natural conditions without the use of the plant dormancy control system **10**. In this preferred embodiment, the plant dormancy control system is used to advance the harvest date of blueberries, while still achieving adequate dormancy and thus maintaining commercial quantities and quality for the harvested blueberries.

In another alternative preferred embodiment of the plant dormancy control system **10**, vertical shade structures **15** can be installed in commercial plantings **11** of plants **12** that are high chill blueberry bushes to extend dormancy in a cold location for longer than the natural climatic conditions would have naturally have maintained dormancy. Because high chill blueberry

varieties can tolerate higher numbers of chilling units, it is possible to extend dormancy of those blueberry trees in a cold location using the plant dormancy control system in order to avoid the dangers of spring frost and to create blueberry harvest dates much later than for the same variety of high chill blueberries grown in the same location under natural conditions. In this preferred embodiment, the dormancy requirements for those blueberry bushes would be extended much longer than under natural conditions without the use of the plant dormancy control system. In this preferred embodiment, the plant dormancy control system **10** is used to delay the bloom date and harvest date of blueberry bushes, thus protecting the cherry trees from the dangers of spring frost and still maintaining commercial quantities and quality for the harvested blueberries.

In another alternative preferred embodiment of the plant dormancy control system **10**, vertical shade structures **15** can be installed in commercial plantings **11** of plants **12** that are no-chill ever-bearing blueberry bushes to induce dormancy in a warm location for the purpose of concentrating the harvest of blueberries into a harvest time frame that is only a several months long, instead of the normal continuous harvest that continues throughout the entire year under natural conditions. While no-chill ever-bearing blueberry varieties do not have any minimum chill requirements, it is possible to use the plant dormancy control system **10** to put those no-chill ever-bearing blueberry varieties into a dormant or semi-dormant state for a period of time, even when natural conditions would not induce a dormant or semi-dormant state. After a sufficient period of time in a dormant or semi-dormant condition, the shade fabric **16** is retracted, and the blueberry plants are allowed to bloom. Because there has been an induced state of dormancy or semi-dormancy, these no-chill ever-bearing blueberry varieties bloom heavily and produce a

large number of blueberries over a period of several months. The no-chill ever-bearing blueberry varieties subjected to an induced dormant or semi-dormant state thus have their harvest window concentrated into a relatively short period of time, and that period of time can start whenever desired by the grower depending on when the plant dormancy control system **10** is deployed in the commercial planting **11**.

All of the preferred embodiments for plant dormancy control system **10** that are disclosed herein can be used alternatively with any variety of fruit tree, nut tree, or perennial berry bushes that requires dormancy, or that will tolerate extended or induced dormancy. As noted above, all varieties of stone fruit varieties, pome fruit varieties, nut varieties, and many perennial berry varieties require dormancy periods and each have their own specific minimum chilling requirements. Additionally, there are no-chill ever-bearing varieties of plants that will nevertheless tolerate an induced dormant or semi-dormant period of time for the purpose of concentrating the harvest time period for those varieties.

The term "substantially," "approximately," and "approximate" are employed herein throughout, including this detailed description and the attached claims, with the understanding that these terms denote a level of exactness as typical for the skill and precision in the generally applicable field of technology.

In compliance with the statutes, the invention has been described in language more or less specific as to structural features and method steps. While this invention is susceptible to embodiments in different forms, the specification illustrates preferred embodiments of the invention with the understanding that the present disclosure is to be considered an

exemplification of the principles of the invention, and the disclosure is not intended to limit the invention to the particular embodiments described. Those with ordinary skill in the art will appreciate that other embodiments and variations of the invention are possible, which employ the same inventive concepts as described above. Therefore, the invention is not to be limited except by the following claims, as appropriately interpreted in accordance with the doctrine of equivalents.

CLAIMS

The following is claimed:

1. A plant dormancy control system, as herein described in the attached specification and drawings.

2. The plant dormancy control system of claim 1, wherein the plant dormancy control system serves a commercial planting of fruit trees, nut trees, or perennial berry bushes.

3. A method of a plant dormancy control system, as herein described in the attached specification and drawings.

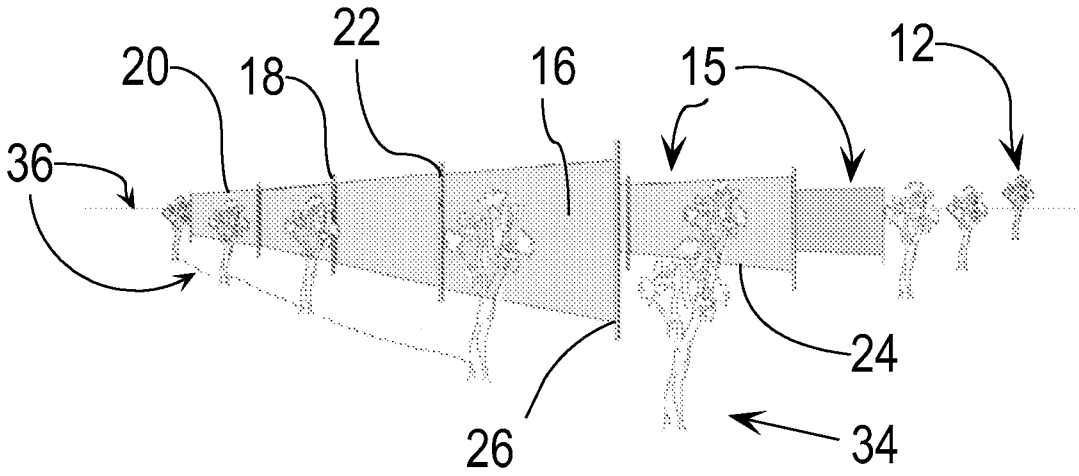


FIG. 1

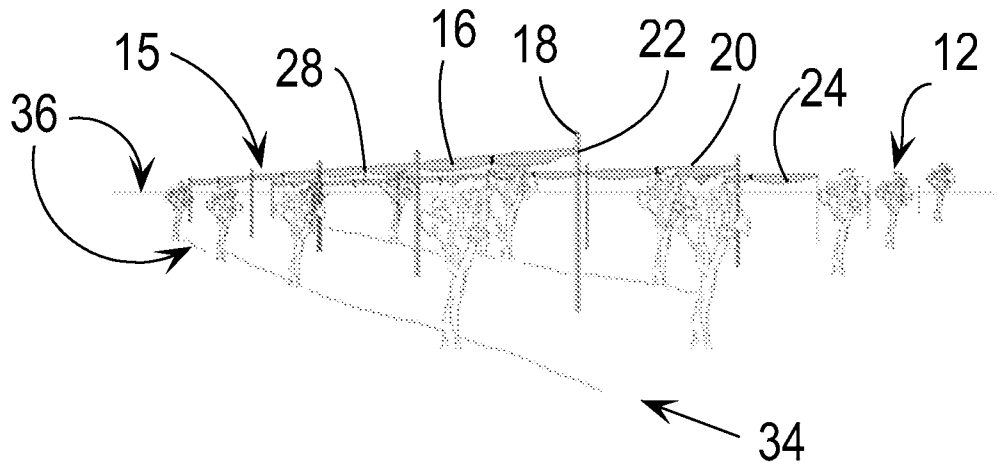


FIG. 2

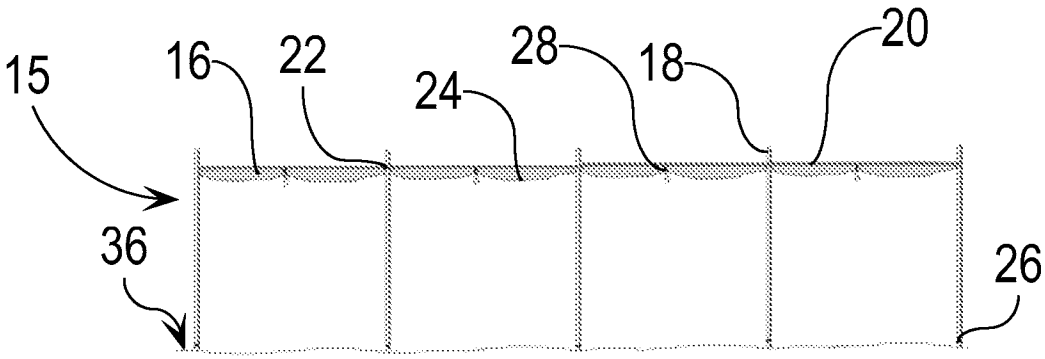


FIG. 3

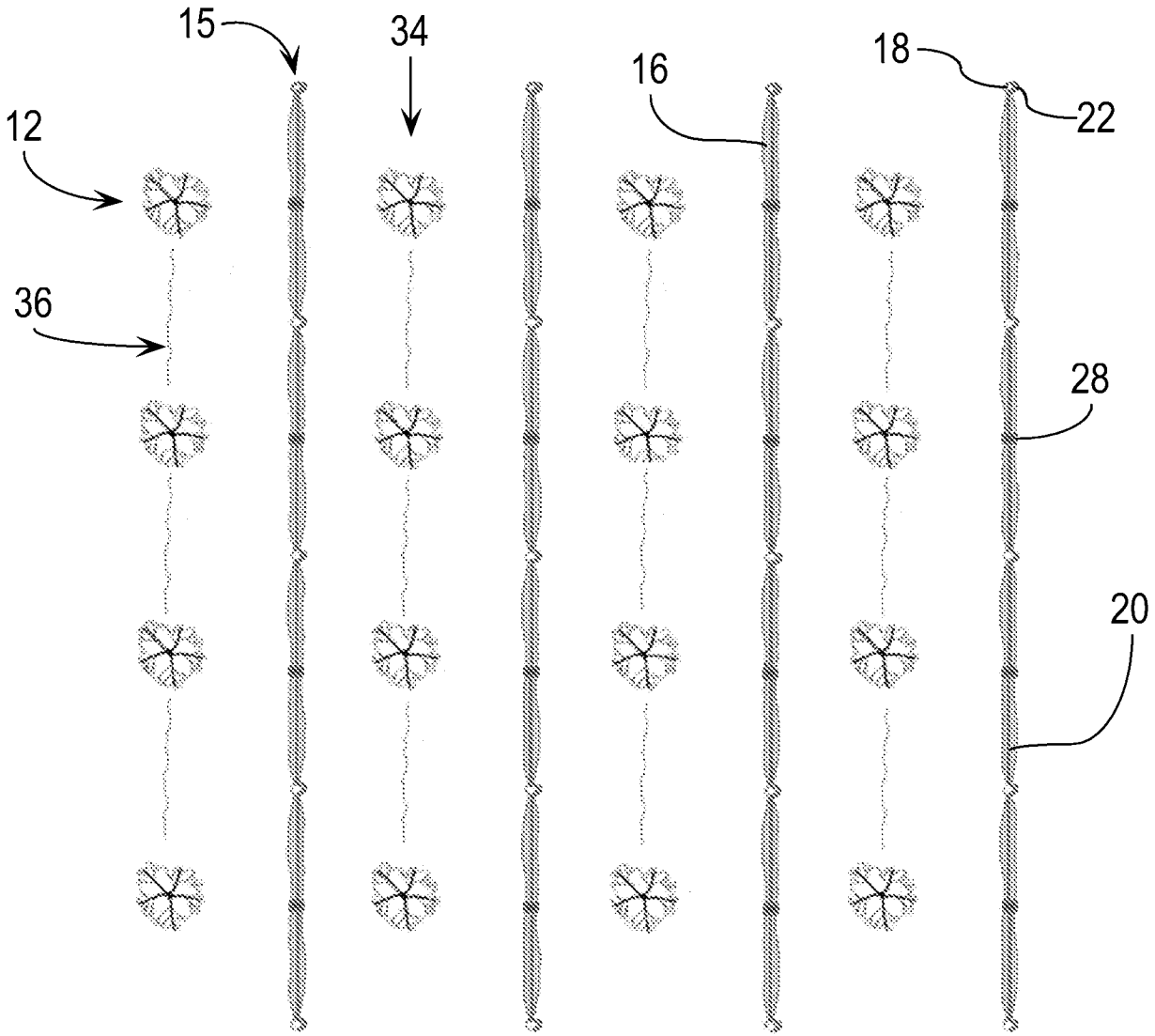


FIG. 4

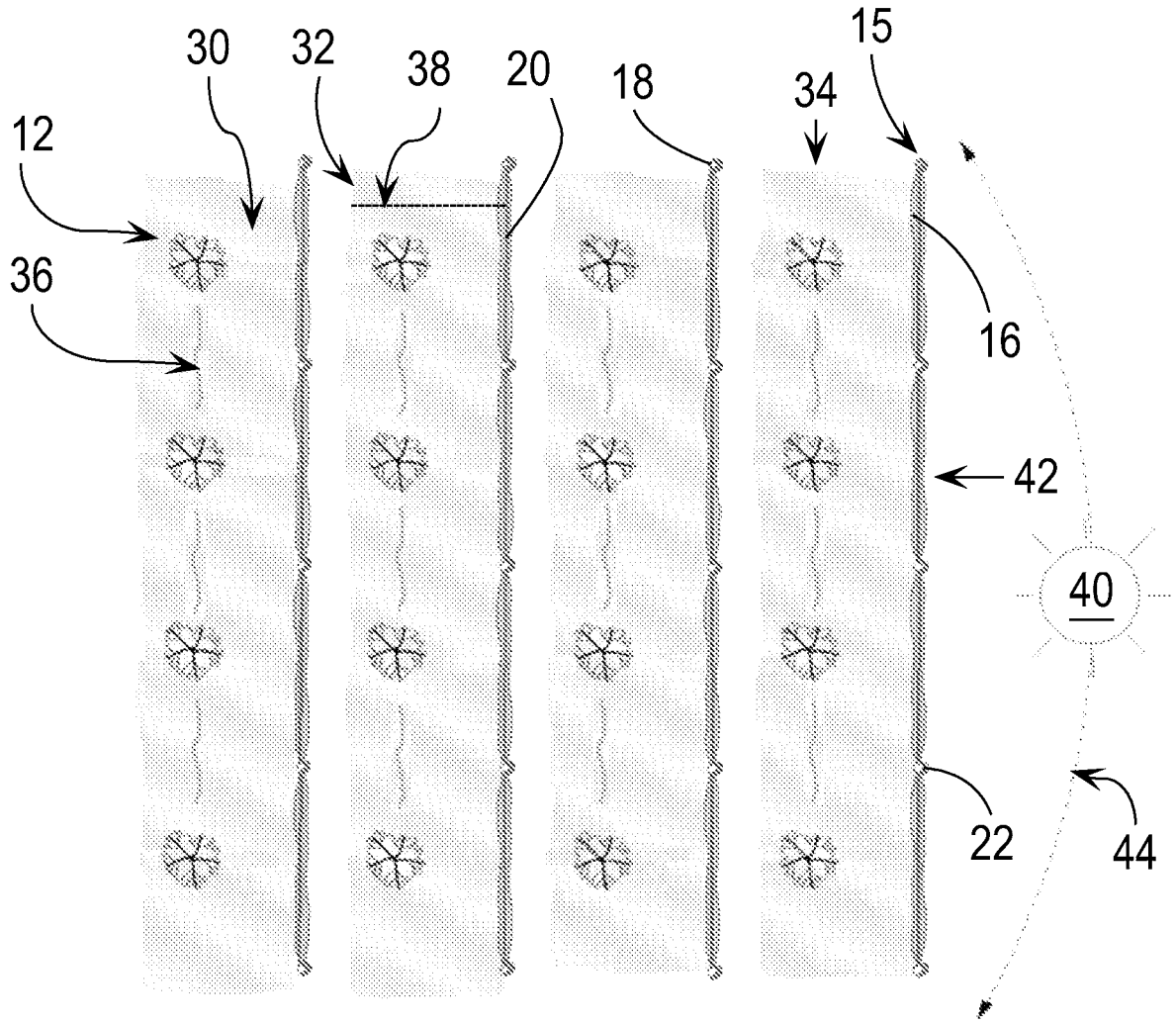


FIG. 5

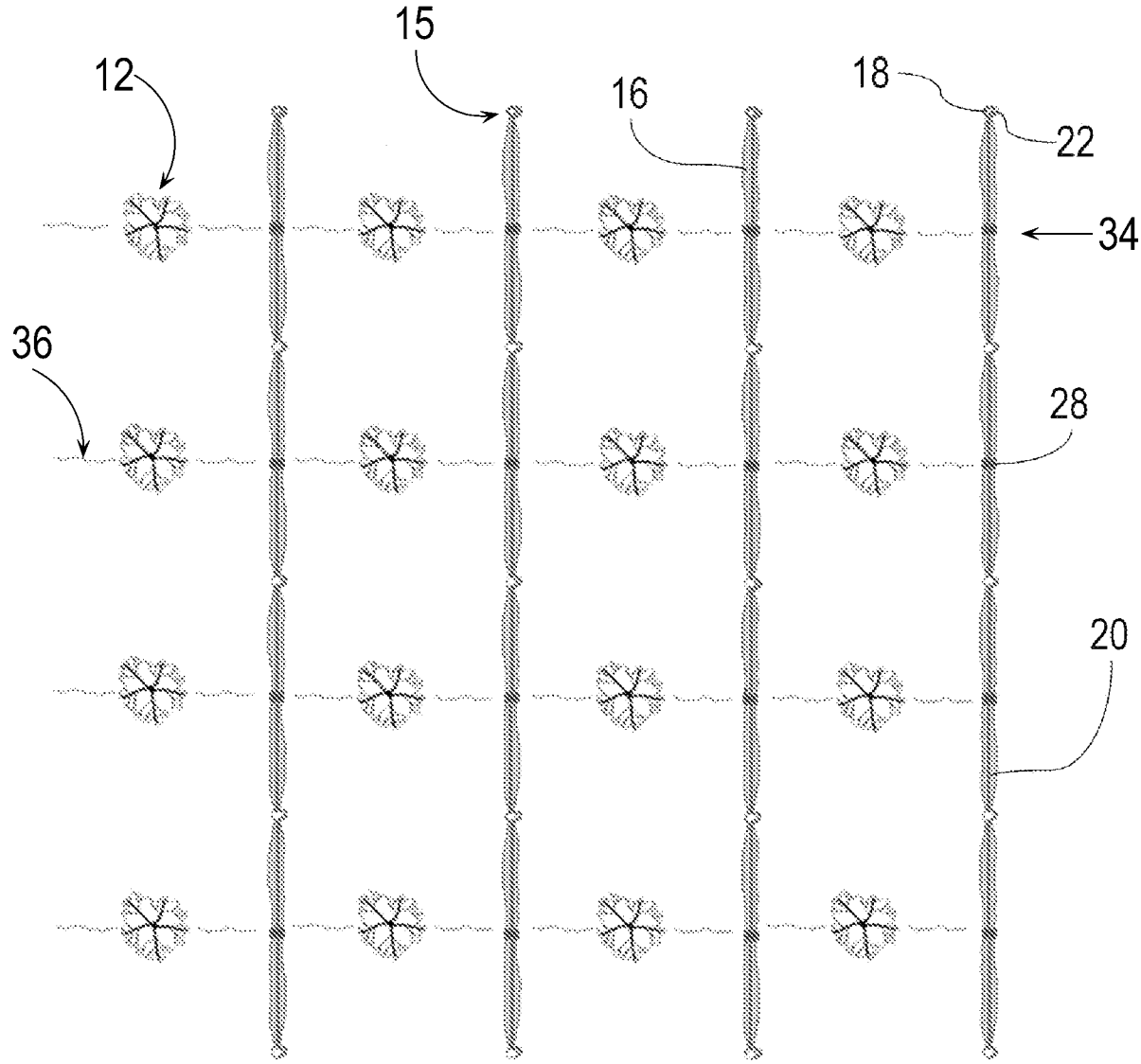


FIG. 6

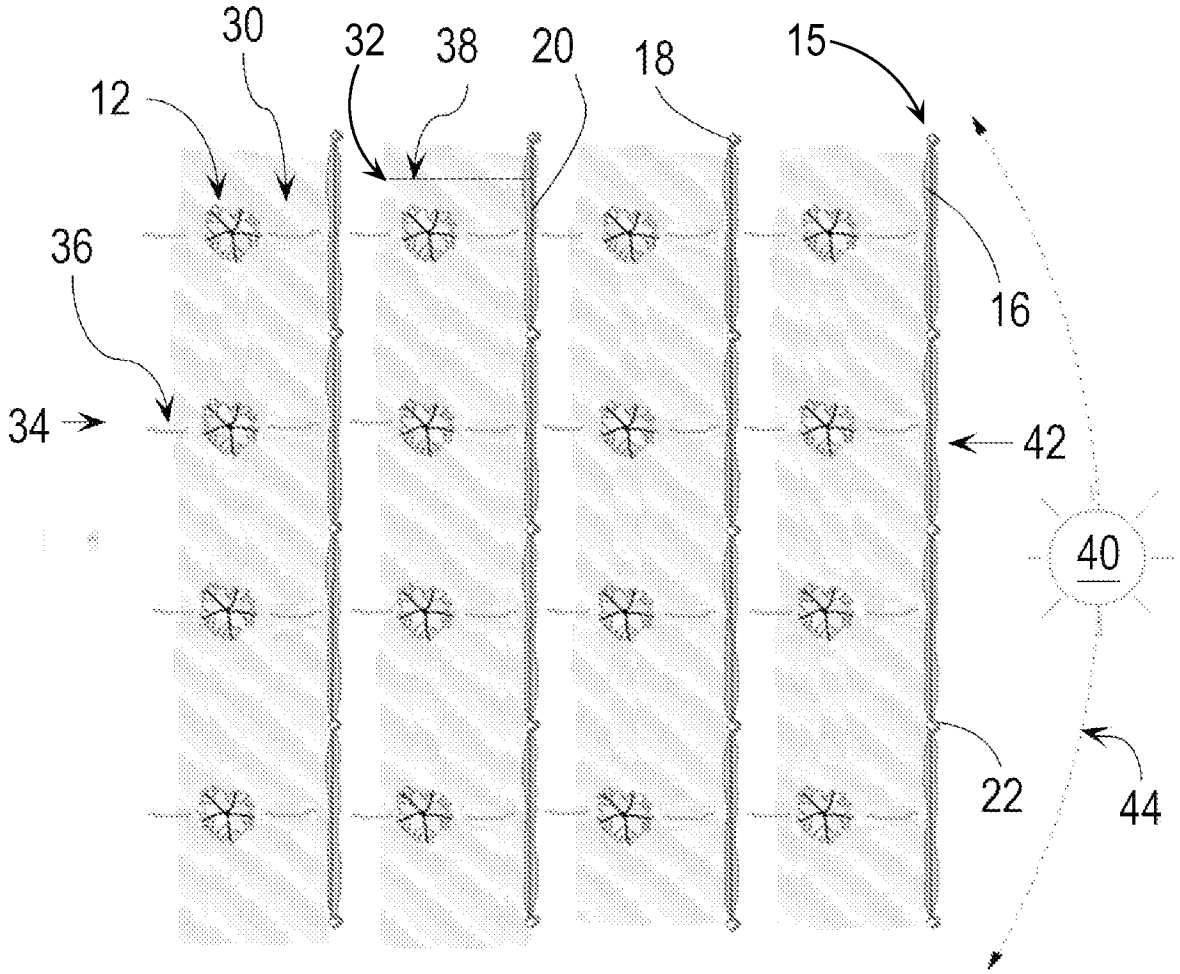


FIG. 7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US15/55100

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - A01G 13/02 (2016.01)
CPC - A01G 13/0206
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): A01G 13/00, 13/02, 13/10 (2016.01)
CPC: A01G 13/00, 13/02, 13/0206

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
PatSeer (US, EP, WO, JP, DE, GB, CN, FR, KR, ES, AU, IN, CA, INPADOC Data); EBSCO Discovery; IP.com; Google; Google Scholar; Google Patents; orchard, plant, retract, shade

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5519965 A (ROBINSON, MD) May 28, 1996; abstract; figure 4; column 1, lines 4-8; column 3, lines 31-40; column 4, lines 14-17	1-3
A	US 1106624 A (CADWALLADER, LT et al.) August 11, 1914; abstract	1-3
A	US 2012/0067388 A1 (ZUMMACH) March 22, 2012; figure 1	1-3

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
04 January 2016 (04.01.2016)	03 FEB 2016
Name and mailing address of the ISA/ Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-8300	Authorized officer Shane Thomas PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

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