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(54) Title: DEVICE FOR INJECTING A LIQUID DOSE INTO A BANANA STEM

(57) Abstract: A device is disclosed for manually injecting a metered dose of a liquid into the soft tissue of a banana stem, comprising :

(i) a liquid dose provision means configured to provide a metered dose of liquid to an adapter element upon manual actuation; (ii) an adapter element adapted to be fitted onto the liquid dose provision means and having two adapter couplers, spaced apart from each other, and able to receive two conduit couplers of longitudinally extending needles, and equipped with a conduit to provide the metered dose of liquid to said adapter couplers; (iii) two longitudinally extended needles for injecting liquid into the tissue of a banana stem, each of said needles comprising a tubular conduit having an outer surface, an inner conduit and a front and rear end portions, said front end portion formed into a tapered end, said outer surface comprising a longitudinal slit near said front end portion and parallel to the longitudinal axis of the tubular conduit and into which the inner conduit opens as an ejector hole such that liquid transported within said inner conduit may flow through said ejector and be deposited outside of said tubular conduit; and a conduit coupler attached to said rear end portion of said tubular conduit for connection to the adapter coupler such that liquid may flow through said conduit coupler, into said adapter coupler and into said tubular conduits, wherein the needles, when attached to the adapter element, are parallel to and spaced apart from each other. Also, a method is disclosed for use of the device according to the invention, in particular for injection of a liquid fertilizer into a banana tree pseudostem.



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DEVICE FOR INJECTING A LIQUID DOSE INTO A BANANA STEM

DESCRIPTION

5 Field

This invention relates to banana stem injection systems and, more particularly, to a device for injecting liquids directly into the pseudostem of a banana plant.

Background

10 A banana is an edible fruit produced by several kinds of large herbaceous flowering plants in the genus *Musa*. In some countries, bananas used for cooking may be called "plantains", distinguishing them from dessert bananas. The fruit is variable in size, colour, and firmness, but is usually elongated and curved, with soft flesh rich in starch covered with a rind, which may be green, yellow, red, purple, or brown when ripe. The fruits grow in clusters, also called bunches,
15 hanging from the top of the plant. Almost all modern edible seedless bananas come from two wild species – *Musa acuminata* and *Musa balbisiana* and a hybrid - *Musa × paradisiaca*. The term "banana" is also used as the common name for the plants that produce the fruit. This can extend to other members of the genus *Musa*, such as the scarlet banana (*Musa coccinea*), the pink banana (*Musa velutina*), and the Fe'i bananas. It can also refer to members of the genus
20 *Ensete*, such as the snow banana (*Ensete glaucum*) and the economically important false banana (*Ensete ventricosum*). Both genera belong to the banana family, *Musaceae*. In this description, when reference is made to a banana plant, it is meant to comprise all species of the banana family, *Musaceae*.

A mature banana plant consists of a pseudostem, which is not a tree, but is formed from
25 tightly packed leaves, which supports the plant. Each pseudostem normally produces a single inflorescence, also known as the "banana heart". The banana fruits develop from the banana heart, in a large hanging cluster, made up of tiers (called "hands"), with up to 20 fruit per tier. The hanging cluster is known as a bunch, comprising 3 to 20 tiers, and can weigh 30 to 50 kilograms. Individual banana fruits (commonly known as a banana or "finger") average 125
30 grams, of which approximately 75% is water and 25% dry matter. After fruiting, the pseudostem dies, but offshoots (also called suckling) will normally have developed from the base, so that the plant as a whole is perennial.

In contrast to tree injection, which is the two-step operation of making a cut or incision in

a tree with a first device and then placing a dose of chemical into the cut or incision using a second device, a banana stem injection is a one-step operation, wherein a spear or needle is inserted into the soft tissue of a banana pseudostem, in particular into the xylem vascular tissue, and an amount of a liquid is injected through said spear or needle.

5 Banana plant injection, also known as trunk or pseudostem injection, is a method described in the literature for the precise application of a dosage of e.g. pesticides, plant resistance activators, and fertilizers into the xylem vascular tissue of a banana plant with the purpose of protecting the plant from pests or for correction of nutrient deficiencies. This method largely relies on harnessing the plant's vascular system to translocate and distribute the active
10 compounds into the pseudostem, canopy and roots where protection or nutrition is needed. Banana plant injection is currently only practiced for the application of Vydate® nematicide, and its nutritional use has not been documented, in particular for fertilizing banana plants.

Various aspects are associated with this injection method: since the banana stem consists of a spongy, soft material, it is imperative that the injection is not invasive and does not damage
15 the stem tissue: it is very easy to manually drive a spear, stick, pole or needle into a banana (pseudo)stem. It is far more difficult to do this in a non-invasive way, leaving only a small wound. Wounds should be avoided as much as possible as they are entry points for insects and diseases. Furthermore, it is imperative that the injection is done in the outer tissue, and not in the core of the banana stem. As this kind of work is done in a routine way by workers in the field, the
20 injection method needs to be simple and fail-safe: it should be impossible to inject into the core of the banana stem. Furthermore, the injection dose needs to be set precisely to dose just the right amount of fertilizer: too much may damage the plant and be an economical loss, a too low amount may be not effective; hence the device should be able to deliver a metered dosage amount.

Background prior art

25 CN 105104031 discloses a method and apparatus for administering a pesticide into banana (pseudo)stems using a backpack type dispensing device comprising a container with liquid inlet and outlet, straps allowing the container to be carried on the back of the user; a hose;
30 a gun assembly and an injection device (syringe) having one needle. A user carrying the device first inserts the injection needle (syringe) in the banana pseudostem and then activates the gun assembly to inject liquid in the banana pseudostem, typically 20 ml. This document is generally silent on administering fertilizers using the disclosed device.

CN107182582 discloses an injection system to apply fertilizer and pesticide into a banana pseudostem, comprising an injection gun having one needle, connected via a hose to a jerrycan-type container.

CN204811181U discloses a device for injecting liquid in banana pseudostem comprising a
5 back bucket, a continuous drencher, a hose and one injection needle.

US5239773A discloses a tree injection system comprising a container for holding liquid, an injection device on which one needle is mounted and a conduit extending between and connected to the container and the injection device.

The open literature mentions the use of a calibrated Philips Drencher to inject Vydate L
10 "Oxamyl" against banana nematodes (<http://banana-networks.org/Bapnet/files-/2013/02/Truegellmann.pdf>). The Philips Drencher is actually designed for oral application to sheep and cattle or for multiple dosing and has one needle.

The Banana Backpack Spear Injector (Sidewinder Pty Ltd, Queensland /
<http://treeinjectors.com/blog/banana-backpack-spear-injector>) is an arm-operated banana-
15 injector to inject kerosene, roundup and most insecticides. It comprises an arm-operated liquid holder to provide an amount of liquid and an aluminium hollow spear, e.g. with a standard length of 1 meter, carrying a single needle, to inject the liquid into the plant.

In general, an injection system is not widely used in banana plantations, except to apply the Vydate nematicide.

20 The inventors have now found a solution to the above-mentioned issues.

Summary

It is therefore an object of the present invention to provide an improved banana stem injection device.

25 Yet another object of the present invention is to provide a banana stem injection device which is relatively light in weight and easily portable and allows easy operation by the operator thereof.

A further object of the present invention is to provide a banana stem injection device which uses two needles to allow an efficient, rapid, error-free banana stem injection in one step,
30 and divide the dose into two halves, particularly to apply simultaneously a dosage of the injected liquid at opposite sides of the pseudostem, with less internal damage of plant tissue.

Still another object of the present invention is to provide a banana stem injection device having dosage adjustment means to vary the amount of liquid introduced into a banana stem.

Another object of the present invention is to provide an improved banana stem injection method, based on the abovementioned one-step operation principle, which will cause relatively little damage to a banana stem.

Finally, an object of the present invention is to provide a device and method for banana stem injection, wherein the device is relatively simple to manufacture and safe and efficient in use, and wherein the method which is both time efficient and cost effective for the farmer.

According to one aspect, the invention relates to a device **1** for manually injecting a metered dose of a liquid into the soft tissue of a banana stem, comprising:

(i) a liquid dose provision means **2** configured to provide a metered dose of liquid to an adapter element **3** upon manual actuation;

(ii) an adapter element **3** adapted to be fitted onto the liquid dose provision means **2** and having two adapter couplers **4a**, **4b**, spaced apart from each other, and able to receive two conduit couplers **5a**, **5b** of longitudinally extending needles **6a**, **6b**, and equipped with a conduit to provide the metered dose of liquid to said adapter couplers **4a**, **4b**;

(iii) two longitudinally extended needles **6a**, **6b** for injecting liquid into the tissue of a banana stem, each of said needles comprising a tubular conduit **7a**, **7b** having an outer surface **8a**, **8b**, an inner conduit **9a**, **9b** and a front **10a**, **10b** and rear **11a**, **11b** end portions, said front end portion **10a**, **10b** formed into a tapered end, said outer surface **8a**, **8b** comprising a longitudinal slit **12a**, **12b** near said front **10a**, **10b** end portion and parallel to the longitudinal axis of the tubular conduit **7a**, **7b** and into which the inner conduit **9a**, **9b** opens as an ejector hole **13a**, **13b** such that liquid transported within said inner conduit **9a**, **9b** may flow through said ejector hole **13a**, **13b** and be deposited outside of said tubular conduit **7a**, **7b**; and a conduit coupler **5a**, **5b** attached to said rear **11a**, **11b** end portion of said tubular conduit **7a**, **7b** for connection to the adapter coupler **4a**, **4b** such that liquid may flow through said conduit coupler **4a**, **4b**, into said adapter coupler **5a**, **5b**, and into said tubular conduit **7a**, **7b**, wherein the needles **6a**, **6b**, when attached to the adapter element **3**, are parallel to and spaced apart from each other.

The device and various embodiments thereof are described in the appended depending claims. In this manner, upon penetration of the free end portion of the needle into a pseudostem to an extent beyond the ejector hole, liquid is injected through the liquid conduit and ejector hole into the banana pseudostem.

According to another aspect, the invention relates to a method for manually injecting a

liquid into the soft tissue of a banana pseudostem having a diameter D, said method comprising the steps of:

(i) providing a device according to the invention, wherein the distance between the two vertical extended needles **6a**, **6b** is less than the diameter D;

5 (ii) providing a container **14** for holding and dispensing the liquid;

(iii) providing a liquid in said container **14**;

(iv) inserting said needles **6a**, **6b** into the pseudostem of a banana plant such that said ejector holes **13a**, **13b** are located interiorly of the outer surface of the pseudostem and such that the plane defined by the two needles **6a**, **6b** is substantially perpendicular to the axis of the pseudostem of the banana plant ;

(v) manually actuating liquid dose provision means **2**, thereby injecting a metered dose of liquid into the pseudostem of the banana plant; and

(vi) retracting said needles **6a**, **6b** from the pseudostem of the banana plant.

In this manner relatively little damage to a banana stem is inflicted and a method which is both time efficient and cost effective for the farmer is provided.

The method and various embodiments thereof are described in the appended depending claims.

According to another aspect, the invention relates to a method for manually injecting a liquid into the soft tissue of a banana pseudostem having a diameter D, said method comprising the steps of:

(i) providing a device according to the invention, wherein the distance between the two vertical extended needles **6a**, **6b** is more than the diameter D;

(ii) providing a container **14** for holding and dispensing the liquid;

(iii) providing a liquid in said container **14**;

25 (iv) inserting said needles **6a**, **6b** into the pseudostem of a banana plant such that said ejector holes **13a**, **13b** are located interiorly of the outer surface of the pseudostem and such that the plane defined by the two needles **6a**, **6b** is tilted with respect to the axis of the pseudostem of the banana plant over an angle α , which angle is sufficient to inject liquid into the outer surface of the pseudostem but not inject the liquid into the centre of the pseudostem of the banana plant;

(v) manually actuating liquid dose provision means **2**, thereby injecting a metered dose of liquid into the pseudostem of the banana plant; and

(vi) retracting said needles **6a**, **6b** from the pseudostem of the banana plant.

In this manner relatively little damage to a banana stem is inflicted and a method which is both time efficient and cost effective for the farmer is provided.

The method and various embodiments thereof are described in the appended depending claims.

5

Description of the drawings

Figure 1 shows a 3D drawing of an injector device according to the invention.

Figure 2 shows a 3D drawing of a needle.

Figure 3 shows a 3D picture of a device according to the invention.

10

Figure 4 shows an assembly of injector device and container, carried by an operator.

Detailed Description of the invention

15

Throughout the description and claims of this specification, the words “comprise” and variations of them mean “including but not limited to”, and they are not intended to (and do not) exclude other moieties, additives, components, integers or steps. Throughout the description and claims of this specification, the singular encompasses the plural unless the context otherwise requires. In particular, where the indefinite article is used, the specification is to be understood as contemplating plurality as well as singularity, unless the context requires otherwise.

20

Features, integers, characteristics, compounds, chemical moieties or groups described in conjunction with a particular aspect, embodiment or example of the disclosure are to be understood to be applicable to any other aspect, embodiment or example described herein unless incompatible therewith. All of the features disclosed in this specification (including any accompanying claims, abstract and drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive. The disclosure is not restricted to the details of any foregoing embodiments. The disclosure extends to any novel one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed.

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The enumeration of numeric values by means of ranges of numbers comprises all values and fractions in these ranges, as well as the cited end points. The term “ranges from ... to ” as

used when referring to a range for a measurable value, such as a parameter, an amount, a time period, and the like, is intended to include the limits associated to the range that is disclosed.

The term “approximately” and “about” as used when referring to a measurable value, such as a parameter, an amount, a time period, and the like, is intended to represent the measurement error associated with the technique to measure such parameter, amount, time period, and the like, and is considered to be 5% or less, depending on the measurement technique used. It should be understood that the value to which the term “approximately” and “about” refers per se has also been disclosed.

10 **Device**

The device **1** is shown in its preferred embodiments in Figures 1 to 4.

According to one aspect, the invention relates to a device **1** for injecting a metered dose of a liquid into the soft tissue of a banana stem. In the context of the present disclosure, the device comprises at least three main portions:

15 Firstly, the device **1** comprises a liquid dose provision means **2** configured to provide a metered dose of liquid to an adapter element **3** upon manual actuation. This can be any means, which is suitable to be used in the field, which is portable and can be operated by one person, and which is able to push a metered dose through a narrow conduit. Examples are the gun-type assembly Philips Drencher, and the Sidewinder Banana Backpack spear Injector
20 (<http://treeinjectors.com/blog/banana-backpack-spear-injector/>), which is equipped with a lever to pump liquid, and is operated by arm.

Most preferably, the liquid dose provision means are a hand-operatable gun assembly as illustrated in Figure 3.

25 The hand-operatable gun comprises an assembly of valves connected to a liquid chamber, being connected to a trigger, that open and/or close to load the chamber and/or expel the liquid out of the gun into the pseudostem of a banana plant.

When the trigger is operated, the liquid is injected, a valve is closed, and a vacuum is generated that forces liquid from the tank by suction into the liquid chamber to recharge the liquid chamber with the liquid at the selected dose.

30 The gun is connected to a container **14**, designed to hold and dispense liquid, such as a fertilizer, an insecticide, a pesticide, an herbicide, a fungicide or a nematocide liquid, wherein the liquid inside is held at atmospheric pressure, with connection means such as a plastic hose, constituting a fully closed system that is ready to load or inject a liquid dose into the liquid

chamber.

The metered dose can be any amount that is useful for dosing to a banana plant. For example, in a co-pending application (PCT/EP2020/072221) has been described the application of a novel fertilizer composition comprising 1 to 3 weight% of P (as P_2O_5), and 10 to 15 weight% of K (as K_2O), and having a pH of about 7, directly, i.e. without first making an incision, injected into the banana pseudostem for increasing the weight of the fruit of a banana plant, as a dose of 10 to 50 ml, preferable 25 ml.

The major difference with the prior art is that the invention is focussed on a double needle system to split the metered dose into two doses, and as a means to prevent the user from injecting the liquid in the center of the banana pseudostem. To this end, the device **1** comprises an adapter element **3**, adapted to be fitted onto the liquid dose provision means **2** and having two adapter couplers **4a**, **4b**, spaced apart from each other, and able to receive two conduit couplers **5a**, **5b** of longitudinally extending needles **6a**, **6b**, and equipped with a conduit to provide the metered dose of liquid to said adapter couplers **4a**, **4b**. The adapter element is thus an element fluidly connecting the liquid dose provision means with the needles. The function of the adapter element **3** is to divide the metered dose into two doses and guide the doses to the two adapter couplers **4a**, **4b** which are designed to receive two conduit couplers **5a**, **5b** of longitudinally extending needles **6a**, **6b**.

In the context of the present disclosure, the adapter couplers **4a**, **4b** and/or the needles **6a**, **6b** being spaced apart from each other is particular in the meaning that the distance between the adapter couplers **4a**, **4b** and/or the needles **6a**, **6b** is similar to or is adjustable to the diameter of a banana pseudostem, such as the diameter of the pseudostem at a height of between 100 cm and 150 cm. In particular embodiments, the distance between the adapter couplers **4a**, **4b** and/or the needles **6a**, **6b** is or is adjustable to a distance between 5 and 30 cm, more particularly between 10 and 20 cm.

According to one embodiment, the two adapter couplers **4a**, **4b** are adjustably spaced apart from each other. In this way, the distance between the two needles **6a**, **6b** can be adjusted to the diameter of the banana pseudostem to be injected. However, including such adjustment system into the injection device may raise manufacturing costs of the injection device. Any mechanical system to be used on banana farms by field workers must be very simple to operate, strong and easy to repair because many field workers may have little schooling, and working conditions in tropical climates involve the use of tools that are as simple as possible.

Therefore, according to another embodiment, the two adapter couplers **4a**, **4b** are fixedly

spaced apart from each other. For example, for the injection of a fertilizer composition, the size of the pseudostem is such that the distance between the two needles **6a, 6b** is about 5 to 30 cm, particularly between 10 and 20 cm, such as about 15 cm. This distance was optimized and determined based on the average diameter of the banana stalks.

5 According to one embodiment, the doses guided to the two adapter couplers **4a, 4b** can have a volume ratio of 1:1, injecting the same amount of liquid on the two different locations in the banana stem, but according to another embodiment, the split ratio may be different, such as 1:2. In this case, the adapter element **3** is provided with means to split the dose in two according to a certain ratio, such as a valve arrangement. The split ratio could also be set
10 manually, e.g. by providing a knob on the adapter element **3**.

According to an embodiment, the adapter element **3** is removably fitted onto the liquid dose provision means **2**. This allows for an easy exchange or removal of the adapter element **3**, e.g. in case of replacement or cleaning thereof.

Thirdly, as illustrated in Figure 2, the device **1** comprises two longitudinally extended
15 needles **6 (6a, 6b)** for injecting liquid into the tissue of a banana stem, each of said needles comprising a tubular conduit **7a, 7b** having an outer surface **8a, 8b**, an inner conduit **9a, 9b** and a front **10a, 10b** and rear **11a, 11b** end portions, said front end portion **10a, 10b** formed into a tapered end, said outer surface **8a, 8b** comprising a longitudinal slit **12a, 12b** near said front
20 **10a, 10b** end portion and parallel to the longitudinal axis of the tubular conduit **7a, 7b** and into which the inner conduit **9a, 9b** opens as an ejector hole **13a, 13b** such that liquid transported within said inner conduit **9a, 9b** may flow through said ejector hole **12a, 12b** and be deposited outside of said tubular conduit **7a, 7b**; and a conduit coupler **5a, 5b** attached to said rear **11a, 11b** end portion of said tubular conduit **7a, 7b** for connection to the adapter coupler **4a, 4b** such that liquid may flow through said conduit coupler **4a, 4b** into said adapter coupler **5a, 5b**, and
25 into said tubular conduits **7a, 7b**, wherein the needles **6a, 6b**, when attached to the adapter element **3**, are parallel to and spaced apart from each other.

The needles **6a, 6b** are designed to convey the metered dose with a minimum of damage to the plant tissue. Normally, an ejector hole is located at the tip of the needle. To prevent clogging of the ejector hole when the needle is inserted multiple times in soft tissue, the ejector
30 hole **13a, 13b** has been arranged in a longitudinal slit **12a, 12b**, opening to the side of the needle. The dose is therefore not ejected at a depth equal to the length of the needle, but at a depth which is less than the length of the needle.

According to one embodiment, one or both needles **6a, 6b** may be provided with a depth

indicator, such as a scale, to measure the depth the needles are inserted into the pseudostem. Alternatively, one or both needles may be provided with an indicator of maximal depth, such as a mark on the needle, or a stopper, to indicate a certain depth the needles should or can be inserted into the pseudostem. Alternatively, the adapter element **3** may be fitted with a depth indicator, like a conventional drill.

According to one embodiment, the combination of conduit coupler **4a**, **4b** and adapter coupler **4a**, **4b** provides a separable arrangement wherein the needle is removable and allows an easy exchange of the needle, e.g. in case of replacement or cleaning thereof.

According to another embodiment, the combination of conduit coupler **4a**, **4b** and adapter coupler **4a**, **4b** provides an inseparable arrangement where the needle is not removable.

According to one embodiment, the device **1** further comprises a container **14** for holding and dispensing the liquid, in fluid communication with the liquid dose provision means **3** for providing the liquid to the liquid dose provision means **3**. The container **14** is designed to hold and dispense a liquid, such as a fertilizer, an insecticide, a pesticide, an herbicide, a fungicide, a nematocide or any other liquid. Preferably, the container **14** is designed as a backpack to be carried on the back of the operator (Figure 4). It can be provided with straps to strap the container **14** onto the back of the operator, or it can be designed as a unit to be inserted into a bay which is strapped onto the back of the operator. A unit-type container particularly refers to a container with standard size and volume, such as with a volume between 1 and 10 liter. Advantageously, the design as a unit-type container allows a quick and easy removal and exchange of a container **14** without the need for unstrapping, as the replacement container has the same size and volume as the empty container, thus improving the productivity of the user. Both type of containers can be designed as refillable containers.

According to one embodiment, the device **1** according to the invention may further comprise a valve switch to close off the feed of liquid to the inner conduits **9a**, **9b**, that is activated when the device **1** is held in a position such that a plane defined by the two needles **6a**, **6b** is in a substantial vertical alignment with the vertical axis of the pseudostem of the banana plant. This has the advantage that it is virtually impossible to inject a dose in the central part of the banana pseudostem, and the device **1** needs to be operated with the two needles in a plane which is substantially horizontal with reference to the vertical axis of the pseudostem of the banana plant.

Method

According to one aspect of the invention, there is provided a method for injecting a liquid into the soft tissue of a banana pseudostem having a diameter D using the device according to the invention.

In particular embodiments, the method comprises 6 steps. In a first step, a device according to the invention is provided, wherein the distance between the two vertical extended needles **6a**, **6b** is less than the diameter D. It is advantageous that the distance between the two vertical extended needles **6a**, **6b** can be adjusted. According to one embodiment, said distance is about 15 cm.

Typically, the pseudostem of banana trees have a diameter between 20 and 35 cm (as measured 1 m above ground level) when they are able to produce fruits.

In a second step, a container **14** is provided for holding and dispensing the liquid. We refer to the above paragraphs for the details on the container **14**.

In a third step, a liquid is provided in said container **14**. We refer to the above paragraphs for the details on the liquid.

In a fourth step, the operator holding the device **1** inserts said needles **6a**, **6b** into the pseudostem of a banana plant with diameter D such that said ejector holes **13a**, **13b** are located interiorly of the outer surface of the pseudostem, i.e. in the outer tissue of the pseudostem and not in the core of the banana pseudostem, and such that the plane defined by the two needles **6a**, **6b** is substantially perpendicular to the axis of the pseudostem of the banana plant. Typically, in this embodiment, the distance between the two needles **6a**, **6b** is at most the diameter of the pseudostem D. In particular, the distance between the two needles **6a**, **6b** is 1, 2, 3, 4 or 5 cm smaller than the diameter of the pseudostem D. Optionally, the operator holding the device adjust the distance between the needles **6a**, **6b** prior to inserting the needles into the pseudostem. In view of the soft tissue, little force is necessary to penetrate the outer surface of the pseudostem. On the contrary, attention needs to be given not to insert the needles too far into the tissue. A depth indicator or stopper could be very useful here.

In a fifth step, said liquid dose provision means **2** are manually actuated, thereby injecting a metered dose of liquid into the pseudostem of the banana plant.

In a sixth step, said needles **6a**, **6b** are retracted from the pseudostem of the banana plant by retracting the device **1**.

According to one aspect of the invention, there is provided a method for injecting a liquid into the soft tissue of a banana pseudostem having a diameter D using the device according to the invention. In particular embodiments, the method comprises 6 steps. In a first step, a device

according to the invention is provided, wherein the distance between the two vertical extended needles **6a**, **6b** is more than the diameter D. It may happen that within a field some trees have a smaller diameter than the device according to the invention.

In a second step, a container **14** is provided for holding and dispensing the liquid. We refer to the above paragraphs for the details on the container **14**.

In a third step, a liquid is provided in said container **14**. We refer to the above paragraphs for the details on the liquid.

In a fourth step, the operator holding the device **1** inserts said needles **6a**, **6b** into the pseudostem of a banana plant such that said ejector holes **13a**, **13b** are located interiorly of the outer surface of the pseudostem and such that that the plane defined by the two needles **6a**, **6b** is tilted with respect to the axis of the pseudostem of the banana plant over an angle α , which angle is sufficient to inject liquid into the outer surface of the pseudostem but not inject the liquid into the centre of the pseudostem of the banana plant. In view of the soft tissue, little force is necessary to penetrate the outer surface of the pseudostem. On the contrary, attention needs to be given not to insert the needles too far into the tissue. A depth indicator or stopper may be added to the needles to ensure this.

In a fifth step, said liquid dose provision means **2** are manually actuated, thereby injecting a metered dose of liquid into the pseudostem of the banana plant.

In a sixth step, said needles **6a**, **6b** are retracted from the pseudostem of the banana plant by retracting the device **1**.

According to one embodiment, the method is performed wherein the distance between the two vertical extended needles (**6a**, **6b**) is more than the diameter D and wherein the plane defined by the two needles is tilted with respect to the axis of the pseudostem of the banana plant over an angle α , which angle is sufficient to inject liquid into the outer surface of the pseudostem but not inject the liquid into the centre of the pseudostem of the banana plant. This embodiment allows injection into pseudostems of which the diameter is smaller than the distance between the two needles **6a**, **6b**. The device can be tilted, and the needles are inserted such that one needle penetrates the pseudostem at one side at a higher point than the other needle at the other side. This allows the use of a device **1** wherein the two adapter couplers **4a**, **4b** are fixedly spaced apart from each other, or the two adapter couplers **4a**, **4b** are adjustably spaced apart from each other but it requires too much effort to adjust the distance with each plant.

This method will cause relatively little damage to a banana stem and is both time efficient and cost effective for the farmer. The device and the method according to the invention are very suited for injection of a liquid into a banana tree pseudostem, in particular a liquid fertilizer. It was found that it was beneficial to inject a liquid fertilizer containing phosphorus and potassium in banana trees to increase the weight of the fruits. In particular, as disclosed in application PCT/EP2020/072221, the liquid fertilizer may be an aqueous fertilizer composition comprising 1 to 3 weight% of P (as P_2O_5), and 10 to 15 weight% of K (as K_2O) and having a pH of about 7.

Furthermore, it is to be understood that numerous modifications and adjustments to both the device and the method of the present invention may be contemplated and performed. For example, a completely different liquid dose provision means than the one described above may be used in conjunction with the two-needle arrangement according to the invention. Alternatively, the needle itself may include a plurality of ejection holes. Therefore, the above description is not intended in any way to limit the scope of the present invention, the scope of which shall follow in the claims as set forth below.

CLAIMS

1. Device (1) for manually injecting a metered dose of a liquid into the soft tissue of a banana stem, comprising:

5 (i) a liquid dose provision means (2) configured to provide a metered dose of liquid to an adapter element (3) upon manual actuation;

(ii) an adapter element (3) adapted to be fitted onto the liquid dose provision means (2) and having two adapter couplers (4a, 4b), spaced apart from each other and able to receive two conduit couplers (5a, 5b) of longitudinally extending needles (6a, 6b),
10 and equipped with a conduit to provide the metered dose of liquid to said adapter couplers (4a, 4b);

(iii) two longitudinally extended needles (6a, 6b) for injecting liquid into the tissue of a banana stem, each of said needles comprising a tubular conduit (7a, 7b) having an outer surface (8a, 8b), an inner conduit (9a, 9b) and a front (10a, 10b) and rear (11a, 11b)
15 end portions, said front end portion (10a, 10b) formed into a tapered end, said outer surface (8a, 8b) comprising a longitudinal slit (12a, 12b) near said front (10a, 10b) end portion and parallel to the longitudinal axis of the tubular conduit (7a, 7b) and into which the inner conduit (9a, 9b) opens as an ejector hole (13a, 13b) such that liquid transported within said inner conduit (9a, 9b) may flow through said ejector hole (13a, 13b) and be
20 deposited outside of said tubular conduit (7a, 7b) ; and a conduit coupler (5a, 5b) attached to said rear (11a, 11b) end portion of said tubular conduit (7a, 7b) for connection to the adapter coupler (4a, 4b) such that liquid may flow through said conduit coupler (4a, 4b), into said adapter coupler (5a, 5b) and into said tubular conduits (7a, 7b), wherein the needles (6a, 6b), when attached to the adapter element (3), are parallel to and spaced
25 apart from each other.

2. Device (1) according to claim 1, wherein the liquid dose provision means is a hand-operatable gun assembly.

- 30 3. Device (1) according to claim 1 or 2, wherein the two adapter couplers (4a, 4b) are adjustably spaced apart from each other.

4. Device (1) according to claim 1 or 2, wherein the two adapter couplers are fixedly spaced

apart from each other, preferably at a distance of about 15 cm.

5. Device (1) according to any one of claims 1 to 4, wherein the adapter element (3) is provided with means to divide the metered dose over the two longitudinally extended needles (6a, 6b).

6. Device (1) according to any one of claims 1 to 5, further comprising
(iii) a container (14) for holding and dispensing the liquid, in communication with the liquid dose provision means (3) for providing the liquid to the liquid dose provision means (3).

7. Device (1) according to claim 6, wherein the container (14) is a backpack-type container that can be strapped onto the back of a person.

8. Device (1) according to claim 6, wherein the container (14) is a unit-type container that can be inserted into a bay, strapped onto the back of a person.

9. Device (1) according to any one of claims 6 or 8, wherein the container (14) is refillable and/or wherein the liquid inside the container is held at atmospheric pressure.

10. Device (1) according to any one of claims 1 to 9, further comprising a valve switch to close off the feed of liquid to the inner conduits (9a, 9b), that is activated when the device (1) is held in a position such that a plane defined by the two needles (6a, 6b) is in a substantial vertical alignment with the vertical axis of the pseudostem of the banana plant.

11. A method for manually injecting a liquid into the soft tissue of a banana pseudostem having a diameter D, said method comprising the steps of:

(i) providing a device according to any one of claims 1 to 10, wherein the distance between the two vertical extended needles (6a, 6b) is less than the diameter D;

(ii) providing a container (14) for holding and dispensing the liquid;

(iii) providing a liquid in said container (14);

(iv) inserting said needles (6a, 6b) into the pseudostem of a banana plant such that said ejector holes (13a, 13b) are located interiorly of the outer surface of the pseudostem

and such that the plane defined by the two needles (6a, 6b) is substantially perpendicular to the axis of the pseudostem of the banana plant ;

(v) manually actuating said liquid dose provision means (2), thereby injecting a metered dose of liquid into the pseudostem of the banana plant; and

5 (vi) retracting said needles (6a, 6b) from the pseudostem of the banana plant.

12. A method for manually injecting a liquid into the soft tissue of a banana pseudostem having a diameter D, said method comprising the steps of:

10 (i) providing a device according to any one of claims 1 to 10, wherein the distance between the two vertical extended needles (6a, 6b) is more than the diameter D;

(ii) providing a container (14) for holding and dispensing the liquid;

(iii) providing a liquid in said container (14);

15 (iv) inserting said needles (6a, 6b) into the pseudostem of a banana plant such that said ejector holes (13a, 13b) are located interiorly of the outer surface of the pseudostem and such that the plane defined by the two needles (6a, 6b) is tilted with respect to the axis of the pseudostem of the banana plant over an angle α , which angle is sufficient to inject liquid into the outer surface of the pseudostem but not inject the liquid into the centre of the pseudostem of the banana plant;

20 (v) manually actuating said liquid dose provision means (2), thereby injecting a metered dose of liquid into the pseudostem of the banana plant ; and

(vi) retracting said needles (6a, 6b) from the pseudostem of the banana plant.

13. The method according to any one of 11 to 12, wherein the liquid is one of a fertilizer, an insecticide, a pesticide, an herbicide, a fungicide or a nematicide.

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14. The method according to any one of claims 11 to 13, wherein the liquid is an aqueous fertilizer composition comprising 1 to 3 weight% of P (as P_2O_5), and 10 to 15 weight% of K (as K_2O) and having a pH of about 7.

30 15. Use of the device according to any one of claims 1 to 10 for injection of a liquid into a banana tree pseudostem, in particular a liquid fertilizer.

FIGURES

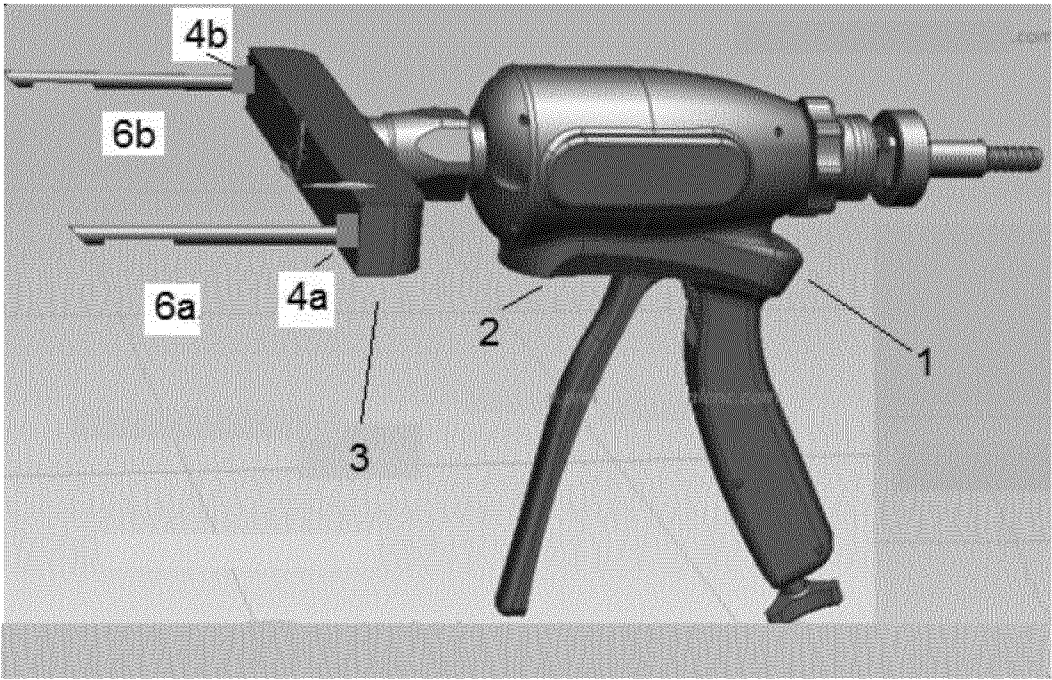


Figure 1

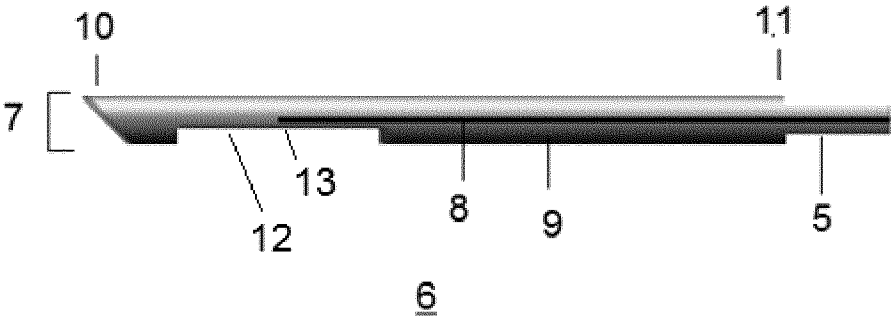


Figure 2



Figure 3

3/3



Figure 4

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2020/074051

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61M5/32 A01G13/00
ADD.

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)
A61M A01G

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)

EPO-Internal, WPI Data, BIOSIS, Sequence Search, EMBASE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 204 811 181 U (INST AGRICULTURAL ENVIRONMENT & RESOURCES YUNNAN A; YIN KESUO) 2 December 2015 (2015-12-02) abstract paragraph [0014] - paragraph [0015] paragraph [0018]	1-15
A	----- CN 105 104 031 A (INST AGRICULTURAL ENVIRONMENT & RESOURCES YUNNAN A ET AL.) 2 December 2015 (2015-12-02) cited in the application abstract Paragraph B.7. paragraph [0048] Paragraph B.8. ----- -/-	1-15



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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Date of the actual completion of the international search

12 October 2020

Date of mailing of the international search report

26/10/2020

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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2020/074051

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 107 182 582 A (POMOLOGY RES INSTITUTE GUANGDONG ACADEMY OF AGRICULTURAL SCIENCES) 22 September 2017 (2017-09-22) cited in the application abstract paragraph [0016] - paragraph [0018] -----	1-15
A	US 5 239 773 A (DOOLITTLE JR GLAYNE D [US]) 31 August 1993 (1993-08-31) abstract figures 1-3 -----	1-15
A	US 2017/165434 A1 (WANG ZHONGTANG [CN]) 15 June 2017 (2017-06-15) abstract figure 7 -----	1-15
A	US 2018/264204 A1 (MANDAROUX BASTIEN [FR]) 20 September 2018 (2018-09-20) abstract figures 2, 3 -----	1-15

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2020/074051

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
CN 204811181	U	02-12-2015	NONE	
CN 105104031	A	02-12-2015	NONE	
CN 107182582	A	22-09-2017	NONE	
US 5239773	A	31-08-1993	NONE	
US 2017165434	A1	15-06-2017	NONE	
US 2018264204	A1	20-09-2018	NONE	