Another problem is the fact pest control in fruit and other food plants is legally restricted. Conventional chemical pesticides can only be used during certain times of the vegetation period to avoid accumulation of chemical residues in the fruits or plant produce. It is therefore desired to replace chemical pesticides with biological control agents which are approved for human consumption. However, these control agents normally have high costs of goods which make a foliar use by spray applications in plantations of trees and other plants like banana, coffee, or cocoa punitively expensive. It is therefore desired to substantially reduce the amount of biological active ingredients in the treatment of especially trees, bushes and other plantations plants.

Therefore, a further problem addressed with the present disclosure relates to a process for modulating the phenotype of a plant or a multitude of plants by installing a plant injection system according to the disclosure in the plant or multitude of plants and administering a liquid formulation of an active ingredient to modulate the phenotype of the plant. A further problem address with the present disclosure relates to a method to modulate phenotypes of plants, for instance to treat, prevent, protect and immunize, which means induce local and systemic resistance to plants from pathogenic attacks and pest attacks. The injection tools described herein distribute liquid formulations directly to the interior of the plant without spraying and the commensurate loss of errantly applied sprayed formulations. The subject matter described herein places the formulations in direct contact with plant tissues and the formulations are selectively administered at appropriate times to minimize (e.g., eliminate or minimize) the accumulation of chemical residues in fruits or crops as mandated.

Summary

In an aspect, the present disclosure refers to an injection tool, comprising:

a base including an inlet port; and

a penetrating distribution body having a distal end away from the base and a proximal end near the base, wherein the penetrating distribution body includes:

a cutting edge at the distal end of the penetrating distribution body,

a penetrating element that extends from the cutting edge to the proximal end of the penetrating distribution body,

wherein the cutting edge and the penetrating element form a wedge type body profile extending along a longitudinal axis of the injection tool,

opposing faces that extend from the base and meet at the cutting edge,

a distribution element that includes:

a main channel that runs longitudinally through the center of the penetrating distribution body;

distribution ports; and

two distribution reservoirs, one on each side of the main channel, wherein each distribution reservoir is an opening that extends through both opposing faces of the penetrating distribution body.

In an aspect, the present disclosure refers to a plant injection system, comprising:

an injection tool of the above aspect; and

a delivery device connected to the injection tool, wherein the delivery device includes a container configured to store a liquid formulation.

In an aspect, the present disclosure refers to a method of distributing a liquid formulation to a plant, comprising:

penetrating the plant with an injection tool of the above aspect; and

distributing the liquid formulation through the injection tool to the plant.

Brief Description of the Drawings

The disclosure is explained in more detail below on the basis of illustrative embodiments depicted in the drawings.

Figure 1 shows a schematic view of an embodiment of an injection system with a first embodiment of an injection tool in axial cross-section and inserted into a tree trunk, as well as first, second and third embodiments of delivery devices;

Figure 2 shows a side view of the injection tool of the injection system of Figure 1;

Figure 3 shows an axial cross-section of the injection tool of the injection system of Figure 1 along the line III-III of Figure 2;

Figure 4 shows an overall view of the first embodiment of the delivery device of the injection system of Figure 1;

Figure 5 shows a schematic hydraulics diagram of the delivery device of Figure 4;