PlantControl CX

A high performance, multi-functional irrigation control system

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Introduction

In a report of the World Economic Forum (WEF) 2014 about the largest risks for humanity, the problem “water” has the third rank. It is expected that in the course of global warming, as well as the further sharp increase in population in Asia and Africa, the water will still gain additional importance (Fig. 1). Water is a strategic resource and all efforts must be made to use this vital substance sparingly.

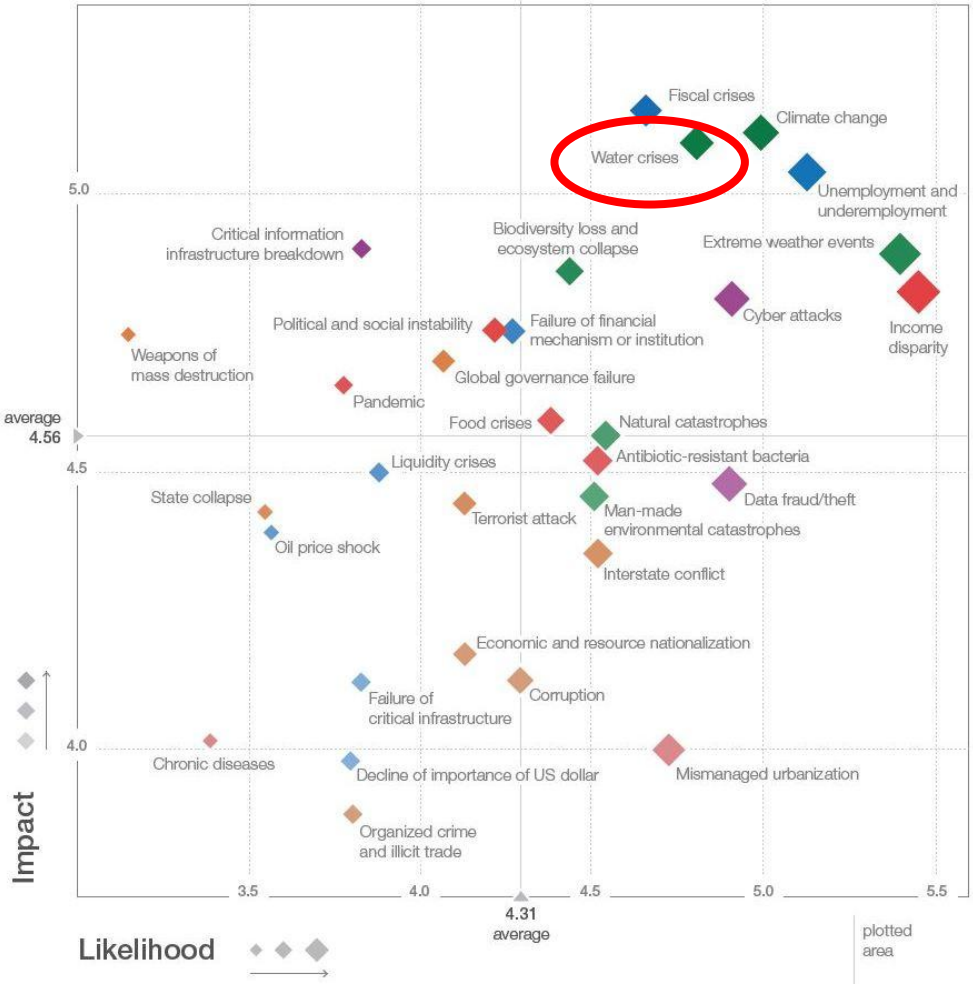

Fig.1: Source: World Economic Forum, Global Risk Perception Survey 2013-2014

Approximately 70% of the useable freshwater for humans is used in agriculture for food production: for watering animals, for watering of agricultural land as well as for processing of crops. It must be noted that water generally cannot be lost, but the problem is the availability of freshwater during increasingly frequent droughts. If not irrigated during these periods, a reduction in yield and, in the limit, a total loss of the crops has to be accepted. Consequently, the use of irrigation systems, particularly micro-irrigation, is strongly increasing worldwide. For the control, in most cases simple timers are used which are possibly equipped with rain sensors or even weather stations. But this cannot ensure responsive watering. The practice shows that too much water is applied to make sure that the plants are not exposed to drought stress. The farmer is usually working according to the law "more is better" and this also because he has virtually no information about the water status in the soil.

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Therefore, a very strong market growth is predicted for the so-called "smart irrigation". (Fig. 2).

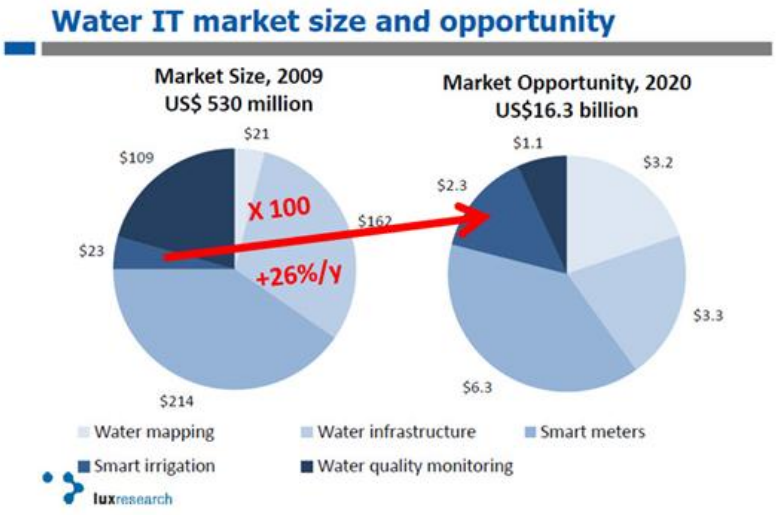

Fig.2: Source: lux research,

PlantCare Smart Irrigation Control

On the basis of a novel method for measuring the amount of plant-available water, PlantCare has developed an irrigation controller (PlantControl CX), which is designed specifically for use on farms and has a number of significant advantages over all previously offered systems. The PlantControl CX has been field-tested in recent years in a number of applications in and has achieved - even for the accompanying scientists - surprising results. In the following, the system is described with the different possible functions and examples from practice are presented.

Fundamentals of soil moisture measurement

Basis of a needs-based irrigation is the reliable determination of the water content in the root zone of the plants. However, the measurement of soil moisture is proving to be a very complex problem. Various sensors with different measurement methods are available on the market, but all these methods are only able to measure soil moisture indirectly. There is only one way to determine the water content in absolute figures: take a soil sample, weigh it, dried for several hours at temperatures around 100 ° C and weigh it again. The weight loss corresponds to the water content in this sample in weight percent. It is self-explanatory, that such a measure is not suitable to control an irrigation.

It should also be noted that soil is not a homogeneous material. The composition as well as the grain size distribution can vary greatly in a natural soil, which means that a single measurement at only one spot does not provide reliable information..

Measuring Methods

Tensiometer

The oldest known methods for soil moisture measurement is the tensiometer (Fig. 3). The measurement result is a negative pressure. This comes from the fact that - by capillary force - water is sucked out of a porous ceramic body embedded in the ground, which is connected to a water-filled and gas-tight sealed tube. Is the soil dry, the capillary forces are stronger and a higher negative pressure is generated accordingly. Even with a very fine porous soil, the suction pressure is higher.

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The soil physicists talk about matrix potential, which corresponds to the energy that is necessary to pull out the water that is retained in the pores of the soil by capillary forces.
In many cases this potential is equated with the energy required to raise the plant to extract water from the soil. But this is a misconception, since the plant roots have no pores or capillaries. The plants absorb the water only by osmotic forces, i.e. the ion concentration in the roots is higher than in the soil, which means that water molecules diffuse through the cell membrane into the cell in order to compensate the difference in concentration. This is also called osmotic potential, but that is higher by orders of magnitude than the matrix potential.
In order to illustrate this fact one can add salt to the feeding water. Thus, the osmosis is reversed and water is flowing from the roots out to the soil and the plant dies of thirst in a wet soil. Plants that have adapted to saline soils, therefore have a higher ion concentration in the roots.

Fig.3: Tensiometer

Electrical Conductivity

Another method utilizes the electrical conductivity of the soil to determine the soil moisture (Fig. 4). Electric charges flow more easily in a wet soil, as in a dry. Unfortunately, the electrical conductivity is also strongly influenced by salinity and the temperature of the soil. To specify a statement regarding the soil moisture in an unit comparable to tensiometers the electrical conductivity is usually converted in sucking pressure by applying a conversion formula which contains a number of roughly estimated parameters.

Fig.4: Watermark Sensor

Capacitance

Other methods make use of microwave pulses to be irradiated along a so-called waveguide in the form of metal pins, to the ground (Fig. 5). Depending on the water content of the soil, the pulses are more or less attenuated or their propagation speed is changed. In principle, by these methods the average dielectric constant of the soil (ε_r) within a soil volume of about 250 to 2000 cm^3 is measured.
This average value of the ε_r is composed of ε_r of the mineral components of the soil, the organic fraction, the air in not water filled pores, the value of free water in the pores, as well as the ε_r of molecularly bound water in clays or organic material. All these substances have very different ε_r values, where free water has a very high value of 81. In addition, these sensors cannot distinguish from the water in the soil from water in the roots, so that these sensors are not suitable for applications in the agricultural sector. Through a complex calculation is then attempted to calculate the volume percentage of water in the soil.

Fig.5: Capacitive Method

All of the above measurement methods have serious drawbacks and its result can not be accepted as "true". If one wants to measure accurately, one would have to calibrate the sensors by taking samples over the entire humidity range, determine the weight fraction by weighing and simultaneously measure with the corresponding sensor in order to obtain a translation table. This calibration would have to be performed for each new soil again, which is not feasible in practice.

For the above reasons and also due to the fact that tensiometers require regular maintenance and other measuring methods have large scatter and can also be very expensive, soil moisture sensors have not been widely used as a control element for irrigation.

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Micro-Heat-Pulse (MHP) Method (PlantCare)

PlantCare has been able to develop a new type soil moisture sensor which eliminates the disadvantages of other sensor technologies.

The PlantCare soil moisture sensor is based on a micro-thermal measurement and the result is - as with all other sensors - not an absolute value for the soil moisture, but a time, which is a measure of the soil moisture. A small tip is heated up by a heating element for a few seconds by about 1° C. After this heating period, the cooling curve is recorded electronically with great accuracy and the time required to reach a certain threshold is measured (Fig. 6).

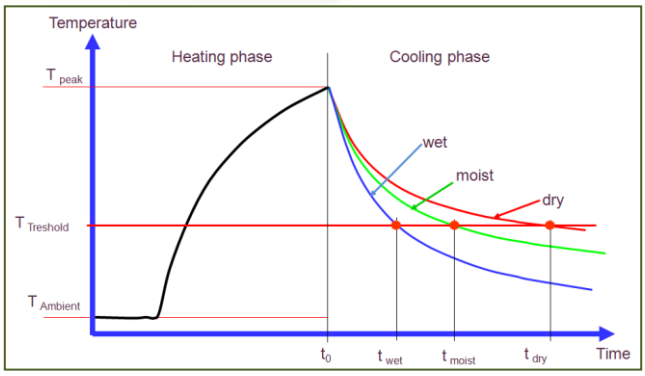

Fig.6: MHP-Method

If the tip is immersed in water, the slightly heated tip cools rapidly as it cools slowly in the air. If this tip would be placed directly into the ground, the contact surface to the soil would not be defined, so that the readings would vary greatly. For this reason, the tip is surrounded by a felt (Fig.7). This hydrophilic felt encloses the tip completely and sucks the freely available water from the soil surrounding them. Therefore, the actual sensor does not feel the soil, but only the water-filled felt. Since the felt retains its properties for several years and also has a very low thermal conductivity compared to water, the sensor measures only the water present in felt.

Although this method provides no absolute moisture values, in practice as well as in many research areas, this is not even asked.

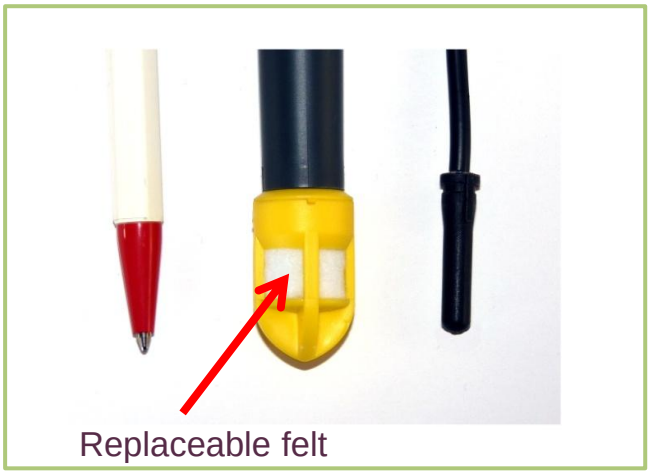

Fig.7: PlantCare Sensor

To define at least two fixed points and also to eliminate any manufacturing variances, all PlantCare sensors are calibrated prior to shipment. This is performed by a self-running calibration process where several measurements are performed first in absolutely dry condition. The sensor calculates the mean value and stores it as a 0% value. Then this process is performed with felts, which are saturated with water to get the 100% value.

This gives two fixed points, 0% and 100% - soil moisture. A measurement between them can only be done relatively, i.e. a measurement of 50% soil moisture, does not mean that only 50% of water is present in the soil. Rather, it means that the soil moisture is decreased to about half between saturation and the absolute dryness.

Nevertheless, this new micro-thermal measurement process shows - over other sensor technologies - massive advantages:

- The sensors measure the plant available water only.
- The water contained in the roots is not measured. The measured values therefore do not change with the growth of plants and accordingly the increasing root volume.
- The measuring range is from 0 to 100% which corresponds to 0-1500 hPa soil water potential.
- The sensitivity of the sensors can be matched to the application. Thus, the sensors can be used in soil with a high clay content, in Hors Sol plantations, as well as in natural grown soil.
- The measurement result is unaffected by salt or fertilizer content and soil temperature.

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- The sensors are easy to install and the embedding in the surrounding soil is not critical as it is in the case of tensiometers.
- The sensors are small and can be simple inserted into pre-drilled holes.
- The measurement can also be done close to the surface, which is not possible with capacitive measuring processes.
- All components are hermetically sealed against moisture and the materials used will not rot even after long usage in the soil. Therefore, the sensors are completely maintenance free.
- The energy consumption of the sensors is very small. A sensor can be powered by two 1.5 V AA-D-cell batteries for one year, provided that the time between two measurements is one hour.
- In many cases, the actual sensor tip must be placed at locations where the sensor electronics can not be accepted. This is the case on lawns or the sensor electronics with the radio antenna must be mounted higher up to improve wireless connection. This is not a problem because the sensor tip can be connected to the sensor electronics by a virtually unlimited long cable.
- In addition, the sensors measure soil temperature simultaneously to the soil moisture.

A significant problem in the use of moisture sensors for irrigation control is the commonly used cable connection to the central control unit. Cables exposed are not only a horror for every farmer, but also often lead to incorrect measurements by electromagnetic interference or energy losses and cables can also be gnawed by wild animals. Since the measuring points are often located quite far away from the controller, the necessary long cables cause additional costs. This problem is exacerbated by the fact that due to the often existing heterogeneity of the soil, several sensors are required, since in such cases, a single sensor at one location is useless.

Fig.8: PlantCare wireless soil moisture sensors are available in various versions optimized for different applications.

PlantCare has therefore - from the beginning - connected the sensors via radio link with the controller.(Fig. 8). This not only has the advantage that all the cables disappear, but also allows the connection of a large number of sensors to the central unit.

In summary, one can say: The PlantCare soil moisture sensors measure only the plant-available water, are robust, easy to install, maintenance free, connected by radio link to the central unit and have easily replaceable, inexpensive batteries for a long time to operate.

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PlantControl CX Irrigation Control System

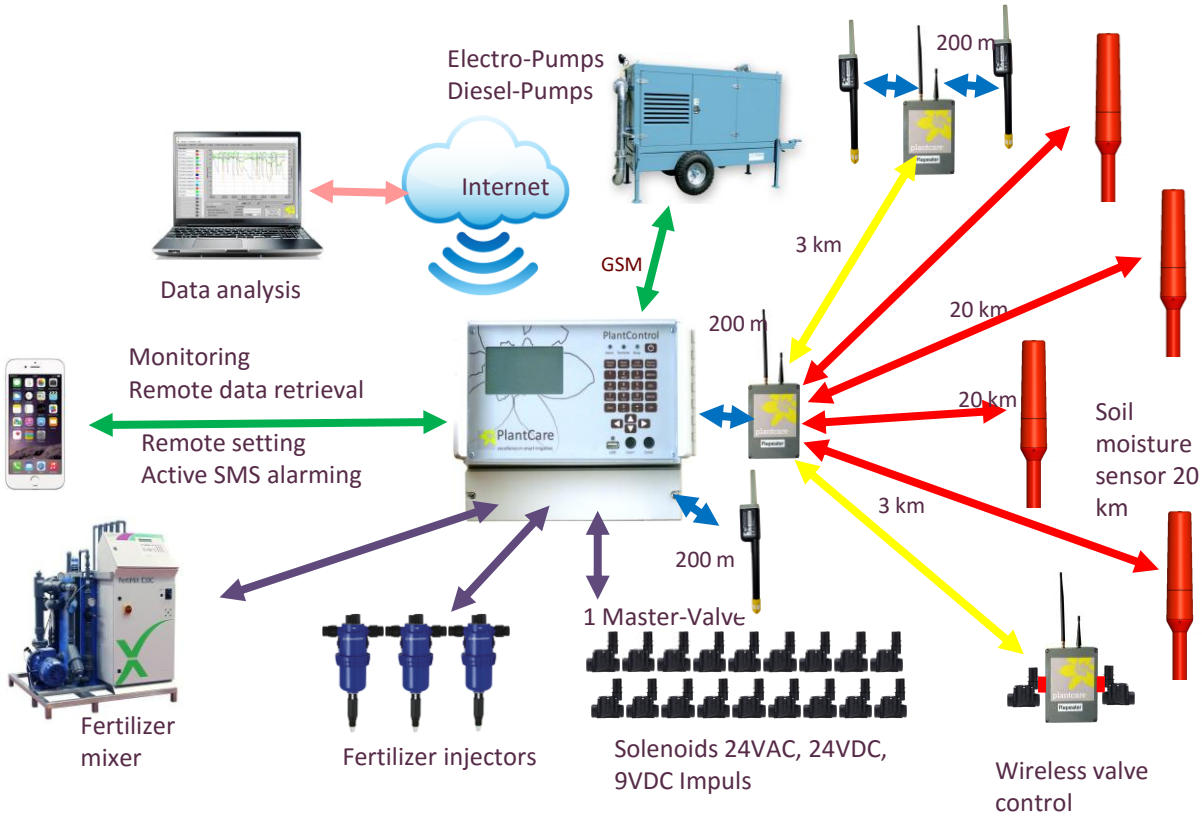

Fig.9: PlantControl CX System

The reliable measurement of soil moisture is an absolutely necessary prerequisite for the design of an intelligent irrigation control (Fig. 9). In addition, other important conditions have to be fulfilled:

- Each irrigation zone must be able to be monitored by multiple sensors and the irrigation control has to be based on the mean value of the readings.
- The sensors must be synchronized time-wise so that they successively transmit their measurements to the controller within a short time period. Otherwise, no meaningful average can be calculated.
- The system must be able to irrigate each irrigation zone with the adequate irrigation mode.
- A smart irrigation controller must be able to determine automatically the right time for the start of irrigation as well as the optimum irrigation duration.
- A smart irrigation controller must automatically detect function errors or deviations from the given limits and inform the operator about it.
- An irrigation system must allow to set arbitrarily defined blocking periods.
- An irrigation system must be able to water and/or to monitor sectors.

The PlantControl CX is the world's only system that fulfills all and even more requirements.

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Basic Functions

The PlantControl CX performs the following basic functions:

-It is able to control 32 valves, of which # 1 must always be used as the master valve. The interface to the valves is performed by modules, each having 8 valve outputs. The number of such modules can be selected as needed from one to a maximum of 4.

-These modules can optionally control 24VAC valves or 9V DC pulse-controlled valves. The modules can also be mixed (24VAC - 9 VDC).

-In addition, a multifunction switch module with 5 floating contacts can also be used. Three contacts can be used to control 3 fertilizer injectors. They can freely be assigned to each water valve. Another output is provided for a connection to a facility management system. A fifth output provides a 30 second pulse when a lower or upper temperature limit is exceeded. Thus, for example, a spray system can be switched on in case of frost.

-The PlantControl CX can be connected with up to 60 wireless soil moisture sensors. These can be assigned to a maximum of 31 irrigation zones as desired, with a maximum of 12 sensors per zone are possible.

-The mean soil moisture and soil temperature is determined per zone.

-The system monitors all key functions and sends – in the event of a malfunction - the user a corresponding SMS.

-The PlantControl CX can be operated with either 230 or 115 VAC or with a 18VDC solar cell.

-By the use of so-called range extender, the range of the sensors can be increased to over 30 km

Control Modes

The Plant Control CX is able to irrigate different areas with different modes:

Timer: This mode controls irrigation like a conventional timer by setting the start time, as well as the watering time for all zones defined. 12 start times per day are possible and the watering time can be entered in minutes and seconds.
Semi-automatic mode: In this mode, a dry-threshold has to be set. As soon as this limit is reached, the irrigation is started. The watering time is defined by the user analogously to the timer mode and is not changed by the system anymore.
Fully automatic: In this mode, in addition a moisture target value to be achieved after irrigation is defined. The system starts watering when the dry-threshold is exceeded and automatically controls the watering time so that after irrigation, the target value is reached. This method is also called Dynamic Runtime Adjustment (DRA).
Cloning: If a homogeneous irrigation zone has to be divided - due to limited availability of water - in more separate zones, one can assemble a zone with sensors and this zone can be controlled either semi or fully automatically. But since the other zones have the same climatic conditions, one can define it as clones of the first zone. Cloning reduces the number of sensors used.
Monitoring: In many cases no fixed irrigation equipment is installed. When the farmer has the feeling the field ought to be irrigated, he takes a movable hose-cart and connects the water supply with one or more sprinklers. The start-time for watering, as well as the irrigation duration is determined by the farmer himself.
In order to cover this case, one can also place soil moisture sensors on such fields. The measured values are treated by the PlantControl CX as with normal irrigated fields, but it will not automatically trigger irrigation. The system monitors the soil moisture and informs the farmer through SMS as soon as the set dry-limit is reached. At the same time the farmer is informed about the status of the other monitored fields also.

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To illustrate the types of controls, an example with 5 valves is shown in the adjacent figure (Fig. 10). As it is shown valve 4 is a clone of valve 2 and valve 5 is a clone from the valve 3. Monitoring can not be shown here, since this mode requires no valve.

Furthermore, it is possible to connect a timer-output in parallel to a senor controlled valve. This means that a sector is always watered independently of the automatic watering when the timer provides for irrigation. This is, for example, advantageous if the automatic watering does not irrigate for long time since it is raining, but the field should nevertheless be fertilized. The timer valve is then coupled with a fertilizer injector so this sector will still be fertilized regularly.

With this method it is also possible to “clean” the soil from excess of salt or fertilizer in certain time periods.

It is always readily possible to switch from one mode to another mode. This can be useful if you do not know after the installation of the system in which humidity range it was watered in the past, when a simple timer was used. Then one can irrigate two or three weeks with identical timers-settings and then analyze the automatically recorded soil moisture data. From this one can derive the settings for a semi -or fully automatic operation quite easily.

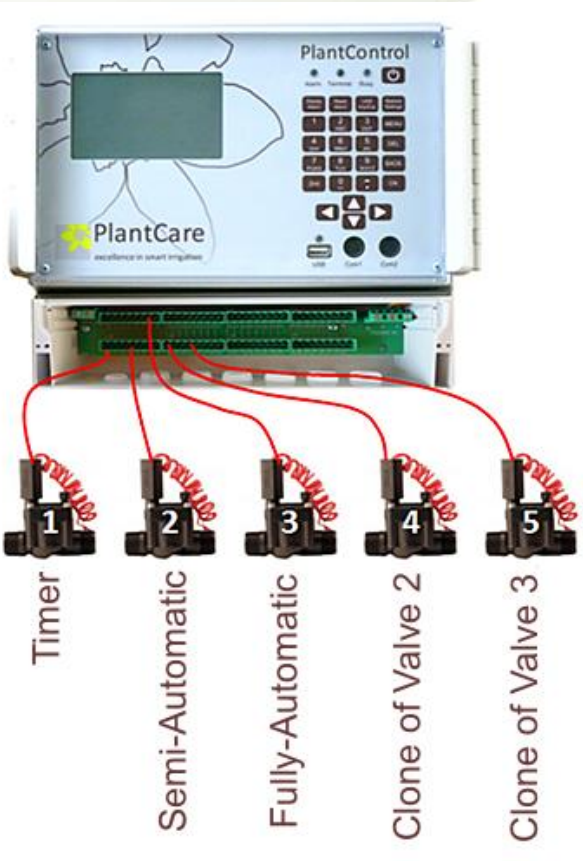

Fig.10: PlantControl CX Control Modes

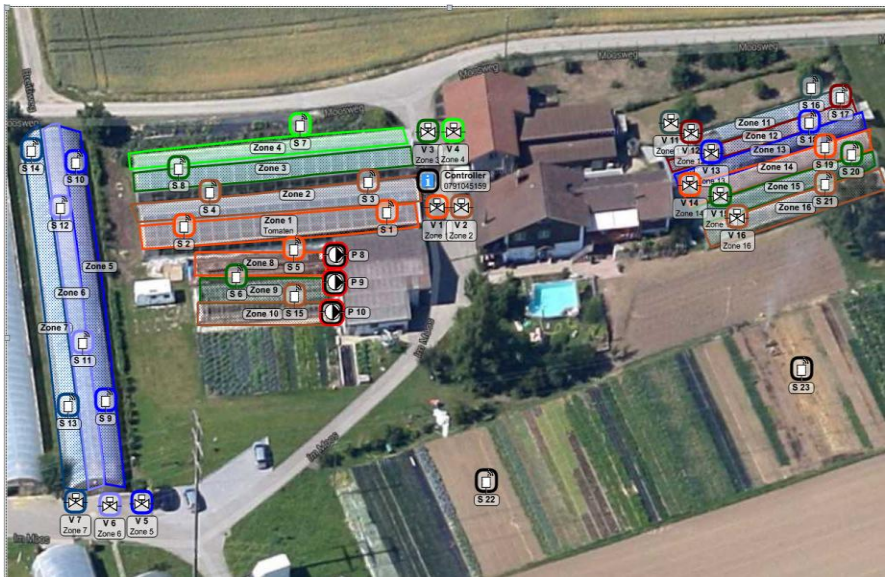

Fig. 11: This smallholder farm contains 16 irrigation zones of which 4 are irrigated using the semi-automatic mode, 8 use the fully-automatic mode and 4 are cloned zones.

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The following figure shows the main differences between the various types of control. In each case, the soil moisture is plotted in the vertical and time is plotted in the horizontal axis.

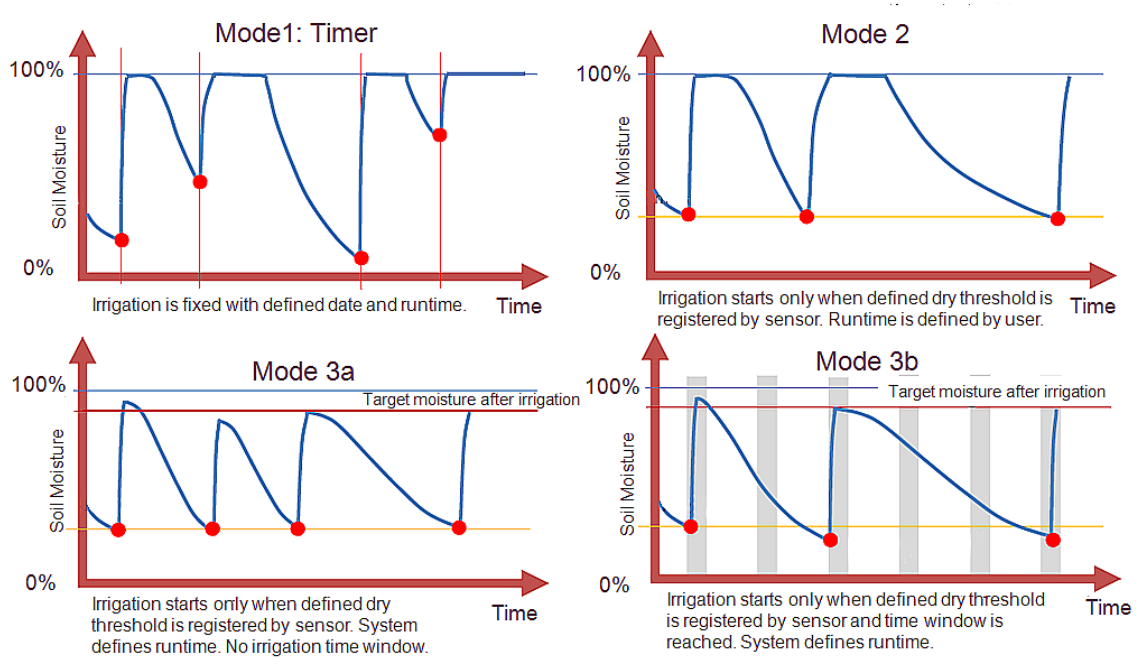

Fig.12: Control modes applicable for any valve

1: Timer - Mode: The timer always switches irrigation on and off at the pre-set times regardless of whether the soil is still wet or already too dry.

2: Semi Automatic - Mode: This mode requires the use of soil moisture sensors as a dry-threshold must be pre-defined. This ensures that whenever the soil moisture content falls below the threshold value, an irrigation starts. The watering time can be arbitrarily chosen and it is not changed by the system. This procedure entails the risk that the chosen watering time is too long, i.e. water is wasted.

3a/b: Full Auto (DRA) - Mode: With fully automatic control there are two sub-types:
a: Watering can be initiated at any time: This is for example the case of drip irrigation systems, wherein usually there are no restrictions on the irrigation starts.
b: Irrigation may only be within specified time window.
In both cases, in addition to the dry-threshold, a target moisture which should be reached after irrigation must be defined. The PlantControl CX automatically determines the watering time so that after watering the target value is achieved.

Automatic determination of the watering time for the fully automatic mode:

To automatically set the watering time, the system needs to know how long it must irrigate to increase soil moisture by one unit. If this number (K) is known, one can calculate from the distance between the dry threshold and the target moisture the necessary watering time:

Watering duration = (target humidity - Dry threshold) * K

The Plant Control CX system is able to automatically determine the number K in a self-calibration process. For this purpose, the system starts a calibration procedure at the first time irrigation is required. To this end, upon reaching the dry threshold the irrigation is permanently switched on and at the same time soil moisture is measured at short intervals.

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This process is shown schematically in the following figure. Irrigation is not stopped until no change is measured between two successive measurements (3). Then, the water supply is shut off and waited a certain time until the excess water is seeped (field capacity) (4).

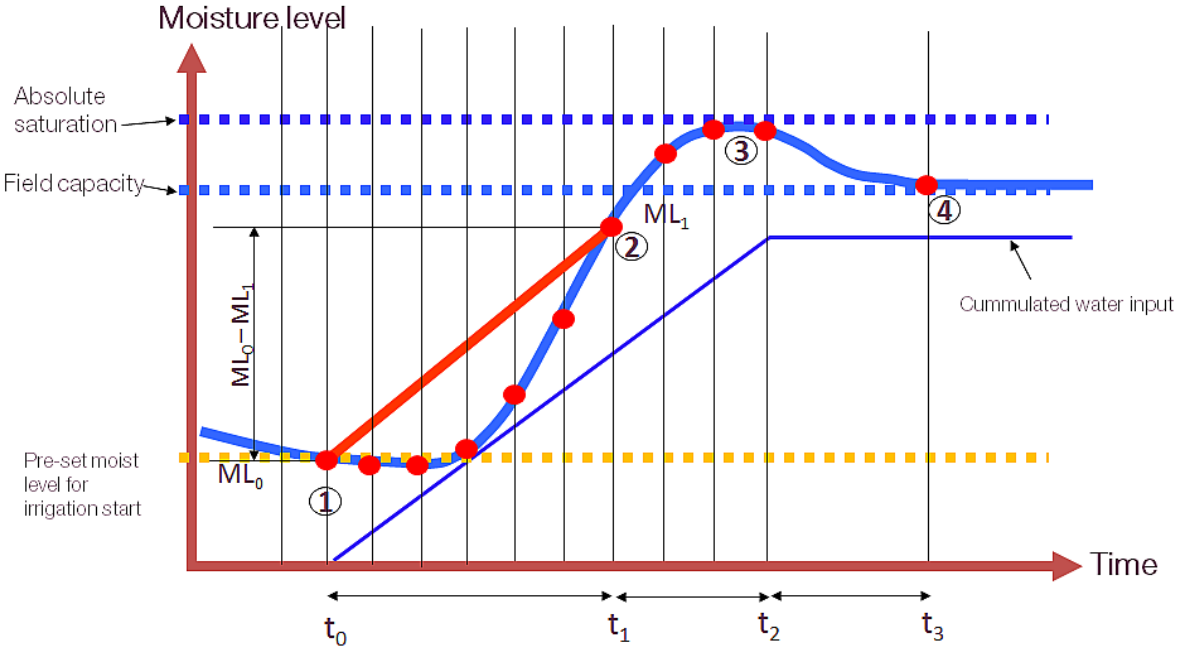


Fig.13: Self-calibration procedure

The system stores the value of the first measurement (1), a value at a higher moisture (2), the value at complete saturation (3) as well as the value of the field capacity (4). From this, the slope of the line between (1) and (2) is calculated. It indicates how long one has to irrigate to increase soil moisture by one unit.

This figure for the slope includes various influencing factors. When the soil e.g. is very clayey, then it will take longer before the water arrives at the sensor location, resulting in a smaller slope. If the soil is, however, very permeable, then the slope will be greater. Also, the water input contributes to the slope. For a sprinkler with low water output, it will take longer to reach the point 2 than with a sprinkler with a high water output.

If for any reason the automatic determination of the number K is not possible – e.g. when the permeability of the soil is so high that the calibration curve is not measurable - then one can manually enter a first watering time. From this, the system calculates a first number K.

But the absolutely unique point about this method is the fact that the number K - the slope of the line - is regarded as only a first value. It will again be determined at every new irrigation, so that a self-learning system is created. This is achieved by a control-measurement after each watering. This control-measurement shows, whether the system has hit the target soil moisture after irrigation or not. If not, the number K is corrected accordingly. This allows for the automatic adjustment of the watering time in varying temperature and climate conditions as well as to the growth state of the plant. A manual adjustment of the watering time, as is necessary for timer-controlled irrigation, is completely eliminated. Another important advantage is the fact that the soil moisture can be maintained within a predefined bandwidth, which - as will be shown later – will result in substantial benefits.

In the figure below, this self-learning adjustment of watering duration is explained in more detail.

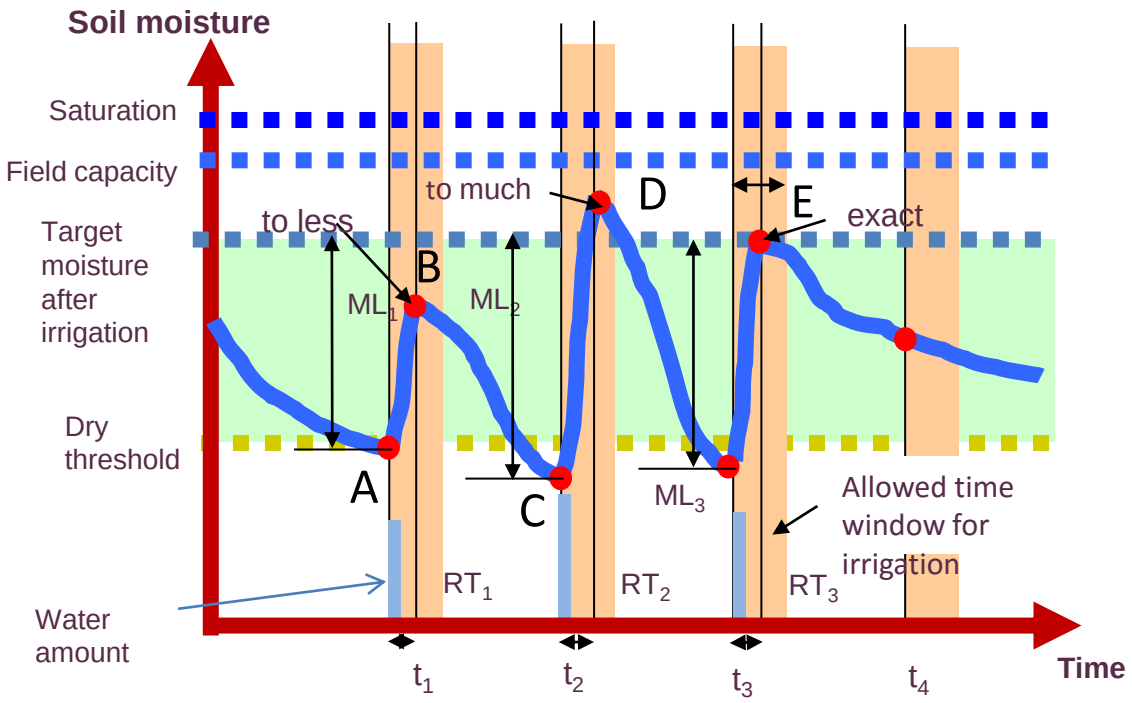


Fig.14: Automatic Runtime Adjustment (DRA) Technology

The figure shows schematically the automatic control of soil moisture. The blue curve shows the variation of the measured values over time. The orange bars indicate the allowed time window for irrigation. The green band indicates the set humidity range between the dry-threshold and the target value.

After the soil moisture has dropped to dry-threshold (A) irrigation is triggered. The irrigation duration, i.e. the amount of water is automatically determined according to the relation:

Watering time = ML1 * K_0

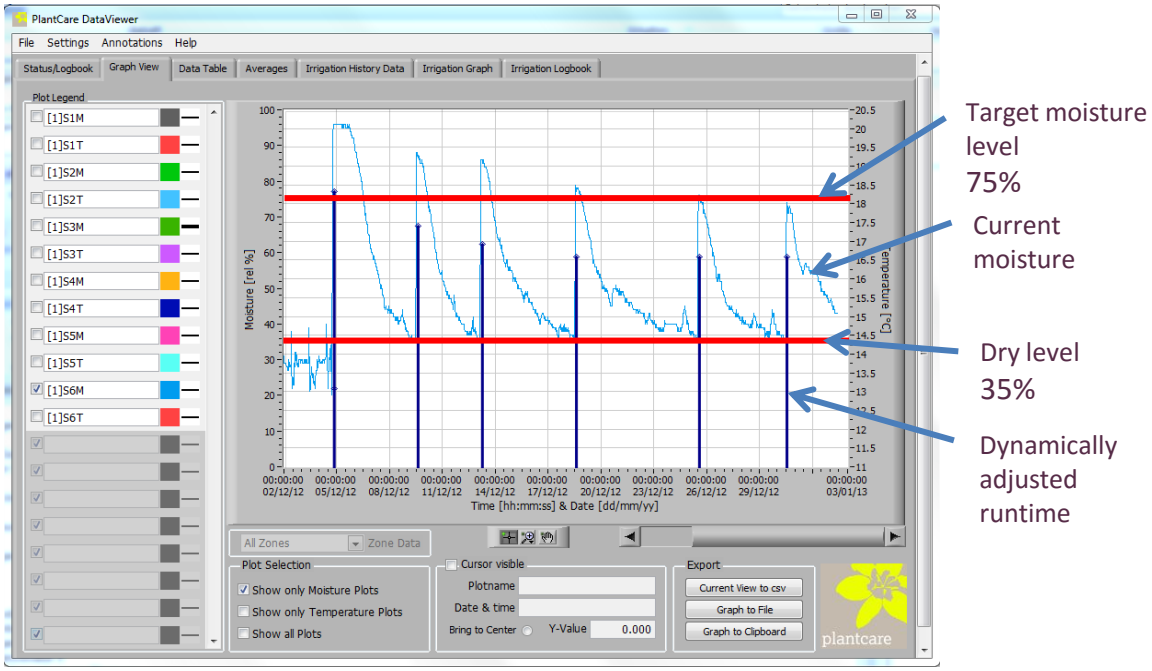
K_0 corresponds to the first predetermined value.

As the figure shows, the irrigation period was obviously not long enough to reach the target moisture value (B). This is determined by a control-measurement. As a result, K_0 is corrected so that the next irrigation will take longer. The next irrigation is initiated at (C). Since the soil moisture is already below the dry-threshold - it could not be irrigated during the blocked time - now a greater moisture difference (ML2) has to be bridged.

The figure shows the case that now there is an overshoot (D) so that the system adjusts K_1 to K_2. At the next watering now the target value is reached (E). In case, the temperature increases and thus the plants needs more water, irrigation will be triggered later and as a consequence, the amount of water is increased and thus tracks the needs of the plants. The same happens when the plant grows and consumes more water. If irrigation is allowed at any time, the dry-threshold is reached earlier, because the plant absorbs more water per unit time and irrigation, therefore, is triggered even earlier. Consequently, the average soil moisture is increasing along the time axis.

Fig.15. The DRA method eliminates any manual readjustment of the irrigation duration.

The following figure 16 (real application) shows the automatic adjustment of the irrigation duration, which also works when the time-distances between waterings are very long.



State Office of Agriculture Hessen / Germany

Fig.16. Example of an automatic adjusted runtime

In special cases which have very short watering time, ranging from a few minutes or even seconds - such as with berries or nursery crops, it is harder for the system to level off automatically. There, the use of semi-automatic is recommended.

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Special Functions

The Plant Control CX is specially equipped for use in the agricultural sector with a number of special features:

Fertigation

By using a multi-function switch module, three fertilizer injectors can be assigned to each valve. This means that whenever a valve is opened, at the same time the associated injectors can be addressed.
With the use of organic fertilizer, it always comes to clogging of the drippers or sprinklers. The PlantControl CX allows the setting of a post-rinse, which cleans the drippers with pure water.

Manual switching of valves

Each valve can be manually opened for a desired time. This feature is especially helpful when testing the system. After the expiry of the pre-set time, the valve closes automatically. In addition, one can also enter a period during which the system performs no irrigation. This is especially necessary if pesticides have been applied and a subsequent irrigation is not allowed. After the expiry of the period entered, the system is active again.

Temperature monitoring

Lower and upper temperature limits can be specified and the system alerts the user when the measured temperature exceeds respectively falls below these limits. Also, irrigation is not recommended if the temperature drops below a critical value. Therefore, an additional function blocks irrigation in this case.

Remote control of pumps

If a watering system is not permanently supplied with water, a pump has to be turned on before irrigation can occur. If the pump is equipped with a corresponding SMS receiver, the PlantControl CX system can send an SMS to the pump before irrigation starts to turn the pump on and will turn it off after irrigation.

More options

The irrigation can be blocked by SMS commands and also unblocked again (see Chapter remote maintenance)

Alarm system

In PlantControl CX system, all important functions are constantly monitored electronically. Each alarm is indicated by a flashing LED light on the controller and the cause of the alarm is described on the display. If the system is equipped with an SMS alarm function, the alarm messages are sent per SMS to up to two receivers. The main alarm refers to the case that a valve is not working or no water is available. This is recognized because after each watering a control measurement of the soil moisture is carried out. If the soil moisture has not been increased after irrigation it must be assumed that no water was applied.

There are also a number of other alarm messages, i.e. if a sensor is pulled out of the ground, or someone cuts through a cable. If, for example, the radio link between the sensors and the control panel is disturbed, an alarm will be notified. Even if the batteries need to be replaced or the credit on a prepaid SIM-card is getting too low, this is indicated by a message.

All alarms can be parameterized, that is, one can determine whether one wants to receive the alerts by SMS or whether it should be displayed only on the control panel. In addition one can set the time period the same alarm is to be displayed again. So it is up to the farmer, if and when he wants to eliminate the cause of the alarm.

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Remote retrieval of data

The PlantControl CX contains all relevant data in a log book. This contains the date and time, all measured values, all calculated values, such as irrigation duration as well as all alarms, changes to the settings, remote inquiries, etc.
By sending an SMS command, it is possible to retrieve the status of all currently valid settings, or even all measured data, or the entire log file. The data are send as an email attachment to the addressee and can be displayed and analyzed by using the PlantCare Data Viewer software which presents the data also graphically (Fig. 17).

This feature is very useful especially after the initial installation as it allows the rapid control of all units without the need of checking them personally on the spot. If it comes to an unexpected problem, one can quickly locate the problem by retrieving the log-file and perhaps even solve it by using the remote maintenance function.

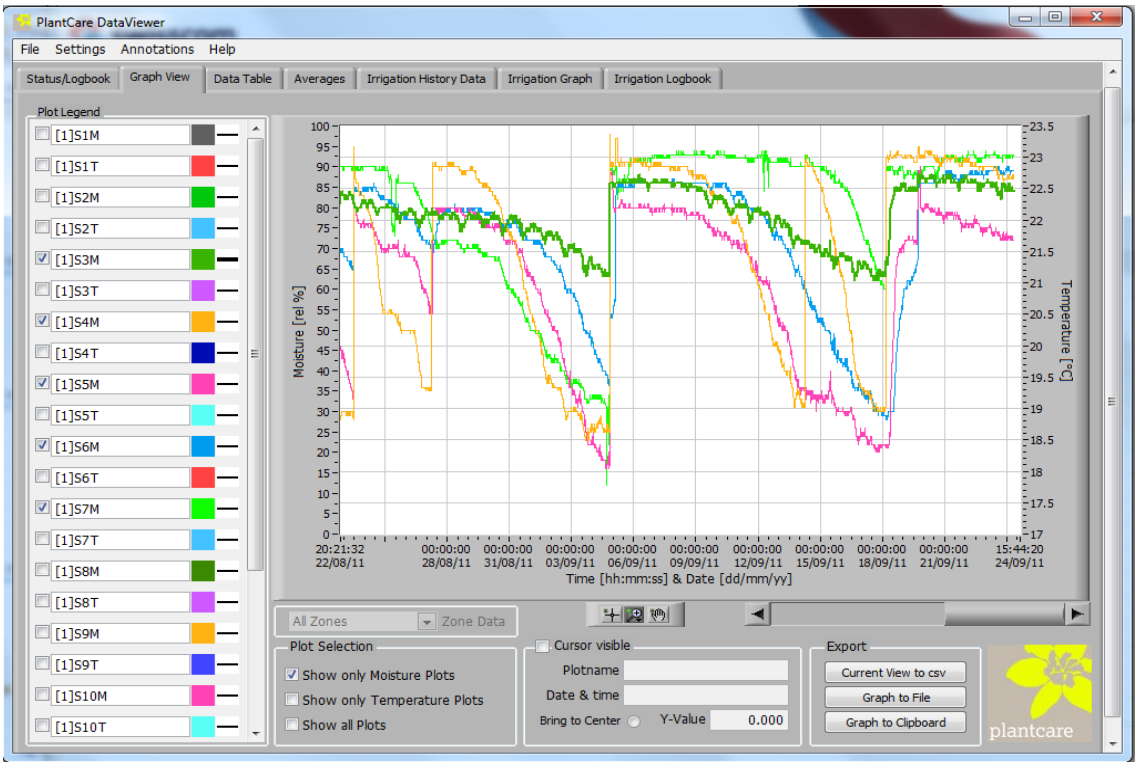

Fig17:Example of soil moisture curves as they are displayed with the help of the PlantCare DataViewer Software

Remote service

Remote service allows to modify all the parameters that are normally entered or modified on the device itself via SMS commands. I.e. thresholds or times settings can be adjusted, sensors can be disabled or valves can be opened remotely.
For companies that offer PlantControl CX systems and the corresponding installations, it is very helpful to have all the equipment under control without leaving the office. This means that many unnecessary and costly inspection trips are avoided.

The unit can also be set so that it automatically transmits the data at a specific time every day or every nth day.

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Installation

The installation of an irrigation system with the PlantControl CX controller, including piping, valves, etc. is basically very similar to an installation with conventional controllers. With the PlantControl CX it is possible and sometimes recommendable to measure and record the soil moisture over a certain period of time (a few weeks) without irrigation followed by an data analysis. This allows to define the irrigations zones much more precise.

In principle it is possible to simply replace an existing timer by the PlantControl CX and leave the watering system untouched, unless one has fundamental problems with the existing zoning, which should be fixed anyway.

A major change to the installation of conventional systems is the placement of sensors, both in terms of location as well as its depth. The number of sensors per irrigation zone depends on several conditions:
- How homogeneous is the zone? I it exposed to the sun, or are there permanently shadowed regions?
- How big is a zone?
- How homogeneous is the soil or substrate?
- Does a zone contain flat and steep areas?

Usually, 1-2 sensors are enough in homogeneous, 2-4 sensors in inhomogeneous zones. The more sensors are placed in a zone, the more accurate soil moisture measurement and, accordingly, the irrigation control will be . In cases where standard substrates are used, such as in pot cultures with berries or in glass houses 1-2 sensors per zone are o.k.

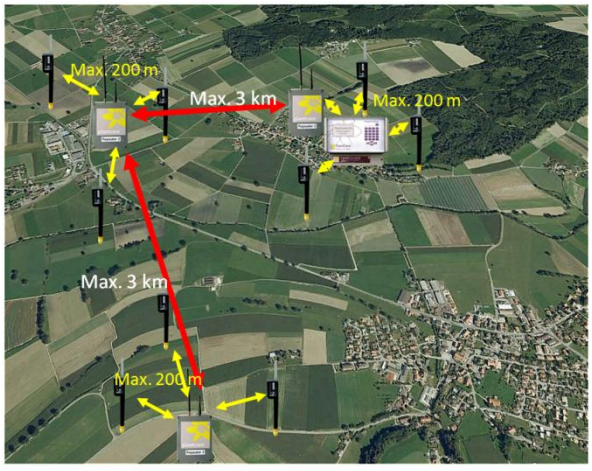
Radio range

An important consideration in the placement of the sensors is the radio range between the sensors and the central unit of maximum 200 meters. The radio range is more or less reduced by absorbing media that stand between the sensor and the central unit. In particular, metal walls, but also trees, shrubs, higher growing foliage plants and buildings may limit the range. To minimize this effect, the sensor electronics should be mounted on a pole, tree or the like. Should there still be a problem, then one can connect to the central unit an outside antenna and attach them also on an elevated position.

The reception strength of signals is measured and displayed by the system automatically. This allow an optimization of the sensors placement quite easily. The measured reception strength should not be less than 10-15%, because when it rains it may fall further which may lead to a loss of contact. If a single radio contact is lost, the system automatically tries 5 times further to establish the connection. If still no connection is possible, an alarm is triggered.

If the general growth conditions in irrigation zone are homogeneous, the sensors can be placed in the vicinity of the central unit and must not be placed over the whole area.

Fields located far scattered around a farm, in most cases, have to be equipped with range extenders (REX). These range extenders or repeaters have a wireless range of over 3 km, which offers a surface coverage of up to 15 km radius. Each REX can be connected to 4 other REX and up to 12 sensors again.



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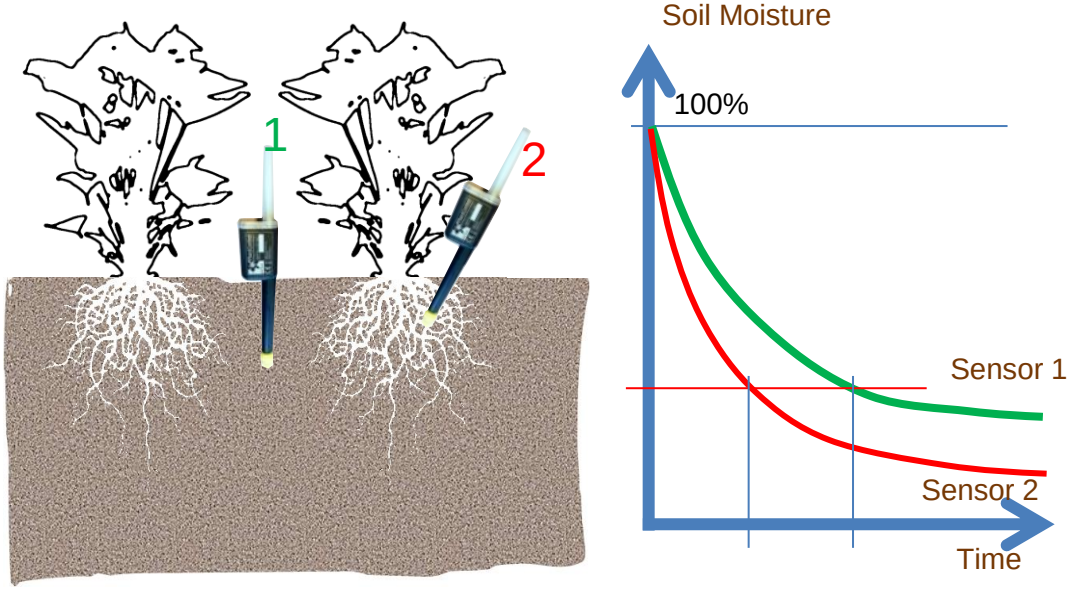
Sensor positioning

A very important point is the positioning of the sensor tip in the ground. Basically, the position of the sensor tip should satisfy two conditions:

- The sensors must be able to detect an increase in moisture after watering. This means that the sensor must be placed under a dropper or within an irrigation zone. In addition, they should not be buried too deep, so that even after a lower water input a gain in moisture can be measured.

-The sensors should be placed where the plant takes up the water from the soil, i.e. in the root ball. Normally plants generate many roots in a range up to about 30 cm depth, because they want to use the water from less abundant precipitation. Some plants produce, in addition to the surface area, also tap roots, in order to get access to deeper, moister soil layers.

The following figure illustrates how much the soil moisture can be different between the root ball and in a position without roots. If the sensor is in position 1, the soil dries out more slowly than at position 2, which means that irrigation would be started too late.



Operation

Operation of the system is very simple and can be learned in a short time. Input keys and a graphical display allow an intuitive setting for the functions and practice has shown that farmers can make all entries within about an hour.

For frequently used features special input keys are provided. So you can simply upload data to a USB stick or call alarm messages in plain text.

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Case studies agricultural applications

On the following pages you will find some practical examples from the agricultural sector (Berries, organic vegetable gardening, agricultural research) as well as an application for the irrigation of vertical greens.

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Sustainability in its purest form

The whole world is clamoring for greater sustainability in agriculture. At the Fischer family's organic vegetable farm in Brütten, canton Zurich, this is already a reality. Organic farmers Max and Daniel Fischer are proving that significantly greater yields can be obtained together with much lower water consumption. Since 2013, these two innovative farmers have put their trust in PlantCare's sensor-controlled irrigation solution. Compared with 2012, father and son have increased their yields by 45% and reduced water consumption to less than a third. Their investment has been recouped in less than a year.

Organic farmers Max and Daniel Fischer with their new PlantControl CX irrigation control system.

Daniel Fischer is obviously satisfied. Since he began using PlantCare's sensor-controlled irrigation system in 2013, he has fewer irrigation problems with watering his plants.

No more timers

Irrigating vegetable crops appropriately is a challenge. Before Daniel Fischer started to use the new technology, he always glanced at the ground before turning on the irrigation to determine the right amount of water. Or he set a timer. Assessing the situation yourself is possible, but it requires in-depth knowledge of the soil. Pure guesswork, he says looking back. And there is never enough time. A major problem when producing vegetables.

Irrigation is adapted to the soil conditions

On their small organic farm in Brütten, canton Zurich, Daniel Fischer and his father cultivate two and a half acres of vegetables and salads, which they sell direct to the public at farmers' markets in Zurich and in their farm shop. A family friend first told them about the smart irrigation computer that measures the soil moisture with innovative sensors and automatically controls both the time when irrigation starts as well as the amount of water.

After giving the matter some thought, both father and son decided to take a chance. In conjunction with PlantCare, a moisture profile of the soil was produced in three of their greenhouses in the fall of 2012.

Based on this profile, the ground area was then divided up into seven zones, in which the irrigation tubes are each operated by an independently controlled valve. Irrigation can thus, be adjusted for each zone - depending on the permeability of the soil and the cultivated plants' requirements.

Each type of plant gets its own moisture bandwidth

In spring 2013, the system was fully installed and ready for its first season. Every hour, 14 wireless sensors inserted about 15 inches deep into the ground transmit a radio signal with the current soil moisture level to the controller from the different zones. For each zone, a minimum and maximum soil moisture content is defined (moisture bandwidth). If, for example, the minimum moisture level is set at 45%, the appropriate valve opens and irrigates the zone as soon as this level falls below 45%. The zone is only irrigated until the moisture level in the soil does not exceed the maximum level of, for example, 95%. On the one hand, this avoids any over-watering and, on the other hand, the irrigation control system keeps the moisture level within the set bandwidth and prevents the plant from having to adapt constantly to new conditions. This freedom from stress results in higher yields and healthier plants.

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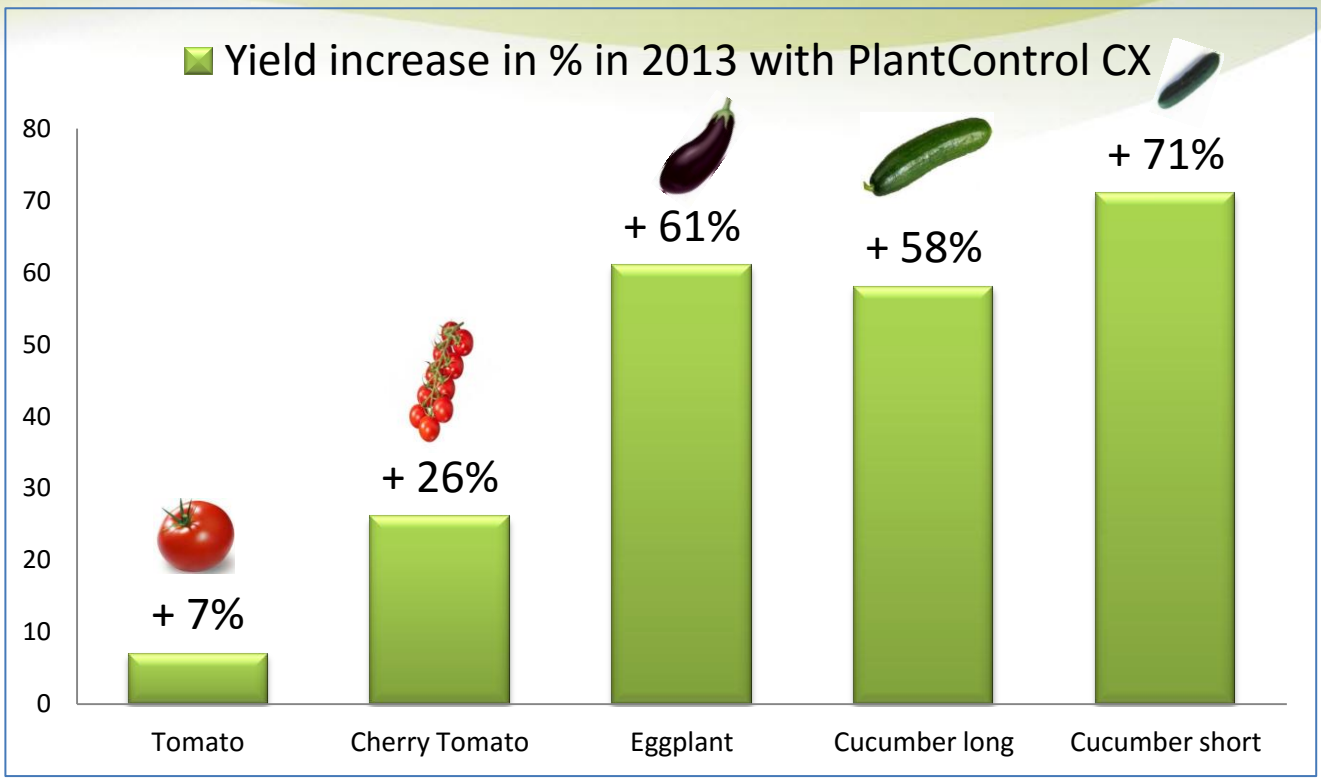


***2013**: Average increase in yield of 45% using the PlantCare system compared with manual/timer-controlled irrigation in 2012.*

Malfunctions reported directly by text message

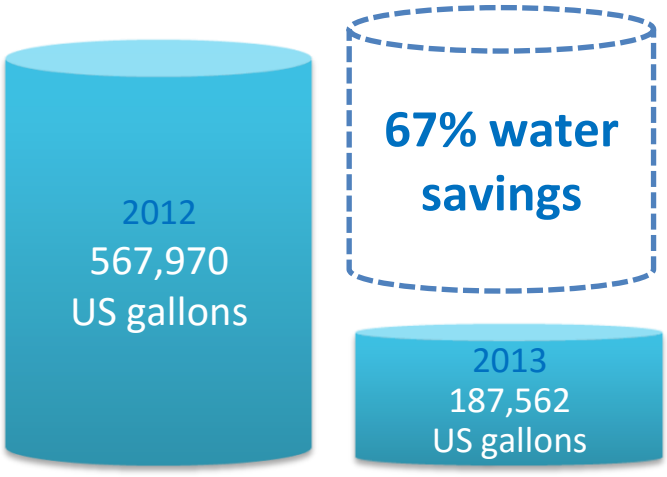
The diagnostic software in the irrigation control system constantly monitors all parameters. If, for example, no increase in moisture is observed after an irrigation cycle, the system informs Daniel Fischer with a text message. This means that faulty valves, clogged water filters or faulty pumps can be repaired before the plants suffer or before there is any danger of losing an entire crop. Not only do plants live free of stress, but Daniel Fischer can also take care of other things on the farm with a clear conscience.

Fertilizer applied directly with each irrigation cycle

The diluted fertilizer is connected directly to the irrigation system and added in small amounts with each irrigation cycle. The supply of nutrients is thus kept as constant as possible in the soil. What is special about the bio-cultures is that the fertilizer used by Daniel Fischer consists of diluted molasses and is therefore sticky. To prevent the pipes and valves from being blocked permanently, another irrigation control mechanism comes into play. The supply of fertilizer is automatically shut off a few minutes before the irrigation cycle comes to an end, which means that only water flows through the system and cleans all of its components.

Less fungus and practically no more red spider mites

Organic farmer Daniel Fischer also confirms what has already been established at the Zurich University of Applied Sciences in irrigation trials with eggplants using the PlantCare system.



67% water savings with sensor-controlled irrigation.

In the very first year with the new system, he has observed considerably less fungus and practically no more red spider mites.

Worthwhile investment

For Daniel Fischer, the investment paid off in its first year, without counting the savings in labor and energy costs. On the same area of land, he harvested 45% more vegetables than in the previous year while reducing water consumption by 67 percent. He is also particularly pleased with the reduction in time needed to attend to the irrigation of his plants. No doubt about his satisfaction: "I now have much more time for other things on our farm."

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Drop by drop for a global market

The following article first appeared in the Swiss daily "DER LANDBOTE" on October 1, 2013.

Russikon: Higher yields matched by reduced water consumption? A new irrigation system from Russikon makes it possible. The development may be a breakthrough for agriculture worldwide.

As all the irrigation outlets had to be opened and closed manually in the past, the strawberries grown at the Vollenweider's family business in Illnau were occasionally overwatered. "Now and then, one of the outlets got forgotten," confessed Patrick Vollenweider. Later on, the family switched to a timed irrigation system, but this tended to give too much water. After all, it ran for the same length of time every day, regardless of rain or shine.

Acquired by Thomas Vollenweider two years ago, the new and innovative system compensates for this deficiency. Now, an intelligent, self-learning system decides whether and how much irrigation his Talacherhof farm in Illnau gets. The basic idea: sensors measure soil moisture levels and temperature and feed the data via wireless link to an irrigation controller. This calculates the required amount of water and opens the valves.

"Irrigation can now be so much more precise," says Vollenweider quoting one example: his raspberries, which "hate getting their feet wet." The new system ensures that the optimum moisture range is maintained. Irrigation begins when moisture levels fall below a certain threshold and water flows precisely until an upper threshold is met. In the case of raspberries, this moisture range is fairly narrow according to Thomas Vollenweider. In contrast to apple trees, which can store water much better, relatively short irrigation periods take place several times during the day.

Human intervention is restricted to supervision

As Thomas Vollenweider puts it, the major advantage of this technology is that he saves both water and time. The only part he plays is that of a "supervisor" and intervention is only required if a valve fails or a pump stops working. Any faults in the system are reported to him immediately by text message.

This fully automatic agricultural technology was developed by physicist Walter Schmidt, head of the ***PlantCare*** company in Russikon. Around nine years ago, he invented the sensors, which are approximately three centimeters long. These are also used today by the German "***Max Planck Institute for Molecular Plant Physiology***" as well as by seed company "***Syngenta***" as the system enables it to monitor fields from China to California.

Thomas Vollenweider uses the Russikon company PlantCare's system on his farm in Illnau. He is very satisfied with the results.
Photo by: Marc Dahinden

The amount of work involved with the irrigation system was fairly low for farmers, says Schmidt. Each culture only requires two to three sensors to measure soil moisture. They are set 4 inches to 12 inches deep into the soil depending on the length of the plant roots, and are removed for maintenance and storage in the fall.

While the sensors are patented worldwide, the software patent is restricted to Europe. However, the process is under way in the USA and in another five countries, says Schmidt. The irrigation system is currently in use on several farms in the Thurgau, Aargau and Three Lakes regions of Switzerland and in the Zurich area in particular. For example, in Strickhof in Lindau or on an organic farm in Brütten as well. "We get valuable input from farmers on a continual basis," says 69-year-old Schmidt. To give one example, the range of the sensor wireless link in the Three Lakes region was increased from 650 feet to almost 20 miles for farmers whose fields are widely scattered.

It is clear to Schmidt that this technology not only saves water, but also increases yields. "Over-watering is prevented, and there is no fertilizer run-off," he says. This also produces healthier plants as borne out by initial research results. The system was recently tested on eggplants as part of a thesis for **Zurich's University of Applied Sciences** in Wädenswil. The result: use of the PlantCare controller generated 30 percent more yield, only consumed 50 percent of the water previously required and no traces of pests were found on the eggplants.

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Drop by drop for a global market

The following article first appeared in the Swiss daily "DER LANDBOTE" on October 1, 2013.

Cont.

The irrigation controller is now to be tested on ten different crops under field conditions. The experiments are being supported by the Swiss Federal Office for the Environment (FOEN) and conducted by the research institute ***Agroscope*** in Wädenswil and by ***Inforama*** in Ins near Biel.

Agribusiness is a global boom market, and the Dutch Rabobank - which has called this Swiss invention a "game changer" in the field of agricultural irrigation - has established that enormous sales in the range of hundreds of millions of Swiss francs can be generated by Schmidt's irrigation technology all over the world. However, the company from Russikon cannot exploit the potential alone. As Schmidt puts it: "That's why we are looking for partners".

Reto Flury

Thomas Vollenweider shows how he controls the system's water management. *Photo by: Marc Dahinden*

Soil moisture sensors supplied by PlantCare continuously measure the moisture level of the substrate and transmit the data by wireless link to a PlantControl CX control unit.

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An impressive result

Irrigation is an essential prerequisite for reliable agricultural yields. In a research project supported by the Swiss Federal Office for the Environment (FOEN), the careful use of water resources and reductions in nutrient and pesticide runoff is now to be examined with PlantCare's sensor-based irrigation control. The aim of a scientific comparison of the new technology with conventional irrigation practice today is to show the potential for reductions in water consumption, run-off as well as the effect on plant health and economy. Researchers are more than just confident following initial scientific findings.

Wireless sensors in a field of Brussels sprouts in Jeuss (FR) supply soil moisture values for the control of drip irrigation.

What has frequently been demonstrated by vegetable and berry producers in Switzerland, is now also to be scientifically substantiated. It concerns the experience acquired by several farms, which have not only drastically reduced their water consumption with the use of PlantCare's sensor-based irrigation control, but have also increased their crop yields significantly.

Scientific substantiation

These promising results in practice have persuaded the Swiss Federal Office for the Environment to fund a three-year research project. Together with industrial partner PlantCare and research partners ***Agroscope*** and ***Inforama***, various irrigation experiments are being conducted in greenhouses and in the field under the supervision of the soil ecology research group of ***Zurich University of Applied Sciences***. With the irrigation control system developed by PlantCare Ltd., the aim is to address farmers' major problems, such as an increase in profitability by means of greater crop yields, improvements in environmental performance based on saving water and reductions in the leaching of critical chemicals (fertilizers, pesticides) in surface water (run-off) or in groundwater (seepage). In this research project, the PlantControl CX irrigation control system is to be tested on up to ten different crops.

This research project was preceded by a study by the Zurich University of Applied Sciences relating to a bachelor thesis. This involved the irrigation of eggplants for one season using a PlantControl CX irrigation control system with different moisture regimes. The results were very surprising, even for experts. It was found that those eggplants that were irrigated with only 50% of the water normally used, not only resulted in a crop that was 30% higher in yield, but also showed significantly higher resistance to pests. A result like this was only possible through the use of a sensor-controlled, intelligent irrigation system, as drought stress cannot be avoided with manual irrigation.

Organic farmers are also interested

This very encouraging result has aroused the interest of other farmers, including organic vegetable producers. The results after one season of using the PlantCare system not only confirmed the results of the Zurich University of Applied Sciences, but also surpassed them in terms of yield. One organic farmer, a direct marketer, was forced to sell part of his crop through wholesalers. In addition, the tomatoes, which were also irrigated by sensor control, had an excellent taste and were sold at a higher price as a result.

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An impressive result

Initial research results

As part of the FOEN research project, which started in 2013, zones with different soil moisture regimes watered by drip irrigation were irrigated in a 15-acre field of Brussels sprouts near Biel. Since the field is located about a kilometer away from the farm, the PlantControl CX control unit is powered by a solar cell. The automatic irrigation zones were compared with others watered manually by the farmer. Water consumption in all zones was measured electronically and recorded to ensure a valid comparison.
Once again, the result was quite clear. Compared to manual watering, which had a water consumption of 203,000 US gallons per acre, the figure was only 64,100 US gallons per acre in the zone with sensor-controlled irrigation and with the soil moisture kept at the lowest level. This corresponds to a reduction in water consumption of more than factor 3! And this was matched by a practically identical yield. The precise figures are given in the table.

This field of Brussels sprouts is supplied with water by a diesel pump, which pumps water from a channel into the drip hoses. Since automatic irrigation always starts when a set dry level is reached, the diesel pump would have to be operated round the clock, which is unacceptable. The PlantControl CX system was consequently modified so that it always sends a corresponding text message command to the pump in advance telling the pump to start. When irrigation is complete, the pump is turned off again by a stop command. This principle can also be applied to an electrically driven pump.

Further valuable insights were gained from these trials. For example, the wireless sensors will be mounted on slalom flex poles in future. This will enable farmers with their sprayer booms to move freely across their fields without having to adjust the height of the spray arms. The flex poles with the sensors mounted on them are pushed over by the spray arms after which they spring back into position.

Another advantage of automatic irrigation is that farmers no longer need to check their fields several times a week as the PlantControl CX unit reports any errors with text messages (for example, a blocked filter).

Eggplant cultures at an organic farm

Since not all fields are equipped with stationary irrigation systems, farmers would also like to know when particular fields need irrigating. Until now, they have often had to drive long distances in order to determine whether irrigation is necessary. To give farmers an effective basis for decision making, PlantCare has now developed a long-range monitoring system. This sends a text message when a field's soil moisture level falls below the set threshold value. The alarm system can cover an area with a radius of up to 30km from the farm.

Previous results indicate that "the more water, the better" is almost always the path pursued in agriculture. This is understandable since farmers are unaware of the soil moisture and then tend to play safe. However, results also show that we can reduce the amount of water enormously by using modern irrigation technologies, without being forced to accept a drop in earnings. In fact, quite the opposite is true. With certain crops at least, a substantial increase in yield can even be expected. On the other hand, there is often a distrust of new technologies in agriculture. Therefore, scientifically-based results that substantiate the impact on ecological and economic aspects, are of enormous importance. Following the initial results of these trials, scientists are very confident.

Irrigation regime	1st crop	2nd crop	Wastage	Total crop	Wastage as a % of the total crop	Water consumption	Water efficiency
	Pounds per acre	Pounds per acre	Pounds per acre	Pounds per acre		US gallons per acre	US gallons per pound
Based on experience/manual	15,755	2,581	5,340	23,676	22	203,000	8.4
Sensor-controlled, high moisture level	14,508	2,492	5,874	22,874	26	160,220	6.9
Sensor-controlled, average moisture level	13,085	2,760	5,162	21,007	25	117,500	5.8
Sensor-controlled, low moisture level	14,420	2,848	4,361	21,629	20	64,100	2.9

Positive results of water consumption and crop yields from irrigation investigations based on a field of Brussels sprouts.

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PlantControl CX: A league of its own!

The production of berries with a high yield and quality requires a lot of experience and is also associated with high labor costs. The optimal irrigation of crops is an important factor that decides between success and failure. The PlantControl CX irrigation computer is ideally suited to meet the needs of a professional berry production. This has already been demonstrated at several farms in Switzerland and Austria. In this newsletter, a case study of the PlantControl CX in a berry farm, located in Kesswil at the Lake of Constance / Switzerland and owned by the family Vogel is described.

Strawberries are undoubtedly one of the most sensitive, but as seen from the financial aspects also one of the most attractive crops in the agricultural world. The professional production of strawberries requires precise knowledge of all influencing factors, such as fertilization, irrigation, substrate type, light availability, and others. Also the right time and the type of disease treatment and pest control have a significant impact on the yield. In addition, strawberry varieties may require different growth parameters.

The optimum irrigation plays a central role. Strawberries need - like other berries too- relatively wet substrates. Depending on which substrate is used - natural grown soil or substrate like Hors-Sol - the irrigation may vary. The water requirement of the plant is, however, not constant over time. Adult plants with large leaf area and many fruits need more water than young plants. Also on hot days, more water is needed than during colder periods. Another problem is the accumulated drain water. This is loaded with fertilizers and fungicides and must be - at least in some countries - collected and recycled or disposed of. This also represents a significant cost factor.

Fig.1 Strawberry crops planted in pots and put in drain water channels as well as in Hors-Sol cultures

The Vogel family produces strawberries, raspberries, blackberries and blueberries in high quality, of with a good portion is sold at the own farm shop. The strawberries are produced either in pots placed in drain water channels, or with the Hors-Sol method (Fig.1).

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Fig.2: Arrangement of the irrigated areas, the sensors , valves and radio repeaters

In 2012, Mr. Vogel has decided to invest in a PlantControl CX irrigation computer, since the irrigation monitoring of different cultures with different water demand required a great deal of his time. Due to the very positive experiences during 2013, further beery fields which are farther away from the farm were integrated in 2014 into the automatic irrigation control by means of radio repeaters.

Although the PlantControl CX is capable of controlling three different fertilizer injectors, an existing Netajet system was additionally connected to the system.

According to berry specialists, it is very important that strawberry crops should not get too dry, nor should they get too wet. Too dry leads to too small fruits and reduced yield. A too high moisture leads to increased susceptibility to fungal infestation and also to reduced yield. However, the mean soil moisture should be quite high.

The PlantControl CX not only allows setting the run-time exact to the second, but also the automatic monitoring of a defined moisture band-width, resulting in virtually constant substrate moisture over time (Fig. 3). At the same time the system can be configured to minimize drain water surplus. The analysis of the data also shows that strawberries obviously need water and fertilizer during the night too (Fig. 4) and experiments at other berry producers with raspberries and blackberries confirm this finding.

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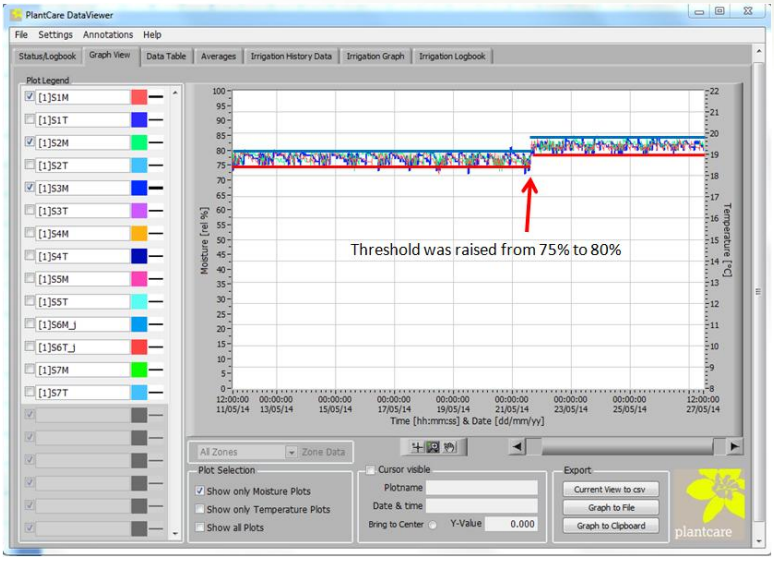


Fig.3: Soil Moisture measurement for sensors 1, 2 and 3.

Figure 3 shows the soil moisture measurement of three sensors from May 11th till May 27th 2014. The diagram gives an impression of the precision of the sensor measurements and the irrigation control of the PlantControl CX system.

At May 21st at 1.40 pm, the dry threshold at which irrigation starts was set 5% higher, what clearly shows up in a jump in the curve.

Figure 4 shows the moisture curve (red) from May 21st till May 26th 2014. It is very easy to see how accurately the irrigation starts when the 80% threshold is reached. The blue curve shows the temperature profile. The blue bars show the irrigations, each lasting 90 seconds, so that the drain water is reduced to a minimum. In addition, the night times are marked in gray.

It turns out that irrigation was triggered during the day 7 times and in the night 2-3 times.

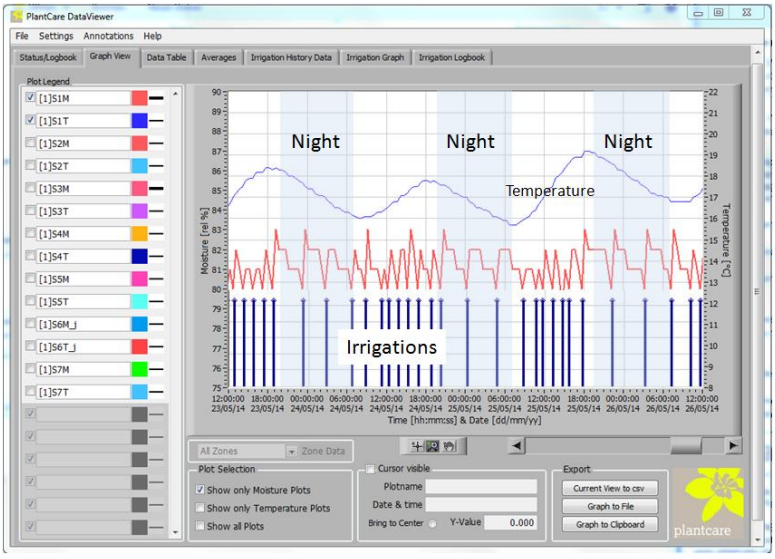
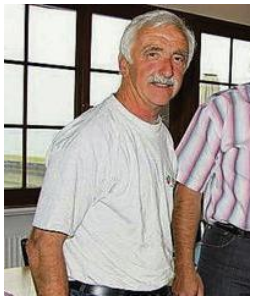


Fig.4: Soil moisture, soil temperature and triggered irrigations

Apparently, plants are able to store energy during the day that is used during the night for a reduced metabolism. When irrigation would be locked during the night, then the soil moisture would fall below 50% until the morning, which would probably not be optimal for the plants.

„Before using the PlantCare system, monitoring and controlling the irrigation system was one of my main tasks," says Mr. Vogel. "Delegating this important job was never an option as I am the only one with the necessary knowledge. With the help of the PlantControl CX, I can now take care of other important tasks on my farm and the system will send me alert notifications, whenever I need to intervene. In addition, it was totally impossible to achieve a uniform moisture bandwidth in the past, which is just standard today thanks to new technology. The PlantControl CX notes even when a dry east wind blows, which dries the plants much quicker and automatically compensates it with more water. The uniform soil moisture prevents any waterlogging and saves me money, as I have virtually no loss of plants anymore. I cannot imagine working without the PlantCare system anymore and can recommend it to any farmer facing similar challenges."



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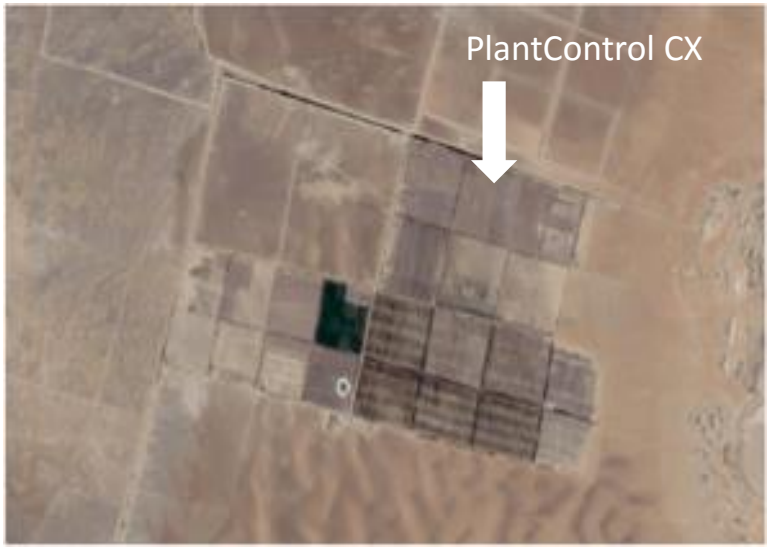
This newsletter wants to illustrate that our products are used all over the world and under extreme conditions. More and more we get inquiries from far away countries or for tasks that can only be tackled with the aid of our technology. Remains to say that PlantCare has never advertised its products – it is only by spreading the word that the world learns about our revolutionary irrigation-technology. The key features of our appliances are maximum water savings capacity combined with substantial yield increase, optimal functionality and operator convenience.

The desert lives!

Well yes, at least where it is irrigated. Needless to say that in dry places, water is an especially valuable asset. Therefore, our water-saving technology is used to regulate irrigation systems in the Egyptian desert. Coming along with the circumstances are some specific challenges.



The company Hydrip in Vienna, Austria, has been networking with organic farmers in Egypt and has recently installed a PlantControl CX in the middle of the desert, namely on the Sekem farm, five hours drive out of Kairo. The appliance is used to regulate the irrigation of date palms, jojoba bushes and vegetable in a greenhouse.

A pump, powered by solar energy, brings up the ground water from great depths. This water needs to be used sparingly. Because of the solar radiation, the heat in the greenhouse mounts to high temperatures. Nonetheless the technology must function correctly and reliably. All components need to be placed within dust-proof wrapping. Moreover, the soil moisture sensors out in the open field are exposed to abrasive sandstorms. Water pipes must be buried, as the water would otherwise begin to boil.

Despite the remoteness of the location there is good mobile reception, which fortunately allows remote enquiry and maintenance.

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From dry to humid

Do you love horse racing and do you happen to be a member of the Sha Tin Jockey Club in Hong Kong?

If so, you may enjoy the green wall of the newly erected clubhouse. The lush front is irrigated by means of our PlantControl CX.

Hong Kong's climate is subtropical and accordingly humid. The central unit as well as the radio sensors are nevertheless compelled to work aboveboard.

Moreover, the plants grow in an artificial substrate composed of felt. For optimal irrigation, the moisture within this substrate must be detected. Our special sensor (PE) masters this task without any difficulty.

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Preserve the tree!

The Freiheitsplatz in Hanau, Germany, used to be a park with lots of plane trees, until the building of a shopping mall brought the end for the trees. One plane tree, though, was literally seized by the local residents and guarded day and night, till it was spared by the construction company.

As the excavation was joined directly to the rooting zone of the tree, the soil within this sector had to be monitored in respect to moisture and irrigated when it became too dry.

The company Matthias Zorn in Wilhelmsdorf, 60km north of Hanau, was responsible for securing the tree's survival. A difficult task, considering that the protégé was 60km away.

Not so difficult a task, if you have a PlantControl CX at hand! Three sensors were inserted into the soil around the rooting zone of the tree, positioned in different depths, and the data was transferred via radio to the CX. The CX then sent emails containing the soil moisture data to the Zorn office. Thus, a remote monitoring was possible without any hassle. In case a sensor had failed due to vandalism or other, the CX would have sent an immediate SMS alert to the company.

How long to go?

This question is one that the tomato farmers in California, US, are confronted with on a daily basis. How long will the water last in order to spray the endlessly vast tomato fields?

PlantCare was invited by Morning Star, the biggest tomato producer in California, to install a trial station on one of their ample fields. The aim of this experiment is to determine how much water may be saved by using our Dynamic-Runtime-Adjustment (DRA) technology compared to conventional systems. Even a few percent would mean a major success when talking about a production output of 630t per hour.

Every day, the monitoring data of the trial station is transmitted to us via email. Thus, we may discuss the results with the people in charge on-site.

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Roses, Roses, Roses in My Garden ....

Even roses bloom more abundantly and over longer periods of time when they are watered exactly according to their needs. PlantCare has recently received the order to deliver an intelligent irrigation control to the Rosarium in the Donaupark in Vienna, Austria. Our partner company Hydrip has convinced the responsible Viennese authorities of the benefits the PlantCare technology has to offer.

Installations in public spaces need to be hidden or placed in a way that protects them from vandalism. This need is met in that the sensor electronics are attached high up on lampposts, while the PlantControl CX is placed in a secret duct. This is only possible, because the length of the cable does not influence the signal between the actual sensor and the electronic device.

Due to the telemetric readout of the data, the irrigation process may be monitored as well as optimized without an expert needing to be on-site. With this, Hydrip is in the position to offer a new service to municipalities.

Last but not least we would like to inform you that our technology is being used by very renowned universities and centers of agricultural research, such as the Max Planck Institute for molecular plant physiology in Potsdam (Germany) or the Julius Kühn Institut in Sanitz (Germany). The Syngenta research center in Stein (Switzerland), has been using PlantCare systems for several years. Recently, we were given the chance to install our irrigation systems in at the ETH Zürich (Switzerland) and in Germany at the technical university in Munich, the research center Weihenstephan and the Agricultural Centre of the State Hessen in Geisenheim, Germany. Moreover, systems have been delivered and put into operation in two research centers in Belgium and orders have been placed by a BASF research center, the university in Trier (Germany) and by the Humboldt University in Berlin (Germany).

P.S.: Please feel free to forward this newsletter to anyone who might be interested.

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Wireless = less Problems

NL 1 2015

Irrigation facilities for agricultural often have to be able to cover quite large areas, which naturally generates a number of technical challenges. In addition to long water supply lines with corresponding large cross sections, the placement of the solenoid valves can also be a problem. Particular, when several irrigation sectors have to be irrigated, either the tubing is very complex, or the control lines can be very long and, principally, cables routed on agricultural grounds constitute a reliability risk. In addition, in many cases valves should be repositioned from one to the other year, causing additional problems.

To resolve this problems PlantCare has developed a radio controller for solenoid valves (Remote Valve Control: RVC) (Figure 1), which is fully compatible with the already worldwide deployed intelligent irrigation control system - the Plant Control CX. This allows a completely free placement of valves and new possibilities for the piping. The main water supply can be provided in the form of a loop or stub line and radio controlled solenoids can be integrated at arbitrary positions. Valves can also be easily repositioned without having to lay new cables. This greatly reduces installation costs(Figure 2).

Fig1. Transceiver for 8 solenoid valves

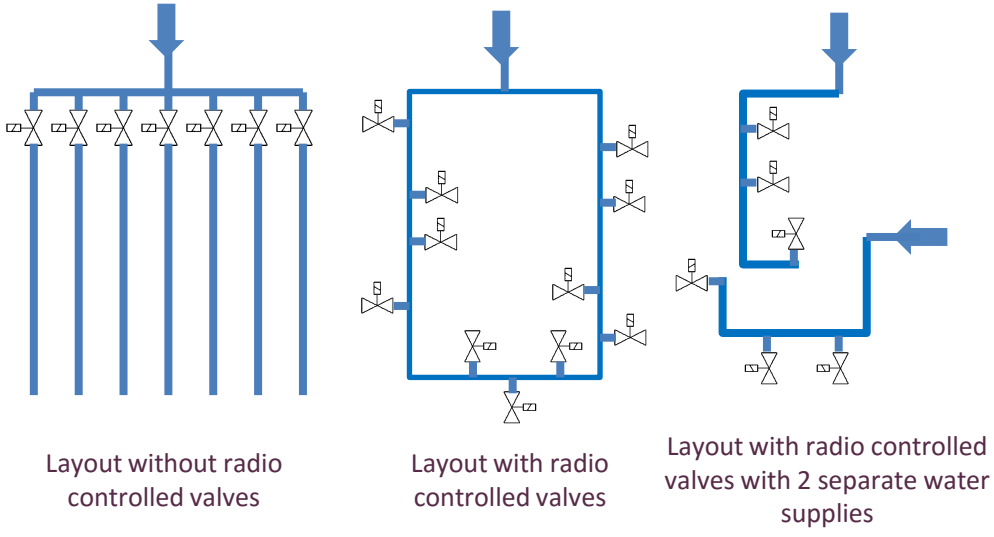

Fig2. Radio controlled solenoid valves allow much simpler water distribution systems

For very large area and complex landscape irrigation systems, such as at golf courses, often several hundred to a thousand valves are not controlled by analog control cables, but via a digital bus with decoders. This method reduces wiring costs considerably but is associated with significant additional costs and programming effort. Cables are also required for this method and repositioning a valve also need rewiring.

Valves controlled via radio are also connected by a digital "radio-bus", i.e. the control information is available for all receiving stations located within an area limited by the wireless coverage. By using PlantCare repeaters with a range of 3 km, in theory the range be extended to a radius of 30 km.

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The receiver electronics decodes the signal, decides whether it is the intended recipient and receives the commands. It should be noted that the receiver electronics can also have their own intelligence. Thus, for example, the central station not only sends the command when to open the valve but also the information, when the valve has to be closed again. However, the valve electronics can also detect malfunctions, monitor the battery status etc. and send the information back to the central station.

In principle, one could assign a separate receiver for each valve. However, this would require considerable additional costs. The practice shows that often the valves are arranged in groups. PlantCare has therefore decided to develop a radio receiver that can operate 8 valves simultaneously, thereby reducing the cost / valve by a factor of 8. Also, just one solar cell for power supply is necessary instead of one solar cell for each valve. Since normally no 230/115 VAC is available, only pulse-controlled 9V DC valves can be used.

In addition, the functionality of the Plant Control CX system is further expanded. In the previous version up to 32 valves can be controlled analogously. The RVC system now allows to connect 40 solenoid valves of which 8 have to be controlled by wires, the rest can be either 24 wired or remotely controlled.

All functions available in the analog mode are also active in the RVC system, i.e. one can manually turn on and off valves, the valves can operated in the timer mode, in semi-automatic as well as in the fully-automatic mode.

Since the PlantControl CX - System is capable to start an electrically, or diesel powered pump automatically via SMS command before an irrigation and then also turn off the pump again after irrigation, even installations can be realized with several independent water supplies.

With this enhancement, already ordered by several customers, PlantCare is expanding its global technological leadership in the field of intelligent irrigation control even further.

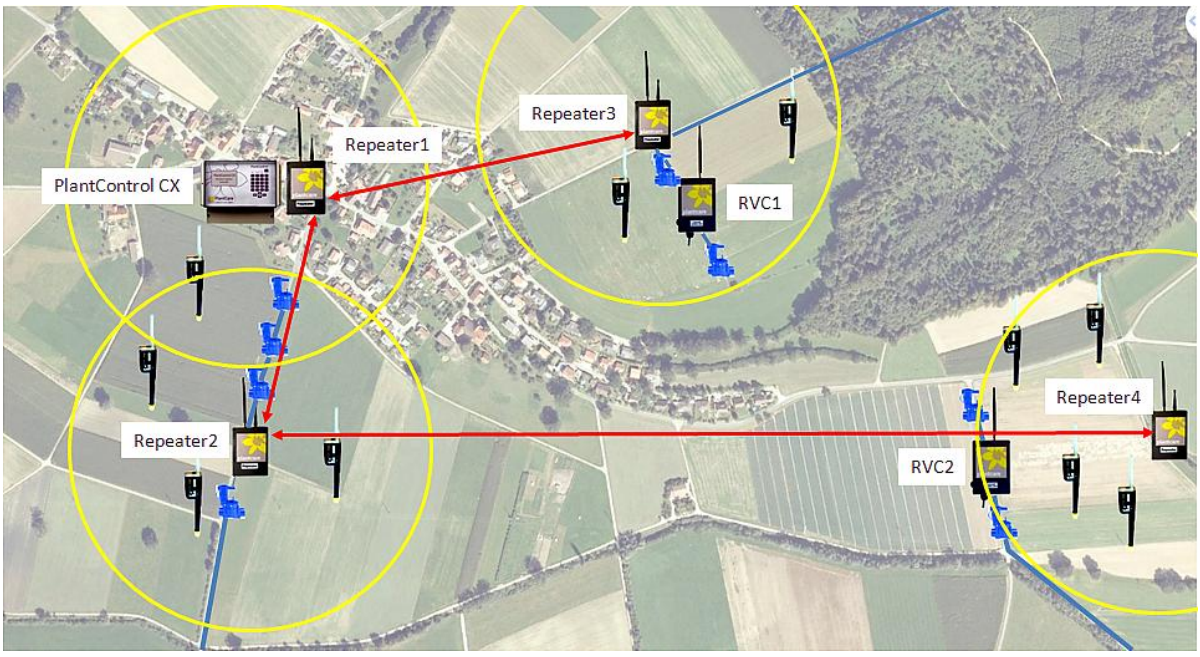

Fig3: Example of a layout with 3 different water supplies

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