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Grape Growing Factors Analysis Based On Wireless Sensor Network

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Abstract. Aim at the problems generated by facility agriculture such as low automation and ineffective environment regulation and control in the grape growing process, the paper proposes grape information collecting and monitoring system based on Crossbow eKo wireless sensor network (WSN), the system collects environmental parameters such as real-time temperature, light intensity, soil moisture and relative humidity and regulates parameters according to the best growing conditions in real-time. The experiment shows that the grape monitored and controlled by eKo system which compared to grapes planted by traditional technology is much improved in some respects such as output, size, luster and taste.

Introduction

Facility agriculture [1] is widely applied in Chinese Mainland in recent years, which contributes to resource utilization and agricultural development. However, it has problems such as low automation and low environment regulation and control. Improvements researched by scholars that make full use of WSN or information technology are applied to facility agriculture. Wang [2] designs irrigating controller. The controller which based on WSN combines with automatic control system and achieves water-saving irrigation function and automatic irrigation according to analysis of meteorological data and farmland information. Song [3] proposes vineyard monitoring system based on WSN and conducts vineyard automatic irrigation according to ecological information collected by sensors. Li [4] presents paddy-rice monitoring system from water-saving irrigation perspective. Yang [5] proposes agricultural information monitoring system based on WSN. The system achieves remotely monitored crop growth environment, collects environmental parameters and processes data according to route protocol in real-time. Si [6] designs monitoring system based on solar-energy greenhouse WSN. Grape growing process is always influenced by environmental parameters such as temperature, humidity, soil-moisture and light intensity. Therefore, it is extremely important to monitor environmental information in vineyard. Chen [7] proposes environmental monitoring system based on WSN. The paper designs vineyard information collecting and monitoring system based on eKo system according to research results already existed. The method monitors environmental factors which influenced grape growing process in real-time and controls environmental factors so that grapes are always located in the best growing conditions.

Framework Description

The paper uses the eKo system which provided by Crossbow company as experimental platform. The platform as agricultural research system has some advantages such as monitoring sensors simultaneously, sending alert properly and sustainable power supply of solar energy. Framework of eKo system is shown in Fig.1.

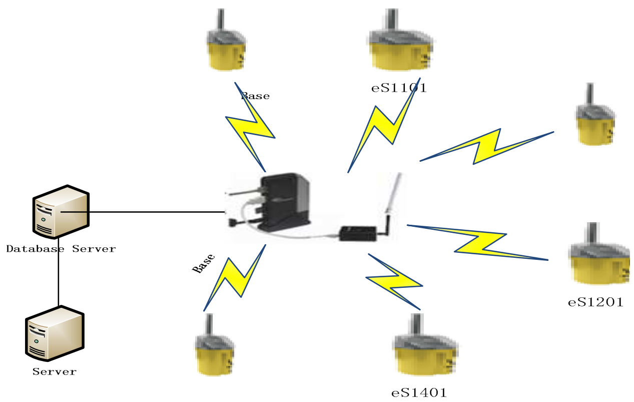

Fig.1. Framework of eKo system

eKo sensor node. eKo sensor node includes soil-moisture sensor node, environmental temperature sensor node and radiation sensor node.

1) Soil-moisture sensor (eS1101) measures the soil moisture at different depths.
2) Temperature sensor (eS1201) measures the air-temperature and relative humidity.
3) Radiation sensor (eS1401) takes charge of global direct radiation and indirect radiation.

Base node

1) eKo's base node consists of a wireless receiver and an eKo gateway.
2) eKo's gateway is embedded sensor device and runs Debian Linux operation system.

Database server. The server consists of oracle database and the data collection program. It saves all of the history data and the newest.

Server. Server provides the website server function and shows the data collected by wireless sensor network from the database server to the website.

Data analysis

The experiment is implemented at Intelligent Agriculture Information Technology Experiment Base for USST from Jan.2011 to Dec.2011. Growing factors such as temperature, humidity and light intensity are saved into database by sensors and are shown by tables so that administrators could inquire history information. Daily averages from Jan.2011 to Dec.2011 are shown in Table.1.

Table.1. Daily averages

Month	Jan	Feb	Mar	Apr	May	Jun
Daily average temperature （℃）	4.7	6.0	9.2	14.7	20.3	23.8
Daily average humidity (%)	38	28	38	32	30	35
Daily average light intensity（kw/h）	2.29	2.63	3.07	4.54	4.38	4.59
Month	Jul	Aug	Sep	Oct	Nov	Dec
Daily average temperature （℃）	28.0	27.8	24.4	19.2	13.5	7.8
Daily average humidity (%)	32	34	30	28	27	26
Daily average light intensity（kw/h）	5.52	5.23	4.03	3.39	2.97	2.38

From Table.1 we know that annual February is the best grape planting season according to the statistic data. Grape has planted, grape enters into bleeding period. Regulating daily average temperature approaching 4℃~5℃ by WSN prompts that grape root actively absorbs moisture and inorganic salts. From March to the last third of April, grape enters into germination period, making daily average temperature approaching 10℃, grape root begins to growth and absorbs nutrient substance in order to sprouting expanding. But germination period is short and administrator regulates daily average temperature approaching 20℃ after one week. The grape petal shapes in

May and June, when daily average temperature approaching 20℃~25℃, grape root accesses to the blooming period. Grape enters into flowering period after the day-average temperature achieved 20℃~27℃ and flowering period has 7~10 days. Regulating the temperature approaching 26℃~29℃ in July and August, grape enters into berry period and daily average light intensity achieves 60~100 days. From September to October, when soil temperature and humidity approaching root growing, grape root growing again. From November to the end of December, with soil temperature declining, grape root gradually stops activity. In January, grape enters into hibernation which period is one month and the temperature lower than 5℃ and light decreasing, then grape enters into bleeding period again. Moreover, grape growing period approaches from April to June. So we pick out data from April to June to analyzing environmental parameters such as temperature, humidity and light intensity influenced on grape growing process.

Firstly, average temperature analysis is shown in Fig.2. In Fig.2, horizontal axis denotes week and vertical axis denotes temperature(℃)。Cold air still exists in April and prevents freezing. Grape enters into flowering period in May and grape root is more active and increases properly room temperature. Plum rain season in June, grape needs to regulate nutrient substance and increases temperature in order to improve flowering. Secondly, relative humidity analysis is shown in Fig.3. In Fig.3, horizontal axis denotes week and vertical axis denotes relative humidity(%). In April, grape growing process not only keeps temperature but also looks out room humidity and rainwater. In May, the process controls fertilizer before flowering period and decreases water yield. In June, the process takes especially into account rainwater discharge and reduces room humidity after flowering periods. Thirdly, light intensity analysis is shown in Fig.4. In Fig.4, horizontal axis denotes week and vertical axis denotes light intensity(kw/h). In April, temperature is still low. The process improves properly light intensity and increases temperature to promoting grape root growth. In the petal period process, high light damages the bud. So the process decreases the light intensity in May. In June, the process increases light intensity to improving fruit rate in the flowering period process.

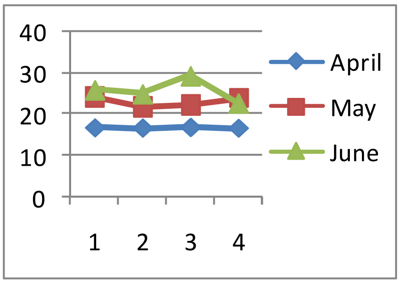

Fig.2. Temperature analysis

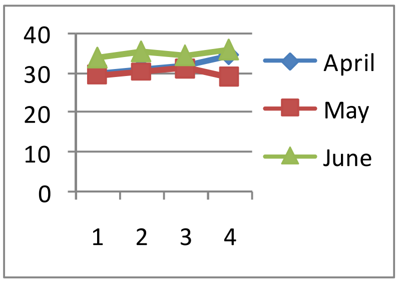

Fig.3. Humidity analysis

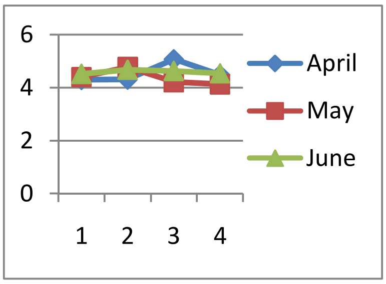

Fig.4. Light intensity analysis

Finally, grape root growing process is relatively long, if the soil temperature keeps at 13˚C ~ 25 ˚C and suitable conditions of humidity. Grape root has not period of dormancy and keeps growing all the year round. Usually, grape has three times growing root peak in spring, summer and autumn, especially in spring and summer. The average temperature analysis shows, when the room temperature up to 10 ˚C and ground temperature up to 4˚C ~5˚C, that the ground part begins to sprout and root absorbs moisture and inorganic salts from the soil. In the sprout process, when daily average temperature above to 10 ˚C, material absorbed by root enters into bud, when temperature up to average 20 ˚C, root grows quickly. When soil temperature up to 5 ˚C, root begins to activity and the over-ground part enters into bleeding period; when soil temperature up to 12 ˚C ~14 ˚C, root begins to grow; when soil temperature up to 20 ˚C ~ 25 ˚C, root enters into active growing process; when soil temperature over 25 ˚C, root growing process stops and is rapidly withering.

Conclusions

Grape planting and growing process monitored by wireless sensor network at Experiment Base for USST which compared to grapes planted by traditional technology is greatly improved in some respects such as output, size, luster and taste. (MaLu grapes are shown in Fig.5 and Fig.6)

Fig.5. (From left to right：JuMeiRen，MeiRenZhi，XiLe)

Fig.6. (From left to right：FenHuaYaDouMi，AoGuSiTe，JingYa)

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