

IoT Based Irrigation System with Magnetic Water for High Crop Yielding



Rameshkumar Priyadharshini, Ramalingam Malathy,
Karuppasamy Narayanan, Chandramoorthy Manimoliselvan,
B. Dinesh Kumar, C. Ajay, and S. Manikandan

Abstract Water is a vital resource for human being, especially for Irrigation of crops. Resources of water are dramatically changing over the periods. Water quality and supply is greatly influenced by natural processes like amount of precipitation, temperature effects and sediment transport and such as farming and industrial development. Poor quality of water for irrigation has direct effects on crop productivity, crop quality, consumers health and farmers who are in direct touch with the irrigation water and also indirectly affects the amount of nutrients/organic matter present in soil. Magnetized or magnetic water possesses exclusive physical and chemical properties making it a dual-purpose compound with potential impact in medical treatment, industrial as well as environmental applications. The unique physical and electrochemical characteristics of Magnetic water have attracted research interests to develop different devices and techniques in agricultural and environmental applications. The purpose of this study is to discuss about enhance of nutrients like nitrogen, potassium, and phosphorus contents in soil by magnetizing the different sources of water which eventually results in improving the crop productivity and quality. Magnetic Field Treated Water (MFTW) can be achieved by passing water through the magnetic field of certain strength which is optimised through IoT Technology.

Keywords Magnetic water in agriculture · High crop yielding · IoT based irrigation system

R. Priyadharshini

Department of Computer Science and Engineering, Sona College of Technology, Salem, Tamil Nadu, India

R. Malathy (✉) · K. Narayanan · C. Manimoliselvan · B. Dinesh Kumar · C. Ajay · S. Manikandan

Department of Civil Engineering, Sona College of Technology, Salem, Tamil Nadu, India
e-mail: malathycivil@sonatech.ac.in

1 Introduction

Water is evidently the most vital element in the plant life. To attain maximum yield, it is mandatory to supply the optimum quantity of water in an efficient way with respect to climatic (or) seasonal rainfall and to maintain timing (Flórez et al. 2007; Yadollahpour and Rezaee 2014). Magnetic field treated water technology showcasing some new trends in the development crop yield in the irrigation field (Belyavskaya 2004). It improves the quality of water and quantity level of water usage; climate and water table level are monitored through IOT technology for optimizing the quantity of water with respect to that. IoT technology greatly helps the farmers to monitor the nutrients of crops and water for high yielding. Magnetic field treated water can be achieved by PERMAG magnet which produces magnetic intensity of 9000 gauss power with focused magnetic field. PERMAG is entirely made of strong rare earth magnet is called Neodymium (N406). Due to the effect of magnetic field, molecular group of normal water is broken down or damaged under the actions of lovenz force, without eliminating the mineral contents present in the water. It also helps to improve the activity of water for high crop yielding. It is observed that increase in magnetic intensity increases pH value but decreases conductivity and surface tension. The other chemical parameters were also studied by various testing like boron, Electrical Conductivity (EC), Total Dissolved Solids (TDS), chloride and sulphate limits as per IS 3025 to check Nitrogen Phosphorus Potassium (NPK) level before and after magnetization (Hasson and Bramson 1985; Wang 1997). To enrich the nutrients rate through NPK. Further this study is extended to investigate the quantity of water required for the different crop species through optimizing the water quantity with respect to climatic condition i.e., temperature, rainfall, humidity etc. Finally, water quality analysis and optimized water quantity is incorporated through IoT technology using arduino UNO board.

2 Components

The magnet which is used to create magnetic field in the flow of water is Permag. It is entirely made up of strong rare earth magnet called neodymium (N406). This magnet can be used to induce the high intense and focused magnetic field. In Fig. 1, it explains that Permag device is fitted on the pipeline, once water passes through the magnet, water gets magnetized. The sensors will be set in the delivery pipe which monitors and measures the amount of nutrients, and it will be programmed according to the crops and soil types to change the nutrients through optimum magnetic field with the help of IoT. Figure 1 shows the entire process of magnetization which is carried out with the components. For different intense of magnetic field, the quality of water will be changed. By observing the various types of quality, the final intensity can be set according to the requirements of the crop. The quality level of water is monitored by the incorporated sensors in the delivery pipe through IoT technology. For predicting

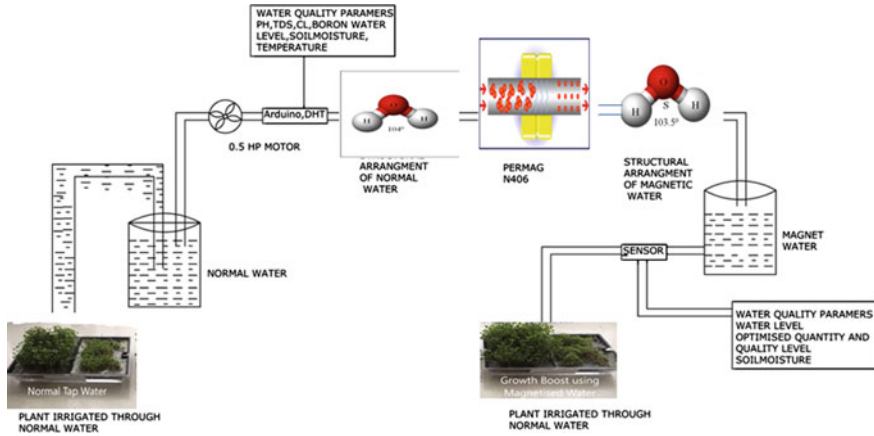


Fig. 1 Arrangement plan of magnetic water irrigation system

the climatic changes, DHT 11 weather sensor is used. Optical transducer has been used to measure NKP content present in the water which helps to analysis the changes in quality of water before and after magnetization of the respective water which passes through the created magnetic field. This study helps in understanding the performance of Permaganet in agriculture. The Components which have been used in the device long last for minimum 10 years with zero maintenance cost. It also acts as water purifier which has been more economical and affordable. IoT plays vital role in the analysis progress of Crops growth and periodical monitoring of the quality of water. Arduino board has been programmed with standard permissible limits of minerals, and with the help of sensor it stored the differences in cloud database at thinkspeak.com through IoT for analysis and then it recommends for corrective action in magnetic field. Application and uses of IoT can be discussed later as a separate topic.

3 Effect of Magnetic Field on Water

When bore well water seep through the magnetic field, the molecules arranged in the respective water will get affected by the enabled magnetic field intensity and have adversely affect on the water. In result, the molecules get rearranged inside the structure of the water molecules which also include increasing the count of crystallization centers and the changing the free gas content. In Fig. 2, it clearly explains the effect of magnetization in water that the water molecules are bond together which is in the form of water molecule clusters. When water molecule clusters are large, it is difficult to enter the root cells of plants. If the water is treated in the magnetic field, the water molecule clusters will break into smaller fragments or small hexagonal clusters. Both effects enhance the quality of water for irrigation. This

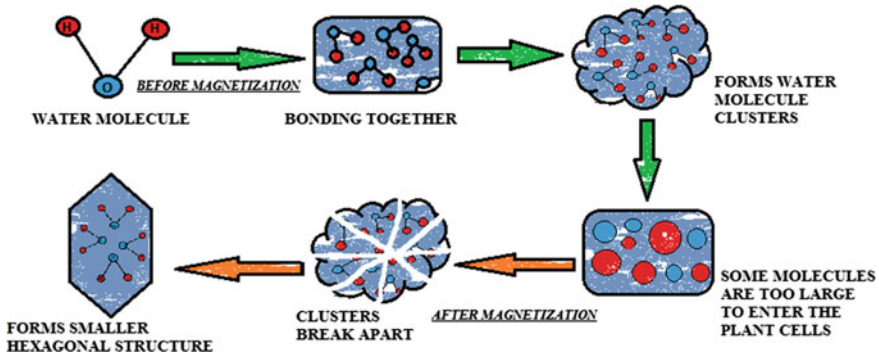


Fig. 2 Properties of magnetized water before and after magnetization

effect on water eliminates certain content like magnesium and chloride which creates hardness in the water and also add certain amount of mineral content in magnet like iron, potassium, phosphorous, and nitrogen which is add up from due to altering free flow of gas content in the water nucleus. This process helps water to carry the needed mineral content in high density and simultaneously, it reduces the hardness present in the water which also helps to carry soda content for soil. Henceforth, magnetic water leaches soil with high phosphorous content compared to the normal water. It also reduces the salt concentration which affects final germination of seeds. The reduction is important for high level of concentration (more than 5000 ppm). The concentration level in water can be monitored and controlled by changing intensity of permag magnet in further based on the requirement of certain crop for enriching with mineral contents. By this way, the amount of water is to be used for irrigation becomes minimal and enrich the content of water with necessary and required minerals in the short period of time and cost efficiency manner. In other words, the magnetic field purifies the bore well water for adopting proper and efficient irrigation system without affecting in the any form of Environment.

4 Effect of Magnetic Field Water on Soil

Soil is a significant part of successful agriculture and is the true source of the nutrients that we use to grow crops. The nutrients travel from the soil into plants that we take like tomatoes (Bogatin 1999). As previously discussed in the above topic, the magnetic field increased the nutrients in the water which also enriches the soil with the similar nutrient contents. Due to smaller hexagonal clusters of water molecules, it easily penetrates the soil and also results in increasing the permeability of soil content which also helps to the free flow of air in the Soil. The magnetic treatment of saline or bore well water is described as a valuable method for soil desalinization (Mostafazadeh-Fard 2010). Water treatment by magnetic field decreases the

hydration of salt ions and colloids that increases the salt crystallization, accelerated coagulation and salt solubility (Kronenberg 1985). The study showed that magnetic water increased leaching of excess soluble salts, lowered soil alkalinity and dissolved slightly soluble salts (Mohamed and Ebead 2013). To improve the plant growth, the soil needs to be fully enriched with NKP mineral content.

The role of NKP in soil:

- Nitrogen support to the enzymatic formation of proteins and is critical to the photosynthetic process. Crops will shift nitrogen around their plant systems from high-nitrogen density to areas deficient in the nutrient.
- Phosphorus plays a vital role in crop growth by aid in fruit production, stock growth, and root growth. A need of phosphorus in crop soil will produce weak plants that are prone to wilting, discoloration, and inadequate fruit.
- Potassium is important to the preservation and inclusion of water in crop soil. Good water saturation leads to strong and fit plants that resist disease and harm from heat.
- In addition to all of this, the magnetic water will drastically reduce the usage of fertilizer and pesticides in the irrigation field which results in organic yield. It helps to increase the water holding capacity of soil and maintains the necessary humidity for irrigation purpose. The magnetic water also enriches the soil with proper and required nutrient content for high crop yielding.

5 Effect of Magnetic Water on Plant Growth

Magnetic treatment in water carries adversely some positive effects for Plant growths. Since it purifies with required mineral content which gives necessary growth to the plant both theoretically and practically, the effect has been clearly showing comparison with previous yielding (Hilal and Hilal 2000). It also observed that the magnetic water increases the germination of seed. Similarly, in other field study indicates an important role of magnetic water irrigation of seeds in improving the growth of seedling. Further, Magnetic water treatment before sowing increases the number of pods per plant and decreased plant losses per unit area. Muraji et al. reported that the roots of maize plant have the highest growth rate under an Magnetic field intensity of 5 mT at 10^{17} Hz. In addition, Magnetic field has an important influence on dry weight of sunflower plants. The significant growth has been identified in maize, paddy, sugarcane, turmeric cultivation under the influence of magnetic water. The changed properties in magnetic water can alter the characteristics of plant, growth and production. Magnetic water changes several parameters that are related with the yield, growth characteristics, potassium, GA3, kinetin, nucleic acids (RNA and DNA), photosynthetic pigments and activity. Several studies revealed the enhancement of water productivity in crops and livestock production, flowers number and total fruits yield for various crops. In weak magnetic field, it adds the size and volume of mitochondria, calcium over-saturation in cytoplasm and disruptions in different metabolic systems including Ca^{2+} homeostasis in cells of root. The significant task

of magnetic water is to reduce the heat stress termination in various seedlings. The main effect of magnetic water in plants includes growth of plants, transplant leaf area, transplant dry weight and seed germination.

6 Prevention and Elimination of Scaling

An impurity like suspended particles, solids present in water give rise to issue in distribution system systems of irrigation or water networks. The scale deposition in distribution system can completely block running water. Accumulation of scale due to entrapped oxygen expands erosion (Busch and Busch 1997; Herzog 1989). At the point when the outside of any channel line or water utilizing frameworks gets scaled, this protecting scale diminishes the proficiency of the framework, builds fuel necessities and support. Hence the prevention and elimination of scaling technique demand evolved, not only economically but also to control the environmental pollution. The significant use of magnetic water is to prevent and eliminate the scale. This magnetic treatment provides effective savings in both production time and price. It has been concluded that the using of magnetic water reduce the mineralized coatings inside the pipes. Barrett and Parsons (1998) investigated the effect of magnetic water on calcium carbonate (CaCO_3) by suppressing nucleation and increasing the rate of crystal growth, and they observed scale reduction. The hexagonally organized of the magnetic water atom bunch would not permit the holding of minerals to it and expels scaling from pipes and would not permit new scaling to produce results. Henceforth, Magnetic water treatment is found to be useful for scale reduction, the exact mechanics of interaction between magnetic treatments and calcium carbonate in solution needs to be studied further (Vashisth and Nagarajan 2010). It can be conduct and studied in controlled laboratory is necessary. On behalf of it, some studies have been conducted on the effects of magnetic treatment of irrigation water on crop, soil, water, and yield (Maheshwari and Grewal 2009).

7 IoT in Irrigation System

Smart agriculture is a resolution to many global agricultural issues, like trending team productivity, monitoring results, communicating with other teams and sub-units, as well as calculating market tendencies. For the most of farms, the implementation of IoT agriculture begins with stylish irrigation. Optimizing the time frame and amount of water seep us to save resources and provide the finest care for crops. Sensor-based IoT technologies collect database about soil and update a crop review and transmit this information from sensors to farm irrigation systems (Yadollahpour and Jalilifar 2014), A. As soon as there is not enough water in the soil, a platform reacts to this alert and the water flow turns on. In Fig. 3, it shows the IoT device or component which have been used in our study to transmit data for analysis purpose. The data

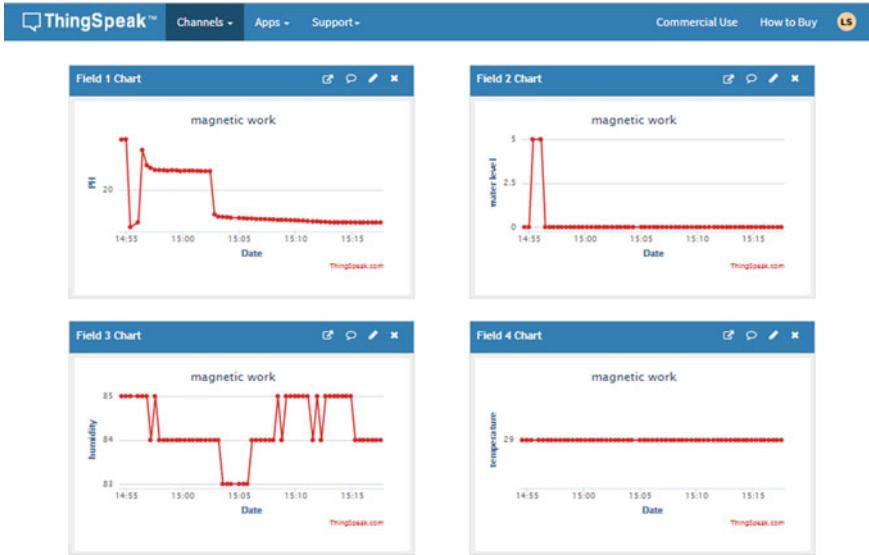


Fig. 4 Field analysis chart of pH, water level, humidity, temperature

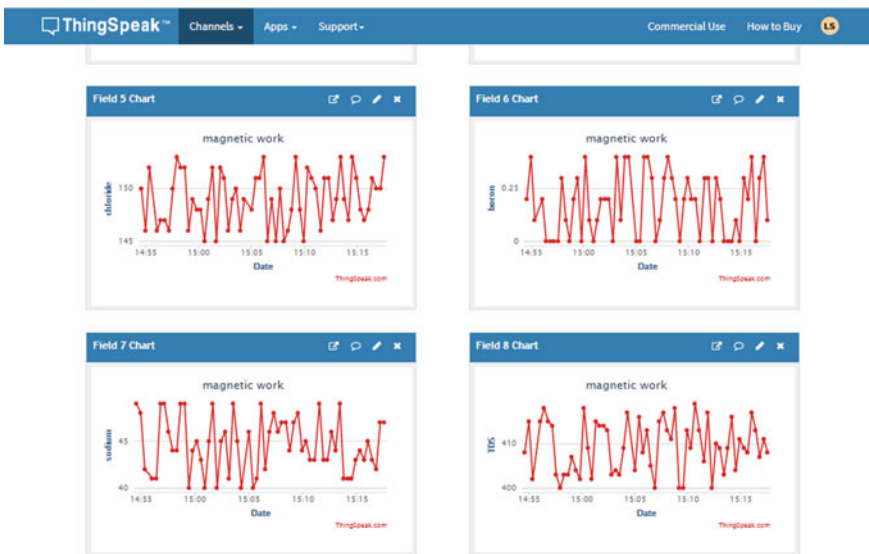


Fig. 5 Field analysis chart of chloride, boron, sodium, and TDS

8 Conclusion

Magnetic water treatment has opened to new research and taken one step forward to the modern way of agriculture. When this type of agriculture incorporated with IoT technology, it ensures the safety, compatibility, and productivity of crops. By using this IoT based magnetic water irrigation, the farmers can save production time, minimal usage of water, and can reduce the initiation cost. This method drastically reduces the use of fertilizers, and excessive use of watering which affects the growth of the crops. The Magnetic irrigation system increases high yielding of crops compared to the conventional water irrigation system. Magnetic water treatment method enhances irrigation water quality and quantity, crop yields and quality, soil improvement, scale prevention/elimination in water using systems and water saving are some of significant benefits in agriculture. In addition, magnetic fields have shown beneficial effects on the germination of seeds, plant growth and development, the ripening and yield of field crops. Magnetic water irrigation proves the growth in plant is purely based on organic manner and does not affect or harm the environmental at any cost. The crop yielded by using this method has enriched with high nutrient content and entirely it is safe and healthy. As it is embedded with IoT, it can reduce work and saves labor cost which can also monitor and controlled in remote without having any physical work.

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