ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Special Issue 2, April 2014

Maintaining Ecological Integrity: Real Time Crop Field Monitoring Using Leaf Colour Chart

K. Alagurani [1], Suresh S [2], Mrs. L. Sheela M.E (PhD) [3]

PG Student [Embedded Systems Technologies] , Dept. of EEE, Regional Centre of Anna University, Tirunelveli, Tamilnadu, India [1]

PG Student [Embedded Systems Technologies] , Dept. of EEE, Regional Centre of Anna University, Tirunelveli, Tamilnadu, India [2]

Assistant professor, Dept. of EEE, Regional Centre of Anna University, Tirunelveli, Tamilnadu, India [3]

ABSTRACT: Drip irrigation is the method widely used in the precision agriculture, which reduce the water conception as it irrigates water to the plant's root region. Another method is fertilizer made as drip, irrigated along with water. The traditional method gives the better yield but present scenario says soil pollution in traditional agriculture practice is drastic due to water flooding, over fertilization, high usage of pesticide. This project provides a system based computation technique to reduce pollution level, an efficient precision agriculture for small scale farming, and reliable data collection from the paddy field. Plant health is monitored using Leaf Colour Chart (LCC) and necessary fertilization is done by actuator deployed in the field. pH of the field varies with temperature and fertilizer used, which decide level soil pollution.

KEYWORDS: LCC (Leaf Colour Chart), paddy, precision agriculture, digital image processing, site specific nitrogen application, sensor, actuators

I.INTRODUCTION

Soil pollution in India is mainly due Industrial, agricultural, transport. This paper focuses particularly on agricultural pollutants, toxic metals and chemical concentration can reduce the soil fertility. The excess application of pesticides, herbicides or fertilizer adds more concentration to soil pollution. These affect both the surface soil and underground soil. A solution to this problem is given in this paper using the sensor and actuator. Precision agriculture in India is done by drip irrigation, which reduce the water conception as it irrigation water to root region. The traditional method gives better yield but the problem here is due to unawareness a practice of over fertilization is followed to raise the yield. The water flooding and usage of pesticide are the other problems in this scenario. The evolution in the field of sensor and actuator employed for monitoring the paddy field. Paddy is one of most fertilizer consuming crop, it is about 37% of total fertilizer used in India.

Paddy crop requires the essential nutrient for its normal growth, Nitrogen (N), Phosphorus (P) and Potassium (K) are known as primary nutrients. Secondary nutrients: iron, manganese, copper, zinc, boron, molybdenum and chlorine trace fewer in amount. The fertilizers available are the complex of NPK which are mixed in different proportion. In many situations more than 60% of the applied N is lost because of over fertilization. The general recommendation of 80 kg N ha-1 for rice is based on crop response functions developed from data for few soils. The general fertilizer N recommendation does not take into account site-to-site variation in N supply capacity of soils to meet crop demand. Site Specific Nitrogen Management reduces the pollution in greater extent.

Leaf Colour Chart (LCC) is a simple tool which is method for plant N is used as indicator of leaf Colour. LCC has 6/4 different Colour shades from yellowish green to dark green. Reading is taken from 2 weeks after transplanting to initiation of flowering as shown in Fig. 1 [3]. Leaf Colour is measures comparing Colour with the Colour shades of

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Special Issue 2, April 2014

LCC. Nitrogen requirement for rice pant is not same throughout the growth period. The optimum use of N comes from matching supply with crop demand.

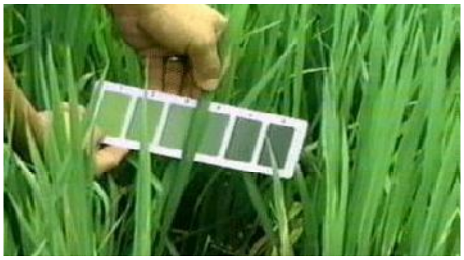

Fig.1 LCC matching on Paddy Leaf

The idea about monitoring the crop fields area without man power, which utilizes the sensors in paddy crop field area using wireless Sensor network (WSN). The sensing and monitoring the temperature, humidity and water level of the paddy crop gives efficient paddy filed monitoring [1]. The advantage if using wireless sensors networks in agriculture are distributes data collection, monitor and control of climate, irrigation and nutrient supply [2].

Nitrogen fertilizer recommendation for specific rice regions are suggested dose ranges from 100 to 120 kg N/ha dry season and 80 to 100 kg N/ha in wet season. N-fertilizer recommendation is lower than the area of alluvium soils i.e. 80-100 kg N/ha in dry season and 60 to 80 kg N/ha in wet season. Besides, a small area of the coastal region from Long An to Ca Mau, N- fertilizer recommendation is as low as 30-50kg N/ha. Normally, farmers divide fertilizers in to 3 to 4 times (even 6-7 times) to apply in a crop season. According to many recommendations, nitrogen fertilizer is suggested to apply by 3 times/crop depending upon the crop growth stage. With the longer crop duration (120 days), nitrogen fertilizer is applied at 10-15 day after sowing (DAS), 30-35 DAS and 65- 70 DAS. Nowadays, with the short-duration rice genotypes (90-110 days) or the ultra-short genotypes (below 90 days), rates and times for nitrogen application are also change.
Paddy crop need much water than other crops this cause less possibility of drip irrigation system, as a spacing of 25cm X 25cm is now being promoted under practice of rice cultivation. the water management is much necessary work in paddy field. The water needed and their necessity of irrigation with the paddy growth is tabulated in TABLE. I

TABLE. I

Paddy Crop Stage and Irrigation Needed

STAGE	WATER	NEED
Seeding	Shallow	Most
Rooting	Deep ponding	Need
Tillering	Shallow, 1/2 drainage	Not need
Young head	Deep ponding	Most
Booting	Deep ponding	Most
Heading flowering	Deep ponding	Most
Milky ripe	Shallow	Need
Dough ripe	Shallow	Need
Yellow ripe	Nil	No need

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Special Issue 2, April 2014

II. SYSTEM FUNCTIONALITIES

A machine vision for the agriculture for the nutrient management through the sensor and actuators thereby provide the ecological integrity. Thus reduces the rate of soil pollution due to agricultural activities. The system of this project aims at

- Data collection from the paddy field
- Transmitting through wired/wireless
- On field actuation through actuator
- Leaf image collection from field
- Image processing to analyse the green of leaf
- Computing the fertilizer (NPK)
- Logging the parameters to database for future reference

III. SYSTEM ARCHITECTURE

To achieve the goals mentioned in the previous section, we designed and implemented a paddy field station and base station for monitoring and responding as shown in Fig. 2. As the block shows there are several types of sensor nodes to be deployed in the crop field area. It captures the physical phenomenon such as temperature, pressure, humidity, water level and pH can be monitored in a paddy crop field. The entire field sensor are connected to microcontroller, it communicate to base station through wireless transmitter. The monitoring station receives the data from paddy field station through RS232 communication port it stores the values to the database, control algorithm checks the threshold value gives the alert or display message.

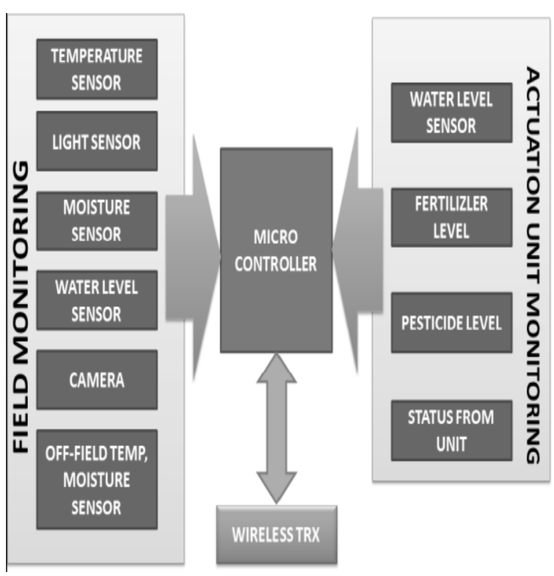

Fig. 2. Paddy field station

The data was received from the temperature sensor, humidity sensor, water level sensor, which was connected to Zigbee which communicate with other Zigbee connected to base station depicted in Fig. 3.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Special Issue 2, April 2014

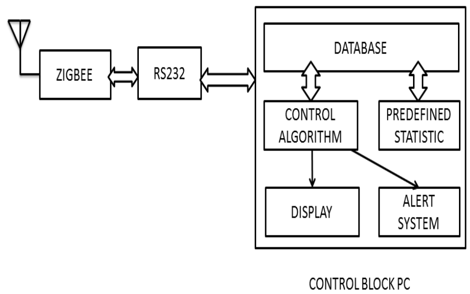

Fig. 3. Base station

The flowchart of field station and base station are shown in Fig. 4 & Fig. 5 each processing is explained later with the implementation towards the project.

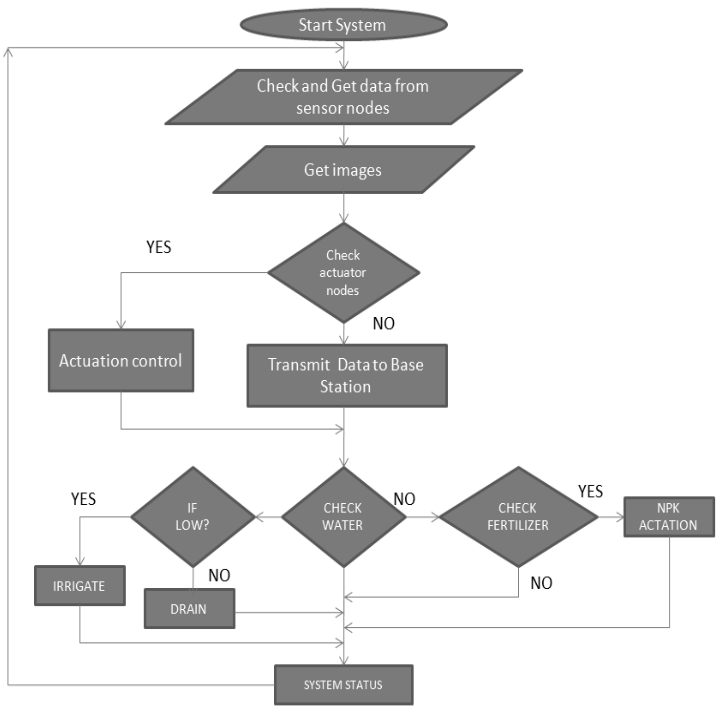

Fig. 4. Flowchart of field station process

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Special Issue 2, April 2014

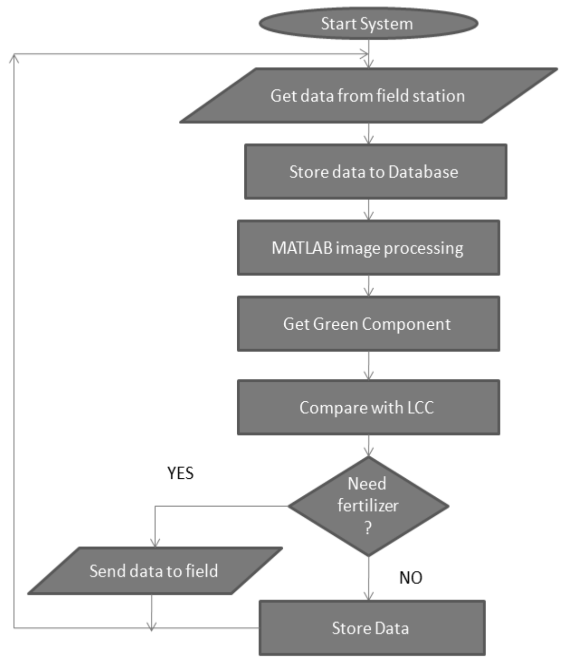

Fig. 5. Flowchart of Base station process

A. Field Sensor System

We implanted various sensors like temperature, light sensor, pH electrode, and water level throughout the test field. The sensor system which composed of the following elements: 1) PIC16F877A, 2) Zigbee, 3) Camera, 4) Power source.

B. Field Actuator System

The actuators includes 1) Micro valves, 2) Irrigating Channel. Each valve is connected to tank which contain fertilizer in liquid form and water. The status of each tank is got by the sensor system. The NPK proportional is decided by the computation process.

C. Transmission system

The data collected at each node is transmitted wirelessly through the ZigBee module is support by IEEE 802.15.4 [1]. It is low data rate, low power and low cost wireless personal area networks. The microcontroller performs tasks, processes data and controls the method in sensor system. The sensing unit have the sensor node which converts the analog signal to digital signal (ADC).

D. Base Station System

The base station system consists of subsystem: 1) Database, 2) Predefined Statistic, 3) Control Algorithm, 4) Display, 5) Alert System. Data received from the field through ZigBee is processed through various subsystems.

1. Database: The database used is MS ACCESS, used to store the data from the field. Control algorithm also has the access over the database to store the image and processing result.
2. Predefined statistic: It stores the data of previous research and metrological parameters. These are helpful in ranging the processing value.
3. Control Algorithm: Control Algorithm is the main part of the project as it includes the overall functionality of the project. Methods of proper fertilizer application have been developed in this project. MATLAB image processing is implemented to extract the features of the paddy leaf. The project adopts the guidelines of LCC [3]. Image processing classifies the green intensity of the leaf and matches it with LCC. The images are taken

in the illumination of sunlight, this cause Colour variation. To eliminate this Colour variation feedback of light intensity is taken under consideration. The image acquisition is done by camera in the paddy field. The image processing module deals with the following process

The first step is image acquisition, where the images are acquired with light intensity parameter. These images are transmitted to the base stage where it checks for the fertilization time and process the image further. A Colour histogram represents the distribution of Colour in an image. This histogram is compared with the statistic value of LCC and other recommendation by the agricultural department. The green intensity of each image is taken and stored to database for future reference. The application developed using the Visual Basic 2010 is capable of storing the value to MS ACCESS database.

4. Display: A GUI is developed to display the data acquired and processed
5. Alert System: it gives alert to user on unconditional, unfavourable act on the field.

IV. RESULT AND ANALYSIS

Soil Type Studied

Black and Red soil taken for the test, from this the black soil more suitable for rice cultivation. Black soil is rich in clay, which retain the water in higher level. The pH analysis made before seeding and the final pH is measured to find the ecological factor after harvesting. The pH of the black soil from the rural area is comparatively high which is due to high basic contents in the soil. The region of kalakad are the resource of more fresh water hence the pH of the water is neutral (7.0) on adding more fertilizer the pH decrease to 5.0 with makes the land acidic. The problem is more worse when the irrigation water is more saline. The testing is done in region of fresh water and saline water. The results presented in this paper are use of fresh water.

pH Analysis

The value of pH decide the amount of soil pollution, on adding the fertilizer to the field the value of pH changes, temperature plays the vital role, analysis is made between the temperature and pH for different fertilizer like Gypsum, DAP, Potassium and water. 50ml of test solution is taken for this process. The fertilizer samples are mixed with the water and their analysed done by raising the temperature. If soil is acidic on adding Gypsum pH value is decreases, pH reduces on adding gypsum the graph shown in the Fig. 6(a). DAP (Di Ammonium Phosphate) is rich in ammonium and phosphate contents on heating the solution the pH value oscillate over the scale shown in Fig. 6(b). The potassium is basic, it does not show significant variation of pH over temperature but it is much needed for plant growth shown in Fig. 7(a). Water a universal solvent the pH of the solution decrease with increase in temperature is shown in Fig. 7(b).

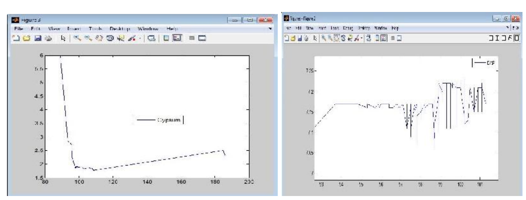

Fig. 6(a) & 6(b) Temperature vs. pH analysis of Gypsum & DAP

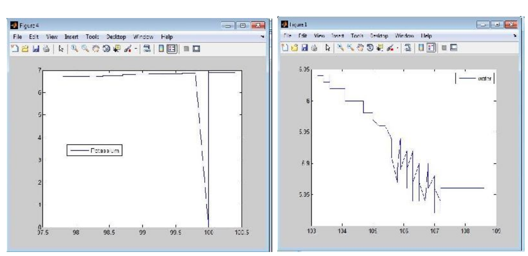

Fig. 7(a) & 7(b) Temperature vs. pH analysis of Potassium & Water

Software GUI model

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Special Issue 2, April 2014

Fig. 8. Shows the data logging model and GUI interface of the project which is developed in Visual Basic 2010. The front panel show the data acquisition from the field station to monitoring station. The experimental work is done through the commercial pH measuring device.

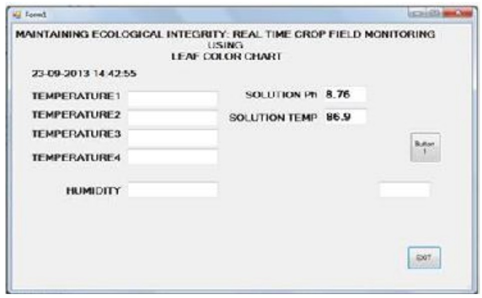

Fig. 8. Software GUI model

MATLAB image processing

The results mentioned here discussed with the LCC plate which are taken manually during the image acquisition. These results are compared with the computation result. The Table II gives details about the MATLAB Green intensity. Fig. 9(a) & (b) shows the LCC chart and leaf sample image. Fig 10(a) & (b) gives the pixel region of imtool.

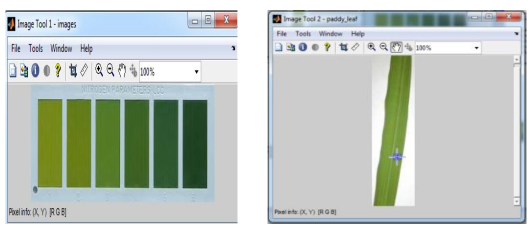

Fig. 9(a) & (b) LCC and Leaf sample Image

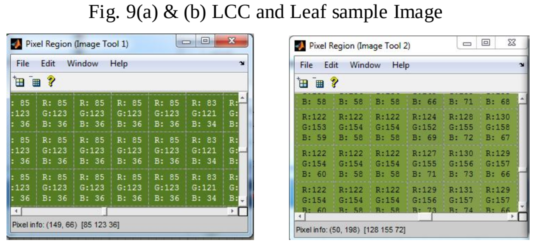

Fig. 10 (a) & (b) Pixel Region of sample images

TABLE II

Green intensity from MATLAB image processing and LCC plate observation

Nitrogen Level /Kg Ha^{-1}	Green intensity	LCC value (6 window)
0	154	3
20	149	3
40	150	3

Hardware Setup Simulation

The hardware used in this project is simulated using the Proteus ISIS7. The sensor nodes are represented in variable resistor, the actuators are represented using LED and the LCD shows the local display. The virtual terminal shows the data sent to the ZigBee. Fig. 10. Shows the hardware simulation

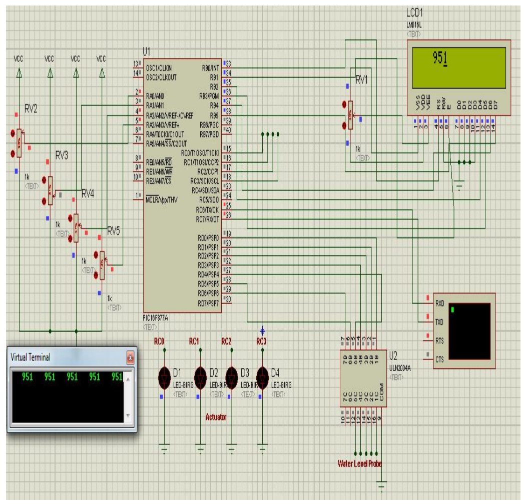

Fig. 10. Hardware Simulation

Comparison with traditional fertilization

Fields are randomly selected for the testing purpose and the traditional fertilization is observed manually. The Table III gives the value of manual and computed fertilization. The test is made at the stage of active tillering. The variety of rice is AMBAI 16.

TABLE III

Comparison of traditional fertilization with computed fertilization

LCC plate value	Traditional N amount (Kg/ha)	Computed N amount (Kg/ha)
3	35	30
4	54	49

V. CONCLUSIONS

This paper presented a new machine based approach for the nutrient management for paddy crop. The use of Visual Basic provides the interactive GUI for the user. pH is important factor which decides the soil pollution, real field data are compared with the experimental results, it show that soil pollution decreased. The accuracy of machine vision on paddy leaf is enhanced by taking feedback of the light intensity sensor from the field. The future work includes implementing into large field and different climate condition to study the wear and tear of the sensor.

ACKNOWLEDGMENT

Thankful to institutions, Agricultural Research Institute, Killikulam, Tamil Nadu, Dept. of EEE, Regional Centre of Anna University, Tirunelveli. I would extend my special word of thanks to all faculty members for their support throughout this work. I express my gratitude to my parents, friends and all other well wishers for their whole hearted support and encouragement during the difficult times of the project work.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Special Issue 2, April 2014

REFERENCES

[1] K. Sriharsha, T.V. Janardhana Rao, A.Pravin, K. Rajasekhar, "Monitoring the paddy crop field using Zigbee network", et al International Journal of Computer and Electronics Research, Volume 1, Issue 4, pp. 202-207, Dec. 2012
[2] Santhosh Simon, K Paulose Jacob, "Wireless sensor networks for paddy field crop monitoring application in Kuttanad", International Journal of Modern Engineering Research (IJMER) Vol.2, Issue.4, pp. 2017-2020, Jul.-Aug 2012.
[3] Project proposal on "Distribution of leaf colour chart", under shriya krishi vikas yojana, directorate of agriculture & food production, Orissa, 2012-13
[4] YIN Shouyi, LIU Leibo, ZHOU Renyan, SUN Zhongfu, WEI Shaojun, "Design of wireless multi-media sensor network for precision agriculture", China Communications, February 2013, pp. 71-87
[5] Christian Bauckhage, Kristian Kersting, and Albrecht Schmidt, "Agriculture's Technological Makeover ", Published by the IEEE CS, pp. 4-7, Apr/Jun 2012
[6] Monjur Ahmed," Wireless Sensor Network: An Emerging Technology", IOSR Journal of Electronics and Communication Engineering (IOSRJECE), ISSN: 2278-2834 vol. 2, Issue 4, pp. 01-04, Sep.-Oct. 2012
[7] Yunseop (James) Kim, Robert G. Evans, William M. Iversen, "Remote Sensing and Control of an Irrigation System Using a Distributed Wireless Sensor Network ", IEEE transactions on instrumentation and measurement, vol. 57, no. 7, pp.1379-1387, Jul. 2008
[8] Wen Hu, Tuan Dinh Le, Peter Corke, Sanjay Jha, "Outdoor Sensornet Design and Deployment: Experiences from a Sugar Farm", Published by the IEEE CS, , pp.82-91, Apr.-Jun. 2012
[9] Kuniaki, Haruyuki, Genya Saito, Yukio Kosugi, "Characterization of Rice Paddies by a UAV-Mounted Miniature Hyperspectral Sensor System", IEEE journal of selected topics in applied earth observations and remote sensing, vol. 6, no. 2, pp. 851-860, Apr. 2013
[10] Iwasaki K, " Study on flow arrival time irrigation canal systems", Bull. National Research Institute of Agr. Eng., pp no.21, 1981
[11] Balaji T, "Standardisation of LCC indices and SPAD values for nitrogen requirement of rice in an ALFISOL of TAMIRAPARANI TRACT", Thesis of Soil Science and Agricultural chemistry, 2002