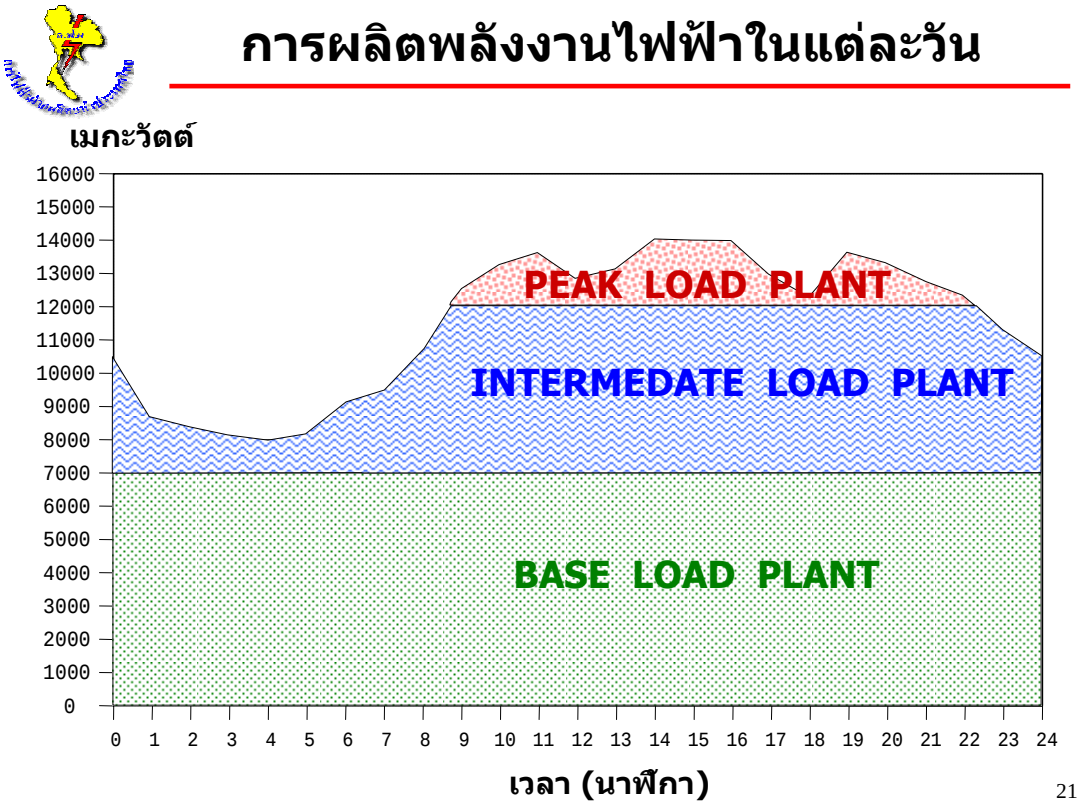
ภาคผนวก ก.
ข้อมูลการผลิตพลังงานไฟฟ้าในแต่ละวัน



ที่มา: เอกสารประกอบการนำเสนอ การลงทุนในกิจการไฟฟ้าภายใต้รัฐบาลปัจจุบัน แผนการพัฒนากำลังผลิตไฟฟ้าของ กฟผ. ณ. ห้องประชุมชั้น 5 เศรษฐศาสตร์ มหาวิทยาลัยธรรมศาสตร์ วันที่ 2 กุมภาพันธ์ 2550 ,เอกสารหน้า 21

ภาคผนวก ข
เครื่องมือและอุปกรณ์

Current Probe

HP / Agilent 1146A

Specifications:

AC/DC, 100 mA to 100 A rms, DC to 100 kHz

Frequency range: DC to 100 kHz (-3dB with current derating)

Current range, 1 mV/A: 100 mA to 10 A peak 10 mV/A: 1 to 100 A peak 10 mV/A ac/dc: 1000 mV peak

AC current accuracy, 100 mV/A (50 mV to 10 A peak) - 3% of reading ±50 mA 10 mV/A (500 mA to 40 A peak) - 4% of reading ±50 mA 10 mV/A (40 A to 100 A peak) - 15% max at 100 A

Working voltage: 600 V max

Battery: 9 V alkaline

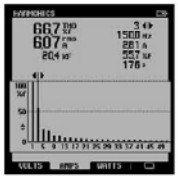
This AC/DC current probe provides accurate display and measurement of currents from 100 mA to 100 A rms, dc to 100 kHz, without breaking the circuit. The Agilent 1146A uses Hall-effect technology to measure ac and dc signals. It is compatible with all Agilent oscilloscopes and any scope with 0.2 to 0.5 V/div sensitivity, a minimum input impedance of 1 MΩ and a BNC input.

FLUKE®

43B Power Quality Analyzer

Get control of power problems!

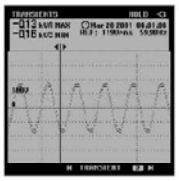
The Fluke 43B Power Quality Analyzer combines the most useful capabilities of a power quality analyzer, scope and multimeter in a single easy-to-use instrument. The user interface is selectable in English, German, French, Italian and Spanish.



- Voltage, current, and power harmonics
- Up to 51st harmonic
- Total harmonic distortion (THD)
- Phase angle of individual harmonics

- Continuously measure volts and amps on a cycle-by-cycle basis for up to 16 days
- Use cursors to read time and date of sags and swells

- One and three phase power on balanced loads
- Watts, power factor, displacement power factor, VA and VAR
- Voltage and current waveforms



- Catch voltage transients and waveform distortion
- Catch and save up to 40 transients
- Correlate the cause of transient with time and date stamps

EN61010-1 600V CAT III

LISTED

FlukeView Power Quality Analyzer software is included

Accessories and Ordering Information

Included Accessories

Fluke 43B: Hard case, voltage and current probes, FlukeView PC software and cable, line voltage adapter/battery charger, applications manual, power quality video and user's manual.

Ordering Information

Fluke 43B Power Quality Analyzer

Pub_ID: 10028-eng
Rev. 03

Specifications

Menu items	Measurements	Ranges	Accuracy
Volts/Amps/Hz	Volts Amps Mains frequency CF Creat Factor	5.000 V–1250 V 50.00A–50.00 kA 40.0 – 70.0 kHz 1.0 to 10.0	± (1%+10) ± (0.5%+2) ± (5%+1)
Power	Watts, VAR, VA PF, DPF, COS φ	250 W–1.66 GW 0.25–0.9 0.90–1.00	± (4%+4) ± 0.04 ± 0.03
Harmonics	Volts Amps Watts K-factor	1st to 51st harmonic 1st to 51st 1st to 51st 1.0 to 30.0	± (3%+2) to ± (15%+5) ± (3%+8) to ± (15%+8) ± (5%+2) to ± (30%+5) ± 10%
Sags & Swells	Voltage and Current	4 min–16 days selectable	± (2%+10)
Transient Capture	40 ns pulse width Up to 40 transients	Select 20/50/100/200% above or below line voltage	± 5% of full scale
Inrush Current	1sec. to 5 min selectable	1 A to 1000 A	± 5% of full scale
Ohms/Continuity/ Capacitance	Ohms Capacitance	500.0 Ω to 30.00 MΩ 50.00 nF to 500.0 µF	± (0.6%+5) ± (2%+10)
Temperature (with accessory)	°C °F	-100.0°C to 400.0°C -200.0°F to 800.0°F	± (0.5%+5)
Scope	Dc, ac, ac+dc, peak, peak-peak, Hz, duty cycle, phase, pulse width, crest factor	Sampling rate: Bandwidth: Voltage BW (Channel 1) Current BW (Channel 2)	25 MS/sec 20 MHz 15 kHz
Screen saves	All functions	20 screens	
Recording	V/A/Hz, Power, Harmonics, Ω/Cap, Temperature, Scope	4 min – 16 days selectable	Select any two parameters in each display mode

Battery life: Rechargeable Ni-Cd pack (charger included), 4 hrs typical (continuous)
Shock & Vibration: Mil 28800E, Type 3, Class III, Style B.
Operating temperature: 0°C to 50°C; **Case**: IP51 (dust, drip, waterproof)
Size (HxWxD): 232 mm x 115 mm x 50 mm **Weight**: 1.1 kg
Safety: EN 61010-1 CAT III, 600V. UL and CSA listed.
Three years warranty

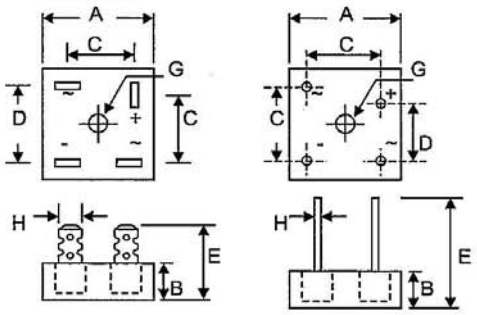
WTE
POWER SEMICONDUCTORS

KBPC1000/W – KBPC1010/W

10A HIGH CURRENT BRIDGE RECTIFIER

Features

- Diffused Junction
- Low Reverse Leakage Current
- Low Power Loss, High Efficiency
- Electrically Isolated Metal Case for Maximum Heat Dissipation
- Case to Terminal Isolation Voltage 2500V
- UL Recognized File # E157705



KBPC KBPC-W

Mechanical Data

- Case: Metal Case with Electrically Isolated Epoxy
- Terminals: Plated Leads Solderable per MIL-STD-202, Method 208
- Polarity: Symbols Marked on Case
- Mounting: Through Hole for #10 Screw
- Weight: KBPC 31.6 grams (approx.)
  KBPC-W 28.5 grams (approx.)
- Marking: Type Number

"W" Suffix Designates Wire Leads
No Suffix Designates Faston Terminals

	KBPC		KBPC-W	
Dim	Min	Max	Min	Max
A	28.40	28.70	28.40	28.70
B	10.97	11.23	10.97	11.23
C	15.70	16.70	17.10	19.10
D	17.50	18.50	10.90	11.90
E	22.86	25.40	30.50	—
G	Hole for #10 screw, 5.08Ø Nominal			
H	6.35 Typical		0.97Ø	1.07Ø
All Dimension in mm				

Maximum Ratings and Electrical Characteristics @T_A=25°C unless otherwise specified

Single Phase, half wave, 60Hz, resistive or inductive load.
For capacitive load, derate current by 20%.

Characteristic	Symbol	KBPC 1000/W	KBPC 1001/W	KBPC 1002/W	KBPC 1004/W	KBPC 1006/W	KBPC 1008/W	KBPC 1010/W	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	50	100	200	400	600	800	1000	V
RMS Reverse Voltage	$V_{R(RMS)}$	35	70	140	280	420	560	700	V
Average Rectified Output Current @T_A = 50°C	Io	10							A
Non-Repetitive Peak Forward Surge Current 8.3ms Single half sine-wave superimposed on rated load (JEDEC Method)	I_{FSM}	200							A
Forward Voltage (per element) @I_F = 5.0A	V_{FM}	1.2							V
Peak Reverse Current @T_C = 25°C At Rated DC Blocking Voltage @T_C = 125°C	I_{RM}	10 1.0							μA mA
Typical Junction Capacitance (Note 1)	Cj	300							pF
Typical Thermal Resistance (Note 2)	$R_{\theta JC}$	6.3							K/W
RMS Isolation Voltage from Case to Lead	V_{ISO}	2500							V
Operating and Storage Temperature Range	Tj, Tstg	-65 to +150							°C

*** Glass passivated forms are available upon request.**

Note: 1. Measured at 1.0 MHz and applied reverse voltage of 4.0V D.C.
2. Thermal resistance junction to case per element mounted on heatsink.

Electromagnetic Field Tester (EMF TESTER)

Model: EMF-827

Range/Resolution: 20 micro Tesla/0.01 micro Tesla

200 micro Tesla/0.1 micro Tesla

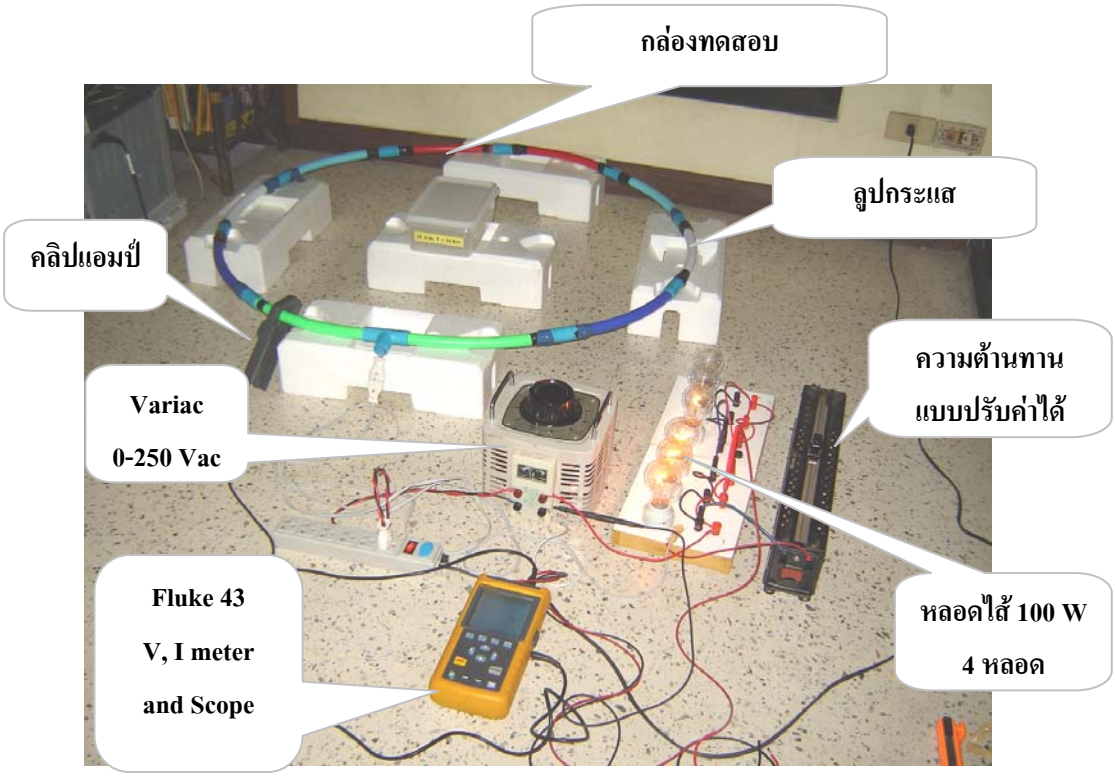
2000 micro Tesla/1 micro Tesla

*1 micro Tesla = 10 mili-Gauss

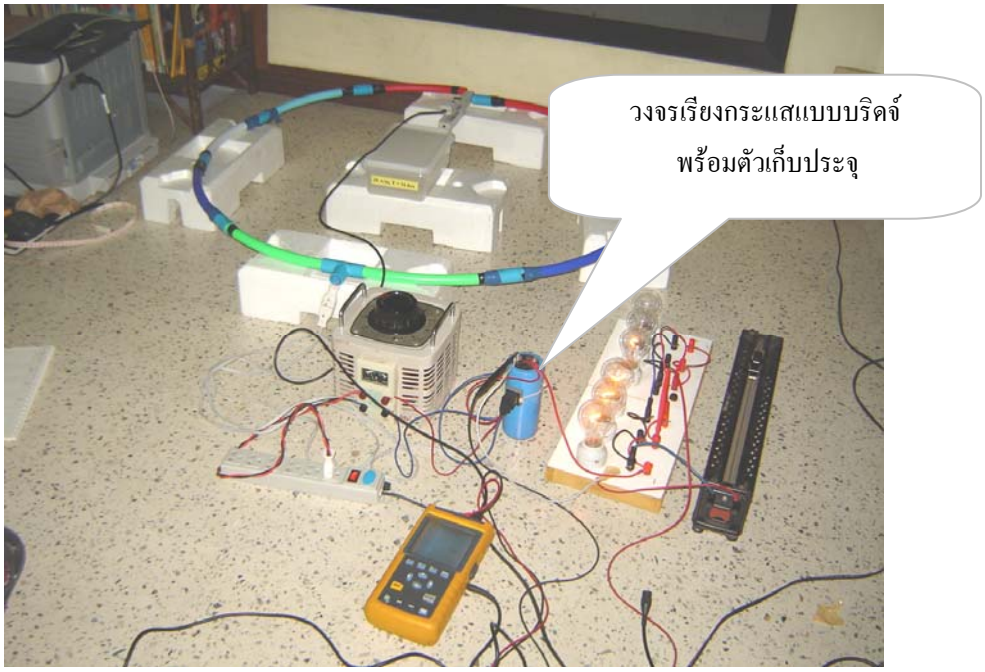
Band width 30 Hz to 300 Hz

ภาคผนวก ค

การทดลอง

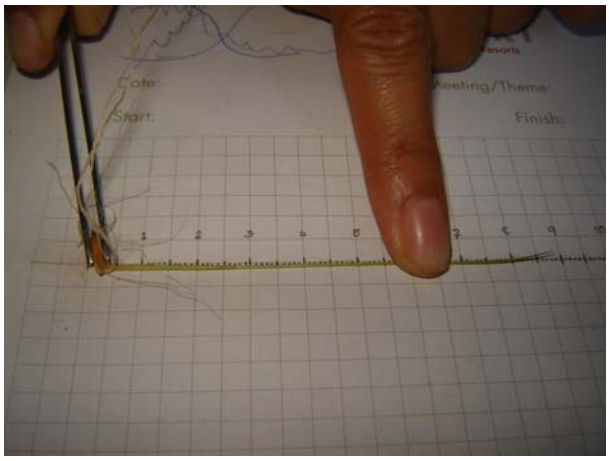


รูปที่ ค.1 การทดลองภายใต้แหล่งจ่ายสนามแม่เหล็กแบบ AC



รูปที่ ค.2 การทดลองภายใต้แหล่งจ่ายสนามแม่เหล็กแบบ DC

รูปที่ ค.3 เมล็ดพันธ์ข้าวที่ผ่านขบวนการแช่น้ำ 12 ชั่วโมงและห่อผ้า48 ชั่วโมงแล้วนำมาคัดเมล็ดที่แข็งแรงสมบูรณ์เพาะลงบนกระดาษเพาะความงอกในกล่องพลาสติก



รูปที่ ค.3 วิธีการการวัดเพื่อเก็บผลการทดลอง

ภาคผนวก ง
บทความที่ได้รับการตีพิมพ์

[1] The Study Effect of Magnetic Field on the Rice Growth P. Sungkhaphun, W. Khan-ngern and S. Nitta. ICEMC 2002, Bangkok, Thailand

[2] The Study of Magnetic Field Intensity and Time Variation Affect on the Rice Growth P. Sungkhaphun, W. Khan-ngern and S. Nitta. EMC 2003, Sendai, Japan

2002 International Conference on Electromagnetic Compatibility

IC EMC 2002

KMITL

Bangkok, Thailand

Proceeding

July 24-27, 2002, The Amari Watergate Hotel, Bangkok, Thailand

IEEE Thailand Section

JICA Japan International Cooperation Agency

ICEMC 2002 / Bangkok

The Study Effect of Magnetic Field on the Rice Growth

P. Sungkhaphun, W. Khan-ngern and S. Nitta*
Faculty of Engineering and Research Center for Communications and Information Technology
King Mongkut's Institute of Technology Ladkrabang, Bangkok, 10520, Thailand
Phone/Fax: +(662) 737-3000ext. 3322
E-mail: tumtip@hotmail.com, kkveerac@kmitl.ac.th
* Graduate School, Production System Engineering
Salesian Polytechnic, 2-35-11 Igusa Sunginami, Tokyo, 167-0021, Japan,
E-mail: nitta@cc.tuat.ac.jp

Abstract

This paper presents a study of the effect of magnetic field on the rice growth [1]. This research focuses on the growth of rice under magnetic field intensity at 40 A/m. The comparison is done under the condition of magnetic field for the period 8 hours, 16 hours, and 24 hours per day and without magnetic field. Research assessment is supported qualitatively by analysis results of the experimental data based on statistic evaluation. The magnetic field effect can be the growth rate of rice, and the physical changing in height of stems and roots [2].

Index Term: magnetic field, magnetic intensity, rice growth

I. Introduction

One of the source of the magnetic field and the electric field is the transmission line. Almost area in Thailand is agriculture land and having the transmission line pass through. It may be affected on plant and the other life. Therefore, the study of bio effect of rice is introduced.

In this paper, the effect of magnetic field intensity at 40 A/m is focused. The duty ratio of operating period is set up at 8 hrs., 16 hrs., and 24 hrs., /day for a week. The Best EMC conducted Immunity Testing System is used as the magnetic field source.

Magnetic field intensity can be calculated by equation (1) [3],

$$\overline{H} = \circ \frac{Id\vec{L}x\vec{a}_R}{4\pi R^2} \qquad (1)$$

$\overline{H}$: Magnetic field intensity (A/m)
I : Current (A)
L : The length of a wire (m)
R : Radius of operation (m)
$\vec{a}_R$: Unit vector of radius

Experimental result is considered by statistic principle

II. Theory

This research is supported qualitatively by analysis results of the experimental data based on statistic evaluation.

There for the statistic evaluation have Mean ($\bar{x}$), Standard deviation(s), Variance (s^2) and the analysis with Z-value. The statistic equation is shown in equations (2-5) [4],

Mean ($\bar{x}$)

$$\overline{x} = \frac{\sum_{i=1}^{n} x_i}{n} \qquad (2)$$

$\sum_{i=1}^{n} x_i$: summation value of the test group
n : number of the test group

Standard deviation (S)

$$S = \frac{\sqrt{\sum_{i=1}^{n} (x_i - \overline{x})^2}}{n} \qquad (3)$$

$x_i - \bar{x}$: the difference between value of group test with mean of test group
n : number of the test group

Variance (S^2)

$$S^2 = \frac{\sum_{i=1}^{n} (x_i - \overline{x})^2}{n} \qquad (4)$$

$x_i - \bar{x}$: the difference between value of group test with mean of test group
n : number of the test group

Z-Value

The experiment analysis results are verified using the statistical Inference for two means by the testing of statistical hypothesis.

The testing of statistical hypothesis about two population means and constructing confidence intervals for difference between two means are focused.

The following assumptions for the methods are used,

1.The two samples are independent.
2.The two samples sizes are large.
That is, $n_1 > 30$ and $n_2 > 30$

The formula for test statistic for two means is

$$Z = \frac{(\overline{x}_1 - \overline{x}_2) - (\mu_1 - \mu_2)}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}} \qquad (5)$$

μ_1, μ_2 : the arithmetic of the test group 1, 2
$\overline{x}_1$: means of the test group 1
$\overline{x}_2$: means of the test group 2
S_1^2 : value of standard deviation of the test group 1
S_2^2 : value of standard deviation of the test group 2
n_1 : number of the test group 1
n_2 : number of the test group 2

III. Experimental Method

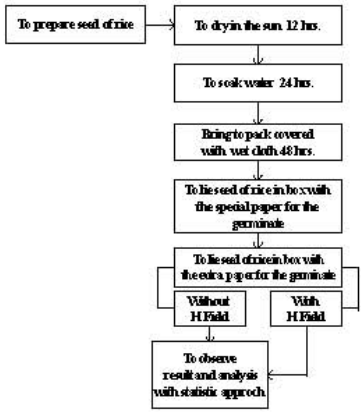


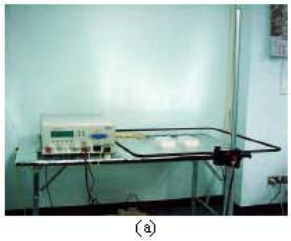
Fig.1 Diagram of the experimental

In this study effect of magnetic field is done under the continuous magnetic field with The Best EMC conducted Immunity Testing System (40 A/m, frequency 50 Hz.) [5] and size of the square loop antennais size 1 m x 1 m.

Suphunburi 1 rice is used in this experiment. Seed of rice is planted in a square plastic box with the special paper for the germinate; the number of seed is laid 10 rows x 10 columns per the group of the test. The experiment is compared for the rice growth under continuous magnetic field and nonmagnetic filed.

The experiment is done for magnetic filed intensity at 40 A/m. The duty ratios of period is set up at 8 hrs., 16 hrs., and 24 hrs. per day respectively for a week. Then, growing rice is observed and recorded the physical changing in height of stems and length of roots at the 7th day.

The condition diagram and configuration of experimental are shown in figure 1 and table 1.



(a)

(b)

Fig. 2 the experimental setup
(a) Experimental growth of rice with magnetic field under the Conducted Immunity Testing System
(b) Experimental growth of rice without magnetic field

Table 1. Show the condition of the experiment

Without H	With H at 40 A/m (hrs/day)		
	8 hrs	16 hrs	24 hrs
✓	✓		
✓		✓	
✓			✓

IV. Results

In this the study, effect of magnetic fields on the rice growth under test of magnetic field intensity 40 A/m, the comparison is done under the condition of magnetic field for the period 8 hrs., 16 hrs., and 24 hrs. per day for a week then record at the 7th day.

The result of experimental analysis bases on statistic evaluation by the testing of statistical hypothesis.

The hypothesis for two means in this paper is

1. The null Hypothesis is H_0: $\mu_1 \leq \mu_2$
2. The alternative hypothesis is H_1: $\mu_1 > \mu_2$

at $(1-\alpha)100\% = 95\ \%$

The result is shown in figures 2-5 and tables 2-5

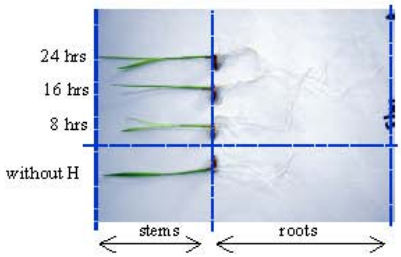


Fig. 2. Comparison of stems and roots sample at various time applying to week shows on the 7th day

Table 2 Means and Standard deviation of stems

	Without H Field	with H Field		
		8 hrs.	16 hrs.	24 hrs.
x_{avg} (cm)	3.19	3.02	3.14	3.25
sd (cm)	2.16	1.87	1.97	2.04

Table 3 Means and Standard deviation of roots

	without H Field	with H Field		
		8 hrs.	16 hrs.	24 hrs.
x_{avg} (cm)	4.90	6.24	6.61	7.10
sd (cm)	3.11	3.13	3.73	4.13

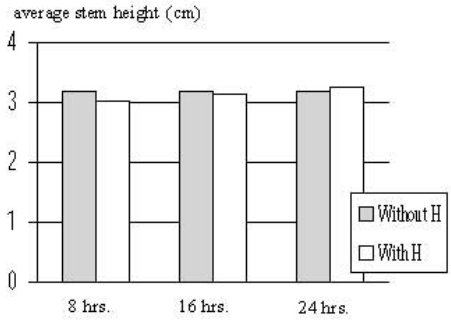


Fig. 3 comparison means of stems at various time applying to week shows on the 7th day

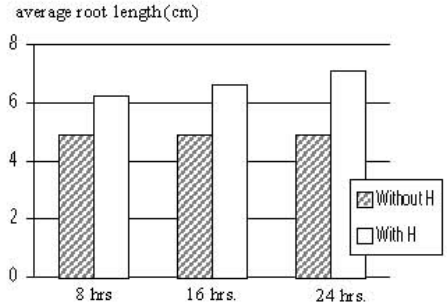


Fig. 4 Comparison means of roots at various time applying to week shows on the 7th day

Table 4 The testing of means of stem

H=40 A/m	Height of Stems	
	X_{avg}	Z-value
without H	3.19	-
8 hrs	3.02	0.596
16 hrs	3.14	0.171
24 hrs	3.25	-0.202

Table 5 The testing of means of root

H=40 A/m	Height of Roots	
	X_{avg}	Z-value
without H	4.90	-
8 hrs	6.24	-3.05
16 hrs	6.61	-3.51
24 hrs	7.10	-4.26

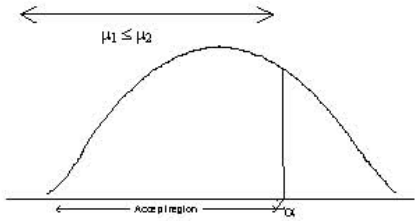


Fig. 5 the region is accepted the hypothesis H_0

V. Analysis

Condition this research is supported qualitatively by analysis results of the experimental analysis using the statistical. The comparison between average of stems by the testing of statistical hypothesis with Z-value at confidence value $(1-\alpha) = 95\ \%$ is done.

Fig. 2 shows the H field effect on the sample of growing rice on the 7^{th} day show that longer applied H field period results a longer levers and roots

Table 2 and 3 show the result of $\bar{x}$ and S.D. of the average height of stems and roots under continuous magnetic field.

Figs. 3 and 4 show the results of the average height of stems and the average length of roots. The longer applied magnetic field intensities period, the higher of the stem is performed. This is the same as the case of the length of the roots.

Tables 4 and 5 show the result of $\bar{x}$ and Z-value of the average height of stems and roots under continuous magnetic field by the testing of statistical hypothesis.

Fig. 5 shows the accepted region for the results all period with magnetic field intensities. At the first hypothesis H_0: $\mu_1 \leq \mu_2$, the longer applied magnetic field intensities period, the higher of the stem is performed. This is the same as the case of the length of the roots.

VI. Conclusion

This paper has proposed the study effect of magnetic field on the rice growth under magnetic field intensity at 40 A/m. The comparison is done under the condition of magnetic field for the period 8 hrs., 16 hrs., and 24 hrs. The applied continuous magnetic field can affect the growth rate of rice.

The results of this research can be guideline for rice treatment to increase the rice development.

VII. Reference

[1] N. Hirota, J. Nakagawa, and K. Kitazawa, "Effect of magnetic field on the germination of plant" Journal of applied physics, vol. 85, No. 8, 15 April 1999, pp. 5717-5719.

[2] M. Muraji, W. Tatebe, and T. Fujii, "Effect of Alternating Magnetic Field on the growth of the primary Root of Corn" IEEE Transactions on Magnetics, vol. 28, No. 4 , pp.1996-2000, 1992.

[3] C. Wisetsakchai, " Electromagnetic Principle", Association of Technology of Promotion Bangkok, 2002. (Published in Thai)

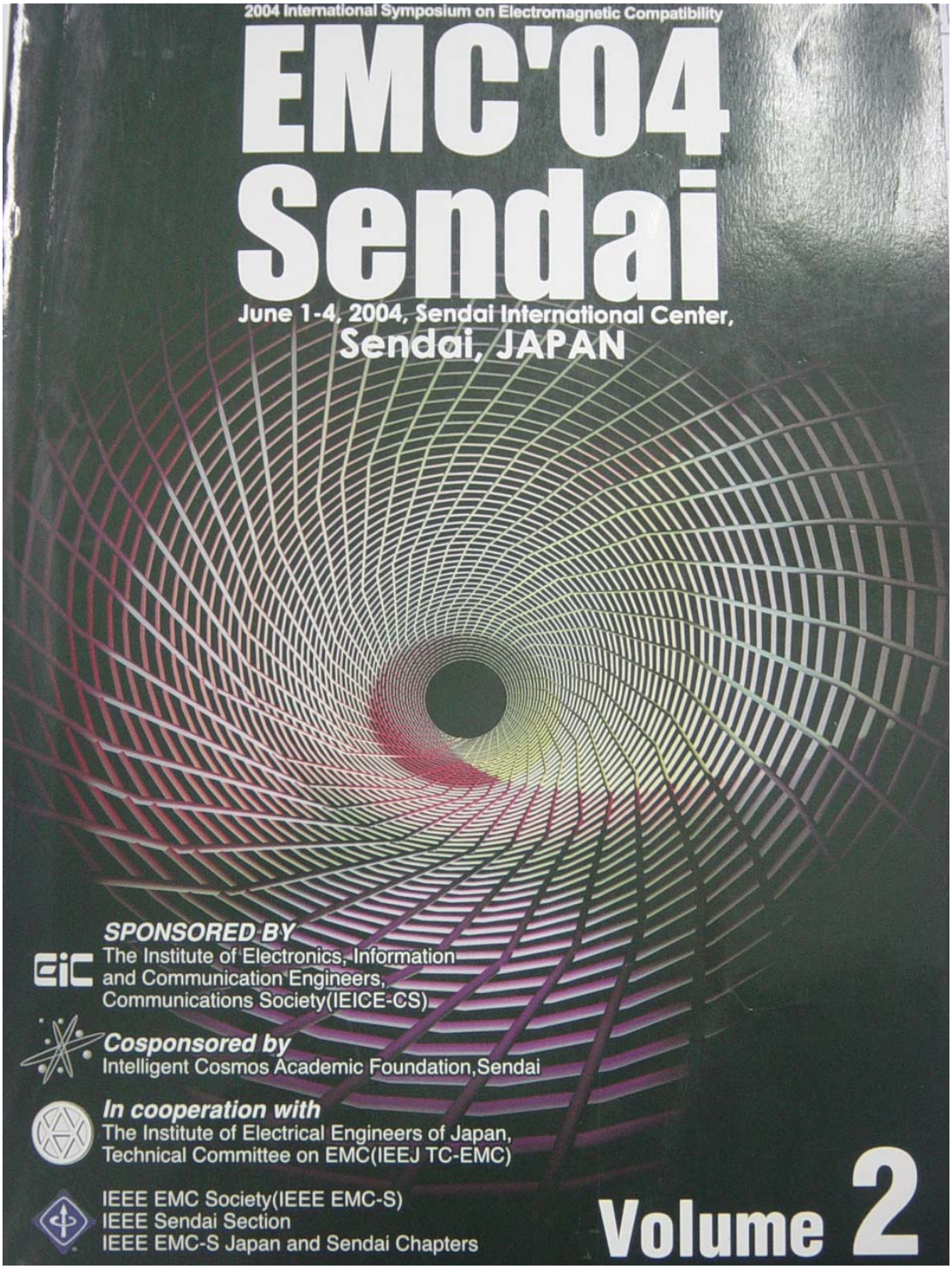
[4] J. Chantalakana, " Statistic Analysis Method and Operating Research", Thaiwattana Panich, Bangkok, 1997. (in Thai)

[5] Best EMC Conducted Immunity Testing System , Schaffner, 2000.

Miss. Pratumtip Sungkhaphun was born in Suphanburi, Thailand. She received the degree of B. Sci. (Mathematic) from Silapakron University in 1993. Her research interests on the area of Bio effect.

Dr. Werachet Khan-ngern was born in 1960, in Ubonratchathani, Thailand. He received the degree of B.Eng. and M.Eng. from King Mongkut's Institute of Technology Ladkrabang (KMITL) in 1982 and 1988, respectively. He received his Ph.D. and DIC from Imperial Collage of Science, Technology and Medicine, the University of London in 1997 in the area of power electronics. He is also a technical committee no. 890: in EMC for the Ministry of Industry and a technical committee no. 23: Electronic Ballast for the Green Label, Ministry of Industry. Dr. Khan-ngern continues his research in the area of EMI & EMC and Power Electronics System.

Prof. Dr. Shuichi Nitta earned BSEE and Ph.D. from Kyoto University and the University of Tokyo in 1960 and 1978, respectively. After working for the electric industry as a system engineer and quality assurance manager, he had been a professor of Tokyo University of Agriculture and Technology from 1985 to 2001. He retired the above university at the end of March 2001. Since April 2001, he is currently a professor of Salesian Polytechnic. His research interests are EMC maintainability and safety. Dr. Nitta is a member of IEEE, IEICE, IEEJ, SICEJ, REAJ and AFSMI.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IEEE EMC Society(IEEE EMC-S)
IEEE Sendai Section
IEEE EMC-S Japan and Sendai Chapters
Volume 2

EMC'04/Sendai

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The Study of Magnetic Field Intensity and Time Variation Affect on the Rice Growth

P. Sungkhaphun, W. Khan-ngern and S. Nitta*
Faculty of Engineering and Research Center for Communications and Information Technology
King Mongkut Institute of Technology Ladkrabang, Bankok, 10520, Thailand
Phone/Fax: +(662) 737-3000 ext. 3322
E-mail: tumtip@hotmail.com, kkveerac@kmitl.ac.th
*Graduate School, Production System Engineering
Salesian Polytechnic, 2-35-11 Igusa Sunginami, Tokyo, 167-0021, Japan,
E-mail: nitta@cc.tuat.ac.jp

Abstract: This paper presents the result of magnetic field intensity and time variation effect to the rice growth. This research focuses on the growth of rice under magnetic field intensity at 40 A/m and 20 A/m. The comparison is done under the condition of magnetic field for the period 8 hours, 16 hours and 24 hours per day and without magnetic field. Research assessment is supported qualitatively by analysis results of the experimental data based on statistic evaluation. The magnetic field effect can be the growth rate of rice, and the physical changing in height of stems and roots. The environment of the experiment such as temperature, light, and relative humidity is controlled in the same condition.

Key words: magnetic field, magnetic intensity, rice growth, mean

1. Introduction

One of the source of the magnetic field and the electric field is the transmission line. Main areas in Thailand are agriculture land and having the transmission line pass through. It may be affected on plant and the other life [1], [2]. Therefore, the study of bio-effect of rice is introduced.

In this paper, the effect of magnetic field intensity at 40 A/m and 20 A/m is focused. The duty ratio of operating period is set up at 8 hours 16 hours and 24 hours/day for a week. The condition of the experiment is shown in table 1.

Table 1: The conditions of the experiment

Group Test	without H	with H (40 A/m)	with H (20 A/m)
group 1 (8hrs)	✓	✓	✓
group 2 (16hrs)	✓	✓	✓
group 3 (24hrs)	✓	✓	✓

2. Theory

2.1 Magnetic Field Intensity (A/m)

The magnetic field intensity can be calculated by equations (1) and (2) [3], [4].

$$d\bar{H} = \frac{Id\bar{L} \times a_R}{4\pi R^2} \quad (1)$$

$d\bar{H}$: Magnetic field intensity (A/m)
$d\bar{L}$: The length of a wire (m)
a_R : Unit vector of radius
R : Radius of operation

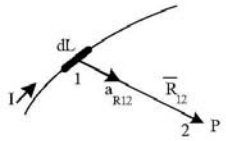


Fig. 1. Construction for finding magnetic field intensity by Bio-Savart law

From Fig. 1, magnetic field intensity can be calculated by equation (2).

$$d\bar{H}_2 = \frac{Id\bar{L} \times a_{R12}}{4\pi R_{12}^2} \quad (2)$$

$d\bar{H}_2$: Magnetic field intensity (A/m)
$d\bar{L}$: The length of a wire (m)
a_{R12} : Unit vector of radius
R_{12} : Radius of operation

Two key factors associated with magnetic field intensity are amplitude of current and the distance.

2.2 Theory of statistic

This research is supported qualitatively by analysis results of the experimental data based on statistic evaluation.

Those the statistic evaluations are Mean ($\bar{X}$) and Standard deviation (S). The statistic equations are shown in equations (3) and (4) [5].

2.2.1 Mean ($\bar{X}$);

$$\bar{X} = \frac{\sum_{i=1}^{n} X_i}{n} \quad (3)$$

$\sum_{i=1}^{n} X_i$: summation value of the test group

n : number of the test group

2.2.2 Standard deviation (S)

$$S = \frac{\sqrt{\sum_{i=1}^{n} (x_i - \bar{x})^2}}{n} \quad (4)$$

$x_i - \bar{x}$: the difference between value of group test with mean of test group

n : number of the test group test with mean of test group

n : number of the test group

Two key data for the assessment are the mean and the standard deviation (S.D.) where the low S.D. is preferred.

3 Experimental

3.1 Experimental Procedure

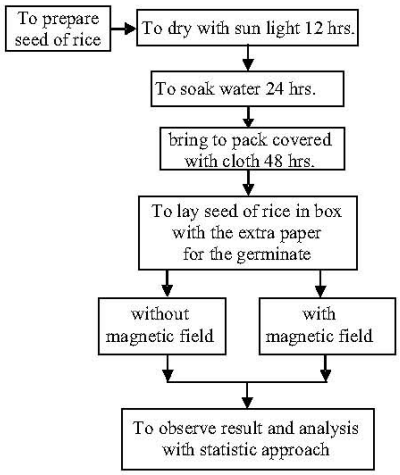


Fig. 2. Diagram of the experimental

Fig. 2. shows the diagram of the experiment. The main stage is to prepare the rice seed for testing. The treatment under magnetic field is set with the variation of magnetic field intensity (20A/m and 40 A/m) and the variation of treatment time per day (8 hours, 16 hours and 24 hours per day). Then, the final stage is to compare and analyze the growth rate of stem and root with in 7 day.

3.2 Experimental Setup

In this study effect of magnetic field is done under the continuous magnetic filed with the magnetic field source (AC source, frequency 50 Hz) and a diameter of loop current is 1 m. The magnetic field source and loop current were designed by

- AC source 220V 50Hz
- Transformer 220/10-40Vac
- Variac 0-300 Vac
- the copper wire No. 20 (A.W.G) and area is 0.5174 mm^2, I_{ac} is 8 A.
- the plastic tube for modify loop current, there is a diameter 1 m.

Suphunburi 1, Thai rice, is used in this experiment. Seed of rice is planted in a square plastic box with the special paper for the germinate, the number of seed is laid 10 rows x 10 columns per the group of the test. The experiment is compared with the rice growth under continuous magnetic field and nonmagnetic filed.

The experiment is done for magnetic filed intensity at 40 A/m and 20 A/m. The duty ratios of period is set up at 8 hours, 16 hours and 24 hours per day respectively for a week. Then, growing rice is observed and recorded the physical changing in height of stems and length of roots at the 7^{th} day.

The experimental setup are shown in Fig. 3-5

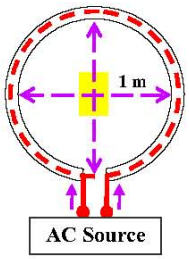


Fig. 3. Layout of loop current

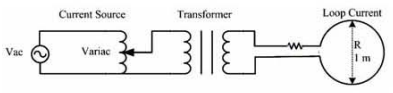


Fig. 4. The circuit equivalent of continuous magnetic field

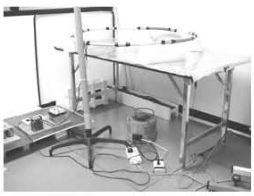


Fig. 5. The experimental setup

4. Experimental results

In this the study, effect of magnetic fields on the rice growth under test of magnetic field intensity 40 A/m and 20 A/m the comparison is done under the condition of magnetic field for the period 8 hours, 16 hours and 24 hours per day for a week then record at the 7th day. The result of experimental analysis bases on statistic evaluation by the mean value and standard deviation. The result is shown in Figs. 6-7 and tables 2-5.

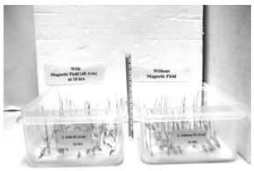


Fig. 6. Comparison of stems sample at various time applying to week shows on the 7th day

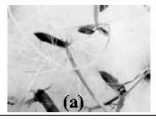
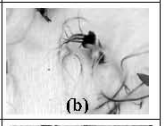
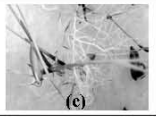
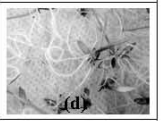
Case	With H (A/m)	Without H (A/m)
40 A/m	 (a)	 (b)
20 A/m	 (c)	 (d)

Fig. 7. Comparison of roots sample at various time applying to week shows on the 7th day
(a) root under magnetic field intensity 40 A/m
(b) root without magnetic field
(c) root under magnetic field intensity 20 A/m
(d) root without magnetic field

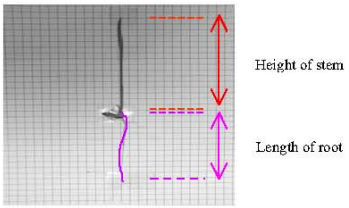


Fig. 8. The region of stem and root were record

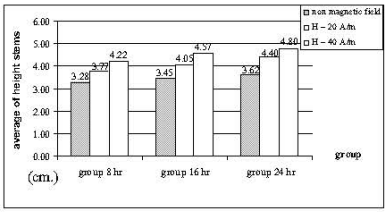


Fig. 9. Comparison of average height stems at various time applying to week shows on the 7th day

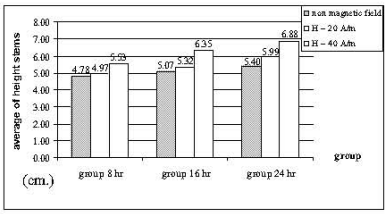


Fig. 10. Comparison of average length roots at various time applying to week shows on the 7th day

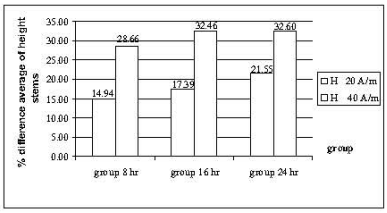


Fig. 11. Comparison of percentage difference average height stems at various time applying to week shows on the 7th day

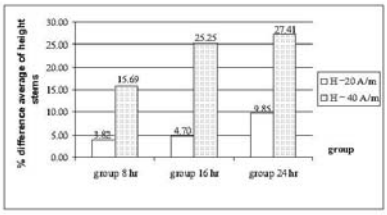


Fig. 12. Comparison of percentage difference average of length roots at various time applying to week shows on the 7th day

Percentage difference can be calculated by equation (5)

$$\%\ difference\ of\ average = \left(\frac{data_{with\ H} - data_{without\ H}}{data_{without\ H}} \right) \times 100 \qquad (5)$$

Table 2 Standard deviation of stems and roots

Group	Standard deviation of stems			Standard deviation of roots		
	Without H	With H		Without H	With H	
		20 A/m	40 A/m		20 A/m	40 A/m
8 hrs.	130	1.74	1.56	1.59	1.65	1.44
16 hrs.	1.37	1.32	1.17	1.40	1.43	1.88
24 hrs.	1.68	2.83	1.24	2.19	2.56	2.84

5. Analysis

The temperature, relative humidity are controlled for all the experiment. The comparison between average of stems and average of roots and with the satisficy standard deviation.

Figs. 6 and 7 show the magnetic field effect on the sample of growing rice on the 7th day show that longer applied magnetic field period results a longer stems and roots.

Figs. 9 and 10 show the results of the average height of stems and the average length of roots. The longer applied magnetic field intensities period, the higher of the stem is performed. This is the same as the case of the length of the roots. For example; height of stem is increased from 3.26 cm. to 3.77 and 4.22 cm. for H=20 A/m and 40 A/m respectively at 8 hours per day treatment. Longer period also provide positive in increasing the height of stems as shown in fig. 9.

In general for these operating conditions longer period, high magnetic field intensity result in longer roots and higher stems.

Figs. 11 and 12 show percentage difference average of height stems and length roots. The higher magnetic field intensities and the longer applied magnetic field intensities period, the higher of the stem is performed. This is the same as the case of the length of the roots.

This is a significant advantage about (28.66-14.94 = 13.72 %), (32.46-17.39 = 15.07 %) and (32.60-21.55 = 11.05 %) between treatment without H and 40 A/m and 20 A/m for 3 difference period as compared height of stems in fig. 11.

This is a significant advantage about 11.87%, 20.55% and 17.56% between treatment without H and 40 A/m and 20 A/m for 3 difference period as compared length of roots in fig. 12.

Table. 2 show standard deviation of stems and roots. The standard deviation of all experiment are satisfied.

6. Conclusion

This paper has proposed the study effect of magnetic field on the rice growth under magnetic field intensity at 40 A/m and 20 A/m. The comparison is done under the condition of magnetic field for the period 8 hours, 16 hours and 24 hours. The applied continuous magnetic field can affect the growth rate of rice.

The results of this research can be guide line for rice treatment to increase the rice development.

References

[1] N. Hirota, J. Nakagawa, and K. Kitazawa, "Effect of magnetic field on the germination of plant" Journal of applied physics, vol. 85, No. 8, 15 April 1999, pp. 5717-5719.

[2] M. Muraji, W. Tatebe, and T. Fujii, "Effect of Alternating Magnetic Field on the growth of the primary Root of Corn" IEEE Transactions on Magnetics, vol. 28, No. 4 , pp.1996-2000, 1992.

[3] C. Wisetsakchai, " Electromagnetic Principle", Association of Technology of Promotion Bangkok Thailand, 2002.

[4] John D. Kraus and Daniel A. Fleisch , " Electromagnetics with Applications", McGraw-Hill Companies, Inc.,Singapore, 1999.

[5] J. Chantalakana, " Statistic Analysis Method and Operating Research", Thaiwattana Panich, Bangkok Thailand, 1997.

ประวัติผู้เขียน

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งานวิจัยที่สนใจ

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