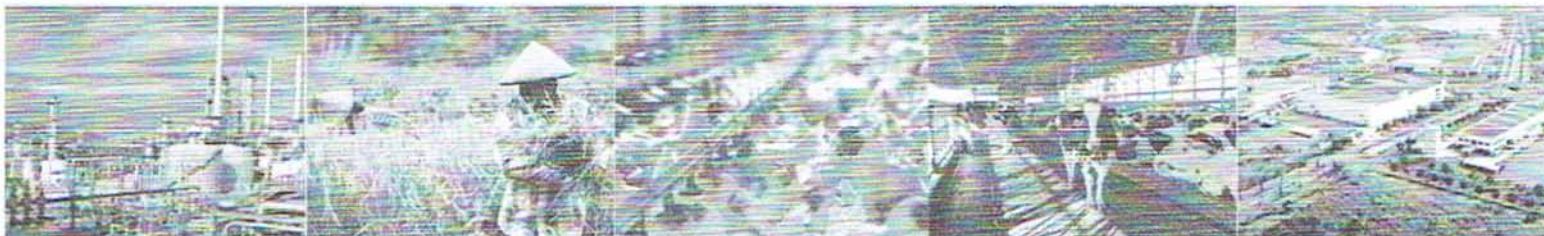


2015 3rd International Conference on Adaptive and Intelligent Agroindustry (ICAIA)

ICAIA 2015



August 3rd - 4th, 2015

IPB International Convention Center

Bogor, Indonesia

ISBN : 978-1-4673-7405-7

IEEE Catalog Number : CFP15C67-ART



TABLE OF CONTENTS

Innovative Agroindustrial and Business System Engineering	
The Feasibility Study of Establishment of Biodiesel And Paving Block Industry From Spent Bleaching Earth	I-1
Febriani Purba, Ani Suryani and Sukardi	
Green Supply Chain Management Innovation Diffusion in Crumb Rubber Factories: Designing Strategies towards Implementation	I-7
Tri Susanto, Marimin Marimin and Suprihatin	
Mobile Business Analytics System for Service Level Analysis of Customer Relationship Decision	I-13
Taufik Djatna and Yudhistira Chandra Bayu	
Exploring an Innovative Approach to Address Non-Tariff Barriers Experienced by Small to Medium Enterprises in Downstream Coffee Production in Indonesia	I-19
Andar Hermawan, Yandra Arkeman, Titi Candra Sunarti	
An Analysis of Innovation Network Performance on the Palm Oil Industry in North Sumatera	I-26
Danang Krisna Yudha, Aji Hermawan and Machfud	
Exploring the Internationalization Process Model of an Indonesian Product – Case study : Fruit Chips SME's	I-33
Dickie Sulisty Apriliyanto, Hartrisari Hardjomidjojo, Titi C Sunarti	
Innovation Management in Indonesian Palm Oil Industry	I-39
Karim Abdullah, Aji Hermawan and Yandra Arkeman	
Technology Innovation Adoption to Improve the Performance of Dairy Small-Medium Enterprises (SME): Case study in Pangalengan-Bandung Regency, West Java, Indonesia	I-45
Nuni Novitasari, Titi Candra Sunarti and Nastiti Siwi Indrasti	
Managing Innovation through Knowledge Sharing in An Indonesia Coconut SME	I-54
Muchammad Kodiyat P, Machfud, Nastiti S Indrasti	
Increasing Added Value of Banana by Producing Synbiotic Banana "Sale" Using Innovation & Technology Strategy Approach	I-60
Eka Ruriani	
An AHP Application for Selecting A Business Innovation Strategy of Chocolate SMEs in East Java	I-65
Yani Kartika Pertiwi, M. Syamsul Maarif and Machfud	
Understanding local food consumers and their motivations: A case study in Padang city	I-71
Poppy Arsil	
Spatial Model Design for Competitive Improvement of Small Medium Scales Enterprises (Case Study: Bogor Area)	I-77
Hartrisari Hardjomidjojo, Harry Imantho and Armaiki Yusmuri	
System Analysis and Design for Selecting Chitin and Chitosan Industry Location by Using Comparative Performance Index Method	I-82
Dena Sismaraini, Nastiti S. Indrasti and Taufik Djatna	
Arduino-Based Temperature Monitoring Device for Cold Chain Transportation	I-90

Delmar Zakaria Firdaus and Endang Warsiki	
Development of Downstream Cocoa Industry: Exploring the Role of Government and Small and Medium Industry in Partnership	I-95
Farda Eka Kusumawardana, Yandra Arkeman, Titi C Sunarti	
The Role of Communication in the Technology Transfer Process	I-101
Anindita Dibyono, Sukardi, Machfud	
The Center for Pulp and Paper Appraising its Productivity in Generating Industry-Applicable Research: A Good Practice Illustration	I-108
Ahmad Rudh Firdausi, Anas M Fauzi, Machfud	
Frontier Approaches in Process and Bioprocess Engineering	
Identification of Flavor Compounds In Cemcem (<i>Spondiazpinata</i> (L.F) Kurz) Leaf Extra	II-1
Luh Putu Wrasati, Ni Made Wartini and Ni Putu Eny Sulistyadewi	
Synthesis and characterization of nanosilica from boiler ash with co-precipitation method	II-5
Wahyu K. Setiawan, Nastiti S. Indrasti, and Suprihatin	
The Comparison Of Media on the Microalgae <i>Nannochloropsis</i> sp. Culture	II-10
Anak Agung Made Dewi Anggreni, I Wayan Arnata and I B Wayan Gunam	
Identification of Media and Indicator Liquid as A Recorder Smart Label	II-14
Endang Warsiki and Riris Octaviasari	
The Effects of Palm Oil MES Surfactant and Inorganic Salt Concentration on Interfacial Tension Values	II-19
Rista Fitria, Ani Suryani, Mira Rivai and Ari Imam	
Effect of Nano Zinc Oxide On Characteristic Bionanocomposite	II-25
Siti Agustina, Nastiti Siswi Indrasti, Suprihatin and Nurul Taufiq Rohman	
The Effects of Molar Ratio Between 80% Glycerol And Palm Oil Acid on the Synthesis Process of Ester Glycerol	II-31
Mira Rivai, Erliza Hambali, Giovanni Nurpratiwi Putri, Ani Suryani, Pudji Permadji, Bonar T.H Marbun and Ari Imam Sutanto	
Selecting Part of Natural Fiber EFB which has Best Mechanical Strength through Tensile Test Analysis for Composite Reinforced Material	II-37
Farkhan, Yohanes Aris Purwanto, Erliza Hambali and Wawan Hermawan	
Identification of phenol red as <i>Staphylococcus aureus</i> indicator label	II-44
Melati Pratama, Endang Warsiki and Liesbetini Hartoto	
Enhancing Ethanol Tolerant of <i>Escherichia coli</i> Recombinant by Glutamate Addition under Aerobic Conditions	II-48
Indra Kurniawan Saputra, Prayoga Suryadarma and Ari Permana Putra	
In Vitro Potentifal of Antibacterial Marine Microalgae Extract <i>Chaetocerosgracilis</i> Toward <i>Staphylococcus epidermidis</i> Bacteria	II-53
Ardhi Novrialdi Ginting, Liesbetini Haditjaroko and Iriani Setyaningsih	
The Potential Applications of Modified Nagara Bean Flour through Fermentation for Innovation of High Protein Analog Rice	II-59

Susi, Lya Agustina and Chondro Wibowo
Studies on the Characteristics of Pasayu (Pasta of Waste-Cassava) II-64
Fortification as a New Product Development

Marleen Sunyoto, Roni Kastaman, Tati Nurmala and Dedi Muhtadi
Optical And Particle Size Properties Of *Sargassum* Sp Chlorophyll As Dye- II-72
Sensitized Solar Cell (DSSC)

Makkulawu Andi Ridwan and Erliza Noor
Alkaline Pre-Treatment of *Gelidium latifolium* and *Caulerpa racemosa* for II-76
Bioethanol Production

Dwi Setyaningsih, Neli Muna, Elisabeth Yan Vivi Aryanti and
Anastasya Hidayat

New Trends in Industrial Environmental Engineering & Management

Use of Biofilter to Improve Quality of Polluted River Water for Drinking III-1
Water Supply

Suprihatin, Muhammad Romli and Mohamad Yani
An Empirical Investigation of the Barriers to Green Practices in Yogyakarta III-8
Leather Tanning SMEs

Dwi Ningsih, Ono Suparno, Suprihatin and Noel Lindsay
Preliminary Study For CO₂ Monitoring System III-15

Farhan Syakir, Rindra Wiska, Irvi Firqotul Aini, Wisnu Jatmiko and
Ari Wibisono
Designing a Collaboration Form to Overcome Innovation Resistance in III-22
Waste Management Practices in Lampung Tapioca Industry

Nur Aini Adinda, Suprihatin, Nastiti Siswi Indrasti
Pollution Reducing Opportunities for a Natural Rubber Processing Industry: III-29
A Case Study

Syarifa Arum Kusumastuti, Suprihatin and Nastiti Siswi Indrasti
Effects of Palm-Dea Non-Ionic Surfactant as an Additive in Buprofezin III-35
Insecticide on the Efficacy of it in Controlling Brown Planthopper Rice Pest

Fifin Nisya, Rahmini, Mira Rivai, Nobel Cristian Siregar, Ari Imam
Sutanto and Ainun Nurkania

Intelligent Information & Communication Technology for Adaptive Agroindustry of the Future

Design of Web-Based Information System With Green House Gas Analysis IV-1
for Palm Oil Biodiesel Agroindustry

Yandra Arkeman, Hafizd Adityo Utomo and Dhani S. Wibawa
Sequential Patterns for Hotspots Occurrence Based Weather Data using IV-8
Clospan algorithm

Tria Agustina and Imas S. Sitanggang
How to Deal with Diversity in Cultivation Practices using Scenario IV-13
Generation Techniques: Lessons from the Asian rice LCI Initiative

Kiyotada Hayashi, Yandra Arkeman, Elmer Bautista, Marlia Mohd
Hanafiah, Jong Sik Lee, Masanori Saito, Dhani Satria, Koichi
Shobatake, Suprihatin, Tien Tran Minh and Van Vu
Development of Life Cycle Inventories for Palm Oil in North Sumatra: IV-16
Modelling Site-Specific Activities and Conditions

Vita D Lelyana, Erwinskyah and Kiyotada Hayashi	
Sequential Pattern Mining on Hotspot Data using PrefixSpan Algorithm	IV-20
Nida Zakiya Nurulhaq and Imas S. Sitanggang	
An Intelligent Optimization Model Analysis and Design of Bio-filtration in Raw Water Quality Improvement	IV-24
Ramiza Lauda and Taufik Djatna	
Development Of People Food Consumption Patterns Information System Based On Webmobile Application.	IV-30
Fadly Maulana Shiddiq, Roni Kastaman and Irfan Ardiansah	
Association Rules Mining on Forest Fires Data using FP-Growth and ECLAT Algorithm	IV-37
Nuke Arincy and Imas S. Sitanggang	
Development Of Expert System For Selecting Tomato (<i>Solanum lycopersicon L.</i>) Varieties	IV-41
Erlin Cahya Rizki Amanda, Kudang Boro Seminar, Muhamad Syukur and Noguchi Ryozo	
Developing Life Cycle Inventories for Rice Production Systems in Philippines: How to Establish Site-specific Data within the General Framework	IV-47
Elmer Bautista, Kiyotada Hayashi and Masanori Saito	
Construction of Site-specific Life Cycle Inventories for Rice Production Systems in Vietnam	IV-50
Tran Minh Tien, Bui Hai An, Vu ThiKhanh Van and Kiyotada Hayashi	
Study on Life Cycle Benefit Assessment as a tool for promoting the solution of Environmental Problems	IV-53
Tetsuo Nishi	
Real Time Monitoring Glycerol Esterification Process with Mid IR Sensors using Support Vector Machine Classification	IV-57
Iwan Aang Soenandi, Taufik Djatna, Irzaman Husein and Ani Suryani	
Extraction of Multi-Dimensional Research Knowledge Model from Scientific Articles for Technology Monitoring	IV-63
Arif R. Hakim and Taufik Djatna	
Performance of Artificial Lighting Using Genetics Algorithms	IV-69
Limbran Sampebatu	
The Application of Fuzzy-Neuro Approach for ERP System Selection: Case Study on an Agro-industrial Enterprise	IV-74
Joko Ratono, Kudang Boro Seminar, Yandra Arkeman and Arif Imam Suroso	

Effects of Palm-Dea Non-Ionic Surfactant as an Additive in Buprofezin Insecticide on the Efficacy of it in Controlling Brown Planthopper Rice Pest

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Abstract—Brown planthopper or BPH (*Nilaparvata lugens*) is still regarded as a major pest in rice cultivation because the damage it causes is quite extensive and almost occurs in every cropping season. The use of pesticide is one of the measures that can be taken to control this pest. In the insecticide formula, surfactant plays a role in increasing the penetration of active compound into the host plant and the target pest and spread it all over the plant tissues. One type of surfactant potential to be used for BPH insecticide applications is diethanolamide (DEA) surfactant. This study was aimed at assessing the effects of the use of a non-ionic DEA surfactant made of palm oil methyl ester as an additive in buprofezin insecticide on the efficacy of the insecticide to control BPH pest. Results showed that the addition of non-ionic DEA surfactant gave significant effects on the efficacy of buprofezin in controlling BPH pest. A probit analysis as part of toxicity test was then done to determine the optimal concentration of non-ionic DEA surfactant to improve the efficacy of Buprofezin insecticide. It was shown that the addition of DEA surfactant of 6% was the most optimal in improving the efficacy of Buprofezin insecticide to control BPH pest.

I. INTRODUCTION

BROWN planthopper (*Nilaparvatalugens*) is still regarded as a major pest and widely distributed in all rice growing areas in Indonesia. BPH is of particular importance, because it is responsible for the transmission of rice viruses which are called grassy stunt, ragged stunt, and wilted stunt viruses [1]. The pest

feeds directly on the growing plant, reducing its yield potential. If the pest density is high, the plant dies and a condition known as hopperburn result [2].

Rice breeders have made many attempts to develop resistant varieties. However, resistant breaker strains of planthoppers have easily appeared in Indonesia. As the main rice pest, planthopper is an insect with high genetic plasticity making it able to adapt to various environment in short time. This is proven by the appearance of new biotype/population that can break the resistance of rice plants to BPH [3]. This has made farmers keep relying on insecticides to control BPH. In Indonesia,

MIPC(2-(1-methyl-ethyl)phenylmethylcarbamate) and cypermethrin were tested for brown planthopper. The insect population increased more than the control when cypermethrin was sprayed [4]. Therefore, it was stipulated in the Republic of Indonesia Presidential Instruction No. 3 Year 1986 on the Development of Brown Planthopper Control in Rice Plants, that buprofezin was the effective active ingredient to be used. Buprofezin is an insecticide that interfere chitin biosynthesis process. Chitin is an important part of an insect body that is difficult to destroy. Chitin also plays an important role in the development of insects. According to Dean *et al.* (1998), the impairment in chitin of an insect might cause a death to the insect during the molting process. Insecticides containing active ingredient of buprofezin has an effective ability to control plant pests and diseases but a narrow spectrum.

To improve the efficacy of buprofezin insecticide, producers often add additive materials including binder, wetting agent, homogenizer, and others. These additives are commonly made from

surfactants of fossil fuel origin and imported surfactants such as ethoxylate. [6] found that non-ionic DEA was another type of surfactant that could function as a binder, wetting agent, and homogenizer in an insecticide. DEA surfactant can be synthesized from palm oil through the amidation process with diethanolamide using a palm methyl ester or fatty acid path. The abundant availability of palm oil in Indonesia is a potential for the development of DEA surfactant that can be used as a binder, wetting agent, and homogenizer of insecticides including buprofezin.

This study was aimed at assessing the effects of assessing the effects of the use of a non-ionic DEA surfactant as an additive in buprofezin insecticide on the efficacy of the insecticide to control BPH pest.

II. METHODS

The study was conducted at the laboratory of Surfactant and Bioenergy Research Center (SBRC) IPB and Pest Laboratory of Indonesia Center for Rice Research (ICRR) in February to November 2014. DEA surfactant was synthesized from palm methyl ester olein at SBRC IPB laboratory by using a method as described in [7]. The formulation was 10% buprofezin insecticide which was mixed with Solvesso 150 solvent, synthesized DEA surfactant, and water. A single factor, namely DEA concentration in insecticide formulations, was used. DEA surfactant concentrations included 4% (formula 1), 6% (formula 2), 8% (formula 3), and 10% (formula 4). Insecticide formulation process was done by using a WiseTis HG-15D homogenizer. Stirring was done for 1.5 to 2 hours at a speed of 450-550 rpm. Insecticide formulas were then analyzed for their density and surface tension. Density measurement was done by using an Anton Paar TAAR DMA 4500M density meter while surface tension was measured by using a Spinning Drop Tensiometer TFX 500C.

Performance test and insecticide formula selection were done at Indonesia Center for Rice Research, Sukamandi. Insecticide activity was tested by using a feeding method (leaf dip/leaf residue method) [8]. Each insecticide formula with DEA inclusion was tested at water concentration of 0.25, 0.5, 0.75, 0.1, 1.25, 2.5, 5, and 10 cm³. The performance of insecticide formulas was compared with those of two controls, namely water

only and commercial buprofezin containing similar amount of active materials, namely 10% buprofezin.

The leaves of Ciherang variety rice were used. Ciherang rice seeds were grown in a seedbed for 20 days. The seedbed was placed in a green house and was covered with gauze fabric to avoid pest, especially brown planthopper, attack. After 20 days, seedlings were, one by one, taken out from the seedbed and cleaned from soil attaching to them. Every single cleaned seedling was then dipped into insecticide solutions of different concentration for 30 second before it was air dried. Thereafter, roots of every two dried seedlings were covered with tissue paper in such a way so that no crevice was found. Ten BPHs obtained from ICRR Sukamandi paddy field were placed in a reaction tube containing rice seedlings. The tube was then covered tightly with gauze fabric. The mortality rate of BPHs was observed in 24, 48, and 72 hours after application.

A completely randomized design with five replicates was used. Data were subjected to an analysis of variance (ANOVA) and a Duncan test. The ANOVA was conducted by using SAS statistical program package (SAS Institute 2002-2003). Probit analysis to determine LC 50 values [9] was done to select the best insecticide formula.

III. RESULT AND DISCUSSION

A. Properties of Formulated Insecticides

Insecticide formulas were tested for their density and surface tension properties. The results are shown in Table 1. The inclusion of DEA by 4, 6, 8, and 10% resulted in insecticides with similar density levels of 0.97 kg/m³. Surface tension levels were found to range from 26.79 to 28.57 dynes/cm. Insecticide formula with 4% DEA had the highest surface tension (28.57 dynes/cm). Low surface tension level found in this study indicated that DEA surfactant added to insecticide formulas could function as the spreading, wetting, and thickening agents of buprofezin insecticide. Insecticides containing this type of surfactant, when they were applied in rice plants, were expected to spread evenly and attached firmly to the leaves or stems of the rice plants so that they were not easily lost or washed out by rain.

TABLE I
DENSITY AND SURFACE TENSIONS OF INSECTICIDE FORMULAS TREATED WITH DEA SURFACTANT

Parameter	Unit	Formula 1 (Buprofezin + DEA 4%)	Formula 2 (Buprofezin + DEA 6%)	Formula 3 (Buprofezin + DEA 8%)	Formula 4 (Buprofezin + DEA 10%)
Density	kg/m ³	0.97	0.97	0.97	0.97
Surface tension	dynes/cm	28.57	26.92	27.21	26.79

B. Selection and test of insecticide performance to BPH

This test was done for selection and assessing the performance of formulated insecticide. The efficacy of insecticide is shown by the mortality rate of BPHs following the application of insecticide. Results showed that there were significant effects of insecticide formulas on the mortality rate of BPHs as shown in Table 2.

TABLE 2.
MORTALITY RATE OF BPHS TREATED WITH INSECTICIDES

Formula	Dosage	Mortality (%)		
		24 hours	48 hours	72 hours
formula 1	0.25 cc	8	bed	28 b-g
	0.5 cc	6	bed	48 abc
	0.75 cc	12	bed	32 b-f
	1 cc	10	bed	28 b-g
	1.25 cc	12	bed	54 ab
	2.5 cc	6	bed	42 a-c
	5 cc	16	bed	44 a-d
	10 cc	4	bed	48 abc
Formula 2	0.25 cc	4	cd	22 d-g
	0.5 cc	16	bed	36 b-f
	0.75 cc	16	bed	32 b-f
	1 cc	18	bed	40 b-e
	1.25 cc	20	bc	40 a-e
	2.5 cc	22	b	42 a-e
	5 cc	18	bed	42 a-e
	10 cc	54	a	66 a
Formula 3	0.25 cc	2	cd	44 a-d
	0.5 cc	8	bed	26 c-g
	0.75 cc	6	bed	26 c-g
	1 cc	4	bed	42 a-c
	1.25 cc	8	bed	20 d-g
	2.5 cc	16	bed	32 b-f
	5 cc	44	a	66 a
	10 cc	18	bed	40 a-e
Formula 4	0.25 cc	18	bed	48 abc
	0.5 cc	12	bed	44 a-d
	0.75 cc	8	bed	38 b-e
	1 cc	14	bed	42 a-e
	1.25 cc	22	b	46 a-d
	2.5 cc	12	bed	42 a-c
	5 cc	14	bed	38 b-e
	10 cc	14	bed	44 a-d
Commercial product	0.25 cc	0	d	16 Efg
	0.5 cc	4	bed	16 Efg
	0.75 cc	0	d	16 Fg
	1 cc	8	bed	42 a-e
	1.25 cc	4	bed	24 c-g
	2.5 cc	12	bed	40 a-e
	5 cc	2	cd	42 a-e
	10 cc	2	cd	38 b-e
Control	0	2	cd	12 Fg
	0	4	bed	6 G
	0	0	d	4 G
	0	0	d	6 G
	0	2	cd	4 G

Note: Different subscripts in the same column indicate significant differences ($p < 0.05$)

It was shown in Table 2 that in general, insecticide formulas made in this study had better

efficacy than commercial insecticide and control. Mortality rate of BPHs invested to the seedlings previously dipped into insecticide solution tended to increase as the concentration of insecticide formula increased. According to Dadang and Prijono (2008), different concentrations of insecticide give different effects on the eating activity inhibition of pests. With all pesticide formulas, eating activity inhibition tended to happen fast as the mortality rate was found to be higher than those in control and commercial insecticide since the first to the third day, not on the second or third day only, was an indicator of high efficacy of insecticide. This was true as the pests that were still survive on the first and second day would be able to attack the seedlings prior to their death. Meanwhile, if the death of BPHs occurred on the first day, although not 100%, it would reduce the level of pest attack or plant loss.

Insecticide Formula	LC50 (cm ³ /liter)
Formula 1	0.1404
Formula 2	0.0535
Formula 3	0.1241
Formula 4	0.0551
Commercial insecticide	0.4387

A toxicity test was conducted to select the insecticide formula that could be further developed. Based on the above mortality rate of BPH, the toxicity value of insecticide formula could be measured by using an LC 50 method which was commonly known as lethal concentration (lethal dose 50%). Lethal dose 50% of a drug or chemical compound is the amount of it which causes death of 50% of the animals tested. Based on the results of probit analysis, insecticide formula 2 (Buprofezin with 6% surfactant inclusion) was the one that killed 50% of BPHs at the lowest concentration of 0.0535 cm³/liter. It was also found that sample insecticides were more efficient in killing BPHs than did commercial insecticide. The latter killed 50% of BPHs at a concentration which was four times higher than those of sample insecticides.

DEA surfactant in insecticide formulation was found to affect the efficacy of buprofezin insecticide in killing BPHs. This was indicated by the comparison of observation results obtained from sample insecticides and commercial insecticide. The finding that DEA surfactant homogenized the insecticide solution and lowered the surface tension of insecticide making the active materials in the insecticide spread evenly on leave and stem surface of rice plants was the suggested mechanism by which DEA surfactant improved the efficacy of insecticide. This was in accordance with

what was found from visual observation that drops of solution containing surfactant could penetrate and spread over fine hairs on leaf surface through capillarity. In contrast, drops of solution containing no surfactant were found unable to spread out and attached on the leaf surface only [10].

IV.CONCLUSION

The inclusion of non-ionic DEA surfactant of palm oil methyl ester significantly affected the efficacy of BPH insecticide containing buprofezin active material. The optimal efficacy improvement of BPH insecticide containing Buprofezin active material was obtained by the inclusion of 6% non-ionic DEA surfactant.

ACKNOWLEDGEMENT

Author wishes to thank Pest Laboratory of Indonesia Center for Rice Research (ICRR) Ministry of Agriculture for their kind cooperation and valuable guidance.

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