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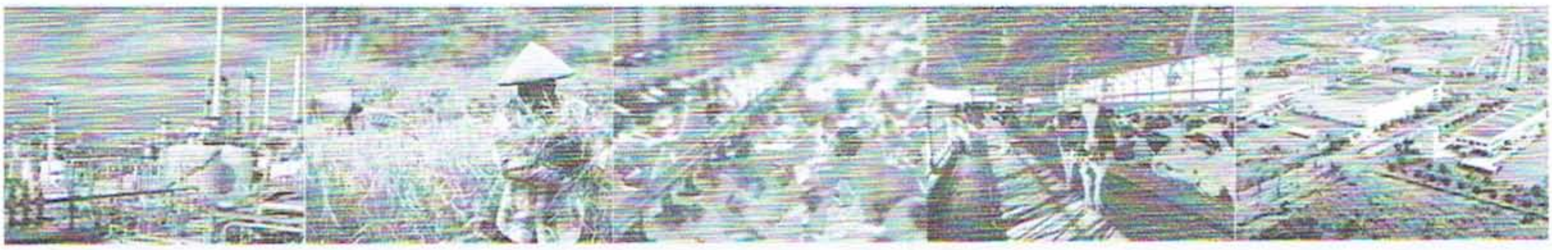

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Effects of Palm-Dea Non-Ionic Surfactant as an Additive in Buprofezin Insecticide on the Efficacy of it in Controlling Brown Planthopper Rice Pest

FifinNashirotun Nisya[1], Erliza Hambali[1], Rahmini[2], Mira Rivai[1], Nobel Cristian Siregar[3], Ari Imam Sutanto[1], Ainun Nurkania[1]

[1] Surfactant and Bioenergy Research Center, Bogor Agricultural University

[2] Indonesian Center for Rice Research

[3]Center of Agro industries, Indonesian Ministry of Industry

E-mail: fifin.nisya@gmail.com

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

BROWNplanthopper(*Nilaparvatalugens*) is stillregardedasa majorpestand 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 appearedin 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-methylethyl)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 diseasesbut a narrow spectrum.

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

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surfactants of fossil fuel origin and imported surfactants such as etoxylate. [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 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 cm^3. 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/m^3. 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 1

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

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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	bcd	28	b-g	78	c-g
	0.5 cc	6	bcd	48	abc	88	a-f
	0.75 cc	12	bcd	32	b-f	92	a-d
	1 cc	10	bcd	28	b-g	100	A
	1.25 cc	12	bcd	54	ab	92	a-d
	2.5 cc	6	bcd	42	a-c	94	a-d
	5 cc	16	bcd	44	a-d	90	a-e
	10 cc	4	bcd	48	abc	86	a-g
Formula 2	0.25 cc	4	cd	22	d-g	74	e-h
	0.5 cc	16	bcd	36	b-f	70	Fgh
	0.75 cc	16	bcd	32	b-f	82	a-g
	1 cc	18	bcd	40	b-e	76	c-h
	1.25 cc	20	bc	40	a-e	84	a-g
	2.5 cc	22	b	42	a-e	80	a-g
	5 cc	18	bcd	42	a-e	76	c-h
	10 cc	54	a	66	a	90	a-e
Formula 3	0.25 cc	2	cd	44	a-d	58	H
	0.5 cc	8	bcd	26	c-g	66	H
	0.75 cc	6	bcd	26	c-g	68	Gh
	1 cc	4	bcd	42	a-e	80	b-g
	1.25 cc	8	bcd	20	d-g	82	a-g
	2.5 cc	16	bcd	32	b-f	80	a-g
	5 cc	44	a	66	a	94	a-d
	10 cc	18	bcd	40	a-e	80	a-g
Formula 4	0.25 cc	18	bcd	48	abc	76	d-h
	0.5 cc	12	bcd	44	a-d	94	a-d
	0.75 cc	8	bcd	38	b-e	92	a-d
	1 cc	14	bcd	42	a-e	84	a-g
	1.25 cc	22	b	46	a-d	94	a-d
	2.5 cc	12	bcd	42	a-e	98	Ab
	5 cc	14	bcd	38	b-e	100	A
	10 cc	14	bcd	44	a-d	100	A
Commercial product	0.25 cc	0	d	16	Efg	74	d-h
	0.5 cc	4	bcd	16	Efg	84	a-g
	0.75 cc	0	d	16	Fg	82	a-g
	1 cc	8	bcd	42	a-e	96	Abc
	1.25 cc	4	bcd	24	c-g	84	a-g
	2.5 cc	12	bcd	40	a-e	80	a-g
	5 cc	2	cd	42	a-e	86	a-g
	10 cc	2	cd	38	b-e	86	a-g
Control	0	2	cd	12	Fg	20	I
	0	4	bcd	6	G	22	I
	0	0	d	4	G	14	I
	0	0	d	6	G	16	I
	0	2	cd	4	G	18	I

Note: Different subscripts in the same column indicate significant differencesp<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 day of observation. High mortality rates 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.

TABLE 3.
LC 50 VALUES OF TESTED INSECTICIDE FORMULAS

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 cm^3/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

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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.

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