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Dynamics of rice planthoppers (RPH) and natural enemies using yellow paper sticky trap and existence of rice stunt virus after outbreak as a buffer management to RPH control

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Abstract
Brown planthopper (BPH) outbreak had often occurred in Indonesia, especially in West Java, among others Subang and Karawang as a hot spot areas. The research of dynamics population of rice planthoppers (RPH), natural enemies and existence of rice ragged stunt virus (RRSV) to anticipate rice damage was carried out in rice field at Sukamandi research station of Indonesian Center for Rice Research (ICRR). The results showed that the BPH and whitebacked planthopper (WBPH) population were very low and didn't damage to rice crop, and also didn't find symptoms of RRSV and grassy stunt virus (RGSV) after outbreak of both BPH and RRSV. Monitoring of RPH and natural enemies on DS 2011 using yellow paper sticky trap (YPST) was very good and effective as well as visual counting. Population of BPH and spiders on visual counting was lower than on YPST, but in WS 2011/2012 otherwise. The WBPH population and *Paederus fuscipes* on visual counting was higher than on YPST on both DS and WS. The population of *Cyrtorhinus lividipennis* on YPST observations was significantly higher than on visual counting on both DS and WS. The general results of pests and natural enemies with visual counting wasn't always higher than YPST observation, and vice versa. This depends on the abundance and movement activity of each pests and natural enemies. Control to BPH and WBPH by insecticide on economic thresholds based on natural enemies (predators) didn't require to be done on both the DS and WS, due to the value of RPH corrected by natural enemies (D_i) always lower than the economic threshold that have been set based on the price of grain at harvest. This indicates that the presence predators of spiders, *Lycosa pseudoannulata*, *P. fuscipes*, and *C.lividipenis* have been able to decrease the population of rice planthoppers.

Keywords: dynamics, RPH, natural enemies, sticky trap, stunt virus, rice, control

1. Introduction
Rice planthoppers constitute a large group of phytophagous insects in the Order Hemiptera especially Delphacidae family to become serious problem on rice production. In Asia, the two rice planthoppers that have economic importance value are the brown planthopper (BPH), *Nilaparvata lugens* (Stål) and the whitebacked planthopper (WBPH), *Sogatella furcifera* (Horvath). Both of them damaging rice crops directly by sucking the cell sap in the plant tissue which causes the plant to wilt or hopperburn. Unfavorable conditions, especially when the rice crop is already dead, the rice planhopper migrate to others rice crop in large number [1]. In China, both brown planthopper and whitebacked planthopper migrate from the warmer, tropical regions of southern China to the Korean peninsula, as well as to Japan and middle China, in the early summer of each year [2].

In Indonesia during period 2009, 2010, and 2011 the rice plantation damage by BPH reached 47,473; 137,768 and 218,060 ha respectively. This BPH outbreak occurred in the province of Banten and West Java on WS 2009/2010, DS 2010, and WS 2010/2011. In East and Central Java province BPH outbreak on WS 2009/2010, DS 2010, WS 2010/2011, and DS 2011. Baehaki *et al* (2017) [3] reported that BPH outbreak in West Java in WS 2009/2010 up to WS 2010/2011 and after that season in DS 2011 the rice plantation was normally growth. The normally rice plantation growth related to the both planhoppers BPH and WBPH in the light trap at Sukamandi Rice Station of Indonesian Center for Rice Research (ICRR) was very low from 2011 up to 2012 [4]. Several sampling techniques were used to collect insects, namely by visual observation, yellow pan trap, yellow sticky traps, blue sticky traps, insect sweep net, pitfall trap, and bait (eggs-plant) traps for egg parasitization. The Small flying insect pests of BPH, WBPH and others attracted to yellow color. The winged adults pests that captured on the yellow paper sticky traps (YPST) before they reach the plants, will be delayed the build-up of pests and then existing insect populations may also be reduced.

The BPH outbreak in period 2009-2011 was followed by rice stunt virus, especially rice ragged stunt virus (RRSV). The symptomatology of rice virus diseases is very difficult to differ markedly from healthy plant in color, but they are stunted to various degrees at all growth stage [3]. The symptom RRSV was showed in difference number of tillers between disease and healthy plant. Other symptoms of RRSV varied according to the stage of plant growth. The predominant symptom are ragged, tattered, torn, or serrated leaves.

The objective of the research to get information dynamics of rice planthoppers (RPH) and natural enemies after outbreaks, monitoring of existence of rice stunt virus, and control to RPH using economic threshold base on natural enemies.

2. Materials and Methods

2.1 Dynamics of rice planthoppers (RPH), natural enemies and symptom ragged stunt virus

Monitoring of rice planthoppers (RPH), natural enemies and rice stunt virus (RSV) (rice ragged stunt virus = RRSV and rice grassy stunt virus = RGSV) was carried out in the DS 2011 and WS 2011/2012 at Sukamandi research station in West Java of Indonesian Center for Rice Research (ICRR), precisely near saung BB Padi and very close to the light trap (06.35063ºS, 107.65128ºE). The famous Ciherang rice variety was planted on 0.20 ha of Sukamandi research station with spacing 25 cm x 25 cm. The area were divided into 50 plot size of 5 m x 8 m. RPH, other pest and natural enemies is monitored by visual counting and yellow paper trap of 20 hills from every plot. In the each time of monitoring randomized from 3 plot sample. The monitoring used model unrepeated plot, it mean in the next observation move to the others plot that do not observation yet. All of the activities in the field without insecticide application.

2.1.1 Visual counting

In the visual counting of RPH, natural enemies, and others was conducted in every 5 days on DS 2011 and one week on WS 2011/2012 starting at ten days after transplanting until 2 weeks before harvested. Observation from 20 hills with random sampling method per plot in first or second diagonal. In every hill recorded amount of RPH, natural enemies, others insects (neutral insect), and existence and severity symptom of RSV. In one plot observation was used for visual counting and yellow paper sticky trap **(**YPST), because in one plot have 2 imaginary diagonal line, first and second. If visual counting use in the first diagonal, then the observations with YPST use the second diagonal and vice versa.

2.1.2 Yellow paper sticky trap (YPST)

The YPST in two side were coated with wet glue and protected with a plastic as cover trap. This YPST was 25.5 cm x 18 cm in size and used only in one side, while the other side of the YPST is still covered to safety handle by hand. Monitoring by YPST to RPH, natural enemies, and others was conducted in every 5 days on DS 2011 and one week on WS 2011/2012, starting at ten days after transplanting until two weeks before harvested. Monitoring on plot 1 as replication 1 on second diagonal to captured insects by YPST and recording RRSV, monitoring on plot 2 as replication 2 in first diagonal, and monitoring on plot 3 as replication 3 on vertical direction (Fig. 1).

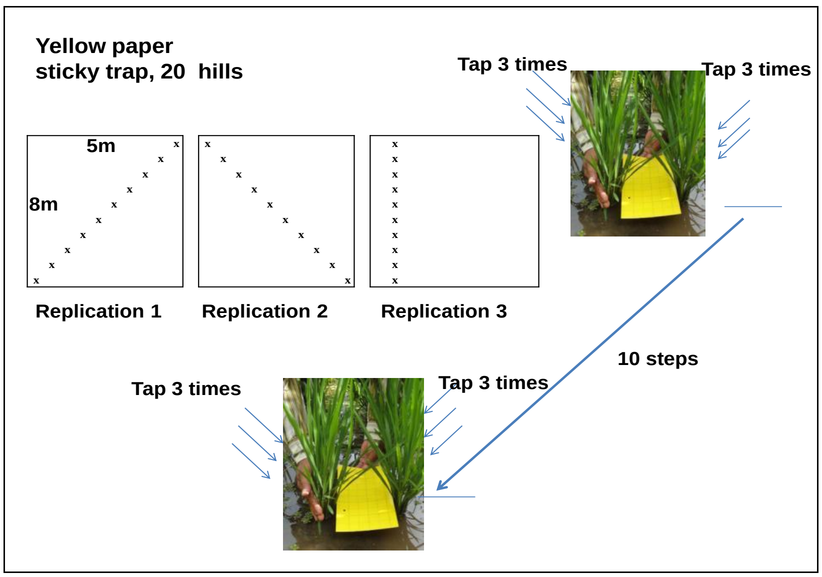

Fig 1: Scheme of monitoring by YPST

Monitoring by YPST got from ten spots trap in one diagonal line or vertically form. On each spot sample by put the YPST between two hills (left-right), and tap three times for each hill in order the insects fall and be captured on the YPST. Insect on YPST can be identified and calculated in 2 kinds proses that is:

a. Direct counting in laboratory by placing YPST under binocular microscope or magnifying glass to know the amount of BPH, WBPH, natural enemies and others insects (neutral insect).
b. Indirect by shooting insects that trapped in YPST with high resolution camera. The image from camera is transferred into the computer and the insect counting process with the computer services.

2.2 Monitoring of RPH and natural enemies for management of RPH control

Monitoring of BPH/WBPH use visual counting in point a and by YPST in point b. Count the number of BPH/WBPH in the i observation (A_i) and the predators such as spiders + *Paederus fuscipes* + *Ophionea nigrofasciata* + *Coccinella* in the i observation (B_i) and *Cyrtorhinus lividipennis* in the i observation (C_i). The predation ability of each predators (spiders + *P. fuscipes*+ *O. nigrofasciata* +*Coccinella*) on planthoppers was 5 RPH/day. The predation ability of *C. lividipennis* on brown planthopper was 2 RPH/day. Use Baehaki (2011) [5] formulae for decision making base on natural enemies as follows.

$$D_i = \frac{A_i - (5B_i + 2C_i)}{N}$$

D_i = number of BPH/WBPH corrected by the predators in the i observation

A_i = number of BPH/WBPH in the i observation.

B_i = numbers predators (spiders + *P. fuscipes*+ *O. nigrofasciata* + *Coccinella*) in the i observation

C_i = number of *C. lividipennis* in the i observation

N = number of sample

The BPH/WBPH corrected by predators (Di), was the remainder of the total planthoppers on rice plants after be preyed by predators. For the decision control of planthoppers base on D_i should be aligned with economic threshold (Table 1). Decision making to RPH control must know the age of rice, ET value and price of rice when going to harvest.

Table 1: Economic threshold base on natural enemies in relation to price at harvested

RPH in age of rice crop (day after transplanted = DAT)	Economic threshold (ET) of RPH/hill at price of rice at harvested (IDR/kg)			
	900	2250	2700	>3150
BPH on under 40 DAT	9	4	3	3
BPH on more than 40 DAT	18	7	6	5
WBPH on under 40 DAT	14	6	5	4
WBPHon more than 40 DAT	21	8	7	6

Remark: 1USD = 13,340 IDR in September 2017

If the price of rice at harvested will be >3150 IDR, then the value of $D_i \geq$ ET (3 BPH/hill) under the rice crop age below 40 DAT or the value of $D_i \geq$ ET (5 BPH/hill) on the rice crop stage more than 40 DAT the crop must be sprayed with the recommended insecticides.

3. Results and Discussions

3.1 Monitoring of RPH and natural enemies by yellow paper sticky trap

The direct visual counting to calculate RPH and natural enemies from each rice hills using a hand counter, and then the amount of RPH and natural enemies was recorded on the data sheet. On the other hand, monitoring RPH and natural enemies use YPST by tapping hills method, in order that insects fall into the trap. Identification of the insects capture on the YPST can be done in 2 ways that is using a microscope or magnifying glass by counting the insects directly. Second identification of the insects that captured on YPST using computer services on JPG images from camera.

All parts of the JPG-YPST can be displayed on a computer screen and be counted pests and natural enemies. To be easy identification of pests and natural enemies can be in close up with augmented enlargement like Fig. 2 for DS 2011 and Fig. 3 for WS 2011/2012. In this study, identification wasn't to all the insects acquired at YPST, but only to the target pest, natural enemies, and neutral insects. The advantage of indirect counting on JPG-YPST for other purposes can be done anytime, and if there is an error can be made to correct quickly. Especially for decision making to control, the identification as soon as possible.

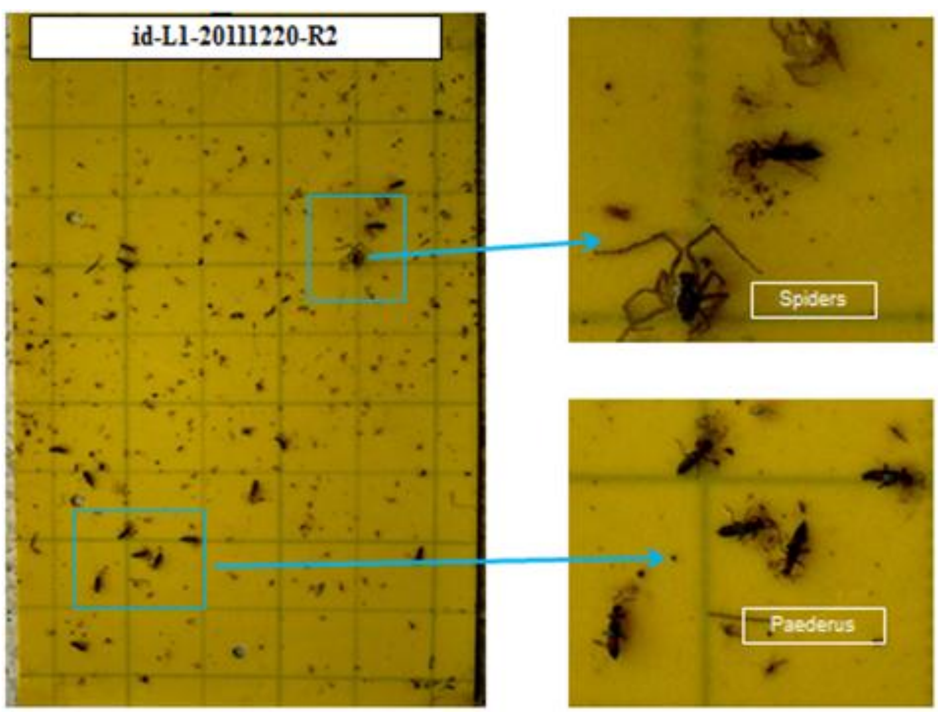

Fig 2: Monitoring RPH and natural enemies by yellow paper sticky trap (YPST) using computer services

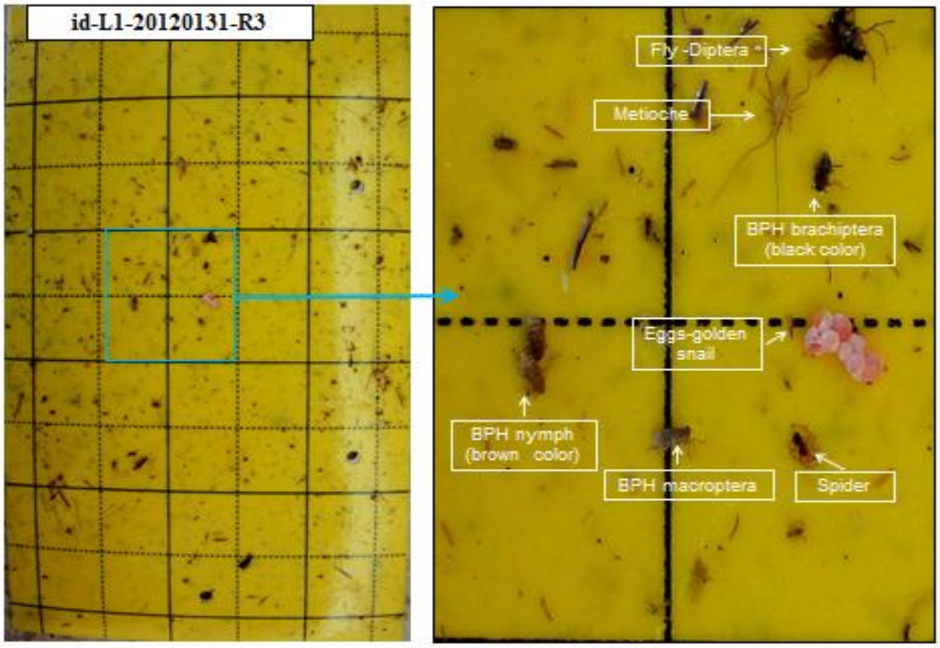

Fig 3: Monitoring RPH and natural enemies by yellow paper sticky trap (YPST) using computer services.

3.2 Monitoring RPH, natural enemies and symptom ragged stunt virus in DS 2011

In the DS 2011, the first visual counting of rice planthoppers and natural enemies on Ciherang variety was begun in 2 June 2011 at ten days after transplanted. In the first observation occurrence of BPH was very low, only 1.0 BPH/20 hills. BPH population was very low development from 2 June to 6 August 2011. In the other hand WBPH population was upper than BPH population. The natural enemy growth follows the development of the RPH population, thus reducing the RPH population below the economic threshold. This shows reach a biological balance between natural enemies-RPH in the rice crop, so it didn't damage the cultivation of Ciherang variety. In the DS 2011 from all observations didn't find the symptoms of ragged stunt virus and grassy stunt virus. In this case can be understandable, because in some observations didn't find inoculum of virus and very low of BPH population in rice cultivation.

Development of rice planthoppers and natural enemies on Ciherang variety that captured by YPST was begun on 2 June 2011 at ten days after transplanted. In the first observation occurrence of BPH was very low only 0.3 BPH/20 Hills. In the other hand WBPH population be upper than BPH. WBPH continuous to develop to increase population, but BPH population was stable from 2 June to 6 August 2011. Similarity to visual counting, the YPST data also show that the natural enemies followed development of RPH that reduced RPH, so in Ciherang variety didn't damage by RPH. In the other hand YPST was a good tool to identified natural enemies and neutral insect chironomid than visual counting. Chironomid was in abundance and very importance as spider food.

The result of two method observation BPH, WBPH, and natural enemies between visual counting and YPST in DS 2011 was high significant result one to another. Average data from 20 hills during one season showed that WBPH population by visual counting was higher than YPST (Table 2).

Table 2: Dynamics population of pests and natural enemies. Sukamandi, DS 2011

Pests/Predators	Monitoring (pests/predators)/20 hills		Significantly Test ($T_{calculate}$) between visual counting and YPST
	Visual counting	YPST	
BPH	23.5	28.9	-11.656**
WBPH	804.6	567.4	16.953**
Spiders	73.3	103.7	-20.362**
P. fuscipes	52.0	16.0	39.834**
C. lividipennis	34.7	67.7	-40.180**

**highly significance, $T_{calculate} > T_{01(26\text{-}df)}$, T_{table}: $T_{05(26\text{-}df)} = 2.056$, $T_{01(26\text{-}df)} = 2.779$

Population of BPH, spiders, and *C. lividipennis* on YPST observations was significantly higher than visual counting observations. The population of WBPH and *P. fuscipes* on visual counting was significantly higher than in YPST observations.

T-calculate value must be taken in absolute value, because the value of T-calculate was in sign positive or negative, and if the value was greater than T-table 5% and 1% that indicate as significant and highly significant respectively. The T-calculate value can be explained as follows: for example BPH visual counting-YPST was negative, it indicates that the visual counting was significantly smaller than BPH at YPST as comparison. On the other hand the T-calculate of WBPH visual counting-YPST was positive, it indicates that visual counting was significant higher than WBPH on YPST as a comparison.

3.3 Monitoring of RPH, natural enemies and symptom ragged stunt virus in 2011/2012

In the WS 2011/2012 the first visual counting of rice planthoppers and natural enemies on Ciherang variety began in 29 November 2011 at ten days after transplanted. In the first visual observation wasn't find brown planthopper, both nymphs and adults, but WBPH populations has been found with very low about 7.3 WBPH/20 hills consist of 1-2, 3-5 instars nymphs, male and female were 4.3, 1.7, 0.3 and 1.0 WBPH/20 hills respectively. On the whole observation at WS 2011/2012, BPH population was very low not more than 12.6 BPH/20 hills at id-L1-20120131-Ra consists of 1-2, 3-5 instars nymphs, male and female were 4.0, 4.3, 2.0, and 2.3 BPH/20 hills respectively.

The results of RPH captured by YPST from 29 November 2011 (id-L1-20111129-Ra) until February 6, 2012 (id-L1-20120206-Ra) was very low for all stadia of brown planthopper. In the other hand, populations of natural enemies that captured on YPST high enough for spiders and *C. lividipennis*. These natural enemies have contributed to suppress population of RPH. The others natural enemies that capture on YPST were *Lycosa pseudoannulata, P. fuscipes, Coccinella*, and Methioce.

In the WS 2011/2012 from all observations didn't find symptoms of ragged stunt virus and grassy stunt virus. It was similar with DS 2011, because in some observations does not found virus inoculum, very low of BPH population, and no RPH of both immigrants and emigrants. The natural enemies reduced RPH development, so in Ciherang variety no damage by RPH although in the wet season, because there has been a biological balance between the RPH and the of natural enemies. The result observation BPH, WBPH, and natural enemies between visual counting and YPST in WS 2011/2012 was high significant one to another. Population BPH, WBPH, spiders, *L. pseudoannulata*, and *P. fuscipes* by visual counting were higher than on YPST (Table 3).

Table 3: Dynamics population of pests and natural enemies. Sukamandi, WS 2011/2012

Pests/Predators	Monitoring (pests/predators)/20 hills		Significantly Test ($T_{calculate}$) between visual counting and YPST
	Visual counting	YPST	
BPH	24.9	7.2	16,.914**
WBPH	80.7	7.2	28.282**
Spiders	167.3	83.4	24.205**
L.pseudoannulata	27.4	12.7	23.242**
P. fuscipes	31.3	3.3	47.901**
C.lividipennis	4.9	30	-30.165**

**highly significance $T_{calculate} > T_{01(21\text{-}df)}$, T_{table}: $T_{05(21\text{-}df)}$ =2.080, $T_{01(21\text{-}df)}$ =2.831

The population of *C. lividipennis* on YPST observations was significantly higher than in visual counting. The results of pest and natural enemies on visual counting weren't always higher than on YPST observations, and vice versa. The number of pests and natural enemies that captured on YPST depends on the abundance and movement activity of each pest and natural enemies on both rainy and dry season.

3.4 Monitoring for management of RPH control

The price of rice in Indonesia at the time of the research was 4,000 IDR/kg more than 3150 IDR/kg, so the economic threshold was 3 BPH/hill for BPH or 4 WBPH/hill for WBPH at < 40 DAT (the time of vegetative) and at > 40 DAT (generative time) was 5 BPH/hill or 6 WBPH/hill (Table 1). The economic threshold of BPH and WBPH was almost very closed one to another. Therefore, in the decision making to control using economic threshold based on natural enemies, the population of BPH and WBPH were combined and AE was taken 3 RPH/hill and 5 RPH/hill for RPH on vegetative and generative respectively.

In DS 2011, the RPH population was quite high on id-L1-20110627-Ra observation that the RPH population was 5.68 RPH/hill at the age of rice was <40 DAT. In the observation of id-L1-20110707-Ra, id-L1-20110712-Ra, id-L1-20110717-Ra population of RPH were 4,815, 4,635, 4,63, and 4,815 RPH/hill respectively. In the observation id-L1-20110722-Ra population RPH was 5,185 RPH/hill at age of> 40 DAT. Actually, if did not refered to the economic threshold based on natural enemies, shows that in id-L1-20110627-Ra observation and in the id-L1-20110722-Ra observation should be applied immediately with insecticide. However, when referring to the economic threshold based on natural enemies the decision didn't need to be applied with insecticides, because the presence of natural enemies play a role to decrease the population of planthoppers. This can be explained by a lower of D_i value compared to the economic threshold.

Based on the calculation D_i using Baehaki (2011) [5] formulae, for rice cultivation on DS 2011, it was found that D_i in minus value on visual counting (Table 4), some D_i in positive value which was very low under economic threshold value on both vegetative and generative.

Table 4: Decision making of RPH control in DS 2011, base on natual enemies of visual counting

Observation times	RPH/ 20 hills (A_i)	Predators/20 hills		RPH corrected by predators (D_i)	Decision making
		Spiders, *L.pseudoannulata, P.fuscipes* (B_i)	*C.lividipennis* (C_i)		
id-L1-20110602-Ra	8.3	5.6	1.7	-1.16	No. appl
id-L1-20110607-Ra	10.3	7.0	2.3	-1.47	No. appl
id-L1-20110612-Ra	19.7	9.3	1.0	-1.44	No. appl
id-L1-20110617-Ra	36.0	7.3	0.3	-0.06	No. appl
id-L1-20110622-Ra	39.3	11.0	0.7	-0.86	No. appl
id-L1-20110627-Ra	113.6	15,3	0,3	1.83	No. appl
id-L1-20110702-Ra	96.3	9.0	2.3	2.34	No. appl
id-L1-20110707-Ra	92.7	15,6	4.0	0.34	No. appl
id-L1-20110712-Ra	92.6	14.4	4.0	0.63	No. appl
id-L1-20110717-Ra	96.3	14.3	4.7	0.77	No. appl
id-L1-20110722-Ra	103.7	18.3	4.3	0.18	No. appl
id-L1-20110727-Ra	98.0	14.3	3.7	0.96	No. appl
id-L1-20110802-Ra	11.0	6.7	3.7	-1.50	No. appl
id-L1-20110806-Ra	10.3	4.0	1.7	-0.66	No. appl

*Remarks: id = Indonesia, L1 = Location (ICRR), 20110602 = year, month, date, Ra = average of three replications. No.appl= not applied by insecticide.

since D_i was lower than the economic threshold on visual counting, the decision making didn't need to be applied with insecticides for each observations id-L1-20110602-Ra to id-L1-20110627-Ra of vegetative phase <40 DAT and for observations id-L1-20110702-Ra to id-L1-20110806-Ra of generative phase age >40 DAT.

In the other hand for rice cultivation that observation by YPST was found that D_i in minus value (Table 5), some D_i in positive value which was very low under economic threshold value on both vegetative and generative. Thus D_i was lower than the economic threshold on YPST, the decision making didn't need to be applied with insecticides for each observations id-L1-20110602-Ra to id-L1-20110627-Ra of vegetative phase <40 DAT and for observations id-L1-20110702-Ra to id-L1-20110806-Ra of generative phase age >40 DAT.

Table 5: Decision making of RPH control in DS 2011, base on natual enemies of YPST

Observation times	RPH*/20 hills (A_i)	Predators/2 hills		RPH corrected by predators (D_i)	Decision making
		Spiders, *L.pseudoannulata, P.fuscipes* (B_i)	*C.lividipennis* (C_i)		
id-L1-20110602-Ra	4.6	1.0	0.3	-0.05	No. appl
id-L1-20110607-Ra	17.0	1.0	2.0	0.40	No. appl
id-L1-20110612-Ra	21.0	1.3	2.3	0.50	No. appl
id-L1-20110617-Ra	21.0	1.3	2.0	0.53	No. appl
id-L1-20110622-Ra	56.7	1.7	2.7	2.14	No. appl
id-L1-20110627-Ra	88.3	7.3	4.7	2.12	No. appl
id-L1-20110702-Ra	96.7	16.0	6.7	0.17	No. appl
id-L1-20110707-Ra	70.6	12.7	5.7	-0.22	No. appl
id-L1-20110712-Ra	48.0	14.0	6.3	-1.73	No. appl
id-L1-20110717-Ra	47.6	14.4	6.7	-1.89	No. appl
id-L1-20110722-Ra	51.4	12.4	7.3	-1.26	No. appl
id-L1-20110727-Ra	29.7	12.3	6.3	-2.22	No. appl
id-L1-20110802-Ra	18.0	12.0	6.0	-2.70	No. appl
id-L1-20110806-Ra	25.7	12.3	8.7	-2.66	No. appl

*Remarks: id = Indonesia, L1 = Location (ICRR), 20110602 = year, month, date, Ra = average of three replications. No.appl= not applied by insecticide.

In the WS2011/2012 was obtained D_i in minus value on both visual counting and YPST observations (Table. 6 and 7), thus since D_i was lower than the economic threshold, the decision making didn't need to control by insecticide for all observation of all rice old.

Table 6: Decision making of RPH control in WS 2011/2012, base on natual enemies of visual counting

Observation times	RPH*/20 hills (A_i)	Predators/20 hills		RPH corrected by predators (D_i)	Decision making
		Spiders, *L.pseudoannulata*, *P.fuscipes* (B_i)	*C.lividipennis* (C_i)		
id-L1-20111129-Ra	7.3	15.1	0.3	-3.44	No. appl
id-L1-20111206-Ra	11.0	17.6	1.0	-3.95	No. appl
id-L1-20111213-Ra	15.3	32..0	0	-7.24	No. appl
id-L1-20111221-Ra	34.9	39.4	2.0	-8.31	No. appl
id-L1-20111227-Ra	2.3	16.0	0	-3.89	No. appl
id-L1-20120103-Ra	2.3	11.0	1.0	-2.74	No. appl
id-L1-20120110-Ra	0,3	7.0	0.3	-1.77	No. appl
id-L1-20120117-Ra	1.0	25.9	0.3	-6.46	No. appl
id-L1-20120124-Ra	8.0	24.7	0	-5.78	No. appl
id-L1-20120131-Ra	21.2	31.3	0	-6.77	No. appl
id-L1-20120206-Ra	2.0	6.0	0	-1.40	No. appl

*Remarks: id = Indonesia, L1 = Location (ICRR), 20110602 = year, month, date, Ra = average of three replications. No.appl= not applied by insecticide.

Table 7: Decision making of RPH control in WS 2011/2012, base on natual enemies of YPST

Observation times	RPH*/20 hills (A_i)	Predators/20 hills		RPH corrected by predators (D_i)	Decision making
		Spiders, *L.pseudoannulata*, *P.fuscipes* (B_i)	*C.lividipennis* (C_i)		
id-L1-20111129-Ra	0.6	5.4	2.3	-1.55	No. appl
id-L1-20111206-Ra	0.6	2.7	0.7	-0.72	No. appl
id-L1-20111213-Ra	0	5.6	6.0	-2.00	No. appl
id-L1-20111221-Ra	0	8.0	9.7	-2.97	No. appl
id-L1-20111227-Ra	1.4	13.3	5.7	-3.83	No. appl
id-L1-20120103-Ra	2.0	0.6	0	-0.05	No. appl
id-L1-20120110-Ra	1.4	1.3	0	-0.26	No. appl
id-L1-20120117-Ra	2.6	19.7	1.0	-4.90	No. appl
id-L1-20120124-Ra	4.6	19.4	2.0	-4.82	No. appl
id-L1-20120131-Ra	0.6	11.7	1.3	-3.03	No. appl
id-L1-20120206-Ra	0.6	11.7	1.3	-3.03	No. appl

*Remarks: id = Indonesia, L1 = Location (ICRR), 20110602 = year, month, date, Ra = average of three replications. No.appl= not applied by insecticide.

In the discussion of both dry and wet season, showed that the visual counting and YPST observations were the good tool to observes BPH and WBPH population to determine economic threshold base on population of natural enemies. The economic threshold base on population of natural enemies was the brilliant technology, in order to avoid misuse of insecticides. In some reports on insecticide misuse is main cause of the current planthopper outbreaks in Asia, namely Thailand, Indonesia and the Philippines. The misuse brings the pesticide tsunami that destroys ecosystem services and create conditions that favor r-strategists pest, like the rice planthoppers [6]. BPH was a pest r-strategic with the characteristics in population growth rate follows the curve of exponential, small insects which quickly found their habitat, rapidly multiply and was able to use a source of food well before other insects competed, and quickly dispersal to a new habitat before the old habitat unuseful.

The BPH outbreak wasn't only caused by the use of insecticides, but also were supported by the others characteristics of BPH namely pattern of pest development follows biological clock, this mean that BPH breeds and destroys rice crops in suitable environments on both rainy and dry seasons (La Nina season). The BPH has been able to weaken the work of insecticides that are considered potent before. BPH was also a latent pest, and can transfer the rice stunt virus [3]. Baehaki (2012) [7] reported that prior to 1994, the BPH attacked during the rainy season, but after 1994 was attacking rice crops during the rainy and dry seasons, when the rain continued into the dry season or the La Nina season.

In recent two decades, sticky traps are used as one of effective IPM strategy for different insect pests in most parts of the world. They provide an easy method for estimation of pest population density. Sticky cards are glue-based traps frequently used in pest control to catch and monitor insects and other pests. Some typically sticky cards consist of a sticky glue layer mounted on a piece of cardboard that is folded into a tent-structure to protect the sticky surface. Most sticky traps contain no pesticides, although some may be impregnated with aromas designed to be attractive to certain pests (https://citybugs.tamu.edu/factsheets/ipm/what-is-a-sticky-trap/). In the other hand the sticky traps are generally not very good at controlling small insect or mite pests, but their best use to detect pests, and monitor changes in pest abundance.

Yellow sticky trap are a commonly used method for population monitoring of many pests. In the other hand blue sticky traps will effectively attract and catch thrip, leaf miner adults, lepidopteran pests, they will also less effectively catch whitefly, flying aphids, sciarid fly, and leaf hopper (http://www.dragonfli.co.uk/product/bio-01-17). Studies of these traps mainly focused on how to use them to monitor populations of pest species such as whiteflies, leafminers, and aphids [8, 9]. In recent years, yellow sticky traps have also been used as a method for the control of some pests, especially for the control of whitefly. The combination of yellow sticky traps and parasitoids has proven to be an effective method for the control of *B. tabaci* in a greenhouse [10].

Baehaki (1985) [11] reported that the migrating pests from the damaged crops can be detected by yellow sticky trap of 200 cm x 30 cm size, and BPH that caught on the sticky traps real positively correlated with BPH population in rice crops. In the other hand there were no significant correlations between sticky trap catches of parasitoids and numbers of parasitized whiteflies on leaf samples in any test fields [12]. In the greenhouse impact of the yellow sticky traps significantly suppressed the population increase of adult and immature whitefly, *B. tabaci* (Gennadius) (Hemiptera: Aleyrodidae), but in the field, the traps did not have a significant impact on the population dynamics of adult and immature whiteflies [13]. These results suggest that yellow sticky traps can be used as an effective method for the control of whiteflies in the greenhouse, but not in the field. This information will prove useful for the effective management of whiteflies in greenhouses. The numbers of *Eretmocerus emiratus* as parasitoid of *B. tabaci* caught by traps for detecting parasitoids at specific locations [12].

Large numbers of the maize orange leafhopper, *Cicadulina bipunctata* Melichar (Hemiptera: Cicadellidae), and the small brown planthopper, *Laodelphax striatellus* Fallen (Hemiptera: Delphacidae), were collected during the experimental period with yellow and blue sticky traps placed in summer crop forage maize fields. A greater number of insects were trapped in yellow traps relative to blue traps, and seasonal occurrence data obtained by the yellow sticky traps showed clearer seasonal occurrences than that obtained by two previously developed methods, suction and light traps, indicating that sticky traps are effective for monitoring the seasonal occurrence of these two insects in forage maize field [14]. Sticky traps of seven different colors (red, brown, green, white, light blue, dark blue and yellow) were installed at the height of 140 cm at different locations in field which gave significant indication of population abundance and the results showed that the most attractive and efficient color in our monitoring trial was the brown color followed by light blue, dark blue, red, green, yellow and the sticky trap having low population was white [15].

4. Conclusions

After outbreak of BPH and rice stunt virus in the WS 2009/2010-WS 2010/ 2011 showed that in the DS-2011 from all observations didn’t find symptoms of ragged stunt virus and grassy stunt virus. In this case, because didn’t find inoculum of virus, very low of BPH population in the rice field and very low BPH from both immigrants and emigrants. Monitoring of rice planthoppers and natural enemies using YPST was very good and effective as well as visual counting.

Population of BPH and spiders on observations with visual counting on DS was lower than on YPST, but in WS otherwise. The population of WBPH and *P. fuscipes* on visual counting was higher than on YPST either on both DS and WS. The population of *C. lividipennis* on YPST observations was significantly higher than on visual counting on both DS and WS. The general results of pests and natural enemies with visual counting weren’t always higher than YPST observations, and vice versa. This depends on the abundance and movement activity of each pests and natural enemies both in the DS and in the WS.

Control of BPH and WBPH with insecticide on economic thresholds based on natural enemies (predators) didn’t require to be done in both D S2011 and WS2011/2012, due to the value of RPH corrected by natural enemies (Di) was always lower than the economic threshold that has been set based on the price of grain at harvest. This situation showed that the natural enemies was a good agents to reduced plant hoppers in IPM technology.

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6. References

1. Catindig JLA, Arida GS, Baehaki SE, Bentur JS, Cuong LQ, Norowi M, *et al*. Situation of Planthoppers in Asia. Planthoppers: new threat to the sustainability of intensive rice production system in Asia. IRRI. 2009, 191-219.
2. Turner RW, Song YH, Uhm KB. Numerical simulations of rice planthopper *Nilaparvata lugens* (Stal) and *Sogatella furcifera* Horvarth (Homoptera: Delphacidae) migration as a component in an internet surveillance system. Bull. Entomol. Res. 1999; 89(6):557-569.
3. Baehaki SE, Iswanto EH, Munawar D, Song YH, Choi IR, Park HH. Abilities of brown planthopper immigrant transmits rice ragged stunt virus on rice of some district of Java-Indonesia. Scholars Journal of Agriculture and Veterinary Sciences (Sch J Agric Vet Sci. 2017; 4(8):300-310. DOI: 10.21276/sjavs.
4. Baehaki SE, Mejaya IMJ, Choi IR, Song YH, Park HH, Goh HG. Overcome the constraints brown planthopper and stunt virus outbreak related to increasing rice production. Presented in the international Seminar “Rice Technology Innovation for Increasing production and Conserving Environment under Global Climate Change, Subang-Indonesia. 2012, 19.
5. Baehaki SE. Strategi fundamental pengendalian hama wereng batang coklat dalam pengamanan produksi padi nasional. Pengembangan Inovasi Pertanian. Badan Penelitian dan Pengembangan pertanian. 2011; 4(1):63-75.
6. Heong KL. Insecticide misuse caused by FMCG selling strategies. International Rice Research Institute, Los Baños, Philippines. 2011;http://ricehoppers.net/wp-content/uploads, 2011.
7. Baehaki SE. Perkembangan biotipe hama wereng coklat pada tanaman padi. IPTEK Tanaman Pangan. 2012; 7(1):8-17.
8. Qiu BL, Ren SX. Using yellow sticky traps to inspect population dynamics of *Bemisia tabaci* and its parasitoids. Chinese Bulletin of Entomology. 2006; 43(1):53-56.
9. Gu XS, Bu WJ, Xu WH, Bai YC, Liu BM, Liu TX. Population suppression of *Bemisia tabaci* (Hemiptera: Aleyrodidae) using yellow sticky traps and *Eretmocerus nr. rajasthanicus* (Hymenoptera: Aphelinidae) on tomato

plants in greenhouses. Insect Science. 2008; 15:263-270.
10. Shen BB, Ren SX. Simulation of control effects of different factors on *Bemisia tabaci* population. Acta Agriculture Universitatis Jiangxiensis. 2003; 25(6):890-895.
11. Baehaki SE. Studi perkembangan populasi wereng coklat *Nilaparvata lugens* (Stal) asal imigran dan pemencarannya di pertanaman. Disetasi S3, Fakultas Pasca Sarjana, Institute Pertanian Bogor. Faculty of Agriculture, Bogor Agricultural University. 1985, 151.
12. Hoelmer KA, Simmons AM. Yellow sticky trap catches of parasitoids of *Bemisia tabaci* (Hemiptera: Aleyrodidae) in vegetable crops and their relationship to in-field populations. Environ Entomol. 2008; 37(2):391-399.
13. Lu Y, Bei Y, Zhang J. Are yellow sticky traps an effective method for control of sweet potato whitefly, *Bemisia tabaci*, in the greenhouse or field? Journal of Insect Science. 2012; 12:113.
14. Matsukura K, Yoshida K, Matsumura M. Efficient monitoring of maize orange leafhopper, *Cicadulina bipunctata* (Hemiptera: Cicadellidae), and small brown planthopper, *Laodelphax striatellus* (Hemiptera: Delphacidae), in forage maize fields using yellow sticky traps. Applied Entomology and Zoology. 2011; 46(4):585-591.
15. Bashir MA, Alvi AM, Naz H. Effectiveness of sticky traps in monitoring insects. Journal of Environmental and Agricultural Sciences. 2014; 1(5):1-2.