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Ability of Yellow Stem Borer Attacks Through to the Next Season Rice Planting and Abundance of Idle Pest Rice Black Bug in Relationship to the Flight on the Light Trap

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Original Research Article

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Abstract: Observation of the major pest yellow stem borer (YSB) and idle pest rice black bug (RBB) in the hot spot of the north coastal areas of West and Central Java were carried out in DS 2012, and was continued to observe the YSB and RBB on nursery as a deposit site of eggs pests in the WS 2012/2013. The results showed that rice stem borers cause an explosion in the Western part and Eastern part of Sukamandi rice research station of Indonesian Center for Rice Research (ICRR) at Ciasem- Subang District. The common rice pests in the Western part, Eastern part and Sukamandi was rice stem borer. The YSB attack on the DS 2012 became an inoculum for rice cultivation in the next season WS 2012/2013. RBB was an idle pest, because although RBB in high populations was captured on the light trap, but there didn't damage to rice crops. There was a very close relationship between the number of egg masses YSB and YSB moths in the nursery with a real positive correlation. Likewise there was a very close relationship between the number of YSB moths in the nursery and YSB moths that captured on the light trap with a real positive correlation. This indicates that the number of moths in the nursery and the number of moths in light traps were a very useful tool for early monitoring system to forecast there will be YSB pest explosion in the ricefields.
Keywords: Yellow stem borer, rice black bug, rice, light trap, nursery, egg masses

INTRODUCTION

Rice stem borers are rice pest belonging to the order of Lepidoptera from Noctuidae and Pyralidae families spread across mainland Asia, America, and Australia. These insects are the small butterflies form called moths generally attracted to the lights at night.

In Indonesia, there are five species of rice stem borers which become obstacles in irrigation, swamp and tidal areas. Baehaki [1] reported that the five rice borers of Lepidoptera: Pyralidae are yellow stem borer (*Scirpophaga* (*Tryporyza*) *incertulas* (Walker)), dark-headed stem borer (*Chilo polychrysus* (Meyrick)), rice striped borer (*Chilo suppressalis* (Walker)), white stem borer (*Scirpophaga* (*Tryporyza*) *innotata* (Walker)), and lepidoptera : Noctuidae is pink stem borer (*Sesamia inferens* (Walker)).

The extraordinary attack of white stem borer occurred on irrigated land, especially in the Northern coastal of West Java in the 1989/90 MH. Before and after that, the pests that many attack rice cultivation, especially in the Pantura pathway is yellow stem borer, which in 2011 reached 146,315 ha, among of them of 391 ha was destroyed (puso) [2]. The focus of the attack occurred in West Java which reached 26.9% and in Central Java 18.4% of all borer attacks in Indonesia. In 2012, yellow rice borer attack occurs in West Java, especially in Karawang, estimated more than 15,000 ha. The borer attacks in Indonesia focused in Java in 2012, 2013, and 2014 were 134,415, 142,725, and 107,725 ha respectively. Incidence of YSB during 2011 and 2012 at Anlao District, Haiphong Province in Vientarn was examined as a measure of controlling of YSB by removal of egg masses and some insecticides [3].

Symptoms of borers attack are the same, in vegetative phase called dead heart and symptoms of borer attacks on generative phase called white head with panicles died, empty grain, and panicles visible white. After entering within the stem by successful boring/tunnelling, the larvae matures and subsequently pupates [4]. Severe infestation by YSB often results in complete crop failure [5]. The rice variety *Oryza sativa* is attacked by yellow stem borer causing dead hearts in

younger plants [6]. Symptoms of this pest is characterised by 'dead heart' in hill at vegetative stage and 'white ear' in panicle at reproductive stage [7].

White stem borer attacked rice cultivation in the Pantura pathway at WS 1989/90 reach 65,040 ha, among them about 15,868 ha was destroyed (puso) [1], this attack occurs after the silent period for 50 years. After that year until 2017 (for 27 years) there has not been a white stem borer explosion yet.

The yellow stem borer is a monophagous rice pest which is the most destructive pest and attacked rice plantation always in high larges area from year to year since 2006-2014, the fluctuation of pest attack didn't seen as the fluctuation of the brown planthopper attack that very clear in fluctuation. Actually the most dangerous was yellow stem borer, but it is so difficult to say the number one pest because in some reports it didn't record percentage of the intensity of the rice damage.

YSB is reported throughout India and is considered as the most dominating and destructive pest species out of the all species of stem borers [8]. West Bengal tops the list in consideration of rice production in India. YSB is reported to ravage in all of the agro-ecological regions of West Bengal sharing about 89.50% of the total rice borer population [9].

The yellow stem borer is an important pest of irrigated rice in south and Southeast Asia. Stem borers are chronic pests, found in every field in every season, but generally at low numbers. Planthoppers and gall midge usually create localized outbreaks, causing high yield losses in relatively small areas. In India the major constraints of rice production is the occurrence of insect pests at various stages of crop growth [7].

The objective of this research to study the continuity of YSB attack from season to season, study to idle RBB pest, relationship of moth and egg masses (the group of eggs laid by a female in a single egg-laying event) in the nursery, relationship of moths in the nursery with YSB on the light trap which as the early monitoring to determine will be happened YSB outbreak in the rice plant.

MATERIALS AND METHODS

YSB dan RBB in North Coastal of West Java

Observation of the distribution of yellow stem borer (YSB) attacks and abundance rice black bug (RBB) was carried out on DS 2012 in several District of West Java, namely Bekasi, Karawang, Subang, and Indramayu, and one district from Central Java (Pemalang District). In each district were selected 1-3 sub districts and in each sub-district were selected 1-3 villages or parts of the village. Observation on 20 hills of rice with same age from one rice field area of each village. Observation intensity every one month, except for Sukamandi area with interval 10-15 days.

YSB Past Through to the Next Rice Planting Season and Relationship Between YSB Moth and Egg Masses

The research was conducted on WS 2012/2013 in Sukamandi rice research station of Indonesian Center for Rice Research (ICRR) at Ciasem-Subang District and the neighboring of sub districts Pabuaran and Patokbeusi. The nurseries were conducted in farmer's fields on 22 September to 29 September 2012 scattered around the light traps. Observation every day from 3 October to 8 October 2012 on several nurseries at 100, 150, 200, 500, 800, 1300, and 1800 m of light trap BSE-G3 model. Observation by visual counting method to calculate how many YSB moths, egg masses, and RBB per m^2/point sample of three point of each nursery. On the other hand the observation of the borers that captured in the light trap in period 3 to 8 October 2012. Specification of light trap BSE-G3 model and calculate of YSB moth and RBB use the method of Baehaki *et al.* [10].

Data analysis was conducted by making the relationship curve between number of YSB egg masses with the YSB moth in the nursery and the relationship between the number of YSB on nursery and the number of YSB that capture on the light trap.

RESULTS AND DISCUSSIONS

YSB dan RBB in North Coastal of West Java

In Bekasi District the observations on DS2012 was conducted in Sukatani (Sukadarma, Sukamulya), Sukakarya (Sukakarya and Sukaindah) and Sukawangi (Sukakerta and Sukawangi) sub district. Varieties that are widely planted by farmers are Mekongga and Ciherang. The first observation on 24 May, 2012 at Sukatani on nursery 15-25 days after sowing (DAS) and in some have planted. The average number of egg masses of YSB was 0.5 egg masses/m^2, while in Sukakarya and Sukawangi were still in a state of fallow.

On 26 June, 2012 in Sukatani the rice transplanting was 17-30 days after transplanted (DAT), while in Sukakarya and Sukawangi on nursery of 7-20 DAS. The damage intensity in Sukatani and some area of Sukakarya were 2.3 and 3.1% dead heart respective and the number of egg masses in nursery was 0.45 egg mass/m^2 (Fig.1).

In Karawang (Palawad) on 3 May, 2012, the intensity dead heart of YSB reached 69.6% in Ciherang variety of 40 DAT and intensity white head before harvest in Tempuran (Tempuran) and Cilamaya (Sukatani) were 62.6% and 27.6% respectively. On the observation of 28 June, 2012 the white head intensity of YSB attacks dropped with the highest attack in Tempuran was 5.14%.

In Subang District, especially in Ciasem Sub district closed to Pabuaran and Patokbeusi on 9 May, 2012 the highest YSB attack in sub district Patokbeusi was 13.6% dead heat at 34 DAT, at Ciasem and Pabuaran were 0 and 3.7% respectively. On 24 May 2012, rice damage in Ciasem, Pabuaran, and Patokbeusi were 2.9, 4.7, and 32.1% respectively.

On the observation of 8 June 2012, the rice damage by YSB of Ciasem, Pabuaran, and Patokbeusi were 2.9, 7.5, and 8% respectively. Particularly in Cijengkol Village of Ciasem Sub district reached 12.7%, this area was an unsynchronize planting. In the observation of 22 June 2012 the intensity of YSB attacks increased again with the white head intensity of Ciasem, Pabuaran (Buwer), Patokbeusi rice plantation on milk stage were 8.0, 20.4, and 39.5% respectively. On 30 June 2012 the attack on rice plantation of Ciasem reached 30.3% white head.

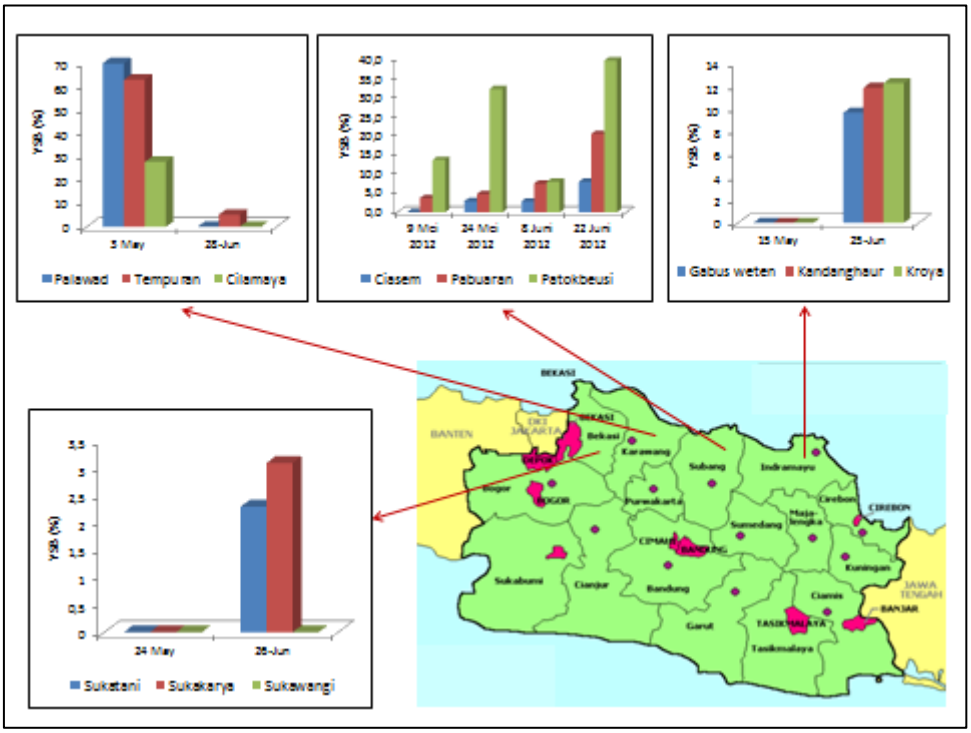

Fig-1: Situation YSB in North Coastal of West Java

On the other hand, observations on 9 May 2012 showed that the population RBB on rice field at Ciasem and Patokbeusi was 3 RBB/ 20 hills, the highest population on Ciherang varieties in Pundong village of Pabuaran was 9.9 RBB /20 hills. On the observation of 24 May, 2012 RBB was zero. On observation 8June RBB population in three sub districts very low was 1.5-2.7 RBB /20 hills. On the observation 22 June, 2012 RBB population increasing especialy in Sukamandijaya (Ciasem) reaches 151 RBB/20 hills.

At 9 May 2012 (1-15 May periods) the RBB population that captured on the light trap reached 192,968 RBB /15 nights and on 8 June (1 to 15 June period) the RBB captured reached 1,406,380 RBB /15 nights (Fig 2). The population on light trap very high, but in the rice crops there is no damage due to RBB. Therefore this pest is called idle pest, because although the abundant RBB in the light trap didn't correlate with the damage in the rice crop.

Abundance of RBB on the light trap didn't signale of high RBB pest populations in the rice crop, because although the populations RBB that caught on the light trap was high didn't cause outbreak in the rice crops. RBB population didn't originate from rice cultivation, but coming from the surrounding environment including herbaceous vegetation [11]. Furtermore Baehaki *et al*., [11] reported the character of RBB abundance in light trap didn't depend upon RBB population in the rice cropping, because throughout the years of pest abundance is always high, although there didn't explosion of RBB in the rice cropping. RBB is still regarded as secondary pests despite its abundance was very high, this RBB mainly still breed in the vegetation of grasses. The RBB catches was higher than BPH and YSB. This indicates that there was an abundance process of RBB will gradually become a major pest, leading to succession to shift the BPH and YSB.

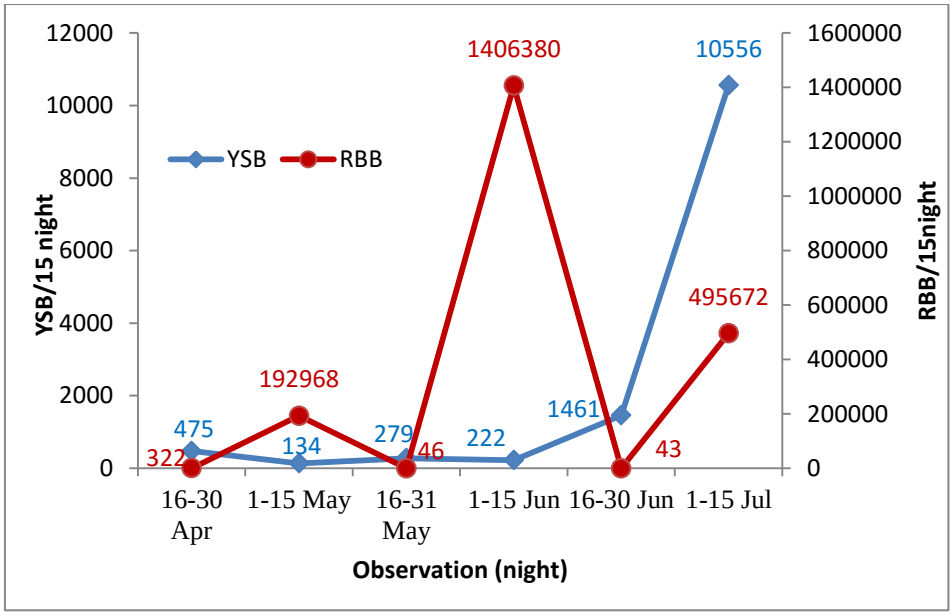

Fig-2: Abundance RBB and YSB on Light trap BSE-G3 Model. DS 2012

YSB that captured on light trap on 9 May (1st-15th May), 24 May (May 16-31), 8 June and (1-15 June) June 22 (16-30 June) were 134; 279; 222; 1, 1461 YSB/15 night (Fig 2) respectively. Abundance of YSB that captured on the light trap indicates a serious damage to significantly decrease production, because the YSB was a k-strategic up to low r- strategic pest.

Observations YSB in Indramayu district on 15 May, 2012 especialy in sub district Gabus Wetan, Kandanghaur and Kroya didn't find YSB and RBB. On 25 June 2012 the intensity of YSB attack in Gabus Wetan, Kandanghaur and Kroya quite high were 9.7, 11.9, and 12.3% respectively.

In Pemalang (Central Java) on the observation of 28 May 2012 showed YSB attack was quite high, especially in the sub district of Pemalang, Taman and Petarukan with average attack intensity 7.6, 14.7, and 16% respectively. The high borer occurred in the village of Widodaren (Petarukan) was 48.1%. On the observation of 28 June 2012 showed that YSB attack on rice in Pemalang, Taman, and Petarukan decreased with average attack intensity were 2.6, 1.3, and 2% respectively.

YSB Through to the Next Season Rice Planting and Relationship between YSB Moth and Egg Masses

In Sukamandi rice research station of Indonesian Center for Rice Research (ICRR) at Ciasem-Sub district and neighboring Pabuaran and Patokbeusi sub district at the time of nursery for planting in the WS2012 / 2013, indicate the population of YSB moth borer was very high. On that time it is necessary to planning seedbeds and planting times by referring to the YSB on light trap. YSB moth and RBB populations that captured by light traps near Saung BB Padi on 1-15 October reached 23,504 and 149,408 tail/15 nights with daily curve on Fig 3. RBB was an idle pest, because although the highest RBB population was captured by the light trap, but did not find in the nursery and damaging rice planted.

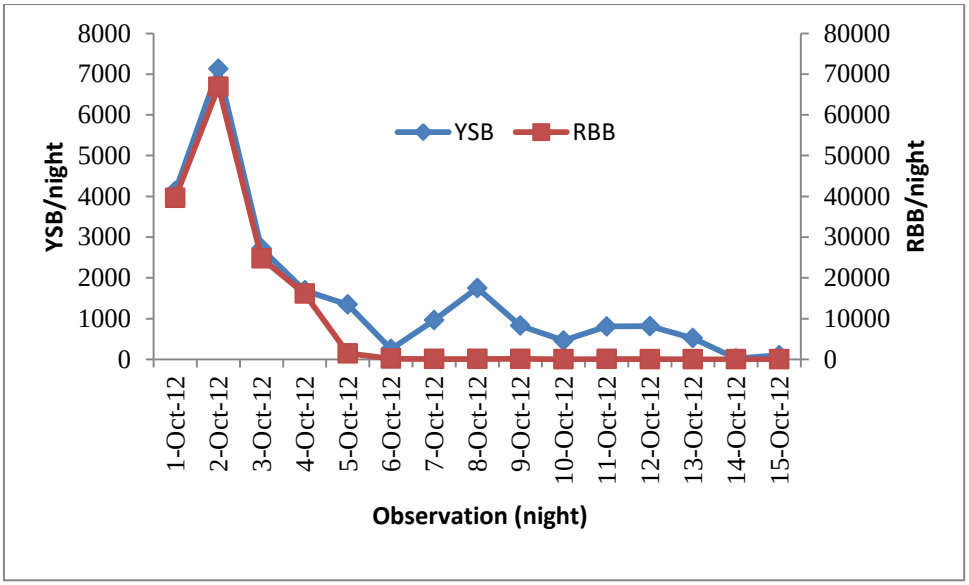

Fig-3: Abundance RBB and YSB on Light trap BSE-G3 Model. WS 2012/2013

Peak population of YSB moth on the light trap occurred on 2 October 2012 was 7,128 YSB/night, then decreased and fluctuated between 18 to 2,720 YSB/night for 15 days (Fig 3). On 2 October 2012 the population of RBB was very high reaching 66,906 RBB/night. This population is almost 10 times to the YSB population. The population of RBB declined and fluctuated for 15 days in early October 2017.

On 3October 2012, observations of moth populations in nurseries showed that the number of moths in the nursery at a distance of 100-1800 m from the trap lights did not show any real difference. At 4,5,6,7, and 8 October 2012 the population of borers at a distance of 100-1300 m were irregularly, not followed by the proximity of the nursery to the light trap will cause the borer to be higher in the nursery followed more closer the nursery to the light trap will cause more higher the borer on the nursery (Table 1).

Table-1: Number of YSB moth on distance nursery of the light trap

Distance nursery from light trap (m)	Number YSB moth on nursery per m^2					
	3 Oct 2013	4 Oct 2013	5 Oct 2013	6 Oct 2013	7 Oct 2013	8 Oct 2013
100	6.33a	2.50 bcd	1.67 bcd	0.50 b	0.33 b	0.67 b
150	4.00a	5.00 a	1.33 cd	0.33 b	0.67 ab	1.00 b
200	4.00a	4.67 ab	3.33 ab	0.33 b	0.00 b	5.67 a
500	6.00a	2.50 bcd	4.00 a	1.00 ab	0.00 b	1.00 b
800	0.50a	0.50 d	1.00 d	0.00 b	0.50 b	1.50 b
1300	2.50a	3.50 abc	3.00 abc	2.00 a	2.00 a	3.00 ab
1800	3.50a	2.00 cd	2.50 abcd	1.00 ab	0.50 b	0.00 b

Remarks: Value in a column followed by the same letter are not significantly different by DMRT at 5% level

On the other hand the number egg masses on nursery in the period of 3-8 October 2012 were not significantly different between distances of nursery with the light trap (Table 2).

Table-2: Number egg masses of YSB moth on distance nursery of the light trap

Distance nursery from light trap (m)	Number egg masses of YSB moth on nursery per m^2					
	3 Oct 2013	4 Oct 2013	5 Oct 2013	6 Oct 2013	7 Oct 2013	8 Oct 2013
100	12.00a	7.83 c	6.00a	0.67a	1.17a	3.00a
150	14.00a	4.00 e	5.00a	1.50a	2.50a	3.50a
200	1.67a	20.33a	4.00a	0.33a	0.67a	1.67a
500	6.50a	6.00 d	5.50a	0.50a	0.50a	2.00a
800	7.50a	8.00 b	4.50a	1.50a	2.50a	3.50a
1300	6.50a	6.00 d	5.50a	0.50a	0.50a	2.00a
1800	7.50a	8.00b	4.50a	1.50a	2.50a	3.50a

Remarks: Value in a column followed by the same letter are not significantly different by DMRT at 5% level

The nurseries every night was visited by YSB then laid the egg masses. After moth egg laying , this moth does not stay in the nursery landing place, but flies back to another place. This fact explains that YSB flights will expand the area of attack by laying eggs everywhere.

The relationship between the number of eggs and moths in nursery is shown by the regression equation with y notation (number of eggs masses/ m^2) as dependent variable, x (number of moth / m^2) as independent variable, a is intercept (constant) and b as the regression coefficient (slope) (Fig.4). The regression as follows:

$y = 1{,}9678x + 0{,}675$; $R^2 = 0.735$

The coefficient of determination $R^2 = 0.735$ showed the number of egg masses on seedbed about 73.5% was explained by abundance of the yellow stem borer on nursery.

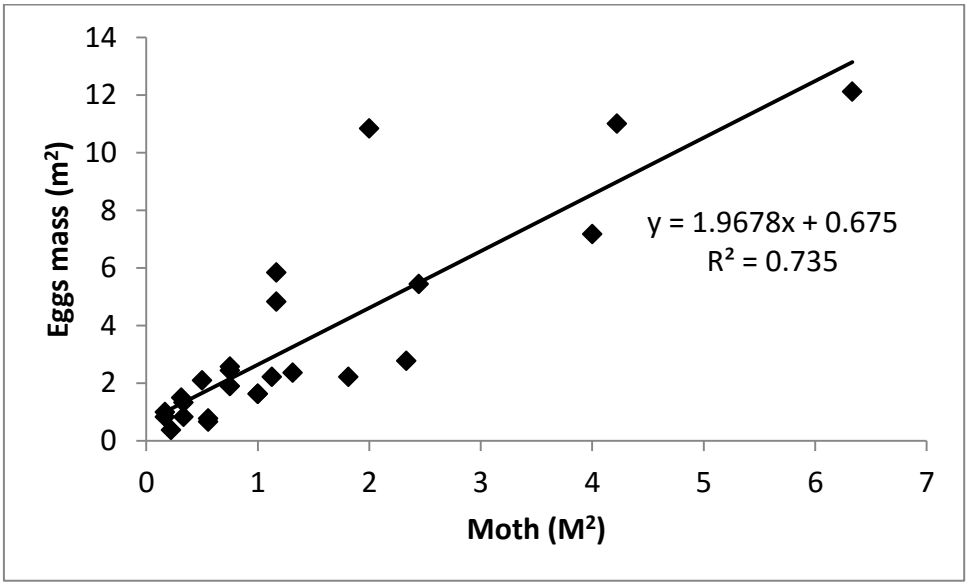

Fig-4:Relationship between number of eggs mass (y) and yellow stem borer (x) on nursery in the field

The relationship between the number of moths in the nursery and the moths caught by the trap lights is shown by the regression equation with y notation (number of moths/m2) as dependent variable, x (number of moths on the light trap) as independent variable, a is intercept (constant), and b as the regression coefficient (slope) (Fig.5). The regression as follows:

$y = 0.0017x - 0.3202$; $R^2 = 0.645$

The coefficient of determination $R^2 = 0.645$ showed the number of YSB on nursery traps about 64.5% was explained by abundance of the yellow stem borer on light trap.

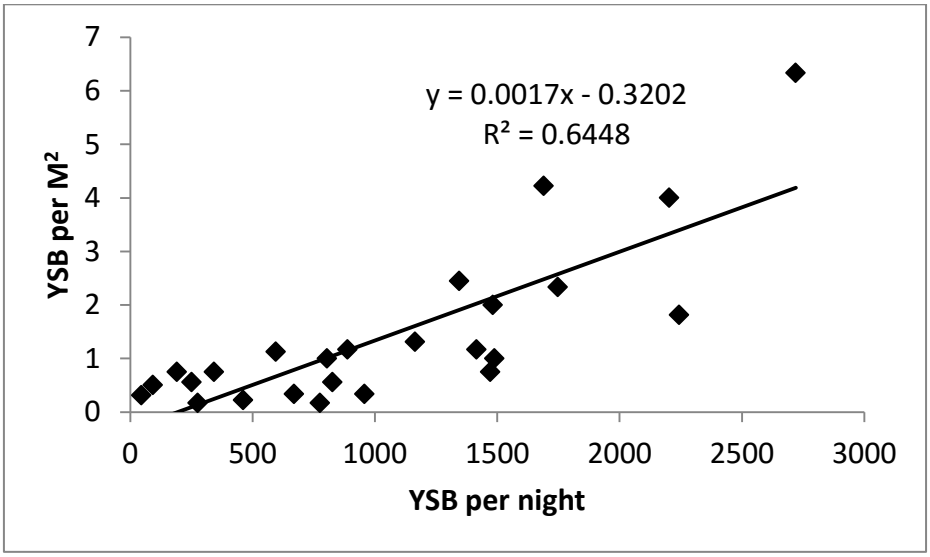

Fig-5: Relationship between yellow stem borer(y) on nursery in the field and yellow stem borer (x) on light trap

The results analysis of the existence of YSB that has attacked on the DS 2012 to become an inoculum for rice cultivation in the next season WS 2012/2013 (Fig.6). This should be the basis of the thinking in the management of YSB that has attacked the previous season's crops will become pests to the following season without aestivation. YSB in Jati Luhur irrigation rice field (include north coastal of West Java) is not entered to aestivation (is a state of animal dormancy, part of diapause in high temperature) in its development from dry season to rainy season, or vice versa. In the other hand the development of white stem borer (WSB), at the end of the dry season, the old larvae do not become pupae, but undergo aestivation in the base of the stem or rice stubble in the soil. In the rainy season (minimal 10 mm precipitation) the pupa coming from the larvae aestivation which will become a moth and lay the eggs in the nursery. Aestivation can occurred in tropical areas that have distinct rainy and dry seasons, or in rainfed areas during dry season or in irrigated areas when the dry season cannot irrigated water.

The most crucial to the sustainability of the YSB attacks is the interconnection of plants between seasons one to the next season, providing a suitable food for pest development. The YSB pests also become a seasoned passers pest that will success in the rice areas when food sources continue to next season or overlap from different ages in one season. Therefor when there was a YSB pest attack in a season, it is necessary tactic by shifting the time nursery for the next season. The nursery for the next season is done 15 days after the peak population of YSB captured on the light trap at the end of the harvest.

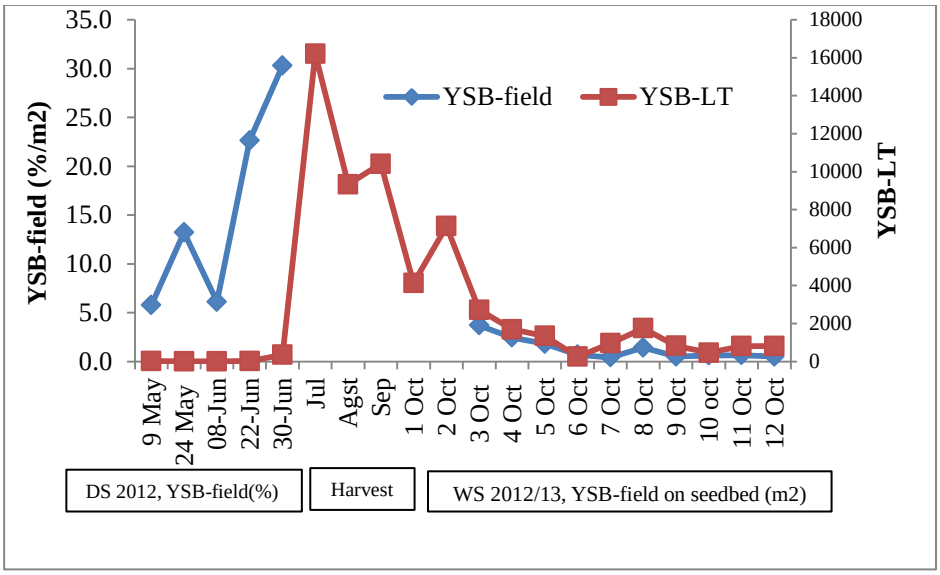

Fig-6:Continuity of YSB attack from DS 2012 to WS 2012/2013

There was very close relationship between the number of eggs YSB and YSB moth in the nursery with a real positive correlation. Likewise there was very close relationship between the number of YSB moths in the nursery as much 64.5% were explained by YSB moths that caught on the lights trap, while as many 35.5% were determined by the other factors. Actually the flight of pests the most cause by abundance of pest in the ricefields that interested to lamp light and in the other hand the pests's flight insignificantly influenced by abiotic factors. The meteorological factors had insignificant effect to pests flight of rice yellow stem borer, rice pink stem borer, rice black bug, and brown planthopper that catched in the lihgt trap of mercury lamp and CFL [12]. Møller [13] reported that abundance of flying insects decreased strongly with increasing wind speed during summer.

The number of moths in the nursery and the number of moths in light traps indicates very useful tool for early monitoring to determine if there will be a YSB pest explosion. Baehaki *et al.* [10] reported that Light trap of solar cell (CFL-20 watt) used for monitoring of immigrant and emigrant pests, whereas electric light trap of mercury (ML-160 watt) BSE-G3, of BSE-G4 model, and BSE-Giant models used for monitoring and reducing of immigrant and emigrant pests. Furthermore Baehaki *et al.*, [14] reported the light traps reduce of rice pests population, but do not reduce population of predators and do not disturb to predators performance.

Although controlling of YSB is application of sex pheromone traps in India and other Southern Asian countries [15], but use of insecticides is a major option for YSB management in most Asian countries, and new insecticides have been introduced. In Pakistan, have been tested the efficacy of different emulsifiable concentration (EC) of 5 insecticides [16]. In Haiphong, in heading stage of the rice, it has been recommended to

spray when the density of egg masses is beyond 0.3 egg mass per m^2. In addition, the second spray has been recommended when the density of egg masses is beyond 1 egg mass/m^2 after to keep the percentage of white heads under 5% [3] .

Light trap is a tool for attracting insects that reliably capture immigrant and emigrants insects used as non-chemical insects pest control. In the other hand the pests caught on the trap can be used in an early warning system of some type, to estimate number of pests in the rice crop and to determine the economic threshold [17]. The light trap data to determine a new economic threshold (ET) of rice stem borer, where as decision making control of insecticides is done on 4 days after the moth caught in the light trap, because after 4 days since the moth landing, eggsmass which were laid to begin to hatch [1]. In the old ET to borer control base on 5% dead heart or 9% white head were very detrimental, because borer control is done at the time of yield already lost. The YSB attack at vegetative stage will be yield losses amount 31.68 kg grain/ha for every increase of 1% dead heart and YSB attack at generative stage will be yield losses about 1% for every 1% increase of white head in short-lived rice varieties or 0.8% yield losses for every 1% increase of white head in long-lived rice varieties [1]. Monitoring of pests by light trap useful for planning a nursery and planting time that could begin in 15 days after the peak pests flight on the unimodal (one peak) or on the 15 days after the second peak pests flights on the bimodal (two peaks) catches pests curve.

YSB moths that laid egg msses on rice plants (on seedbed, tillering phase, or generative phase) will hatch starting 4 days after egg laid. A few hours after the instar-1 larvae appear, they gather around the eggshell, then begin to borer and enter to the leaf blade toward to the initial growth. The symptoms of borer attack on the vegetative phase called sundep (Indonesia = dead hearts) with the symptoms of the young leaf died. Symptoms of generative phase are called beluk (Indonesia = white heads) with the symptoms of panicle died, empty grains and white color. Panicle of rice is easily removed because the basal of the panicle is cut off due to YSB larvae. Symptom dead hearts has been seen since 4 days after the larvae borers. The borer larvae always go in and out move to the other rice straw, because the complete development from larvae to adult moth required 6-15 tillers of rice [1]. The larvae are almost always in the hole inside the plant, making it difficult to touch by natural enemies or insecticides.

To more understanding of pest-natural enemy-insecticide interaction is needed to formulate more effective integrated pest management strategies [18]. Therefore, it should be understood the damage on nursery as well as on the transplanted up to maximum tillering stages causing dead heart. The critical infestation of the YSB occurred during vegetative and panicle initiation. Damage to the nursery due to the borer attack is a serious mistake, because if the nursery has been attacked YSB will be brought to rice transplanted. The development of larvae on the rice transplanted to complete its life cycle into adult moth and will become an inoculum for generative plants.

CONCLUSIONS

The results showed that rice stem borers cause an explosion in the Western part and Eastern part of Sukamandi rice research station of Indonesian Center for Rice Research (ICRR) at Ciasem- Subang district. In the North coastal of Java the damage area of YSB not only in Subang District -West Java but also in Pemalang District-Central Java.

The YSB attack on the DS 2012 became an inoculum for rice cultivation in the next season WS2012/2013. RBB was an idle pest, because although RBB in high populations was captured on the trap lights, but there didn't damaged to rice crops

There was a very close relationship between the number of eggs YSB and YSB moths in the nursery with a real positive correlation. Likewise there was a very close relationship between the number of YSB moths in the nursery and YSB moths that captured on the light trap with a real positive correlation. This indicates that the number of moths in the nursery and the number of moths in light traps were a very useful tool for early monitoring system to expect a YSB explosion in rice plantation.

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