Major Rice Pest Development After Increasing Rice Planting Index and Acceleration of Planting Time in Lampung Province

I N Widiarta\textsuperscript{1*}, Kiswanto\textsuperscript{2}, and A A Rivaie\textsuperscript{2}
\textsuperscript{1}Indonesian Center For Food Crop Research and Development, Jl. Merdeka 147, Bogor 16111
\textsuperscript{2}Indonesian Assessment of Agricultural Technology, Lampung.

*Corresponding author: manwidiarta@yahoo.com

Abstract. Agriculture development in Indonesia has been targeted to attain food resilient by increasing rice production. Lampung has been involved in rice production increasing activity since 2008 up to now. Rice transplanted area in Lampung was increased by distinctive effort by mean of increasing rice planting index and acceleration of planting time to boost rice planting areas as well as production. The objectives of this study were to observe pest before and after; as well as ongoing rice field with and without increasing rice planting index and acceleration of planting time, and to analyze factors involved in the pest attack. The results showed that brown planthopper and rat were main pest problem. Infested area by brown planthopper and rat were negatively correlated with delayed planting but were increased by increasing planting index. The rise of brown planthopper populations was affected by pest management, planting system, integrated crop management implementation, and resistant variety planted. Meanwhile, the increase of rat attack was influenced by increasing of rice planting index, acceleration of planting time, and the dose of urea fertilizer. The brown planthopper and rat threaten sustainability of rice production in which increasing rice planting index and acceleration of planting time were implemented.

Keywords: planting time, planting index, pest

1. Introduction

Food resilient is one of a focused program on agricultural development in Indonesia to increase production and added value of strategic crops as well as farmer welfare. Rice farming has been intensified to meet domestic demand on rice caused by high rate in rice consumption and population increase [1]. Lampung province as one of rice bowl among 34 provinces in Indonesia has participated in rice production increase since 2008. Although an average rice yield was less than 5 ton/ha [2], the Government of Lampung province targeted to produce 3.6 metric tons of rice, which will be harvested from 707.266 ha rice field. Therefore, rice yield should be increased more than 5 ton/ha [3]. Adoption of new technologies, expansion of planting areas, farmer institution development and financial support are necessary.
Intensification and expansion of planting areas programs were implemented to increase rice production. The aim of rice intensification was to increase land productivity by introducing new technologies and hence increasing yield and decreasing pre-harvest yield lost could be achieved [4]. Expansion of planting areas was implemented by extending a new area of planting and increasing planting index. A distinctive effort on increasing rice production was implemented by means of increasing rice planting index and acceleration of planting time. Rice planting area in Lampung was increased from 722.625 ha in 2015 to 832.645 ha in 2016. Meanwhile, as a result, planting index was also increased from 1.96 to 2.25 times. However, rice yield decreased from 5.149 t/ha to 4.993 t/ha. Pest infestation was considered the main factors for rice yield drop [3].

Pest is a result of the triangle relationship between pathogen/insect, host, and environment. Changes in one component will change the balance of triangle relationship, those can trigger pest outbreak [5, 6]. Increase in planting index will be prolonged host availability, as well as promoting pest occurrence which will affect yield. Oka [7] reported that continuous rice planting during off-season trigger pest occurrence. Staggered rice planting provide suitable host for pest development which will also reduce the yield. Increasing rice planting index and accelerate planting time create off-season rice planting, those will in favor for pest development. Brown planthopper (BPH), rat, and stemborer were reported as important pest in Lampung [8]. The high-density population of BPH caused hopper burn. Climate condition such as temperature and humidity influence pest development, instead of host [9]. Pest occurrence can be dynamics caused by interaction between biotic and abiotic environments [10]. Pest monitoring and judiciously used of pesticide should be implemented on increasing rice planting index and acceleration of planting time to prevent outbreak [11]. The objectives of this study were to observe pest before and after; as well as ongoing rice plantation with and without increasing rice planting index and acceleration of planting time, and to analyze factors involved in the pest attack.

2. Materials and methods

2.1. Field study

The study was conducted in two regencies. Two sub-district were selected in each regency and finally three villages were selected from each sub-district. Rejo Asri, Rejo Basuki and Rukti Harjo villages in Seputih Raman regency and Kota Gajah Barat, Kota Gajah Timur, Sumber Rejo in Kota Gajah regency were selected as study location in Central Lampung. Rejo Katon, Rama Indra, Restu Rahayu villages in Raman Utara regency and Purwosari, Tulung Balak, Kedaton II villages in Batang Hari Nuban regency were selected as study location in East Lampung province. The farmer interview was conducted to 5-10 respondents in each village. Studies were conducted in the period of March-December 2017.

2.2. Data collection and analysis

Pest condition and rainfall before and after (pre-post) implementation of increasing rice planting index and acceleration of planting time in the period of 2014-2016 were obtained from Institute of Plant Protection and local Meteorological Office in Lampung for the period of 2013-2017, respectively. Field observation of pest was conducted in the rice field which implements or not increasing rice planting index and acceleration of planting time of (with-without). In this study acceleration planting time means reduce duration of fallow period 45-90 days to 30-45 days between two planting times.

Pest observation was conducted in the farmer field using pest surveillance guideline for pest observer [12]. Pest observation was conducted twice in each planting season in 2017 to identify pest species, population density, and crop damage. Farmer interview was conducted to understand how farmer doing pest management practices, culture practices, planting pattern, variety selection and fertilizing. The interview was conducted twice in the second and third of 2017 crop season to 68 cooperative/non-cooperative farmers respondents using structured questionnaire.
Pest infested areas and rainfall before and after implementation of increasing rice planting index and acceleration of planting time were tabulated to understand their correlation. Interview data, as well as data of field observation such as population density and crop damages, were converted to quantitative value by using Likert scale [13]. Crop damage categorized as: (1) healthy: no damage until degree of damage below economic injury level (EIL); (2) lightly: on the EIL up to 25% damage intensity; (3) moderate: 25%-50% damage intensity; (4) severe: 50-85% damage intensity and (5) completely damage: damage intensity over 85%.

Absolute damage intensity of pest was calculated using the following formula:

\[ I = \left( \frac{a}{b} \right) \times 100\% \]

I: Damage intensity (%)
a: Number of plant or part of plant invested among samples
b: Number of samples

Score was adopted to calculate relative damage intensity. Relationship between score and damage described as following number:

0 = no damage
1 = percentage of damage 1 – 20 %
3 = percentage of damage 21 – 40 %
5 = percentage of damage 41 – 69 %
7 = percentage of damage 61 – 80 %
9 = percentage of damage 80 %

Relative damage intensity was calculated using formula:

\[ I = \frac{\sum (n_i \times v_i)}{Z \times N} \times 100\% \]

I = damage intensity
Ni = number of plant/part of plant invested with i-th score
Vi = value of i-th score
N = number of samples.
Z = highest score

Multiple regression analysis was employed to analysis pest damage causing factor using the following formula:

\[ Y = b_0 + b_1X_1 + b_2X_2 + b_nX_n + e \]

where:
Y = Damage intensity
b0 = Intercept
b1…bn = Regression coefficient
X1..Xn = Independent variables (farmer status, planting system, accelerated planting, pesticide, fertilizer, planting pattern, culture practices, integrated pest management, etc)
e = Residual error.

Coefficient determinant \((R^2)\) explains on how independent variables explained damaged intensity as fix variable. Rank Spearman correlation was employed to know relationship between acceleration planting time or increasing planting index to pest damage.

3. Results

3.1 Pest and disease-infested area 2014-2016 (before-after)
Pest and disease-infested areas after implementation of increasing rice planting index and acceleration of planting time in 2016 were increased in comparison with 2015 for both in Central Lampung and East Lampung provinces (figure 1 and 2). Brown planthopper, rice stemborer, and rat-infested area
significantly increased in Central Lampung (figure 1). At the same time blast disease slightly increased in 2016. While in East Lampung, BPH and stemborer infested areas were higher in 2016 than 2015 (figure 2).

3.2. Pest and disease in 2017 (on-going)

Rat, BPH, stemborer, and blast disease damage observed during vegetative and generative stages of rice in the implementation area of increasing rice planting index and acceleration of planting time in second crop season in 2017 (table 1). Rat, BPH, stemborer, and blast disease damages in non-implementing areas were lower than in the implementing area. Cropping pattern using corn or soybean was implemented by farmers in non-implementing area in the third crop season in 2017. Leaf folder, rat, bacterial leaf blight (BLB), and blast diseases were observed in the implementing field in the third crop season in 2017.

![Figure 1. Pest (rat, brown planthopper, stemborer) and disease (bacterial leaf blight, blast) infested area in 2014-2016 in Central Lampung.](image)

3.3. Analysis factors of pest damage intensity.

Analysis factor affecting on damage intensity was focused on the important pest, BPH and rat. In general all variables i.e. farmer status on pest management, planting system, amount of organic fertilizer, acceleration planting, integrated crop management (ICM) implementation, integrated pest management (IPM) implementation, volume of pesticide, nitrogen fertilizer and variety significantly affected damage intensity caused by BPH at 1% standard error (table 2). Furthermore, in detail only farmer status on IPM, planting system, ICM implementation, and variety selection variables significantly affected BPH damage intensity.

Analysis of factor affecting damage intensity for rat damage was shown in table 3. All variables i.e. farmer status on pest management, planting system, amount of organic fertilizer, acceleration planting, ICM implementation, IPM implementation, volume of pesticide, nitrogen fertilizer and variety overall significantly affected damage intensity caused by rat at 1% standard error. Furthermore, in detail only acceleration planting, planting index and nitrogen fertilizer variables significantly affected rat damage intensity.
5

Figure 2. Pest (rat, brown planthopper, stemborer) and disease (bacterial leaf blight, blast) infested area in 2014-2016 in East Lampung.

Table 1. Pest and diseases damages in second crop season in 2017.

| Location                                                                 | Damage on Vegetative stage (%) | Damage on Generative stage (%) |
|--------------------------------------------------------------------------|--------------------------------|--------------------------------|
|                                                                          | BPH   | Rat  | Stemborer | Blast | BPH | Rat  | Stemborer | Blast |
| Area of increasing rice planting index and acceleration of planting time | 0     | 20   | 1,55     | 2,0   | 25  | 33   | 1,91      | 2,5   |
| Non-Area of increasing rice planting index and acceleration of planting time | 0     | 10   | 1,5      | 1,2   | 20  | 25   | 1,5       | 1     |

Table 2. Pest and diseases damages in third crop season in 2017.

| Location                                                                 | Damage on Vegetative stage (%) | Damage on Generative stage (%) |
|--------------------------------------------------------------------------|--------------------------------|--------------------------------|
|                                                                          | Leaf folder | Rat  | BLB  | Blast | Leaf folder | Rat  | BLB  | Blast |
| Area of increasing rice planting index and acceleration of planting time | 3,11        | 0    | 4,21 | 2,0   | 3,34        | 2,9  | 3,18 | 2,21 |
| Non-Area of increasing rice planting index and acceleration of planting time | Corn or soybean was planted in the areas |                                |

3.4. Correlation between planting time and planting index to pest attack.
Brown planthopper attack negatively correlated with a fallow period as well as rat (table 4 and 5). Prolonged fallow period tends to reduce BPH and also rat attack. In opposite way, their damages tend to increase by increasing planting index.
4. Discussion

Rat, BPH and blast disease were common rice pest and disease in tropical Asia [14]. Pest occurrence in the area was affected by climate, especially humidity fluctuation related to the annual rainfall pattern [15]. The wet-dry season which usually affect pest occurrence, particularly BPH [16] only occurred in 2013 during a period of 2013-2017 in Central and East Lampung provinces. Therefore, BPH population increase in 2016 was probably not affected by wet-dry season.

**Table 3.** Factor analysis for BPH damages in the second crop of 2017.

| Variable                      | Regression coefficient | T-calculated | Significance |
|-------------------------------|------------------------|--------------|--------------|
| Farmer status on IPM          | -9.835***              | -2.188       | 0.033        |
| Planting system               | -10.189****            | -3.251       | 0.002        |
| Dosage of organic fertilizer  | 0.001ns                | 0.998        | 0.322        |
| Acceleration planting         | -0.053ns               | -0.524       | 0.602        |
| Planting index                | 2.103ns                | 0.495        | 0.623        |
| ICM implementation            | -7.853*                | -1.334       | 0.187        |
| IPM implementation            | -2.951ns               | -0.409       | 0.684        |
| Pesticide volume              | -0.077ns               | -0.264       | 0.793        |
| Dosage of urea                | -0.004ns               | -0.387       | 0.700        |
| Variety                       | -10.163****            | -3.305       | 0.002        |
| Constant value                | 93.435                 | 2.781        | 0.007        |
| \( R^2 \)                     | 0.735                  |              |              |
| \( F \)-calculated            | 6.697                  |              |              |

**Table 4.** Factor analysis for rat damages in the second crop of 2017.

| Variable                      | Regression coefficient | T-calculated | Significance |
|-------------------------------|------------------------|--------------|--------------|
| Farmer status on IPM          | 1.093ns                | 0.144        | 0.886        |
| Planting system               | 3.647ns                | 0.700        | 0.487        |
| Dosage of organic fertilizer  | 0.001ns                | 0.206        | 0.838        |
| Acceleration planting         | -0.505****             | -3.022       | 0.004        |
| ICM implementation            | 2.310ns                | 0.235        | 0.815        |
| IPM implementation            | 2.851ns                | 0.217        | 0.829        |
| Planting index                | 10.052*                | 1.405        | 0.166        |
| Dosage of urea                | 0.080***               | 2.041        | 0.046        |
| Pesticide volume              | -0.220ns               | -0.300       | 0.765        |
| Variety                       | 1.342                  | 0.258        | 0.797        |
| Constant value                | 47.611                 | 0.840        | 0.405        |
| \( R^2 \)                     | 0.501                  |              |              |
| \( F \)-calculated            | 1.915                  |              |              |

**Table 5.** Correlation between planting time and planting index to BPH and rat attack in second cropping season in 2017.

| Variable       | Damage intensity of BPH | Damage intensity of Rat |
|----------------|-------------------------|-------------------------|
|                | Coefficient correlation | Significance            | Coefficient correlation | Significance |
| Planting       | -0.157                  | 0.100                   | -0.486                  | 0.001        |
| Acceleration   |                         |                         |                         |              |
| Planting index | 0.326                   | 0.003                   | 0.490                   | 0.001        |
Farmer status on IPM implementation significantly affected BPH infestation as found by this study. Farmers who implementing IPM managed to control BPH as shown by alumnus of farmer field school. The alumnus have mastered to grow healthy crops as well as how to conserve natural enemies [17]. Farmer willingness to participate in implementing IPM was key success to control BPH [18]. Alumnus of farmer field school learned a novel aspect of implementing IPM and realized negative effect of irrational used of pesticide. Ratna et al. [19] reported that sub-lethal as well as overdoses of pesticide derived BPH population outbreak. The adoption rate of leaf color chart by farmers was low, those meant that overdose of urea application may contribute to increasing BPH damage [20]. Htwe and Singleton [21] agreed that overuse of nitrogen also increased rat population. Rat population outbreak in South Sulawesi was reported caused by continuous rice planting and asynchronous harvesting [22]. Synchronous planting restricted host availability for rat as well as BPH, therefore, damage can be reduced [18, 23]. Those increasing rice planting index and acceleration of planting time increase duration and quantity availability of food for rat and also BPH.

5. Conclusion
A distinctive effort on rice production enhancement by mean of accelerating planting time and increasing planting index were main factors caused increasing in pest and disease threat, particularly brown planthopper and rat in which threatening sustainability of rice production.

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