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Effectiveness of neem based biopesticide to enhance rice (*Oryza sativa*) productivity

Puteri Sarah Diba Kamarulzaman[a], Suzana Yusup[a,*], Noridah Osman[a], Noor Hafizah Ramli@Yusof[a], Benjamin Wei Bin Kueh[a], Raudah Talib[b]

[a] *Biomass Processing Laboratory, Center of Biofuel and Biochemical Research, Mission Oriented Research (Green Technology), Chemical Engineering Department, Universiti Teknologi PETRONAS, 32610 Bandar Seri Iskandar, Perak, Malaysia*
[b] *Agriculture Department of Perak Tengah, 32600 Bota, Perak, Malaysia*

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ABSTRACT

Rice contributes towards food security and consumed widely by about 2 billion people in Asia. Losses because of pest and diseases are considered as the main constraints in rice production. Wide ranges of methods have been applied to control pests however conventional pesticide is the most widely practice. Biopesticide which is more environmental friendly can be the alternative for paddy cultivations. Bioactive secondary metabolite azadirachtin compound which is present in neem (*Azadirachta indica*) could be used to produce effective biopesticide that possesses insecticidal properties. The effectiveness of the biopesticide derived from neem is assessed with its application on the actual paddy field and compared with conventional pesticide with niclosamide as its active ingredient. The paddy yield component and paddy yield were recorded and the traits associations are determined using statistical analysis. Descriptive data of biopesticide for range, mean and standard deviation of yield components such as number of panicle per m^2 (368.8 ± 11.4), panicle length (25.3 ± 0.19), percentage of productive spikelets per panicle (80.8 ± 1.13), 1000 grains weight (27.7 ± 0.10) and grains yield per m^2 (1151.3 ± 46.8) were notably higher than conventional pesticide. Biopesticide showed higher rice yield components at 5% level of significance as indicated by *t-test* analysis. Based on the results, the productivity of rice yield after application of biopesticide was verified to be positive interdependent with the components studied. Higher grain yield is obtained for biopesticide with higher positive association among the grain yield and yield components which offered an alternative for healthier rice cultivation.

1. Introduction

Rice, scientifically known as *Oryza sativa* plays a vital role in contributing towards food security and it is widely consumed as staple food by about 2 billion people in Asia (International Rice Research Institute, 1993; Pareja et al., 2011). To increase the production of rice with increasing population, there is an urgent need to enhance the productivity of irrigated paddy fields. However, Malaysian warm and humid weather attracts a number of pests that severely affects the productivity of paddy fields leading to reductions in overall rice yield. Appropriately over 800 herbivore insect species inhabit the ecosystem (Prasad, 2010). According to Matteson (2000), the major reason of low rice yield in the tropical Asian region is due to vitiation of insects and pests. In addition, various types of diseases caused by virus, bacteria and fungi affecting the growth and rice yield. Anand et al. (2014) reported that the major insect pests at national significance in rice production are brown plant hopper , leaf folder, yellow stem borer, gundhi bug, white backed plant hopper , gall midge while the major rice diseases are sheath blight , rice blast, brown spot , bacterial leaf blight and false smut. Other than that, San Martin et al. (2008) also identified that golden apple snails (Pomacea canaliculata) as the major serious pests facing by the farmers as it induces damages by eating the young leafs and stems of the paddy plant completely. Other common rice pests found in Asia are rice bugs (Leptocorisa oratorius) and black paddy bug (Scotinophara coarctata). In our current studies, the pests and diseases that faced by the farmers in Bota Perak are golden apple snails, brown plant hopper, bacterial leaf blight, brown leaf spot, sheath brown rot and panicle blast. Thus, in order to increase the competence for soils, energy, water, labor and others while increasing the overall yields, pest management is crucial in these context.

A vast of approaches has been practiced physically and chemically to control pests but the chemical spray is the most widely and extensive

* Corresponding author.
E-mail addresses: put3.sara89@gmail.com (P.S.D. Kamarulzaman), drsuzana_yusuf@utp.edu.my (S. Yusup), noridah.osman@utp.edu.my (N. Osman), anihafizah@gmail.com (N.H. Ramli@Yusof), benjamin.kueh_g03616@utp.edu.my (B.W.B. Kueh), raudahtalib@gmail.com (R. Talib).

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practice used in controlling pests (Shahid et al., 2003). The reasons behind is due to its effectiveness after application with simple handling. Thus, an increment in the utilization of pesticides has been noticed in recent time (Debashri and Tamal, 2012). Agricultural production could be increased with the application of chemical pesticides (Debashri and Tamal, 2012) but heavy dependence on chemical pesticides to deal with the pests could ends up in ecological distress and health related problems (Wakilet et al., 2011; Cantrell et al., 2012). For instance, ceaseless use of chemical pesticides has resulted in environment pollution, human ill-health as well as negatively impacted on agricultural production and sustainability (Pimentel, 2005). The toxic pesticide is extremely harmful to public health when exposed through consumption, dermal contact or inhalation. Chronic health effects such as cancer, neurobehavioral changes, liver abnormalities, kidney dysfunction and parkinson's disease may occurred after extended period of exposure with a lack of awareness of safety protocol while handling pesticides among farmers (Kim et al., 2016).

Correlation analysis is used as consistent methods to study the effectiveness of the biopesticide by evaluating the dependencies and association between the yields components and rice productivity. The agronomic characteristics are normally correlated with yield in the study. One of the quantitative characters, rice grain yield is greatly influenced by numerous environmental factors. Lakshmi et al. (2014) also reported that the study of the relationship between the grain yield with its components characters such as plant height and grains number per panicle are significant for enhancement of grain yield.

Rice grain yield is positively correlated with plant height (Bhadru et al., 2011; Yadav et al., 2011; Lakshmi et al., 2014), percentage of productive spikelet (Ranawake et al., 2014; Pradhan et al., 2015) and grains weight (Rajeshwari and Nadarajan, 2004; Mirhoseini et al., 2013). To date the study of efficacy of the biopesticide derived from neem on actual paddy field condition are still limited. In conjunction, the insight of the endurance of paddy plants against pests after the application of biopesticide is analyzed through quantification of Pearson's correlation coefficients between the paddy yields with the rice characteristics using statistical package for social science (SPSS) software. The objective of the study is to derive the correlation between yield components and the rice grain yield to assess the effectiveness of neem-derived biopesticide.

2. Material and method

2.1. Site location

The study spot was situated at Excellence Center of Paddy, Titi Serong, Parit Buntar, Perak, Malaysia with geographical coordinates of Latitude: 5° 06' 60.00" N, Longitude: 100° 29' 59.99" E.

2.2. Field test

Both biopesticide and conventional pesticide is applied on 0.72 ha paddy field. Two fields with two blocks each were prepared where one of the fields was applied with biopesticide whilst another with conventional pesticide with niclosamide as its active ingredient. Lowland rice cultivation was used and the variety planted has a growth period of 105-115days. Direct seeding of three-germinated seeds with seeding weight of 150 kg/ hectare was applied for the 0.72 ha of the studied plot. Neem derived biopesticide of BV 500WS and BV 612EC were acquired from collaborative partner, Bio-X Techno Sdn Bhd company. Locally derived rice (*Oryza sativa*) variety was employed. The seeds for the case in biopesticide plot were dipped in diluted biopesticide BV 500WS with water before sowing. As for the conventional site, the seeds were immersed in water beforehand prior to sowing. The crop management which includes fertilizing, weeding and other protection was implemented. For biopesticide plot, BV 612EC was then sprayed for pest control after sowing of seeds while for conventional plot, conventional pesticide was sprayed.

2.3. Crop cutting analysis

The analysis of crop cutting is utilized to estimate the yield of rice in particular area. Tiller density is determined by counting the total number of tillers over an area of 0.5 m × 0.5 m taken at the center of the field. The samples are manually cut with a sickle at the base of all tillers together with the leaves and panicles in the quadrant at harvesting stage. The panicles are used for yield component study. Twelve samples for each replicates are selected inside each plot with a total of 6 plots for analysis. 48 randomly paddy plant samples with maximum growth stage from the total were used for data analysis for yield characteristics.

2.4. Assessment of rice yield attributing component

Plant height (cm), number of panicle per meter square, panicle length (cm), number of spikelets per panicle, number of productive spikelets per panicle, percentage of productive spikelets, 1000 grains weight (g) and grain yield per meter square (gm^{-2}) are measured from the maximum growth stage of 48 randomly selected paddy from each of the block. The grains were sun-dried till 14% moisture content, threshed and were cleaned thoroughly. Thousand grain weights (g) were then counted independently and weighed from the threshed product of each plot.

2.5. Data analysis

The analysis was conducted at Excellence Center of Paddy, Titi Serong, Parit Buntar, Perak, Malaysia. Statistical analysis of the data collected is done using SPSS version 16.0. Frequency distribution, t-test and correlation coefficient analysis are calculated. The data analysis specifically for Pearson's Correlation Coefficient and independent samples t-test, adopts the previous works carried out by Kamarulzaman et al. (2016).

3. Results and discussion

3.1. Descriptive data and t-test

Table 1 shows the approximate for mean, range and standard deviation for yield components of both biopesticide and chemical

Table 1
Descriptive statistics for biopesticide and chemical pesticide components.

Components	Pesticide	Mean ± SE	Min-Max	Std. Dev
Plant height (cm)	Biopesticide	104.3 ± 0.44	101.0–110.7	3.02
	Chemical	114.8 ± 0.73	105.0–120.2	5.09
Panicle length (cm)	Biopesticide	25.3 ± 0.19	22.0–27.0	1.33
	Chemical	25.2 ± 0.16	23.0–26.0	1.09
No. of panicle/m^2	Biopesticide	368.8 ± 11.4	204.0–537.0	79.1
	Chemical	279.3 ± 10.9	148.0–519.0	75.5
No. of spikelets/ panicle	Biopesticide	140.7 ± 3.77	88.9–198.0	26.1
	Chemical	182.1 ± 5.47	110.1–266.2	37.9
No. of productive spikelets/panicle	Biopesticide	113.9 ± 3.60	61.6–166.3	24.9
	Chemical	127.9 ± 5.33	59.8–209.8	37.0
% of productive spikelets	Biopesticide	80.8 ± 1.13	54.5–93.6	7.85
	Chemical	69.8 ± 1.77	44.0–91.0	12.2
1000 grains weight (g)	Biopesticide	27.7 ± 0.10	26.8–29.1	0.67
	Chemical	25.6 ± 0.09	24.3–26.7	0.62
Grains yield (g/m^2)	Biopesticide	1151.3 ± 46.8	562.6–2089.0	324.1
	Chemical	897.5 ± 41.4	255.2–1556.0	286.6

SE = Standard error indicates the differences between the sample mean data with the true population mean.
Min-Max =Minimum to maximum indicates the range of the data values Std. Dev = Standard Deviation is used to quantify the dispersion of a set of data values to mean value.