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INFLUENCES OF PACLOBUTRAZOL ON GROWTH, YIELD AND ITS ACCUMULATION OF RICE OM18

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ABSTRACT

Reducing height and increasing tiller number of rice is Paclobutrazol, which has been used by farmers for a long time and high contents. The main aims of this study were evaluated: (i) effects of paclobutrazole on the growth, yield composition and yield of rice OM18, (ii) PBZ accumulation of crop soil and its accumulation on stems and grains. The field experiment was carriout in randomized complete block design (RCBD) with four plots (R1: 70 N - 60 P - 30 K kg/ha, R2: 3.0 kg PBZ/ ha, R3: 3.5 kg PBZ /ha, R4: 4.0 kg PBZ /ha) and four replications. The research results observed that soil pH and plant height of PBZ amendment treatments (R2, R3 and R4) reduced significantly comparison with control treatment (R1). Number of available tillers at 42 DAS in three treated treatments of PBZ were higher than those of control treatment. However, there were insignificant differences and remarkable decrease of available tillers at 72 DAS. The yield composition and yield of rice OM18 were not remarkably various among treated and untreated treatments. Especially, PBZ store of soil, stems and grains was higher than the control treatment from 76.2, 98.6 and 100%, respectively. From this study, it may be suggested for local farmers to stop using PBZ, which can improve to pollute the crop soil environment and enhance agricultural quality.

KEYWORDS: accumulation, available tiller, paclobutrazol, rice OM 18,

1. Introduction

Rice (*Oryza sativa* L.), which is one of the most important food crops planted around the world, is an indispensable staple food crop for Asia in general and Vietnam in particular. The cultivated area of Vietnam is about 7.9 million hectares and the everage rice yield obtains 5.16 t/ha in 2021-2022 [1]. Today, farmers have been using many types of plant growth regulators through foliar and root fertilizers. Among plant growth regulators to increase rice yield, paclobutrazol (PBZ) plays an important role for the growth and yield of rice [2]. Paclobutrazol has the ability to improve the physiological response of plants under stress conditions including drought [3]. Paclobutrazol has beneficial effects on plants such as stimulating tillering, increasing number of shoots and number of heads; thus, increase rice yield [4]. When more new shoots are created, more new roots are also promoted [5]. Furthermore, many new rice shoots rice could be created many nodal points of rice roots, which plays an important function of the root system to take much more water under limited irrigation water conditions [6]. The prior study of Chuong (2020) [7] showed that 100% of local farmers, who has been using high levels of PBZ

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for a long time during ten continuous seasons mixed PBZ with inorganic fertilizer to apply to the first stage rice from 20 to 25 days after sowing (DAS) and 40 - 45 DAS. paclobutrazol has been using in rice cultivation to raise the growth, productivity and quality of rice. Two advantageous and disadvantageous impacts of PBZ on matureness as well as rice metabolism were demonstrated that average weight of PBZ was used 3 kg/ ha [8] (Ashraf et al., 2011). According to recent research of Chuong and Lap, (2019) [9], demonstrated that high application of PBZ (3 kg/ha) did not increase the yield constituent and yield of rice IR50404 comparison with control treatment (without PBZ application). Moreover, the highest Content of PBZ in rice stems (2, 22 0 ppb) and grains (550 ppb) observed in treatment with 3.0 kg PBZ/ha; conversely, the lowest PBZ content was not detective in rice grains and in stems (34.0 ppb). The goal of this study is to discover the impacts of PBZ on yield components, yield, and its accumulation on crop soil, stems and grains of rice OM 18

2. Materials and methods

2. 1. Time and location of the experiment

A field experiment was designed from December 2021 to April 2022 in Chau Thanh district (10°25′58″N, 105°23′4″E), An Giang province at the experimental area of local rice farms. The yearly average levels of rainfall, temperature and humidity are 1.840 mm, 27^{0}C and 80%, respectively.

2.2 Design, Treatments and Materials of Experiment

The experiment was carried out by using a split-split plot in a randomized complete block design (RCBD) with four replications. Rice stems, grains and soil samples, which were collected from the study areas, were determined PBZ by Philip et al., (2004) [10] . The soil attributes are presented in Table 1. Seeds of Rice OM18 were used druring the research season. PBZ (Bonsai 10WP collected from Map Pacific Company, Vietnam. Sowing density of rice OM18 was 90 kg/ha [11]. Rice OM18, which has the growth time from sowing to harvest, is 90-95 days. Plant height of rice OM 18 is 90- 95 cm. Fertilizers: (70 N - 60 P - 30 K) kg/ha. All experimental treatments were applied by all chemical Fertilizers and PBZ. Each repeat (5 m × 6 m) had four plots. The area of each experimental lot is 30 m^2 (6 m x 5). Number of experimental lots are 16 and total experimental area is 480 m^2.Control treatment (R1) did not use PBZ; treatment R2 (3.0 kg PBZ/ha) mixed PBZ with chemical fertilizers at 22 DAS and 42 DAS; treatment R3 (3.5 kg PBZ/ha) mixed PBZ with chemical fertilizers at 22 DAS and 42 DAS; R4 (4.0 kg PBZ/ha) mixed PBZ with chemical fertilizers at 22 DAS and 42 NSS (50% of PBZ was applied per time)

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TABLE 1: Soil properties before the experimental design

Soil properties			
Details	**Results**	**Details**	**Results**
Sand (%)	20.5	Total N (%)	0.307
Clay (%)	44.5	Available P (mg/kg)	15.3
Silt (%)	35.0	Exchangeble K (meq/100g)	0.189
Texture	Silt loam	$CaCO_3$ (%)	2.60
pH_{soil}	4.53	OM (%)	4.98
$pH_{irrigation\ water}$	4.9	Carbon (%)	2.89

The physical-chemical properties of soil in the first time of experiment consisted of Texture, pH_{soil}, $pH_{irrigation\ water}$, total nitrogen, available phosphor, exchangeable potassium were determined by Arnold Klute, (1986)[12]. Paclobutazol concentration of soil and plant samples was analysed by mass gas chromatography (GC-MS/MS) [13]. The agronomy components and yield of rice was observed during the matureness of plants such as height and branch number, No. of pods per plant, weight of fresh nodule, fresh weight of fill and empty pods each plant (g). The rice yield was counted by tons/ha for fresh grains. The soil samples before the experimental design were the sandy loam, low pH of soil and irrigation water (4.53 and 4.9, respectively), total nitrogen (0.307%), the available phosphorus (15.3 mg/kg) was quite rich. The exchangeble K and $CaCO_3$ in soil were the low contents (0.189 meq/100g and 2.60%, respectively).

2.3 Statistical determination

Data were determined to analysis of ANOVA using Statgraphics-Centurion-xv. The significantly different means were compared at 5% level among treatments.

3. Results and discussion.

3.1 Soil pH

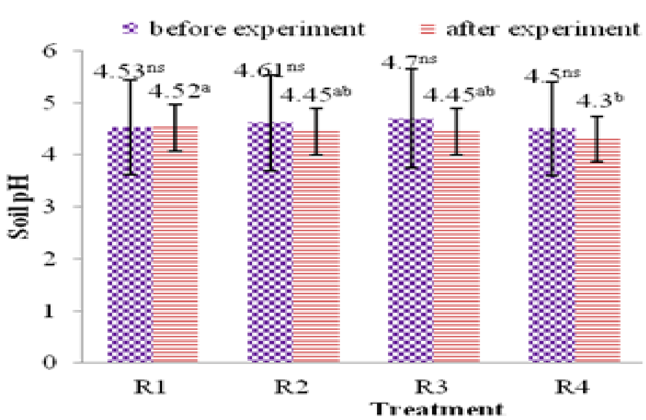

FIGURE 1: Soil pH of experimental treatments

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Soil pH of the experiment ranged from 4.5 to 4.7 before the degsined experiment and insufficient diferrence at 5% level. However, there were adequately diferrent at 5% level of experimental end, which valued from 4.3 to 4.52. In generally, soil pH of harvested stage decreased remarkably comparision with soil pH before experimental design. Furthermore, soil pH reduced the highest level (4.3) at treatment R4 (4.0 kg PBZ/ha) and the lowest pH (4.52) at control treatment without PBZ application. The prior study of Miuraet et al. (2013)[14], showed that plants that were regularly added and fertilized with PBZ exhibited a gradual decrease in soil pH n comparison with the soil pH without PBZ-fertilized.This result may explain that when PBZ entered to the crop soils, which may combine with non polar cations such Ca^{2+}, nitrogen… and release H^+ ions reduced pH of crop soils [15]

3.2 The growth of rice OM 18

3.2.1. Plant height

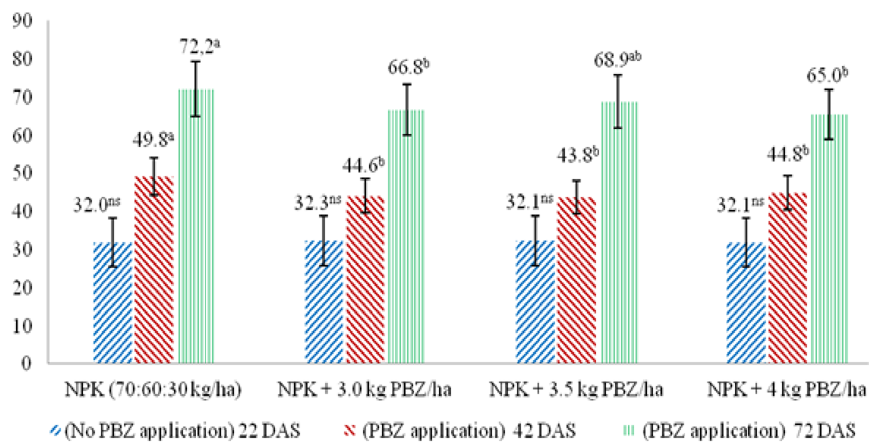

FIGURE 2: The height of rice OM 18

During the first time of 22 DAS was not the PBZ application, the height of rice OM 18 in all treatments was insignificant variousness at 5% level, which had uniform heights of experimental rice OM 18 before PBZ application (FIGURE 2). 42 and 72 days after PBZ addition, the first impact of PBZ on rice height was presented that plant height reduced during both growth stages (42 and 72 DAS) at three treatments (R2, R3 and R4). The rice OM height of three PBZ addition treatments, which were R2 (NPK + 3.0 kg PBZ/ha), R3 (NPK + 3.5 kg PBZ/ha) and R4 (NPK + 4.0 kg PBZ/ha), were lower than from 9.03% to 10.8% comparision with the control treatment (without PBZ application). According to Kamran et al., (2018a) [16] showed that PBZ application reduced remarkably the crop height. There were negative effects of PBZ on the rice height when PBZ weight of 50g/ha was applied at maturity to reduce the rice height at harvest [17].

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3.2.2. Available tiller of rice OM 18

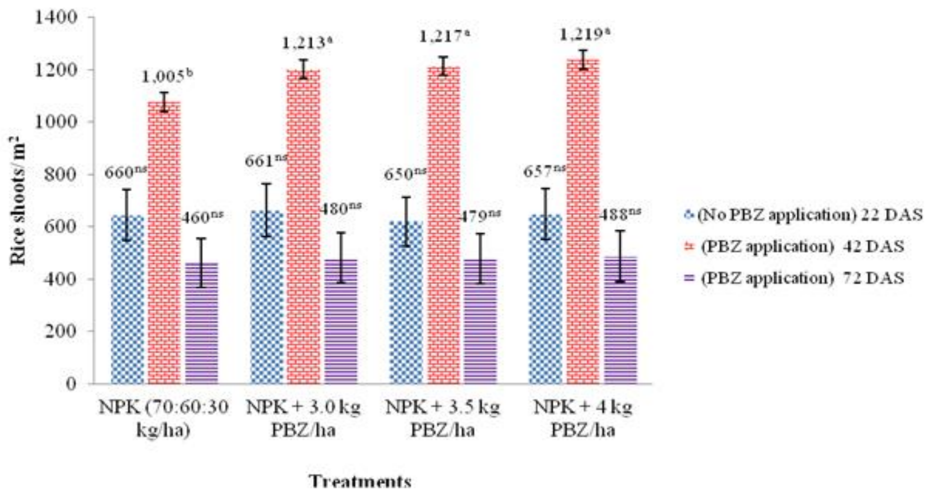

FIGURE 3: The rice OM 18 tillers at three growth stages

Results in FIGURE 3 showed that rice branches of all treatments were insignificantly variousness at periods of 22 DAS and 72 DAS (except 42 DAS). The number of available tillers of 42 DAS were 1.005 to 1.219 per m^2, which were higher than control treatment (R1-without PBZ application) and reached the maximum value at R1, R2 and R3 (R2: 1.213; R2:1,217 and R4: 1.219 tillers/ m^2) but presented the reducing trend until 72 DAS and kept until harverst. The influences of PBZ application on the number of rice branches was clearly demonstrate at 42 DAS after PBZ addition, which had more branches in PBZ applied crop (3,5 kg/ ha) than without PBZ application. All Untreated and treated treatments reduced remarkably available tillers per m^2 and were insignicantly various at 5% level (FIGURE 3). Application PBZ improved the branch capacity of crop [4]. The long - term abuse and high levels of PBZ application was not only no increase but also diminution of available branches at the mature stage [7].

3.3 The yield components and yield of rice OM 18

The results in Table 2 showed that influences of different ratios of PBZ application were insignificant variousness ($P > 0.05$) on yield components, which consisted of thousand grains weight, number of filled grains per panicle,

The percent of filled grains and number of panicle per m^2. From this above result, yield components of rice OM 18 was not impacted by PBZ application with four various rates. Many prior studies proved that continuous application and high ratios of PBZ could decrease the yield attribute and yield of rice at harvest [8, 19, 7]. Yield and yield composition of rice based on carbohydrate storage at seed filling, plant genotype and cultivar [20]. From the results in TABLE **2**, it may be strongly demonstrated that three different rates of PBZ from 3.0; 3.5 and 4.0 kg/ did not affected on yield components.

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TABLE 2: The yield component and yield of rice OM 18

PBZ rates (kg/ ha)	Wt. of 1,000 grains (g)	No. of filled grains/panicle	The percent of filled grains (%)	No. of panicle /m^2
0.0 (R1)	27.1	66.9	57.9	476
3.0 (R2)	26.8	66.8	56.5	478
3.5 (R3)	27.1	66.5	56.5	478
4.0 (R4)	26.9	66.7	56.6	481
F	ns	ns	ns	ns
CV (%)	9.72	9.75	17.0	13.7

ns:insignificant at p < 0.05 level

3.4 Concentration of PBZ in soil, plant and yield of rice OM 18

TABLE 3: PBZ accumulation on crop soil, plant and yield of rice OM 18

Treatments	PBZ concentration				Yield (t/ ha)
	Soil (µg/kg)		Stems	Grains	
	Before application	After application (at harvest)	(µg/kg)		
R1	6.35	6.49^d	33.6^d	0.00^d	7.78
R2	6.10	10.1^c	1,796^c	116^c	7.77
R3	5.83	17.8^b	1,905^b	273^b	7.97
R4	6.20	27.2^a	2,437^a	633^a	7.88
F	ns	**	**	**	ns
CV (%)	6.80	15,8	19.1	26.5	4.28
ns:insignificant at p < 0.05 level, **: significant at p < 0.01 level					

3.4.1 PBZ accumulation in soil, stems and grains

There was the presence of PBZ in the soil before the experimental design (TABLE 3). Because the local farmers, who have continuously applied PBZ during rice easons, mixed PBZ with chemical fertilizers to appy for their rice field in the period of 20 - 22 DAS and 40 - 45 DAS. This result in Table 3 also shows that PBZ has the ability to store on the crop soil if farmers use many crops continuously or store it from the previous crop to the next crop. Therefore, PBZ should be considered when using PBZ on rice cultivation. The PBZ content of the treatments at the time of pre-application was significantly different at the 5% level. However, there were remarkably various among the treatments at harvest. The highest PBZ content in the soil was recorded in treatment R4 (27.2 µg/kg) and the lowest PBZ content of R1 (6.49 µg/kg). All treated treatments were significantly the soil concentration higher than the control treatment (Without PBZ addition). Similar to the PBZ accumulation of soil, the presence of PBZ in the stems and grains of rice at harvest valued from 33.6 to 2,437 µg/kg and 0 to 633 µg/kg, respectively. The maximum PBZ contents were contained 2,437 µg/kg in stems and 633 µg/kg in grains and minimum PBZ values of 33.6 µg/kg in stems and 0.0 µg/kg in grains of rice OM 18 in treatment R1 (TABLE 3). Especially, there was no PBZ accumulation in

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rice grains at the control treatment, which was not amended by PBZ during the experimental season. According to the prior study of Jacyna and Dodds, (1995) [21] demonstrated that PBZ remained in the soil for three months when foliar sprayed without agricultural mulch and 11 months for soil irrigation treatments. Similarly, when PBZ is applied directly to the leaf that may absorb the PBZ and disperse it to other parts could keep significant amount of PBZ on crop leaves. The paclobutrazol is readily taken up through roots, stems and leaves, but it is mainly transported to xylem tissue for growing organs [22]. Furthermore, the results of this study also showed that the control treatment that was not provided with PBZ in the experimental design also recorded the PBZ presence of 33.5 µg /kg in stem, which could explain that PBZ local tillers used PBZ at previous rice seasons. Prior studies have shown that PBZ application on uncontaminated soils of PBZ with a dose of 1kg/ha at the mature stage, which reduced the plant hight and falls may increase the number of tillers and grain yield along with increased profits [23]. However, recent studies have found that long-term use of PBZ at doses above 1kg per ha, which did not increase the number of available tillers, yield and PBZ accumulation of rice stems and grains [7, 9]. There was insignificant differences from yield components of rice among treated and untreated controls (Table 2). Therefore, the PBZ application did not increase the yield of rice in all experimental treatments (Table 3). According to prior study of Nguyen Van Chuong, (2020) [7] presented that local farmers have been using PBZ with a high level for a long time. One hundred percent of tillers mixed PBZ with chemical fertilizers to apply rice in the first stage of 20 - 25 DAS and 40 - 45 DAS with 3 kg PBZ per ha. Similarly, PBZ application did not increase yield and its accumulation on stems and grains of rice IR50404 [7, 9].

4. Conclusion

Application of PBZ at doses of 3.0, 3.5 and 4.0 kg/ ha combined with NPK fertilizer for rice OM18, which did not raise the yield components and yield. On the contrary, there were higher PBZ concentrations of crop soil, rice stems and grains compared to the untreated treatment. Therefore, it can be recommend to stop using PBZ for local farmers. Furthermore, long-term PBZ use could cause to pollute the environment, the quality decrease of crop products.

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