
Study on the effect of some of N, P, K Fertilizer Compounds on the Yield and Quality of Bp53 Rice Variety

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An experiment to evaluate the effect of nitrogen, phosphorous and potassium fertilizer doses on yield and quality of PB53 rice variety was conducted in Phu Tho province during Spring crop in 2015, with four different levels of nitrogen 80 kgN ha⁻¹ (N1), 100 kgN ha⁻¹ (N2), 120 kgN ha⁻¹ (N3), 140 kgN ha⁻¹ (N4), together with four different levels of phosphorous were 60kg P₂O₅ ha⁻¹ (P1), 80kg P₂O₅ ha⁻¹ (P2), 100kg P₂O₅ ha⁻¹ (P3), 120kg P₂O₅ ha⁻¹ (P4), and four different levels of potassium were 60kg K₂O ha⁻¹ (K1), 80kg K₂O ha⁻¹ (K2), 100kg K₂O ha⁻¹ (K3), 120kg K₂O ha⁻¹ (K4). The results showed that, when level of nitrogen, phosphorous and potassium were increased, the grain yield increased, too. Application of nitrogen improved protein content of processing rice, decreased amylose content and gel consistency, but had not significantly affected gelatinization temperature. Application of potassium decreased gel consistency and increased grain protein content but had not significantly effected gelatinization temperature. This research result showed that applying phosphorous fertilizer cause less effect to quality of rice. However, when level of nitrogen was increased up to 140kg N ha⁻¹, the grain yield and quality of rice decreased. when it increased up to 120kgP₂O₅ ha⁻¹ and 120kgK₂O ha⁻¹, the rice yield didn't increase. It is also found that N3P3K3 compound produced highest yield and quality of rice.

Keywords: quality of rice, rice yield, compound of fertilizer

Introduction

Rice (*Oryza sativa* L.) is one of the most important cereal crops, and as a primary source of food for more than 3 billion inhabitants. With the likely growth of world's population toward 10 billion by 2050, the demand for rice in the world will grow faster than for other crops (Krishnan P. *et al.*, 2011). To respond to this demand, rice yield increase average 1.7% annually from current yield level (Rosegrant *et al.*, 2008). In the other hand, beside to improve rice yield, it is also required to raise its quality. However, rice grain quality

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characteristics in terms of quality cooking and nutritional quality are affected by many factors. Fertilizer is an important factor that can increase the yield and improve the quality of rice (Alam *et al.*, 2009). Major research results showed that nitrogen and phosphorus together with potassium fertilizer are major essential plant nutrients for increasing crop yield (Nguyen Van Bo *et al.*, 2003). Application of N and P fertilizers increase number of tiller, lead to the yield will be increase (YoseTaba, 2012). Also the different chemical fertilizer created a significant difference on quality parameters, as improved protein content and gel consistency (Nasrollah Zadeh *et al.*, 2014). However, application of high nitrogen level also reduces cooking quality (Junfei Gu *et al.*, 2015). With that reason, an experiment on NPK fertilizer compound had been conducted in Phu Tho province, Viet Nam in Spring season 2015 to find out most effected NPK compound to PB53 rice variety in the reasearch area.

Materials and methods

To investigate the effect of nitrogen, phosphorous and potassium fertilizer on yield and quality of PB53 rice cultivar, an experimental design in Phu Tho province during Spring crop 2015 had been carried out. Different doses of fertilizers (N, P, and K) constitutes thirteen treatments including N1P1K1 (Control), N1P2K2, N2P2K2, N3P2K2, N4P2K2, N2P1K2, N2P3K2, N2P4K2, N2P2K1, N2P2K3, N2P2K4, N3P3K3, N4P4K4 of each fertilizer (N1: 80kg Nha⁻¹; N2: 100kgN ha⁻¹; N3: 120kgN ha⁻¹; N4: 140kgN ha⁻¹; P1: 60kgP₂O₅ ha⁻¹; P2: 80kgP₂O₅ ha⁻¹; P3: 100kgP₂O₅ ha⁻¹; P4: 120kgP₂O₅ ha⁻¹; K1: 60kgK₂O ha⁻¹; K2: 80kgK₂O ha⁻¹; K3: 100kgK₂O ha⁻¹ K4: 120kgK₂O ha⁻¹) had been test. The experiment was field laid out in randomized complete block design (RCBD) with 3 replications. The plot size was consist of 2×5 meter. Yield, amylose content (AC), protein content (PC), gelatinization temperature (GT), gel consistency (GC) was measured. The data were analyzed following IRRISTAT5.0 software. The LSD test was used to compare the means at 5% of significant.

Results

Grain yield

Fertilizer is one of most important factors to improve rice yield. Reseach results showed that in the given condition, applying higher level of N, P, K fertilizer to rice had brought back higher rice yield.

Nitrogen fertilizer showed close correlation and not linear one with rice yield at $R^2 = 0,898$. At the level of P2 (80kg ha⁻¹), K2 (80kg ha⁻¹) rice yield reach the highest level at N3 (120kg ha⁻¹) application. However, application at 140kg ha⁻¹ level, rice yield is not increase but decrease (Figure 1 and figure 2).

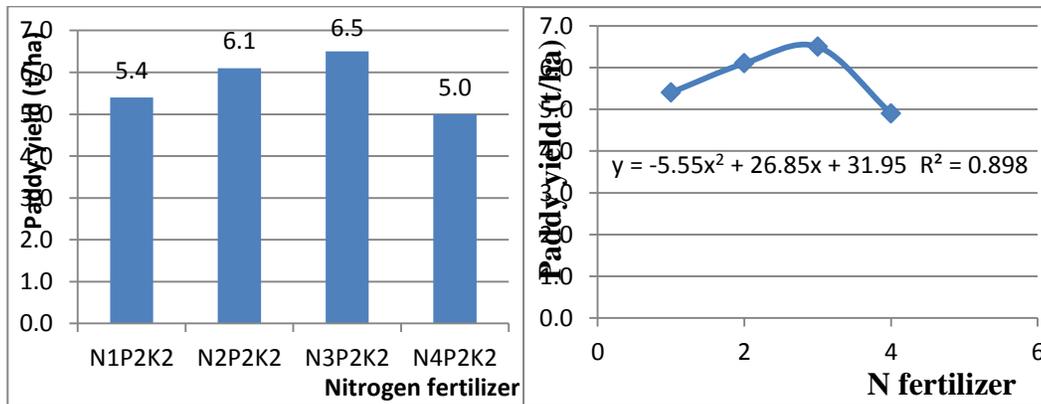


Figure 1. Effect of nitrogen fertilizer on paddy yield

Figure 2. Relationship between nitrogen fertilizer and paddy yield

Phosphorous fertilizer also showed close correlation and not linear one with rice yield with $R^2 = 0.9789$. At the base of N2 (100kg ha⁻¹), K2 (80kg ha⁻¹), the application of phosphorous fertilizer up to 120kg ha⁻¹ do not improve rice yield in comparison with the application of 100kg ha⁻¹ (Figure 3 and figure 4).

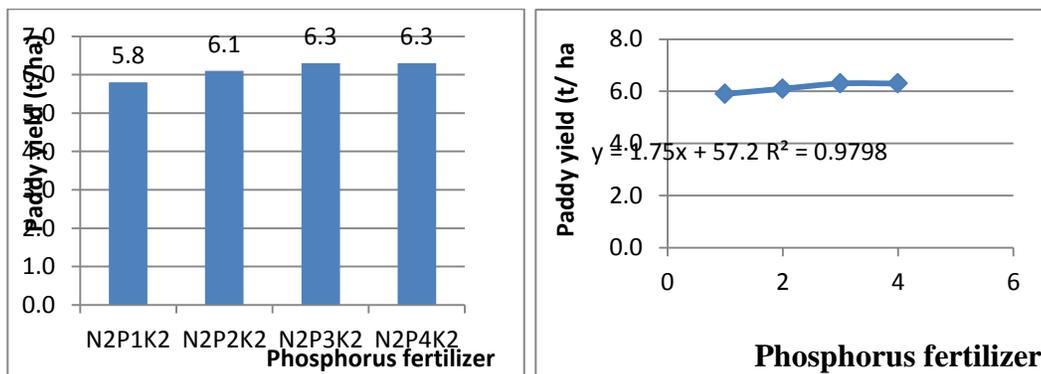


Figure 3. Effect of phosphorous fertilizer on paddy yield

Figure 4. Relationship between phosphorous fertilizer and paddy yield

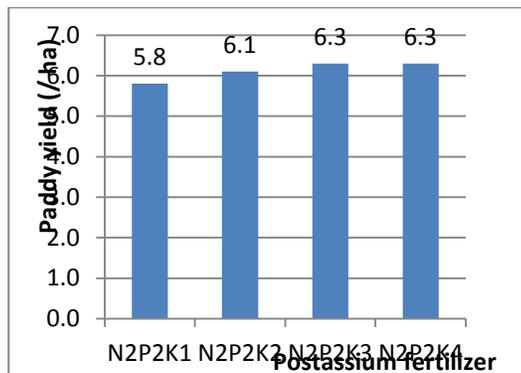


Figure 5. Effect of potassium fertilizer on paddy yield

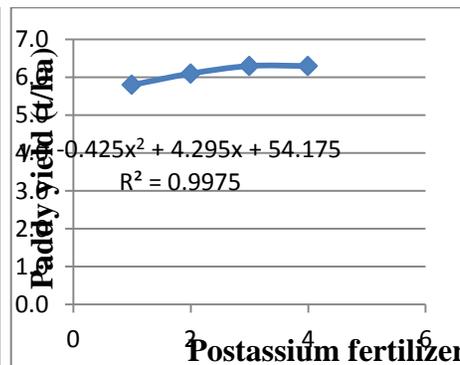


Figure 6. Relationship between potassium fertilizer and paddy yield

Like the other 2 nutrient elements, potassium fertilizer had close correlation and not linear one with rice yield with $R^2 = 0,9975$. At the base of N2 (100kg ha⁻¹), P2 (80kg ha⁻¹), the application of potassium fertilizer up to 100kg ha⁻¹ (K3) had improved rice yield, but the application upto 120kg ha⁻¹ (K4) rice yield has tend to decrease.

Table 1. Effect of N, P, K fertilizer treatments on paddy yield

| Treatments | Yield (tons/ha) |
|------------------|-----------------|
| N1P1K1 (Control) | 4.9h |
| N1P2K2 | 5.4g |
| N2P2K2 | 6.1e |
| N3P2K2 | 6.5b |
| N4P2K2 | 5.0h |
| N2P1K2 | 5.9f |
| N2P3K2 | 6.3c |
| N2P4K2 | 6.3bc |
| N2P2K1 | 5.8f |
| N2P2K3 | 6.3c |
| N2P2K4 | 6.3c |
| N3P3K3 | 6.8a |
| N4P4K4 | 5.9ef |
| LSD (P ≤ 0.05) | 0.2 |

* the same letters in a column are not significantly different at P<0.05

Application all N, P, K fertilizer at the same time effected rice yield significantly. The result of evaluation 13 treatment fertilizer compound (table 1) showed that N3P3K3 had produce highest rice yield at 95% significant level. The results of table 1 also showed that, with the application of 100kg ha⁻¹ (N2)

of nitrogen fertilizer, application of phosphorous fertilizer from 60 kg ha⁻¹ to 120kg ha⁻¹ as well as from 60 kg ha⁻¹ to 120kg ha⁻¹ all make rice yield increased. Thus, NPK fertilizer had reaction each other in producing grain yield. The research results of Johnston N. *et al.* (2001) had pointed out that rice yield will increase up to 50% together with the application of nitrogen fertilizer in the condition of supplying enough potassium in comparison with not adequate potassium condition.

Table 2. Effect of N,P,K fertilizer on quality rice

| Treatments | Amylose content (%) | Protein content (%) | Gelatinization temperature (°C) | Gel consistency (mm) |
|-----------------|---------------------|---------------------|---------------------------------|----------------------|
| N1P1K1(Control) | 19.5ab | 8.9e | 4.6a | 49.2bc |
| N1P2K2 | 19.2abc | 9.4de | 4.6a | 54.7a |
| N2P2K2 | 17.9de | 9.7bcde | 4.6a | 55.5a |
| N3P2K2 | 17.1e | 10.6ab | 4.9a | 56.7a |
| N4P2K2 | 18.4bcd | 9.2de | 5.0a | 55.9a |
| N2P1K2 | 18.6abcd | 9.2de | 4.6a | 53.7ab |
| N2P3K2 | 18.2cde | 9.5cde | 5.0a | 54.1a |
| N2P4K2 | 18.4bcd | 9.7bcde | 5.0a | 55.7a |
| N2P2K1 | 18.0de | 9.1e | 4.6a | 57.1a |
| N2P2K3 | 19.0abcd | 10.1abcd | 4.8a | 50.4bc |
| N2P2K4 | 20.9a | 10.0abcd | 5.0a | 46.0c |
| N3P3K3 | 18.5bcd | 10.7a | 4.9a | 58.2a |
| N4P4K4 | 18.4bcd | 9.6cde | 5.0a | 57.4a |
| LSD (P ≤ 0.05) | 1.2 | 1.0 | 0.5 | 6.1 |

* the same letters in a column are not significantly different at P<0.05

Amylose content

Applying nitrogen fertilizer effected to amylose contents. At the rates of application P2 (80 kg ha⁻¹), K2 (80 kg ha⁻¹) higher application of nitrogen fertilizer cause lower amylose content and reach lowest at the rate of N3 (17.1%), but higher amylose content can be reach at the rate of 140 kg N ha⁻¹. At the base of N2 (100 kg ha⁻¹) and K2 (80 kg ha⁻¹), application phosphorous fertilizer from 60 kg ha⁻¹ to 120kg ha⁻¹ do not make the changes of amylose content. However, at the same base, on applying higher rate of potassium fertilizer, amylose content tend to increase, and reach the highest level at the rate of 120 kg N ha⁻¹ (20.9%). Although the content of amylose changes but all of it still at low level, only treatment N2P2K4 produce highest amylose level at 20.9%, belong to everage group (table 2).

Protein content

At the rate of P2 (80 kg ha⁻¹) and K2 (80 kg ha⁻¹) application, application higher nitrogen fertilizer make protein content tend to increase, and reach the highest level at the rate of 120 kg N ha⁻¹ (N3), and at the rate of 140 kg N ha⁻¹ (N4), protein content decrease. This result similar to those one of Hoang Vu Tuyen *et al.* (2001) on researching to P6 rice variety rice, protein content will decrease when applying up to 150 kg N ha⁻¹.

On relating to potassium fertilizer, at the same level of N2 (100 kg ha⁻¹), P2 (80 kg ha⁻¹) applying potassium fertilizer, increasing the rate of potassium applying lead to the increasing protein content, but up to 120 K₂O kg ha⁻¹ do not make it increase any more. Applying phosphorous fertilizer cause less effect to protein content (table 2).

Gelatinization temperature

Data showed that fertilizer do not effect to gelatinization temperature of rice. Gelatinization temperature of all treatments range from 4.6 to 5.0, were placed at intermediate gelatinization temperature level from 70⁰C to 74⁰C (table 2).

Gel consistency

Gel consistency of all 13 treatments range from 46.0mm to 58.2mm. Research results show that at the same level of N2 (100 kg ha⁻¹), P2 (80 kg ha⁻¹) if supplying more potassium fertilizer make gel consistency decreased. Again at the same level of applying K, P fertilizer, it is found that nitrogen fertilizer do not effect to gel consistency. The same result is also with phosphorous fertilizer.

Discussions

Fertilizer is an important element effect to yield and quality of rice. In the past, researchers pay much attention to the effect of fertilizer to rice yield. The results of researches had pointed out the most effective amount of fertilizer to different type of soil to get maximum yield. In our research results, it is found that nitrogen fertilizer may improve protein content in rice grain as well as reduce amylose one in it. The results of table 1 also showed that, with the application of 100kg ha⁻¹ (N2) of nitrogen fertilizer, application of phosphorous fertilizer from P1 (60 kg ha⁻¹) to P4 (120 kg ha⁻¹) as well as from K1 (60 kgha⁻¹

¹) to K4 (120 kg ha⁻¹) all make rice yield increased. At the same level of N3 (120 kg ha⁻¹), application phosphorous and potassium fertilizer at N3 (120 kg ha⁻¹), K3 (100 kg ha⁻¹) had highest rice yield. This result is consistent with studies of Bo Nguyen Van (2013), applying potassium fertilizer increases the coefficient of nitrogen use to 39-49%, so rice yield increase.

Hao H. *et al.* (2007) showed that, the protein content in rice increased with increased rate of nitrogen fertilizer, while amylose content decreased. The research of Hirano T. *et al.* (2005) had pointed out that supplying more nitrogen fertilizer make activities of synthesize branched starch enzymes raising, so amylose pectin increased and amylose also reduced. This is reason increasing nitrogen in a certain limit will cause reduced amylose .

Conclusion

From above discussion, it is clear that fertilizer effects to rice yield and its quality. Applying more fertilizer had improved rice yield, and reach to the highest yield at the NPK compound 120kgN: 100kgP₂O₅:100kgK₂O ha⁻¹. Surplus of nitrogen fertilizer applying may lead to the decrease of rice yield. Applying nitrogen fertilizer upto 120kgN ha⁻¹ level lead to the lower amylose content, higher protein one, but do not effect to gelatinization temperature and gel consistency. Application of potassium decreased gel consistency and increased grain protein content but had not significantly effected gelatinization temperature. This research result showed that applying phosphorous fertilizer cause less effect to quality of rice.

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