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Effects of different levels of fertilizer combinations on the growth and yield of green super rice 8

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Abstract

Fertilizer plays a vital role in plant development. But massive application of inorganic fertilizer can harm the environment if not used correctly. Therefore, adding some organic fertilizer will help to mitigate deficiencies. The Randomized Complete Block Design (RCBD) with three replications was adopted in this study from January to May 2016. The study aimed to determine the effects of different levels of organic foliar and inorganic fertilizer on the growth and yield performance of green super rice 8.The agronomic characteristics of plants were highly affected by the application of plain commercial fertilizer where an increase of NPK causes also the increase of vegetative growth of plants. Organic foliar fertilizer did not give much effects on the yield where sprayed during flowering. Moreover, the addition of organic foliar with commercial fertilizer during vegetative and reproductive stage of crop gives positive result. Economic analysis showed that treatment 2 is the best among all treatment means. Using 60-60-60 kg NPK/ha is the best fertilizer to use in GSR 8 rice under CSU Piat condition. However, use of organic foliar in combination with small amount of NPK at vegetative and reproductive (T_4) could be compared to 60-60-60 kg NPK/ha. The NPK level of 60-60-60 kg/ha is recommended for GSR 8 under CSU Piat condition. However, the spray of organic foliar using higher frequency is still recommended as additional fertilizer to inorganic for the cause of friendly environment technology.

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Introduction

Rice (*Oryza sativa*Linn.) is the oldest domesticated grain and considered to be the staple food for about 2.5 billion people. Rice provides 21% of global human per capita energy and 15% of per capita protein. Calories from rice are particularly important in Asia, especially among the poor, where it accounts for 50-80% of daily caloric intake. Rice can also be found in cereals, snack foods, brewed beverages, flour oil, syrup and religious ceremonies to make a few other uses. Studies also showed that due to the increasing population, it is expected that the demand for rice will also increase. Thus, the government is supporting the product of research with regards to the development and improvement of rice in the country.

Organic agriculture considers the medium and long-term effect of agricultural interventions on the agro-ecosystem. It aims to produce food while establishing an ecological balance to prevent soil fertility or pest problems. Organic agriculture takes proactive approach as opposed to treating problems after they emerge. The impact of organic on natural resources favors interactions within the agro-ecosystem that is vital for both agricultural production and nature conservation. Ecological services derived include soil forming and conditioning, soil stabilization, waste recycling, carbon sequestration, nutrients cycling, predation, pollination and habitats. By opting for organic products, the consumer though his/her purchasing power promotes a less polluting agricultural system.

The hidden costs of agriculture to the environment in terms of natural resource degradation are reduced. Thus, the use of organic foliar fertilizer prepared at Cagayan State University at Piat Campus was used to test its efficiency in rice as a test crop. This was conducted to have a benchmark data on the technology introduce by the Korean.

Generally, the study aimed to determine the effects of different levels of fertilizer combinations on the growth and yield of green super rice 8. Specifically, it aimed to: (1) determine the agronomic and yield characteristics of green super rice 8 under different fertilizer combinations and (2) evaluate the return on investment of the green super rice 8 subjected to different levels fertilizer combinations under irrigated condition.

Materials and methods

The following materials were used: Green Super Rice 8, organic foliar fertilizer, fertilizer (14-14-14), placards, measuring device, record book, sprayer and native plow. An area of 16 m x 13 m was used for the study in which the area was thoroughly prepared and laid out using the Randomized Complete Block Design (RCBD) with three replications each to test the following treatments: T_1 – Control, T_2 – 60 – 60 – 60 kg NPK/ha, T_3 – 30 – 30 – 30 kg NPK/ha + organic foliar at reproductive stage, T_4 – 30 – 30 – 30 kg NPK/ha + organic foliar from vegetative up to reproductive stage, T_5 – Pure organic spray from vegetative up to reproductive stage, and T_6 – 60 – 60 – 60 kg NPK/ha + organic foliar at reproductive stage.

Statistical Analysis

The data were analyzed using STAR, version 2.0.1 2014. Biometrics and Breeding Informatics, PBGB Division, International Rice Research Institute, Los Baños, Laguna following procedures for analysis of variance (ANOVA) for Randomized Complete Block Design (RCBD) to test the significant differences among treatments. The Least Significance Difference (LSD) test was also used to analyze mean comparisons.

Results and discussion

Theoretical NPK contributed by the fertilizer treatment (kg/ha)

Table 1 shows the theoretical NPK per treatment in hectare basis. In terms of N T_6 obtained the highest N content of 64.27 kg/ha. This was followed by T_2, T_4, T_3 and T_5 with an amount of 60.0, 45.76, 34.27 and 15.76respectively. In terms of P/ha, T_4 obtained the highest amount of 166.64 kg/ha this was followed by T_5, T_6, and T_4 with a corresponding means of 136.64, 97.22 and 67.22 kg/ha.

Table 1. Theoretical amount of NPK contributed of the different treatments.

Treatments	Fertilizer	N	P	K
Treatment 1 (Control)		0	0	0
Treatment 2 (60-60-60 kg NPK/ha	14-14-14	60	60	60
Treatment 3 (30-30-30 kg NPK/ha + organic foliar at flowering	14-14-14	30	30	30
	Organic foliar application at reproductive stage	4.27	37.22	23.58
Sub Total for T3		34.27	60.22	53.58
Treatment 4 (30-30-30 kg NPK/ha + organic foliar at vegetative to flowering	14-14-14	30	30	30
	Organic foliar application at vegetative stage	11.49	99.42	62.89
	Organic foliar application at reproductive stage	4.27	37.22	23.58
Sub Total for T4		45.76	166.64	116.47
Treatment 5 (Pure organic spray from vegetative to flowering	Organic foliar application at vegetative stage	11.49	99.42	62.89
	Organic foliar application at reproductive stage	4.27	37.22	23.58
Sub Total for T5		15.76	136.64	86.47
Treatment 6 (60-60-60 kg NPK/ha	14-14-14	60	60	60
	Organic foliar application at reproductive stage	4.27	37.22	23.58
Sub Total for T6		64.27	97.22	83.58

On the other hand, T_2obtained the lowest P in kg/ha. In terms of K/ha, the same ranking of treatments was observed in P, except for T_2 and T_3 where it ranks 4th and 5th, respectively. T_1 or control received no NPK since it was not applied with fertilizer.

Number of days to 50% flowering

Fig. 1 shows that plants applied with high amount of NPK/ha obtained in T_2, T_6, T_3 and T_4 has the same effect on the number of days to flower since plants on these treatments bear flower uniformly at 55 days.

Table 2. The economics of treatments in hectare basis.

	TREATMENTS					
Description	I	II	III	IV	V	VI
Total Cost of Production	24635.43	38959.35	39975.6	51838.98	43219.83	45177
Gross Income	38700	106740	88200	99360	75780	104220
Net Income	14061.57	67780.65	48224.4	47521.02	32560.17	59043
NRPI	0.36	0.64	0.55	0.48	0.43	0.57
ROI (%)	36.34	63.50	54.67	47.82	42.96	56.65

In addition, plants on treatments applied with pure organic foliar fertilizer (T_5) and unfertilized plants (T_1) bear flower late. Analysis of variance shows highly significant difference among treatment means. This means that plants applied with organic foliar and in combination with inorganic fertilizer will induced the plants to produce flowers earlier compared to the unfertilized one.

Number of days to maturity

Fig. 2 reflects the plants applied with high amount of NPK/ha registered in T_2, T_6, T_3 and T_4 were observed to mature late. Analysis of variance reveals highly significant result among treatments tested. Rice crop regardless of varieties have the same reproductive duration which is 30 days and 35 days from panicle initiation to maturity during dry and wet season

planting respectively. This could be attributed to the amount of nitrogen received by the plants that lengthen their vegetative stages.

Height at maturity (cm)

Fig. 3 shows the average height of plants at maturity. Plants applied with 60-60-60 kg NPK/ha combined with organic spray (T_2 and T_6) obtained the tallest plants this was followed by plants applied with lower level of organic foliar (T_4 and T_3) with means of 92 cm and 89 cm, respectively. Result revealed that there exist highly significant differences among treatment means.

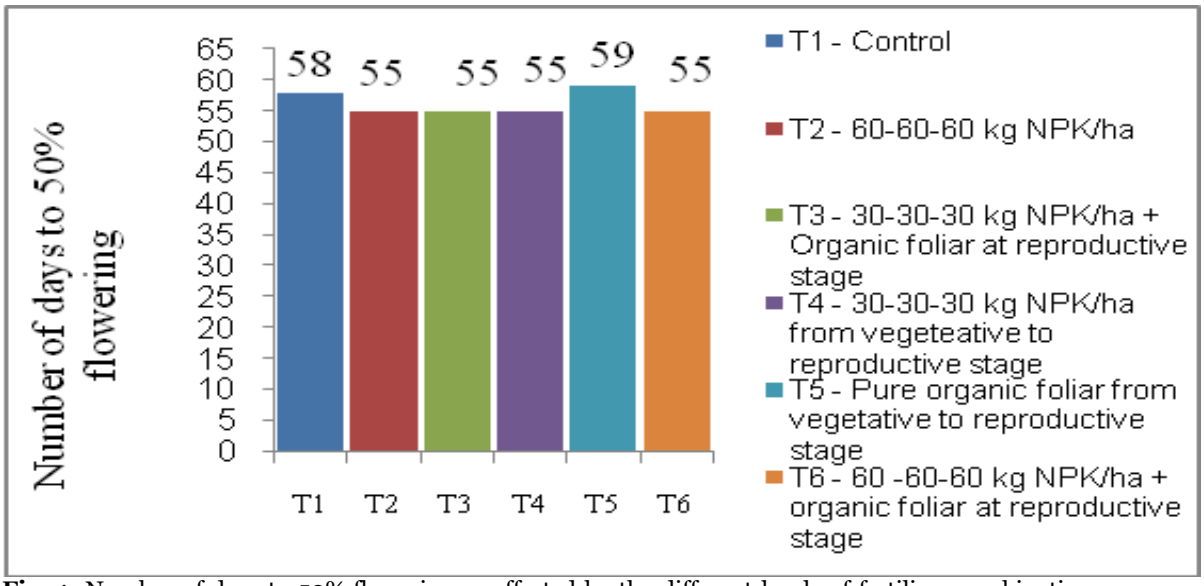

Fig. 1. Number of days to 50% flowering as affected by the different levels of fertilizer combinations on green super rice 8.

This means that height of plants was affected by the amount of nitrogen received by plants. As the amount of nitrogen increase there is also a corresponding increase in height of plants. The variation in plant height due to nutrient sources was considered to be due to variation in the availability of major nutrients. Muhammad (2008) observed similar results with application of organic manure and compost in rice.

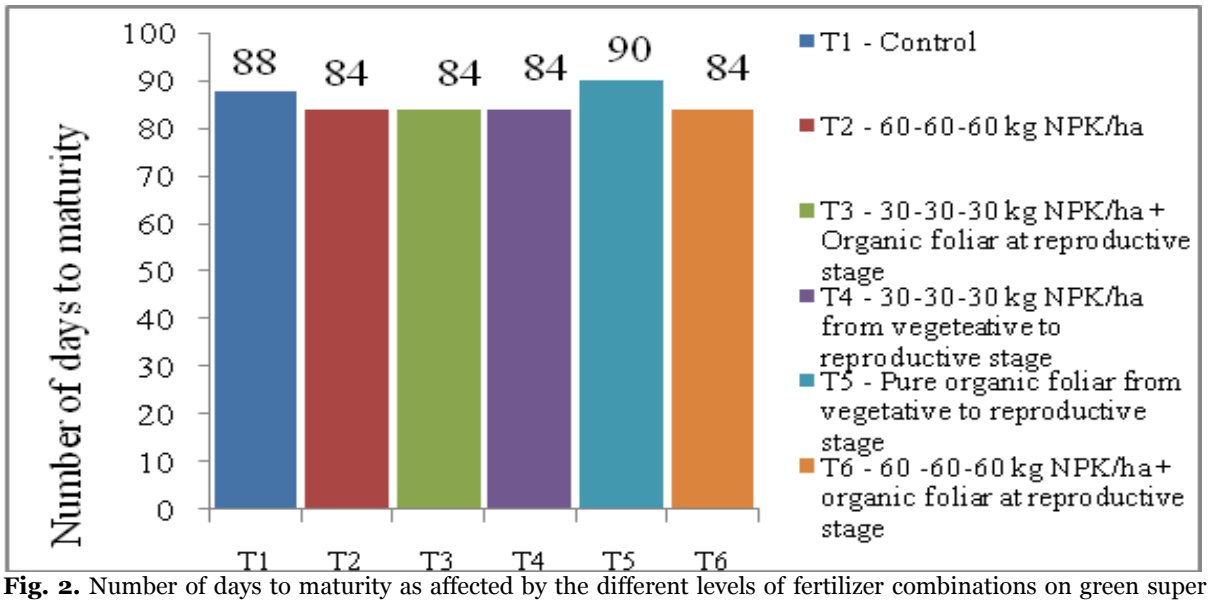

Fig. 2. Number of days to maturity as affected by the different levels of fertilizer combinations on green super rice 8.

The available nutrients might have helped in enhancing leaf area, which thereby resulted in higher photo-assimilates and more dry matter accumulation. These results are supported by the findings of Swarup and Yaduvanshi (2000) and Yadana *et al.* (2009).

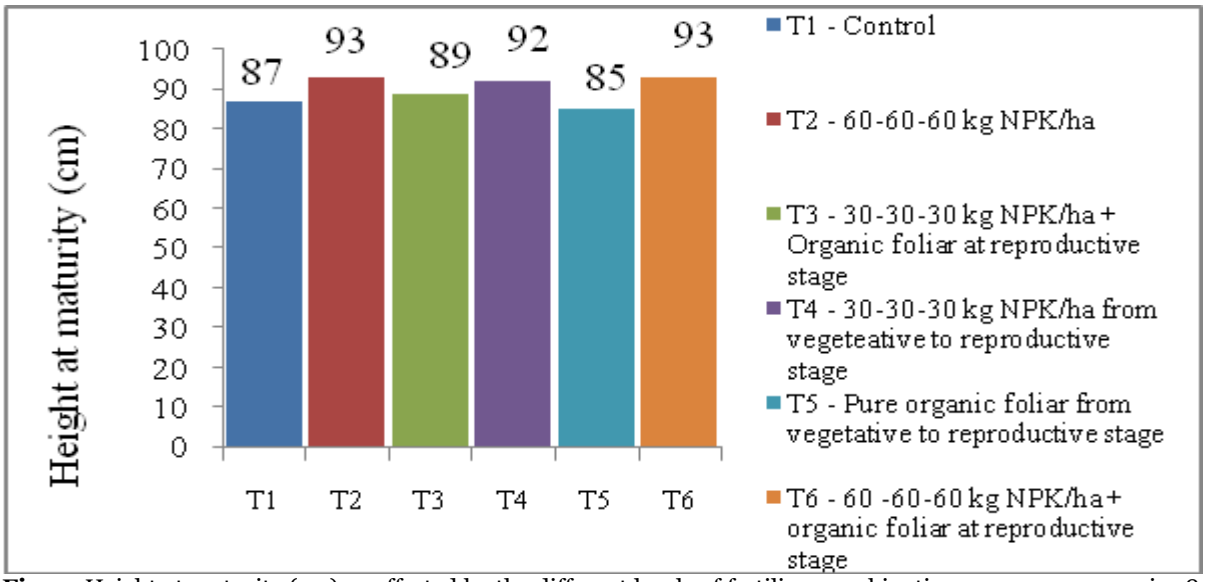

Fig. 3. Height at maturity (cm) as affected by the different levels of fertilizer combinations on green super rice 8.

Percentage productive tillers

Fig. 4 shows significant result obtained from treatment means. On comparison among means, when T_1, T_2, T_4, T_5, T_6 compared with each other, no significant difference exist but when these treatments compared with T_3 significant result was observed.

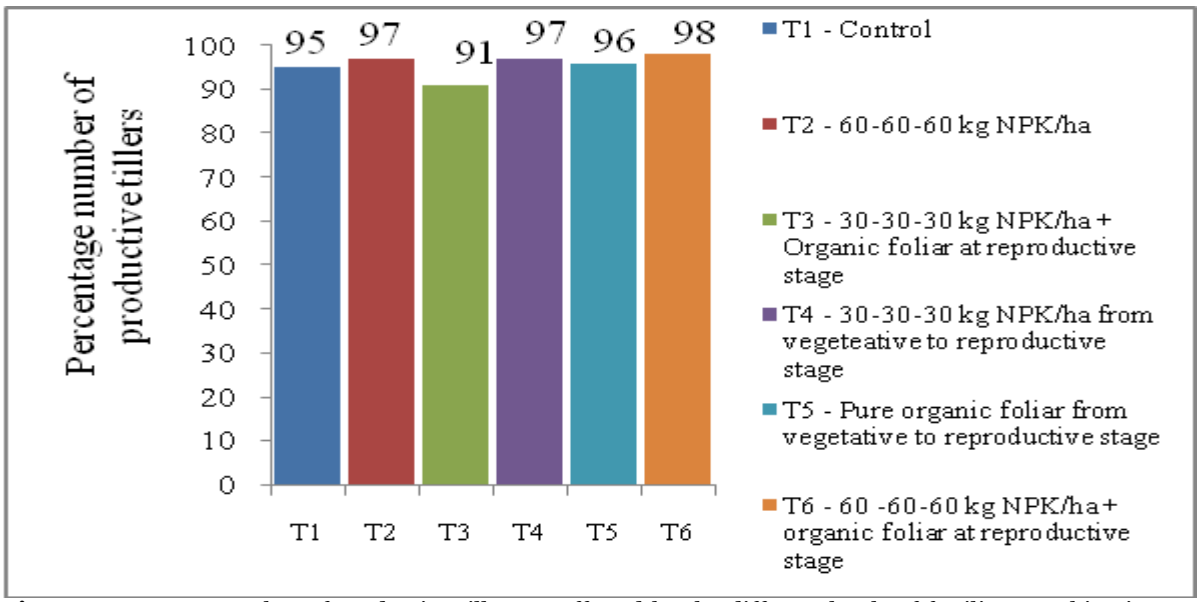

Fig. 4. Percentage number of productive tillers as affected by the different levels of fertilizer combinations on green super rice 8.

Tillering is an important trait for grain production and is thereby an important aspect in rice yield. Mirza *et al.* (2010) reported increase in number of tillers in rice plants due to influence of different fertilizer combinations. According to them more number of tillers per square meter might be due to the more availability of nitrogen, which plays a vital role in cell division of plants. Organic sources offer more

balanced nutrition to the plants, especially micro nutrients which positively affect number of tiller in plants (Miller, 2007).

Panicle length (cm)

Fig. 5 shows that plants applied with inorganic fertilizer (T_2, T_3, T_4 and T_6) obtained the longest panicle length while T_1 and T_5 registered the shortest length of panicle. This means that the application of inorganic and organic foliar spray will increase the length of panicle of GSR 8. Plant leaves are important organs which have an active role in photosynthesis. To achieve high yield maximization of leaf area is an important factor. In present investigation we found that organic fertilizer alone and in combination with chemical fertilizers significantly increased the flag leaf length over untreated control. Similar findings are reported by Mirza *et al.* (2010).

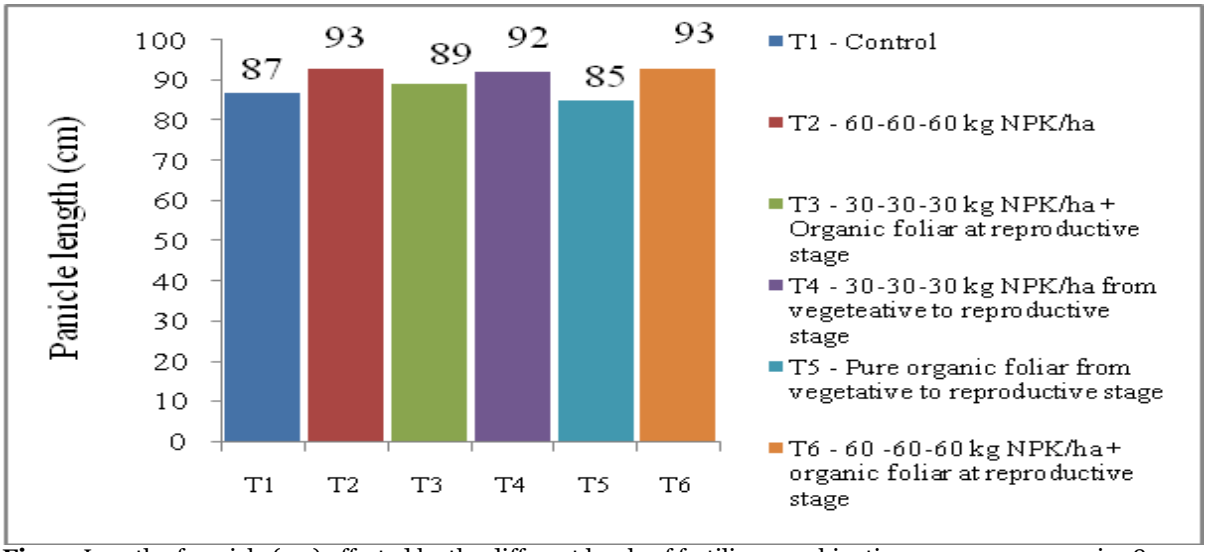

Fig. 5. Length of panicle (cm) affected by the different levels of fertilizer combinations on green super rice 8.

Percentage number of filled grains

Plants applied with 60-60-60 kg NPK/ha obtained the highest percentage filled grains (Fig. 6). Plants under T_4, T_6, and T_3obtained the second ranker followed by T_5 and T1 with 85 % and 83.66% respectively. Similar observations were made by Luong and Heong (2005). They observed reduction in unfilled grain percentage, increase in grain weight of rice with application of organic manure.

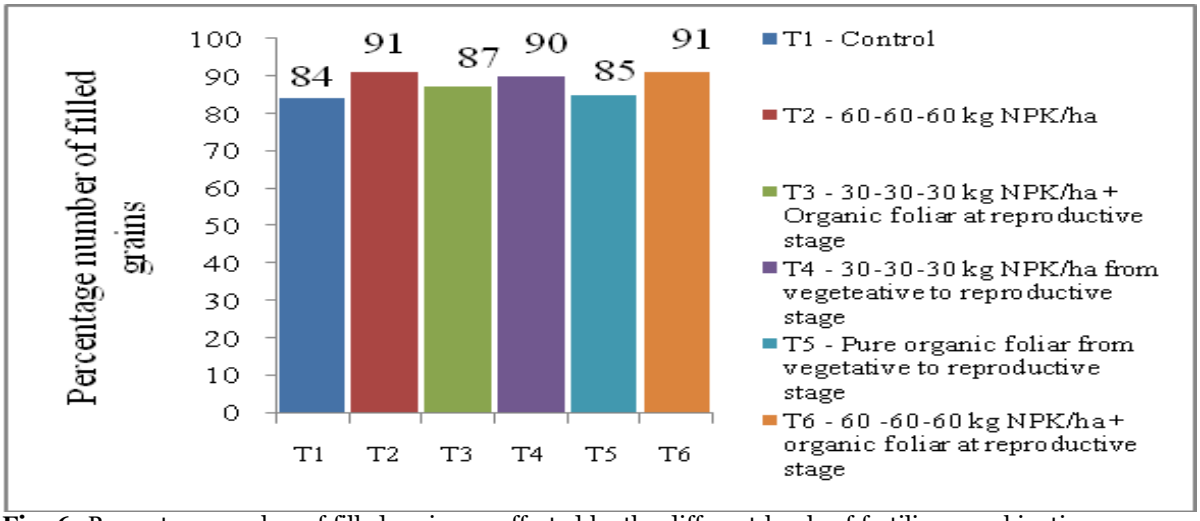

Fig. 6. Percentage number of filled grains as affected by the different levels of fertilizer combinations on green super rice 8.

Average weight of 1000 grains

Fig. 7 reflects the plants applied with plain 60-60-60 kg NPK/ha (T_2), combination of 60-60-60 kg NPK/ha and combination of 30-30-30 kg NPK/ha (T_3 and T_6 and organic foliar fertilizer and the application of 30-30-30 kg NPK/ha and twice application of organic foliar spray obtained to be the first ranker since no significant different existed among them. Moreover, the application of plain inorganic fertilizer gives significant result to the average weight 1000 grains especially when it is combined with organic foliar spray.

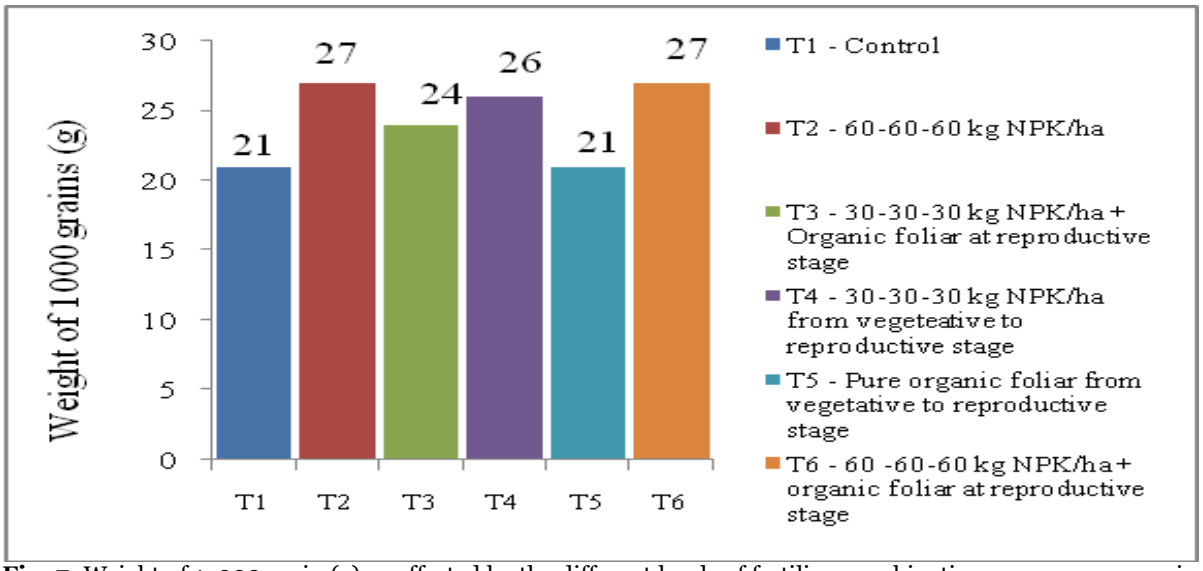

Fig. 7. Weight of 1, 000 grain (g) as affected by the different levels of fertilizer combinations on green super rice 8.

This study was contradicting with result reported by Mirza *et al.* (2010), observed significant difference in 1000-grain weight of rice as affected by variation in fertilizer packages. Luong and Heong (2005) observed reduction in unfilled grain percentage, increase in grain weight of rice with application of organic manure.

Yield in tons/hectare

Fig. 8 shows the projected yield of GSR 8 using organic foliar and inorganic fertilizer in tons/ha. Analysis of variance revealed that there exist significant differences among treatment means. Treatment 2 (60-60-60 kg NPK/ha) and treatment 6 (60-60-60 kg NPK/ha + organic foliar at flowering) and treatment 4 (30-30-30 kg NPK/ha +organic foliar from vegetative to flowering) obtained the highest yield. The increase in biological and grain yield could be due to the increase in yield attributes (plant height, number of productive tillers/hill, panicle weight and 1000-grain weight) consequently (Ebaid *et al.*, 2007). Their yield was statistically the same (3.69 to 4.5 tons/ha) other treatments (T_3, T_5, and control obtained lower yield (2.91 to 3.63 tons/ha). This means that the amount of NPK in the fertilizer applied for the treatment favorably affected the result of the yield. The higher yielder treatment has treatment has a range of 45 to 64 kg N/ha, 60 to 166 kg P/ha, 60 to 166 kg K/ha. The spray of organic foliar at flowering stage did not give much effect to increase the yield. Spray of organic foliar at reproductive stage and reproductive stage give positive effects on the yield of rice if mixed with minimal amount of NPK from inorganic source is use (30-30-30 kg NPK/ha).

According to Shavoshi *et al.* (2010) organic fertilizer can be a better supplement of inorganic fertilizer to produce better growth and yield. It was observed that 1.5 ton/ha organic fertilizer along with 50 % recommended chemical fertilizer could give similar yield. However, among organic fertilizer treatments the 2.0 tons/ha itself produced the better grain yield compared to others organic fertilizer treatments.

From the economic point of view farmers can use the combination of organic fertilizer and reduced rate of inorganic fertilizers to boost the yield of rice as well as to maintain and improve soil health.

Cost and Return Analysis

Table 2 shows the economics of treatments in hectare basis. In terms of the total cost of production T_4 was the highest cost of production of ₱51, 275.7, this was followed by T_6, T_5, T_3, T_2 and T_1 with total production cost of ₱43,974.4, ₱41,795.1, ₱38, 226.3, ₱37, 107.5, and ₱21, 352.3, respectively.

The high amount of production was due to the high fertilizer cost and labor of spraying organic foliar fertilizer.

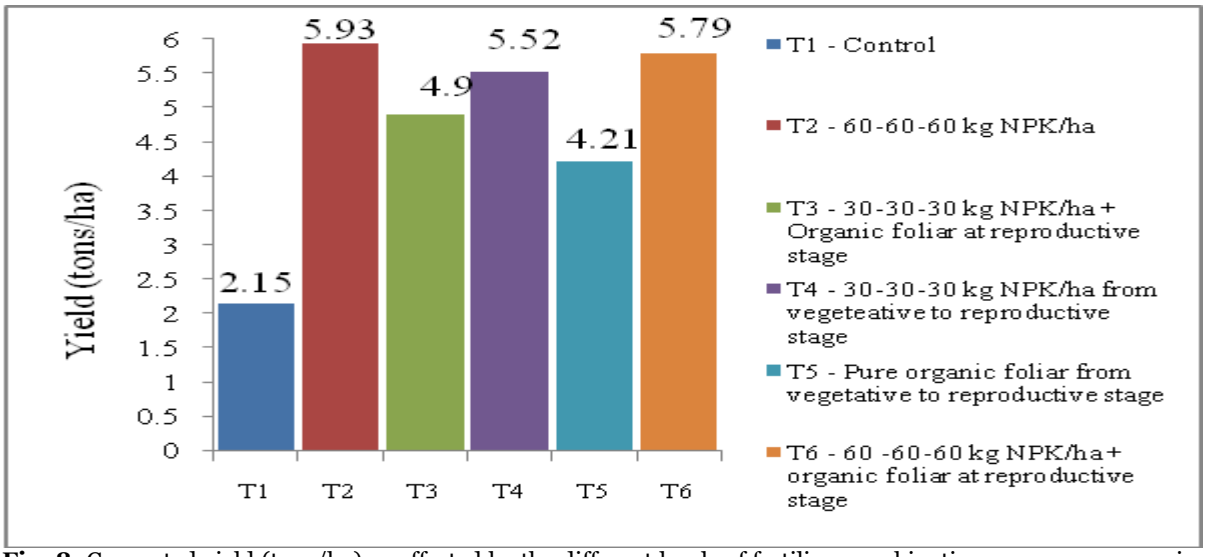

Fig. 8. Computed yield (tons/ha) as affected by the different levels of fertilizer combinations on green super rice 8.

In terms of gross income, T_2 obtained the highest income of ₱81, 540, followed by T_4 with ₱68, 580, while T_6, T_3, T_1 have a gross income of ₱66.420, ₱65,540 and ₱54,900. On the other hand, T_5 has the lowest gross income of ₱52,380.

Based on their net income of the following treatments, still T_2 has the highest net income of ₱44,432.1, Treatment 1 (Control) followed with a net income of ₱33,547.7.

This is because control has lesser cost of production since it was not applied with fertilizer and has a less labor incurred. Other fertilized treatment had a net income of ₱24,312.9 – 32,270. This means that the application of NPK from inorganic source at the rate of 60-60-60 kg NPK/ha is still the best treatment in terms of profitability. The higher yielder treatment has a range of 45 to 64 kg N/ha, 60 to 166 kg P/ha and 60 to 166kg K/ha.

Conclusion

Based on the result of the study, organic foliar fertilizer did not give much effects on the yield where sprayed during flowering. However, the addition of organic foliar with commercial fertilizer during vegetative and reproductive stage of crop gives positive result.

Economic analysis showed that treatment 2 is the best among all treatment means. The NPK level of 60-60-60 kg/ha is recommended for GSR 8 under CSU-Piat condition. However, the economic point of view farmers can use the combination of organic fertilizer and reduced rate of inorganic fertilizers to boost the yield of rice as well as to maintain and improve soil health. Further studies should be recommended using higher frequency of organic spray.

However, if organic spray is to be used minimal amount of NPK from inorganic source will be applied.

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