

# **Yield and Agronomic Variables of Rice PSB Rc52 (Gandara) as Affected by Crop Establishment, Fertilizer Sources and Rates of Application**

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## **Abstract**

**Y**ield response and agronomic traits of directly seeded and transplanted lowland rice applied with inorganic, organic and foliar fertilizer using different rates were evaluated using a randomized complete block design in split-split plot arrangement.

Results showed that directly seeded rice during the February to June cropping (Table 1.) were significantly taller at 35 DAS (38.04 cm), matured earlier (117.85 days), produced more number of

productive tillers (21.17) and more number of spikelets per panicle (116.97). Transplanted rice were significantly shorter with 27.95 cm height at 35 DAS, had delayed maturity (123.33 days) and significantly developed less number of spikelets (107.77) per panicle. Application of inorganic fertilizer during this season significantly induced the production of more tillers (21.56/hill) and number of spikelets/panicle (116.48). However, this treatment also had the highest blight infection (85.42%) compared to those fertilized with organic and foliar fertilizer which had statistically comparable results. A similar trend of response was observed among plants applied with various sources of fertilizers. Inorganic fertilizer on rice significantly induced early flowering (87.11 days).

Grain yield was significantly higher in direct seeded (3288.81 kg/ha) compared to transplanted (2135.84 kg/ha) crops during the February to June cropping because the percent tungro infection of direct seeded was lower (46.65%) compared to transplanted which was higher (48.38%). The tungro infection was first spotted and recorded when the plants were 21 days old or 1 week after the transplanted crops were established in the field. Newly established crops were weak because they were still recuperating from stress in transplanting shock, thus vulnerable to infection. Tungro was prevalent in the experimental area due to asynchronous rice planting and the use of cultivars, which were homogenous genetically and high yielding variety (Sebastian, 1995).

During the July to November cropping, the directly seeded rice exhibited early flowering (86.7 days) and mature (107.3 days) with taller plants at 35 DAS (30.30 cm) compared to transplanted whose flowering and maturity were delayed at 91.55 and 113.89 days, respectively. The methods of crop establishment did not significantly affect other agronomic traits, such as yield and yield components of rice. However, the percentage blight severity significantly increased with direct seeding, 67.31% compared to transplanting 52.04%. The rate of fertilizer application affected only the plants height at maturity and the number of productive tillers during the wet season. Application of the recommended rate (90-45-45 kg NPK/ha) + ½ RR (135-67.5-67.5 kg NPK/ha) developed the tallest plants (73.37 cm) and the most

number of productive tillers (21.53) per hill. The grain yield was statistically comparable although the transplanted yielded relatively highly (3636.84 kg/ha) as compared to direct seeded (3245.67 kg/ha). This was a contradiction of the previous planting because of its significantly low percent sheath blight infection (52.04%) and low tungro infection (43.76%) compared to those from the direct seeded which was 67.31% and 46.87%, respectively. The high gross income for direct seeded rice (Table 1) was applied with inorganic fertilizer  $\frac{1}{2}$  above RR (135-67.5-67.5) with a grain yield of 4509.44 kg/ha, which also gave the highest net income of P30391.06, but for the highest ROI were the plants applied with RR (90-45-45) with 190.76%. For transplanted rice, the highest gross income (P45190.38) was applied with foliar  $\frac{1}{2}$  below RR (9.99 li GB + 13.33 li YB/ha) with also the highest net income of P31242.08, and the highest ROI of (224.92%) was the one applied with inorganic fertilizer  $\frac{1}{2}$  below RR (45-22.5-22.5 kg NPK/ha). This treatment got the lowest incidence of tungro infection compared to the rest of the treatments.

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## Introduction

Rice (*Oryza sativa* L.) is the major staple food of more than 85% of the Philippine population and constitutes 76% of food among Asian nations.

In the Philippines, the rice industry provides employment to more than 70% of the Filipino people (Phil Rice, 1992). It is also a major source of income among farmers (D.A., 2000).

It is estimated that Philippine population increasing at least 2.5% yearly will reach about 138 million in the year 2020 which will consume about 22 million tons of rice (Phil Rice, 1998).

In response to these challenges, efforts should be directed to produce more yields per unit area and to increase areas for production. Higher yield can only be attained through research using improved

technologies such as the use of improved rice varieties, fertilizers, and chemicals in the right condition with other cultural practices. The rice variety PSB Rc52 or Gandara is a newly-developed variety whose agronomic and yield performance at different geographic locations have not been tested. Hence this study was conducted to determine agronomic traits and yield of lowland rice variety PSB Rc52 (Gandara) in response to method of crop establishments, source of fertilizer and rates of application. Specifically this study was aimed to:

1. Compare the effects of direct seeded and transplanted crop establishments on the agronomic traits and yield of rice;
2. Evaluate the effects of the various sources of fertilizer on the agronomic traits and yield of rice;
3. Determine the effects of different rates of fertilizer on the agronomic traits and yield of rice;
4. Identify the appropriate method of crop establishment, source of rate(s) of fertilizer that will give the best agronomic traits and maximum yield of lowland rice variety PSB Rc52 (Gandara) and
5. Find out the cost and return of investment of different treatment.

## **Review of Literature**

Javier and Cruz (1997) emphasized that the availability of water supply, relatively inexpensive herbicides, and reduced labor costs have encouraged many farmers in the Philippines to shift from transplanting to broadcast or wet direct seeding. From 1992-95, the percentage of farmers adopting direct seeding increased from 2.5 to 48% in irrigated areas (Javier and Cruz, 1997). Direct seeding of rice has overall advantages in saving labor and transplanting cost, however, a switch to direct seeding may have lowered rice yield slightly compared with transplanting rice, but farmers have found such a change to be still economically profitable.

The transplanting method is favorable if low wage rate and adequate water supply is available (Pandey et al, 1995).

Inorganic fertilizers are easier and cheaper to handle. It contains relatively high nutrient elements, is readily soluble and brings about rapid reaction and an immediate effect on plant growth, and the supply is readily available. However, inorganic fertilizer may also impose an adverse effect on soil life, particularly if the soil is highly acidic.

Nitrogen fertilizer have been implicated in the depletion of the upper atmosphere ozone layer, which protect us from cancer-causing ultra-violet rays (Collings, 1962).

Organic fertilizers are derived from animal wastes, crop residues, composts and numerous other by-products of living organisms; they have low content of plant nutrients and must undergo a thorough decomposition before the nutrients become available for plant use. Organic fertilizers do not only supply nutrients to the plants, but also promote favorable soil properties such as granulation and good tilt, giving efficient aeration, easy root penetration and improved water holding capacity (Chang, 1989). Crops applied with organic fertilizer are less susceptible to attack of pest and diseases (BIG, 1996).

Foliar fertilizers are any forms of substances applied to the plants in liquid manner. The application of foliar fertilizer to plants does not replace soil-applied fertilizer, but increases their uptake. This increased efficiency can reduce the need for soil-applied fertilizer, which reduces leaching and run-off of fertilizing nutrients (Witney, 1998). It is declared that the application of foliar fertilizer to the plant is a shotgun method and is economical, thus avoiding spending more time, effort and money in soil and leaf analysis.

## Materials and Methods

The experiment was conducted in the periods of February 22 to June 20, 2000 for the first cropping and of July 22 to November 18, 2000 for the second cropping at Central Mindanao University Lowland Rice Project.

### *Materials Used*

- A. Inorganic Fertilizer - Complete fertilizer (14-14-14) and urea (46-0-0)
- B. Organic Fertilizer - BUSCO Organiks (3.0-2.0-2.0)
- C. Foliar Fertilizer - Vitagrow foliar fertilizer Growth Booster (GB) and Vitagrow foliar fertilizer Yield Booster (YB)
- D. Variety use - PSB Rc52 (Gandara)

### *Experimental Design*

Randomized Complete Block Design in split-split arrangement with three (3) replications.

### Treatments

- |              |  |
|--------------|--|
| Main Plot    | (A) = crop establishments namely;<br>A1 = Row Sown or direct seeding<br>A2 = Transplanted  |
| Sub Plot     | (B) = Fertilizer sources namely;<br>B1 = Inorganic granular fertilizer<br>B2 = Commercial organic fertilizer [BUSCO Organiks (3-2-2)]<br>B3 = Organic foliar fertilizer-Vitagrow foliar fertilizer (GB) (11-3-5) and Vitagrow Yield Booster (6-3-12) |
| Sub-sub Plot | (C) = Rate of each fertilizer source   |

C (Rate)	Inorganic NPK/ha	BUSCO Organiks Bag/ha	Vitagrow Foliar	
			GB li/ha	YB li/ha
C1=1/2 RR	45-22.5-22.5(Feb-Jun)	10	9.99	13.33
C2=RR 1	• 90-45-45	20	19.19	26.67
C3=RR + 1/2 RR	135-67.5-67.5(Jul-Nov)	30	30.00	40.00

- RR = recommended rate for each fertilizer source

Treatment combinations and their corresponding numbers:

Treatment numbers	Treatment combinations
T1	A1B1C1
T2	A1B1C2
T3	A1B1C3
T4	A1B2C1
T5	A1B2C2
T6	A1B2C3
T7	A1B3C1
T8	A1B3C2
T9	A1B3C3
T10	A2B1C1
T11	A2B1C2
T12	A2B1C3
T13	A2B2C1
T14	A2B2C2
T15	A2B2C3
T16	A2B3C1
T17	A2B3C2
T18	A2B3C3

- Schedule used in foliar fertilizer spraying

GROWTH PHASE	AGE OF RICE DAYS OF AFTER SOWING (DAS)	GROWTH STAGE	TYPE OF VITAGROW
Vegetative	15	Seeding	Growth booster
	25	Seeding	Growth booster
	35	first tiller to max Tillering	Growth booster
	40	late tillering to early Panicle initiation (PI)	Growth booster
Reproductive	55	panicle initiation	Yield booster
	70	booting	Yield booster
	85	flowering/fruit setting	Yield booster

- Based on Vitagrow pamphlet

After the land was thoroughly prepared, there was staking and lay-outing. The pregerminated seeds were directly row-sown to direct seeded plots while the pregerminated seeds for transplanting was yet raised in a modified *dapog* seedbed. After 14 days from sowing, the seedlings were rolled and transplanted to the plots with a spacing of 20 cm x 20 cm using 3 seedlings per hill.

All organic fertilizer, all P and K sources, and  $\frac{1}{2}$  of N of inorganic fertilizer requirements in the experiment were applied as basal just before leveling of the plots to allow them to be incorporated in the soil. The remaining N (urea) for the inorganic fertilizer was applied 45 days after sowing.

Five days after transplanting or sowing the experimental plots were provided with irrigation water to a depth of 2-3 cm. Each experimental plot was provided with each own irrigation water inlet, as well as a drainage outlet, to ascertain that there was no contamination of irrigation water to and from other plots, which are given different fertilizer treatments. The water from the experimental

plots was withdrawn 7 days before harvesting.

The experimental plants were subjected to normal plant pest and disease control. Hand pulling of weeds as well as spraying of weedicides were done earlier to avoid competition of the plants. Spraying of insecticides was done regularly.

The data plants were harvested when the rice grain possessed 80-85% golden yellow color. Threshing was done by foot, winnowing was applied to separate chaff from the grain. Sun drying was done to reduce the seed moisture roughly to 14% w.b.

## **Data Gathered**

### **A. Agronomic characters**

1. Days from sowing to 50% flowering. This was done by counting the number of days from sowing up to the time when 50% of the tillers have shown flowers.
2. Days from sowing to maturity. This was done by counting the number of days the seeds first touch the soil to 80-85% of the panicle exhibit golden yellow color.
3. Plant height at 35 DAS. This was measured from the base of the plant to the tip of the uppermost leaf of each plant during the vegetative phase.
4. Plant height at maturity (cm). This was measured from the ground level to the tip of the panicle at mature stage.

### **B. Yield Components**

1. Number of productive tillers - This was determined by counting the total number of tillers in the representative hills minus tillers without panicles. Productive tillers were determined by counting the tillers with bearing panicles.
2. Length of panicle - This was done by measuring in centimeters from the base internodes of the panicle up to the tip of the

- panicle.
3. Number of spikelet per panicle - This was determined by counting the number of spikelets (filled and unfilled) in the panicle.
  4. Percentage filled grain per panicle - This was done by counting the filled per panicle over the total grain filled or unfilled multiplied by 100, using 10 randomly selected panicles samples per plot.

$$\% \text{ Filled spikelets} = \frac{\text{Number of filled grain/panicle}}{\text{Total number of grain (Filled or unfilled panicle)}} \times 100$$

5. Weight (g) of 1000 seeds - This was taken from the sampled panicles; grains were removed, dried to 14% M.C. w.b. and weighed using triple beam balance.

### C. Yield

1. Grain yield (kg/ha) - This was measured by using the clean and dry palay.

Formula:

$$\text{Grain yield} = \frac{\text{Yield / plot (g)}}{1,000 \text{ g/kg}} \times \frac{10,000}{\text{harvested area}} \times \text{M.F.}$$

Where: M.F. = moisture factor so that yield will be based on 14% M.C. computed as:

$$\text{M.F.} = \frac{100 - \text{M.C. at weighing time}}{100}$$

2. Grain-straw ratio - At harvest there were five random sample hills from each treatment that were cut close to the ground and were labeled properly. The grains from these samples were threshed and dried separately from the straw. Drying of the straw was done until there was no more change in weight. The moisture content of the grain was 14%.

$$\text{Grain-straw ratio} = \frac{\text{Weight of the grain (14\% c.m.)}}{\text{Weight of straw}}$$

#### D. Disease rating

##### 1. Percent Sheath Blight Severity (100 DAS)

The percent sheath blight severity per plot was obtained at late dough stage (100) DAS by careful visual examination of the infected sheath of the ten sample hills chosen at random from each plot. The percent severity from each sample hill was carefully determined by the use of the Disease Rating Scale with each scale having an accompanying description. The disease rating obtained from each sample hill was then computed to the disease severity formula:

#### Disease Rating Scale

Scale Rating	Description
0	No incidence
1	1-10% incidence
2	11-25% incidence
3	26-50% incidence
4	50-100% incidence

Percent Disease Severity Formula:

$$= \frac{\text{One} + 1n_1 + 2n_2 + 3n_3 + 4n_4}{4n}$$

Where:

$$\begin{aligned} n &= \text{total number of samples} \\ \text{One} + \dots + 4n_4 &= \text{number of samples showing the scale} \\ 4 &= \text{represents the highest scale} \end{aligned}$$

## 2. Percent Tungro Infection at 78 DAS

The percent tungro infection per plot was obtained by counting the number of hills infected with tungro in a one-meter quadrat over the total number of hills in a quadrat (36 hills). This procedure was repeated three times and the average was obtained.

Formula:

$$\% \text{ Tungro} = \frac{\text{Total number of infected hills}}{\text{Total number of hills}} \times 100$$

E. Cost and Return Analysis - The cost of the production was determined by summing up all the expenditures in each treatment combination. The return of investment was computed using the formula:

$$\text{Percent Return on Investment} = \frac{\text{Net income}}{\text{Cost of Production}} \times 100$$

## Results and Discussion

Results revealed that the average flowering of PSB Rc52 rice ranged from 86.37 to 91.33 days after sowing, regardless of treatments during the February to June cropping (Table 1). However, rice plants applied with different fertilizer sources and rates flowered more or less uniformly 88.50 to 89.00 days from transplanting.

Directly seeded plants significantly mature earlier (107.33 to 117.85 days) and mature uniformly at about 120.6 days regardless of fertilizer sources and rates of application, during the February to June 2000 cropping.

Plant height at 35 DAS was significantly affected by crop establishment during the February to June cropping. Plants from direct seeding were significantly taller (38.04 cm) compared to those that were transplanted (27.95 cm).

Moreover, rice plants applied with inorganic fertilizers were taller than those applied with either organic or foliar fertilizer, which have comparable heights.

At maturity, plant height of PSB Rc52 during the February-June cropping was not affected by crop establishment, fertilizer sources and rate of application. The application of inorganic fertilizer markedly increased (78.74 cm) compared to those applied with inorganic fertilizer (75.49 cm) and foliar fertilizer (76.93 cm). This may be due to the higher NPK analyses of inorganic fertilizer compared to foliar and organic fertilizer (Hsiek, 1987), (Witney, 1998).

Similarly, plants applied with different rates of application more or less have a uniform height, which range from 76.54 to 77.31 cm.

The number of productive tillers was significantly increased in direct seeded (21.07 tillers/hill) than transplanted (18.46 tillers/hill) rice in February to June cropping due to its early crop establishment

in the soil without disturbance as compared to those transplanted seedlings that have experienced stress due to uprooting, hauling, distribution in addition to delay and exposure of the seedlings to unfavorable environment awaiting transplanting. Rice plant applied with inorganic fertilizer significantly exhibited the tillers/hill (21.56) statistically comparable to those applied with organic fertilizer (19.96 tillers/hill) but differed with reduced foliar fertilizer (17.93 tillers/hill). This significant increase could be attributed to the high nitrogen content that enhanced the development of tillers. According to Murayama (1979), as cited by Dimala (1998), about 50-60% of the total nitrogen in high yielding rice plants are absorbed between early vegetative stage and early panicle initiation stage. Likewise, Vallador (1998) stated that application of fertilizer soon after transplanting encouraged maximum tillering.

The length of panicles was not affected by the various treatments on February to June cropping.

The number of spikelets per panicles (February to June) was statistically significant (117.00) in direct seeded plants compared to those transplanted (107.77). The sources of fertilizers and the rate of application did not affect this parameter.

The weight of 1000 seeds during the February-June cropping was statistically significant for direct seeded plants (23.82 g) compared to those transplanted (21.25 g) crops. This difference may be due to its undisturbed early establishment which enabled the plants to have good development of roots and leaves needed for photosynthesis. The higher photosynthetic efficiency of plants consequently results in the accumulation of more carbohydrates particularly during grain filling and ripening stages.

Grain yield of PSB Rc52 during the February to June cropping was affected by crop establishment. Grain yield was significantly higher in direct seeded (3288.81 kg/ha) compared seeded was lower (46.65%) compared with those from the transplanted (2135.84 kg/ha) because the percent fungi infection of direct seeded was lower (46.65%)

compared to transplanted which was higher (48.38%). The tungro infection was first spotted and recorded when the plants were 21 days old or one week after transplanted crops were established. Newly transplanted crops were weak because they were still recuperating from stress in transplanting shock thus, were vulnerable to infection. Tungro is prevalent in the area due asynchronous rice planting. In addition, the higher yield may be due to the longer exposure and adaptation of the rice plants in the field resulting in the development of more resistant plants.

During the February to June season, the grain/straw ratio of transplanted crop in general is less than 1.0 except for directly seeded (1.08 ratio) and those applied with recommended rates of fertilizer (1.0 ratio). These results imply that carbohydrates partitioning during this cropping season favored the development of vegetative parts (straw).

The high gross income (Table 3) for direct-seeded rice (February to June) cropping was applied with 45-22.5-22.5 kg NPK/ha with a net profit, as well as return of investment, at P37,820.35 and P26,115.61 respectively.

For transplanted rice, the high gross income is applied with foliar fertilizer (9.99 li GB + 13.33 li YB/ha) (P255959.77), followed by inorganic (45-22.5-22.5 kg NPK/ha) (P2579.54). In terms of net income, foliar fertilizer application of 19.99 li GB + 26.67 Li YB/ha gave the highest net income, which also gave the highest return of investment. The lowest yielder was transplanted establishment (1547.34 kg/ha) applied with 135-67.5-67.5 kg NPK/ha, followed by 30 bags BUSCO organics/ha with a yield of 1812.10 kg/ha of February-June cropping.

Both transplanted and direct-seeded rice were infected with 79.81% and 73.43% sheath blight, respectively, during the February to June cropping. Sheath blight infection was higher in plants applied with inorganic fertilizer (85.42% compared with those applied with organic (71.25%) and foliar (73.20%) nutrients.

Percent tungro infection during February to June cropping was not affected by crop establishment fertilizer sources and rates of fertilizer application.

During the February to June cropping, plants that are established through transplanting have relatively higher percentage of tungro infection compared to those plants that are directly seeded, with 48.38% and 46.65% respectively.

During the July to November cropping season, directly seeded plants flowered significantly earlier (86.70 days) than transplanted rice (91.55 days). The delayed flowering of transplanted rice plants may be attributed to the longer period of recovery from stress during uprooting, hauling and transplanting before they were established in the field.

On the other hand, De Datta (1970), as cited by Rejas (1998) revealed that in the tropics the recovery of rice seedlings after transplanting is very rapid when grown at 12-14 days by the *dapog* method. These findings may lend support to the above results that although the difference in the number of days to flowering between directly seeded and transplanted rice is significant, this difference of about five days may account for the recovery period from stress among transplanted rice. However, rice plants applied with inorganic fertilizer flowered significantly earlier (87.11 days) than those with organic and foliar fertilizer, which flowered at 90.61 and 89.67 days, respectively.

Direct-seeded rice of July to November cropping significantly matured earlier (107.33 days) compared to those transplanted which had 113.89 days to maturity. This is consistent with their flowering parameter, which flowered earlier, matured earlier. These results indicate that factors for growth and development of rice plants were more or less homogenous except for the method of crop establishment that caused a significant difference in their maturity. This result is similar to the findings of Labrador (1992) who reported that transplanted rice is more or less taller and matures later compared to direct-seeded plants. According to Pandey and Velasco (1999)

transplanted rice plants may experience exposure to stress and prolonged period of recovery from transplanting shock.

Plant height at 36 days during the July to November cropping was significantly taller in the direct-seeded (30.30 cm) compared to those of the transplanted which have significantly decreased to 19.5 cm. The difference could be attributed to early germination of seeds and continuous growth, compared to the transplanted seedlings which may have been affected by the uprooting and transplanting shock (Pandey and Velasco, 1999). Likewise, the application of inorganic fertilizer significantly promotes taller plants (29.04 cm) compared to those applied with inorganic (22.69 cm) and foliar fertilizer (23.07 cm). The different rates of fertilization did not markedly increase the plants height, which ranged from 24.36 cm to 25.20 cm.

Plant heights at maturity during the July to November cropping were statistically similar, which ranged from 72.26 to 71.88 cm. Taller plant heights at maturity were significantly induced by the application of organic fertilizer (74.42 cm), which differed significantly from those fertilized with inorganic (71.48 cm) and foliar nutrients (70.03 cm). The significantly taller plants, which were applied with inorganic fertilizer, may be attributed to the characteristics of inorganic fertilizer, which have readily absorbable and high nutrient element content (PCARR, 1979).

Plant height maturity was significantly taller with the application of  $\frac{1}{2}$  above the recommended rate (135-67.5-67.5) kg NPK/ha with (70.37 cm). However, the application of  $\frac{1}{2}$  below the recommended rate (45-22.5-22.5) significantly reduced the plant height at maturity to (70.75 cm).

The number of productive tillers was not affected by crop establishment and the use of different sources of fertilizers during the July to November cropping. However, the rates of application significantly affected this parameter. Rice plants applied with  $\frac{1}{2}$  above the recommended produced a significantly high number of productive tillers (21.13 tillers) compared to those applied with the recommended

rate which have significantly reduced to 19.89 tillers and those applied with 1/2 below the recommendation with 18.95 tillers.

The length of panicles during the July to November cropping was not affected by crop establishments, fertilizer sources and rates of application, which could be attributed to the genetic characteristics of the variety being used rather than the influence of the different factors employed, since all rice plants, regardless of treatments, had more or less similar length of panicles in both February to June and July to November cropping seasons.

The number of spikelets per panicle was not affected by crop establishment, with 109.96 spikelets per panicle in the transplanted and relatively reduced to 106.82 spikelets per panicle in the direct-seeded plants. However, the use of inorganic fertilizer significantly produced a high number of spikelet per panicle (114.63), which was significantly reduced to 109.18 and 101.37 spikelets in the organic and foliar fertilizer, respectively. According to Vergara (1979), nutrients for spikelets formation and development are critical during the tillering and panicle formation stages. Likewise, (Murayama, 1979) found that application of inorganic fertilizer during these stages increased the number of panicles. PCARR (1979) added that inorganic fertilizers have higher nutrient content that are readily absorbed and utilized compared with organic fertilizer.

The percentage of filled spikelet of July to November cropping was not affected by crop establishment, fertilizer sources and rates of fertilizer application.

Likewise, the weight of 1000 seeds during the July to November cropping was not affected by crop establishment, fertilizer sources and rate of fertilizer application. The relatively heavier weights of 1000 seeds during the July to November cropping may be attributed to the higher cropping average temperature (27.70 C) and more rainfall (249.53 mm) (see Table 2). In comparison, a lower average cropping temperature (27.77 C) and lesser rainfall (151.52 mm) prevailed during the February to June cropping.

The observation and results are best supported by the report of Vergara (1979) and Chandler Jr. (1971) that environmental conditions, particularly higher temperature not exceeding 35 C, and available moisture enhanced the development of heavier weight of rice seeds since these environmental factors would contribute to the production and accumulation of more carbohydrates particularly from fertilization up to the ripening stage.

Grain yield was higher in transplanted rice (3636.84 kg/ha) compared with those directly seeded with only 3245.61 kg/ha. However, their differences were not significant. Likewise, a statistically comparable yield was obtained among rice plants applied with different sources such as inorganic, 3707.9, organic, 3087.4 and foliar, 3528.4 kg/ha. Although, those fertilized with inorganic fertilizer exhibited the highest yield during the July to November cropping, this may be due to the findings of PCARR (1979) that inorganic fertilizer contains relatively high nutrients (N, P, K), that are readily soluble compared with organic fertilizer. Results further implied that under favorable environmental conditions, particularly during the July to November cropping, rice variety PSB Rc52 respond to inorganic fertilizers as compared to the February to June cropping. In addition, there was a low percent sheath blight infection (52.04%) and low tungro infection (43.76%) compared to those from the direct seeded which was relatively high, at (67.31%) and (46.87%), respectively.

Direct seeding of rice is best in February to June, cropping with a mean yield of 3288.81 kg/ha, while transplanted crop establishment is best suited in July to November cropping (3636.8 kg/ha).

The grain straw ratio for July to November cropping was not significantly affected by crop establishment, fertilizer sources and rates of application. In comparison, between the two cropping seasons, the July to November cropping had markedly high grain straw ratio compared to February to June cropping. This slight increase may be attributed to the favorable environmental conditions prevailing during the season which do not cause more competition of food in the different

parts of the plants; instead, food is preferentially mobilized into the grains as sink.

Table 4 shows the highest gross income of direct-seeded rice when applied with inorganic fertilizer at 135-67.5-67.5 kg NPK/ha, with a grain yield of 4509.44 kg/ha which also gave the highest net income of P30391.06, but the highest ROI was the plants that was applied with 90-45-45 kg NPK/ha with 190.76%. For transplanted rice, the highest gross income (P45190.38) was applied with foliar fertilizer (9.99 li GB + 13.33 li YB/ha) and the highest net income of P31245.08 and the highest ROI of (224.92%) was the one applied with inorganic fertilizer (45-22.5-22.5) kg NPK/ha.

For both cropping seasons, the highest grain yielder was the directly-seeded (July to November) cropping with the application of 135-67.5-67.5 kg NPK/ha, with a yield of 4509.44 kg/ha, followed by transplanted crops applied with foliar (9.99 li GB + 13.33 li YB/ha) in the July to November cropping season, with a yield of 4366.22 kg/ha.

In the July to November cropping, sheath blight infection was significantly higher in the direct-seeded (67.31%) than in the transplanted (52.04%) rice. Similarly, application of inorganic fertilizer significantly increased the sheath blight infection to 84.72% compared with those applied with organic (51.25%) and foliar (43.06%) fertilizers. The high percentage occurrence of sheath blight among rice plants that were directly seeded compared with the transplanted may be attributed to the early and longer exposure of these plants in the fields where the surrounding fields were also infected with the same diseases. These results are parallel with the study of Ou (1980) stating that the pathogen that survived in the soil and infected residues as sclerotia and could be disseminated by insects, running water, wind and other agents. Therefore, exposure of healthy and newly established plants to sheath blight-infected areas would predispose them to infection, since plants share the same climatic environment, irrigation water and surrounding air. Moreover, the presence of previous inoculum in the field due to continuous cropping in the area is likely

to contaminate and cause infection on the experimental plants (Ou, 1980 and Matsumoto et. al., 1973).

The percentage of tungro infection was relatively high from the direct-seeded plants (46.87%) compared to those with transplanted crops (43.76%); however, this did not affect the crops significantly. Meanwhile, the use of different sources of fertilizer affects the percentage of tungro infection (statistically significant at 56.77%) in the application of inorganic fertilizer compared to those with 40.38% which was applied with organic and markedly lowered to 38.81% with the application of foliar fertilizer. The different rates of application did not affect this parameter.

On the basis of the above results, the following conclusions are made:

1. Rice variety, PSB Rc 52, directly seeded in rows, regardless of fertilizer source and rates of applications, gave higher yields and net profit.
2. Application of inorganic fertilizers induced early flowering, increased the number of productive tillers, number of spikelets/panicles, percent filled grains and increase grain yield and net profit.
3. Rice plants applied with  $\frac{1}{2}$  above the recommended rate of inorganic fertilizers gave the highest yield.
4. Direct seeding of rice PSB Rc52 applied with inorganic fertilizer with  $\frac{1}{2}$  above the recommended rate gave the best agronomic traits, highest grain yield and net profit.
5. Foliar fertilizer (transplanted) application (19.99 li GB + 26.67 li YB) gave the highest net income and the highest return of investment (February to June cropping). Direct-seeded rice applied with 45-22.5-22.5 had the highest net profit as well as return of investment (Table 1 and table 2).
6. Inorganic fertilizer was best for both seasons with a mean yield of 3167.29 kg/ha.
7. Direct seeding was better in February to June cropping season with a mean yield of 3288.81 kg/ha.
8. Transplanted crop establishment was better in July to November cropping with a mean grain yield of 3636.8 kg/ha.

**Table 1.** Summary table on days to flowering, days to maturity, plant height (cm) 35 DAS, plant height at maturity, number of productive tillers, length of panicles (cm), number of spikelets/panicle, % filled spikelet, weight of 1000 seeds (g), grain yield (kg/ha), grain straw ratio, % sheath blight severity, and % tungro infection as influenced by crop establishment, fertilizer sources and rates of application (February to November 2000).

PARAMETERS		Crop Establishment		Fertilizer Sources			Fertilizer Rates		
		A1	A2	B1	B2	B3	C1	C2	C3
Days to flowering	Feb-June	86.37	91.33	89.00	89.06	88.50	89.11	88.55	88.95
	July-Nov	86.70	91.55	87.11	90.61	89.67	89.40	89.11	88.83
Days to maturity	Feb-June	117.85	123.33	120.72	120.39	120.67	120.61	120.61	120.56
	July-Nov	107.33	113.89	110.56	110.61	110.67	110.61	110.60	110.61
Plant ht. (cm) 35 DAS	Feb-June	38.04	27.95	36.33	31.45	31.21	32.08	33.10	33.80
	July-Nov	30.30	19.57	29.04	22.69	23.07	24.36	25.24	25.20
Plant ht. (cm) at maturity	Feb-June	76.39	77.71	78.74	75.49	76.93	76.54	77.29	77.31
	July-Nov	71.88	72.26	74.72	71.47	70.03	70.75	72.11	73.37
No. of prod. Tillers	Feb-June	21.17	18.46	21.56	19.96	17.93	19.94	20.63	18.87
	July-Nov	19.52	20.46	20.94	19.83	19.21	18.95	19.89	21.13
Length of panicles	Feb-June	21.71	22.78	22.69	21.86	22.19	22.11	22.06	22.58
	July-Nov	21.16	22.21	21.95	21.74	21.38	21.59	21.67	21.81

TATIL: YIELD AND AGRONOMIC VARIABLES / 97

No. of spikelets/ Panicle	Feb- June	117.00	107.77	116.48	110.00	111.00	115.31	107.89	104.33
	July- Nov	106.82	109.96	114.63	109.18	101.37	108.00	108.02	109.16
% Filled spikelets	Feb- June	75.65	70.36	71.18	73.56	74.27	72.17	73.30	73.54
	July- Nov	83.77	80.42	83.66	81.68	80.97	82.15	81.84	82.30
Wt. of 1000 seeds	Feb- June	23.82	21.25	22.51	22.57	22.52	22.23	22.59	22.78
	July- Nov	35.21	34.24	35.53	36.13	32.53	35.03	35.55	33.56
Grain yield (kg/ha)	Feb- June	3288.8	2135.8	2626.6	2764.2	2746.1	2763.7	2867.0	2506.5
	July- Nov	3245.6	3636.8	3707.9	3087.4	3528.4	3370.5	3461.2	3491.9
Grain straw ratio	Feb- June	1.08	0.73	0.96	0.84	0.90	0.80	1.00	0.95
	July- Nov	1.48	1.44	1.50	1.39	1.50	1.42	1.53	1.43
Sheath blight (100 DAS severity)	Feb- June	79.81	73.43	85.42	71.25	73.20	77.50	76.53	75.83
	July- Nov	67.31	52.04	84.72	51.25	43.06	56.11	58.89	64.03
% Tungro infection (78 DAS)	Feb- June	46.65	48.38	48.57	48.77	45.21	46.61	46.90	49.03
	July- Nov	46.87	43.76	56.70	40.38	38.81	42.78	44.98	48.20

**Table 2.** Average monthly climatological data during the conduct of the experiment (February-November 2000)

MONTH	AIR TEMP C	RELATIVE HUMIDITY %	SOLAR RADIATION mj/sq.m	RAINFALL mm.	NO. OF RAINY DAYS
February	24.93	92.25	429.55	133.6	12
March	24.93	92.25	425.55	133.6	12
April	27.02	77.98	615.29	181.9	13
May	25.56	80.6	606.75	309.2	24
June	26.41	80.95	617.92	199.3	18
July	31.91	75.4	606.75	327.95	25
August	26.53	76.33	643.28	315.8	19
September	26.41	80.95	617.92	199.3	18
October	26.59	75.99	691.9	222.7	18
November	27.02	77.98	615.29	181.9	13

\* Source: CMU-Agromet Station  
Musuan, Bukidnon

**Appendix Table 1.** Production cost of rice, PSB Rc 52 (Gandara) under (Ap. Table 1) different crop establishments, fertilizer sources and rates of application, Dry and wet Season (Feb-Nov. 2000)

PARTICULARS	CROP ESTABLISHMENT								
	ROW-SOWN								
	T1	T2	T3	T4	T5	T6	T7	T8	T9
<b>a. Labor Cost</b>									
Turtle passing	900.00	900.00	900.00	900.00	900.00	900.00	900.00	900.00	900.00
Harowing & Leveling	172.00	172.00	172.00	172.00	172.00	172.00	172.00	172.00	172.00
Diking	172.00	172.00	172.00	172.00	172.00	172.00	172.00	172.00	172.00
Slashing of weeds	86.00	86.00	86.00	86.00	86.00	86.00	86.00	86.00	86.00
Seed soaking & Incubation	43.00	43.00	43.00	43.00	43.00	43.00	43.00	43.00	43.00
Row-sowing, marking & fertilizer application	450.00	450.00	450.00	450.00	450.00	450.00	450.00	450.00	450.00
Harvesting & threshing 12:2	4707.31	5206.42	5151.82	4086.12	4782.69	4587.21	4281.11	4395.48	4458.93
Hauling	276.98	306.26	303.05	240.36	281.34	269.84	251.83	258.57	262.29
Subtotal	6807.29	7335.68	7277.87	6149.48	6887.03	6680.05	6355.94	6477.05	6544.22
<b>B. Materials &amp; Supplies</b>									
Seeds	540.00	540.00	540.00	540.00	540.00	540.00	540.00	540.00	540.00
Fertilizer	1616.23	3230.15	4839.45	1650.00	3300.00	4950.00	2465.30	4932.70	7400.00
Pre-emergence herbicide (Sofit)	700.00	700.00	700.00	700.00	700.00	700.00	700.00	700.00	700.00
Post-emergence herbicide (2-4 D)	430.00	430.00	430.00	430.00	430.00	430.00	430.00	430.00	430.00
Insecticide (Assorted)	810.00	810.00	810.00	810.00	810.00	810.00	810.00	810.00	810.00
Empty sacks	275.00	275.00	275.00	275.00	275.00	275.00	275.00	275.00	275.00
Subtotal	4371.23	6015.15	7615.15	4319.45	6060.00	7700.00	4135.30	7672.70	10140.00
<b>GRAND TOTAL</b>	<b>11178.52</b>	<b>13698.12</b>	<b>14897.32</b>	<b>10519.08</b>	<b>12947.03</b>	<b>14380.03</b>	<b>10491.24</b>	<b>10149.75</b>	<b>16684.22</b>

PARTICULARS	TRANSPLANTED								
	T10	T11	T12	T13	T14	T15	T16	T17	T18
a. Labor Cost									
Turtle passing	900.00	900.00	900.00	900.00	900.00	900.00	900.00	900.00	900.00
Harvesting & Leveling	172.00	172.00	172.00	172.00	172.00	172.00	172.00	172.00	172.00
Diking	172.00	172.00	172.00	172.00	172.00	172.00	172.00	172.00	172.00
Slashing of weeds	86.00	86.00	86.00	86.00	86.00	86.00	86.00	86.00	86.00
Seed soaking & Incubation:									
seedbed preparation	129.00	129.00	129.00	129.00	129.00	129.00	129.00	129.00	129.00
Transplanting, marking & fertilizer application	900.00	900.00	900.00	900.00	900.00	900.00	900.00	900.00	900.00
Harvesting & threshing 12:2	3984.13	4064.75	3807.64	4142.78	4230.65	3039.81	4869.38	4213.48	4448.22
Hauling	234.36	239.12	223.98	243.69	248.86	178.88	286.42	247.85	261.66
Subtotal	6577.49	6662.87	6390.62	6745.47	6838.51	5577.69	7514.81	5920.33	7068.88
B. Materials & Supplies									
Seeds	540.00	540.00	540.00	540.00	540.00	540.00	540.00	540.00	540.00
Fertilizer	1616.23	3230.15	4839.45	1650.00	3300.00	4950.00	2465.00	4932.70	7400.00
Post-emergence herbicide (2-4 D)	860.00	860.00	860.00	860.00	860.00	860.00	860.00	860.00	860.00
Insecticide (Assorted)	810.00	810.00	810.00	810.00	810.00	810.00	810.00	810.00	810.00
Empty sacks	235.00	240.00	220.00	245.00	250.00	180.00	285.00	250.00	260.00
Subtotal	4061.23	5680.15	7269.45	4105.00	5760.00	7340.00	4960.30	7392.70	9870.00
GRAND TOTAL	10638.72	12343.02	13660.07	10850.47	12598.51	12917.69	12475.11	13313.03	16938.88

**Table 3.** Production cost of PSB Rc 52 (Gandara) under different crop establishments, fertilizer sources and rates of application (February - June 2000)

TREATMENTS ROW- SOWN	GRAIN YIELD (KG/HA.)	GROSS INCOME AT 10.35/K	PRODUCTION COST	NET INCOME 10.35/K	ROI%
ROW-SOWN					
T1 A1B1C1	3454.14	37820.35	11704.74	26115.61	223.12
T2 A1B1C2	3537.44	36612.5	13134.2	23474.2	178.76
T3 A1B1C3	2763.72	28604.5	13518.03	15086.47	111.6
T4 A1B2C1	3552.15	36764.75	11576.18	25188.57	217.59
T5 A1B2C2	3574.74	36998.56	13260.12	23738.44	179.02
T6 A1B2C3	7276.25	33909.19	14442.36	19466.83	134.79
T7 A1B3C1	3022.7	31284.95	11552.02	19732.93	170.82
T8 A1B3C2	3174.95	35860.73	14263.14	18597.59	130.39
T9 A1B3C3	3276.5	33911.78	16887.76	17024.02	100.81
Ave.	3314.73	34307.48	13370.95	20936.53	160.77
TRANSPLANTED					
T10 A1B1C1	1764.79	18265.58	8977.4	9288.18	103.46
T11 A1B1C2	2492.31	25795.41	11742.57	14052.84	119.67
T12 A1B1C3	1547.34	16014.97	11859.97	4155.5	35.04
T13 A1B2C1	2313.96	23949.49	9884.94	14064.55	142.28
T14 A1B2C2	2056.26	21282.29	11123.4	10158.89	91.33
T15 A1B2C3	1812.1	18755.24	12367.18	6368.06	51.41
T16 A1B3C1	2508.19	25959.77	11006.28	14953.49	135.86
T17 A1B3C2	2364.47	24472.26	13243.42	24339.83	183.79
T18 A1B3C3	2363.19	24459.02	15708.78	11792.4	55.7
Ave.	2135.85	22106	11770.38	11792.4	102.06

Labor cost at P86.00/man day

Palay prevailing price (NFA) = 10.35/kg

**Table 4.** Production cost of PSB Rc 52 (Gandara) under different crop establishments, fertilizer sources and rates of application (July - November 200)

TREATMENTS ROW- SOWN	GRAIN YIELD (KG/HA.)	GROSS INCOME AT 10.35/K	PRODUCTION COST	NET INCOME 10.35/K	ROI%
<b>ROW-SOWN</b>					
T1 A1B1C1	2991.48	30961.82	10656.45	20305.37	190.55
T2 A1B1C2	3212.79	39462.38	13572.15	25890.23	190.76
T3 A1B1C3	4509.44	46672.7	167281.64	30391.06	186.66
T4 A1B2C1	2216.8	22940.57	9477.7	13462.87	142.05
T5 A1B2C2	3177.3	32885.06	12633.96	20251.1	160.29
T6 A1B2C3	3199.6	33117.93	14317.7	18800.23	131.31
T7 A1B3C1	3254.55	33684.59	11919.78	21764.81	182.59
T8 A1B3C2	3030.41	31364.74	14032.23	17332.51	123.52
T9 A1B3C3	3018.45	31240.96	16480.71	14760.25	89.56
Ave.					
<b>TRANSPLANTED</b>					
T10 A1B1C1	3859.86	39949.55	12295.03	27654.52	224.92
T11 A1B1C2	3246.16	33597.76	12938.42	20659.34	159.67
T12 A1B1C3	3828.16	39621.46	15470.27	24151.19	156.11
T13 A1B2C1	3534.67	36583.83	11816	24767.83	209.61
T14 A1B2C2	3916.12	10534.95	14068.66	26466.29	188.12
T15 A1B2C3	2479.4	25661.79	13443.08	12218.71	90.89
T16 A1B3C1	4366.22	45190.38	13948.3	31242.08	223.4
T17 A1B3C2	3583.96	37093.99	15177.67	21916.32	114.4
T18 A1B3C3	3916.65	40537.33	18168.98	22368.35	123.11
Ave.	2135.85	22106	11770.38	11792.4	102.06

Cost at P86.00/man day

Sailing price (NFA) =10.35/kg

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