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Growth and Yield Performances of *Tubigan* Rice Varieties under Abra, Philippines Conditions

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ABSTRACT

Increased rice production through the use of high yielding varieties is a possible solution for rice shortage in the Philippines. The study on six (6) Tubigan rice varieties which was conducted for wet and dry growing seasons at Abra State Institute of Sciences and Technology, Lagangilang, Abra, Philippines was aimed to determine their growth and yield performances of *Tubigan* rice varieties under Abra Conditions. Results revealed that there were significant differences in the number of days to mature, height of plants at maturity, number of unfilled grains per panicle, length of panicle, harvest index, weight of 1000 seeds and yield per hectare between the Tubigan varieties. The varieties tested showed highly significant differences in the parameters studied except in the number of filled grains. NSIC Rc158 outranked the other varieties in yield probably because it produced the highest number of tillers per hill, filled grains per panicle, high harvest index and yield per hectare of 6.4 tons/ha. NSIC Rc160 was the tallest at maturity and produced the longest panicle. NSIC Rc156 produced the highest number of unfilled grains. The yield of all the varieties exceeded the average production of lowland rice in Abra, which was 3.48 t/ha (PhilRice & BAS, 2002). NSIC Rc158 could be grown by rice farmers in irrigated lowland condition in Abra because it exceeded the average yield of the check variety NSIC Rc160 and found acceptable to consumers.

Keywords **–** Agricultural Science, Tubigan rice varieties, growth and yield, experimental design, Abra, Philippines

INTRODUCTION

In 1990, paddy rice accounted for 27 percent of value added in agriculture and 3.5 percent of GNP. The yield per hectare is low as compared to other Asian countries, like in Indonesia, Gedagal and Bogor Putih cultivars which produced 2.99 tons/ha at plant spacing 20x20 cm. In Eastern India, the yield of Rajlaxmi is 7100 kg/ha and in Pakistan, BRRI Dhan 34 showed a grain yield of 4.5 tons per hectare. In Thailand, paddy rice production is 6 tons per hectare. As of 2010, the fifth largest rice producer in the world and the second biggest rice exporter is Vietnam. Using improved varieties in Southwestern Nigeria, the yield increase was 37.8%. However, the mean yield is still considerably low, although improved rice technology had led to a 19.45 increase in rice production. This scenario is similar with the findings in the Philippines that a 50.5% increase was obtained for irrigated areas (Pablico, 2007).

Rice is the number one crop grown in the Province of Abra where 72.64% of Abreños are planting rice (Department of Agriculture, 1998). It is also considered as the number one food crop of Filipinos and produced extensively in different parts of the country especially in Luzon, the Western Visayas, Southern Mindanao, and Central Mindanao. In 1989, nearly 9.5 billion tons of rough rice were produced. Add the recent statistics of rice in Abra. The authors may get those in the website of Bureau of Agricultural Statistics.

Different lowland rice varieties were introduced to rice farmers in Abra, but some were not performing well. High performing varieties must be considered and adapted to increase rice production. There is a need to search and identify potential rice varieties in a particular environment. High yielding varieties were already developed, but there's a need to conduct adaptability trials to identify the best variety in terms of growth and yield. Studies should be undertaken on the different aspects of rice culture like suitability test to attain the aim of farmers, which is to produce the maximum yield. Using adapted varieties and high yielding varieties is one of the answers to the challenge for increased food production and self-sufficiency.

According to Padolina (2009), PSB Rc4, PSB Rc10, PSB Rc54, NSIC 124H, NSIC Rc132H, NSIC Rc122, Rc128, Rc144, Rc156, Rc158, Rc160, and Rc168H have average yields ranging from 4.6 to 6.0 t/ha for inbreds; 5.7

to 7.1 t/ha for hybrids, with maturity ranging from 104-122 days. These rice varieties have good eating quality. (The paragraph is appropriate under results and discussion section).

According to PhilRice (2002), Abra's rice production is 3.12 tons/ha for modern varieties; 3. 48 tons/ha for irrigated and 2.20 tons/ha for lowland rainfed and 1.23 tons/ha for modern varieties. Based on the study of Pablico (2007), NSIC Rc 158 yields an average of 7.036 tons/hectare. There is then an increase of 3.55 tons/hectare produced by rice farmers in Abra in case this variety will be grown, hence, this study was conducted to prove it.

OBJECTIVES OF THE STUDY

The general aim of the study was to determine the performance of six Tubigan rice varieties selected. Specifically, the study was done to:

Specific Objectives	Percentage of Completion			Milestones
	Y_1	Y_2	Y_3	
1. Identify the best Tubigan rice variety under Lagangilang, Abra condition in terms of growth and yield.	50%	50%	100%	*Tubigan* rice growth and yield in the field evaluated. Best variety identified. Yield determined
2. Select and recommend best varieties to rice farmers in Abra.			100%	Best varieties selected and recommended to farmers for planting.

METHODOLOGY

The wet season cropping started in June 2011 and terminated on October, 2011 while dry season cropping of the study started on January, 2012 and ended on April, 2012. The study was conducted at the ASIST Rice R & D experimental area.

Preparation of Planting Materials

The area used in sowing the seeds was prepared by plowing and harrowing twice at one week interval, then seedbeds were constructed using the wet bed method. The seeds of the different varieties were sown separately in the seedbed. Proper care and maintenance were done in growing the rice seedlings until ready

for transplanting. Rate of fertilizer applied was based on soil analysis conducted with a recommendation of 60-30-30.

Each block measuring 1.5 meter by 32.8 meter is divided into six, where the six varieties were planted. The treatments were the following:

V_1 - NSIC Rc-130
V_2 - NSIC Rc-138
V_3 - NSIC Rc-154
V_4 - NSIC Rc-156
V_5 - NSIC Rc-158
V_6 - NSIC Rc-160 (check)

Cultural Management Practices

Land Preparation. The area was plowed and harrowed with an interval of 14 days to ensure proper decomposition of weeds in the area. Complete fertilizer (14-14-14) was applied before transplanting by broadcasting to the plots.

Transplanting. Seedlings were uprooted carefully to minimize damage, and each variety was bundled separately in convenient sizes for easy transplanting. Seedlings of each variety were transplanted in each designated plot with three seedlings per hill following the straight row method spaced at 20 x 20 cm between hills and rows. Replanting was done a week after transplanting.

Weeding. There was hand weeding when weeds were observed during the growing period after the rice plants have recovered. The plots were kept free of weeds. **Pests and Diseases Control**. There was strict pest population monitoring at peak vegetative stage, reproductive stage up to maturity. Recommended cultural management practices were followed to ensure good crop stand and development.

Harvesting. Harvesting was done manually when almost all the grains in the panicles turned yellow. Manual threshing was properly done separately for the different varieties. Threshed rough rice of the different cultivars were sun-dried for two to three days having a moisture content of 14% and winnowed.

Data Collection

The following data were properly gathered:

1. The number of days from sowing to maturity. Counting started from the time of sowing up to the time grains are ripe.
2. The height measured at maturity (cm). A day before harvest, the height of ten sample hills per plot were measured with the use of a meter stick starting from the base of the plant extending up to the panicle tip.
3. The number of productive tillers per hill. Ten sample hills were counted at random. Rice plants that produced panicles were counted.
4. The length of panicle at harvest (cm). These data were taken from panicle base to panicle tip at the time of harvest.
5. The number of filled and unfilled grains per panicle. The number of filled and unfilled grains per panicle were counted using ten sample panicles taken at random.
6. The weight of 1,000 filled grains (g). One thousand seeds were randomly selected after oven drying at about 14% moisture content and weighed using a digital balance.
7. The harvest index (%). These data were taken from three sample hills per treatment which were uprooted at harvest then dried and weighed and computed using the following formula:

$$\text{HI \%} = \frac{\text{Economic yield}}{\text{Biological yield}}$$

where : Biological yield includes vegetative parts and the panicle

Figure 1. The experimental treatments at maturity

8. The grain yield per plot (kg). These data were taken by winnowing the spikelets after drying to approximately 14% moisture content. Only the filled spikelets were weighed per treatment.
9. The grain yield per ha (kg). These data were taken by converting the grain yield per plot into hectare by using the formula:

   Yield (kg./ha.) = Yield in kg./5 m2 plot x 2000 plots

   *Assuming that there are 2,000 plots in one hectare of the area

10. The observed incidence of pests and diseases. An evaluation was taken during peak vegetative stage, reproductive stage and a week before harvest. The following rating scale was used to evaluate resistance of rice varieties to pest:

Rating Scale	*Description*	*Remarks*
1	1 – 10% of plants per plot are infected	Resistant (R)
3	11-20% of plants per plot are infected	Moderately resistant (MR)
5	21-30% of plants per plot are infected	Intermediate (I)
7	31-60% of plants per plot are infected	Moderately Susceptible (MS)
8	61% and above of plants per plot are infected	Susceptible (S)

Evaluation of the severity of diseases was being observed from the plants from the center row. Computation on the % infection was determined using the formula.

$$\% \text{ infection} = \frac{\text{no. of plants infected}}{\text{total no. of plants}} \times 100$$

The following rating scale was used:

Rating Scale	*Description*	*Remarks*
1	0-5% infection	Resistant (R)
3	6-10 % infection	Moderately resistant (MR)
5	11-15% infection	Intermediate (I)
7	16-25% infection	Moderately susceptible (MS)
9	26% infection	Susceptible (S)

11. Consumer acceptability of cooked rice. Rice samples were cooked for acceptability. Cooked rice was assessed by 10 farmers and 10 students as the panelist on the general acceptability of cooked rice. Varieties by at least 75% acceptability of the panelists were considered acceptable.

Data analysis

Data were statistically analyzed using the Analysis of Variance in Randomized Complete Block Design (RCBD), Least Significant Difference (LSD) and Duncan's Multiple Range Test.

RESULTS AND DISCUSSION

Maturity

High significant differences were observed among the cultivars on the number of days to maturity based on the analysis of variance. The mean differences of all the varieties when compared showed significant differences with the check variety. NSIC Rc156 was the earliest variety to mature (103 days). In varying number of days, the following cultivars reached maturity after NSIC Rc 156 had matured: NSIC Rc 160, NSIC Rc 130 and NSIC Rc 154, NSIC Rc 138. NSIC Rc 158 was the latest to reach maturity requiring 114 days. This finding is more or less the same as the statement of Pablico (2007), that NSIC Rc 158 matures in 113 days. The earlier ripening of some varieties tested was affected by their varietal differences; others had shorter life span and attained physiological maturity stage earlier than the other cultivars.

Plant Height

At maturity, the height of plants among the varieties tested revealed significant differences based on ANOVA. NSIC Rc 160 was significantly the tallest among the six cultivars with a height of 9.77 cm and significantly different to the other varieties except NSIC Rc 158. The shortest subspecies was observed in NSIC Rc 154 with a mean of 88.84 cm. The significant variation in plant height could be affected by their genetic variation. Similar finding was found out in Indonesia that the plant heights of six cultivars differed significantly at harvest time (Yazid & Budi, 2013).

Productive Tillers

It was observed that NSIC Rc158 produced the highest number of shoots among varieties with a mean of 24 shoots. As such, the number of the former and NSIC Rc130 which produced the lowest number is significantly different to the check variety. The significant differences could be affected by the fact that high yielding varieties (HYV's) have relatively high tillering capacity (De Datta, 1981).

Filled and Unfilled Grains

The six varieties evaluated did not significantly differ in terms of the number of filled grains per panicle produced (Table 1). This implies that the different varieties have produced more or less the same number of filled panicles in the study.

Table 1. Average number of filled and unfilled grains per panicle of the different varieties.

TREATMENT	*FULL GRAINS*	*UNFILLED GRAINS**
NSIC Rc 130	111	20
NSIC Rc 138	114	18
NSIC Rc 154	114	26*
NSIC Rc 156	108	32*
NSIC Rc158	121	24
NSIC Rc 160	118	18
CV (%)		2.38

Based on observed means.

* The mean difference is significant at the .05 level LSD.

Analysis of variance revealed high significant differences in the number of unfilled grains per panicle among the different Tubigan rice varieties tested. NSIC Rc 156 had the highest number of empty grains followed by NSIC Rc 154 (Table 1). The number of empty grains they produced was significantly different compared to NSIC Rc 160 which is the check variety. NSIC Rc 158, NSIC Rc 130, NSIC Rc 160 and NSIC Rc 138 had statistically similar number of unfilled grains per panicle. This finding could be affected by the agronomic characteristics of the varieties.

Incidence of Pests and Diseases

The different Tubigan rice varieties tested were observed as pest resistant to stem borers and rice bugs in particular and disease resistant specifically in rice blasts and leaf blight evaluated during the peak vegetative, reproductive and ripening stages. This finding agrees with the idea of Pablico (2007), Agriculture Business Week (2009) and PCARRD (2003) that these varieties are resistant to pests and diseases.

Table 2. Incidence of pests and diseases of the different varieties

TREATMENTS	REACTION TO STEMBORER and RICE BUGS	REACTION TO RICE BLAST and BLIGHT
NSIC Rc 130	1	1
NSIC Rc 138	1	1
NSIC Rc 154	1	1
NSIC Rc 156	1	1
NSIC Rc158	1	1
NSIC Rc 160	1	1

1 - Resistant

Length of Panicle

The analysis of variance on the length of panicle showed high significant differences among the treatments. NSIC Rc 130, NSIC Rc 138 and NSIC Rc 156 had produced panicle significantly different to that of the check variety (NSIC Rc 160) as seen in Figure 2. NSIC Rc 154 and NSIC Rc 158 were not significantly different from the farmers' variety. They have produced more or less in the same length of panicles. The significant differences in panicle length among the Tubigan rice varieties could be attributed to their genetic make-up.

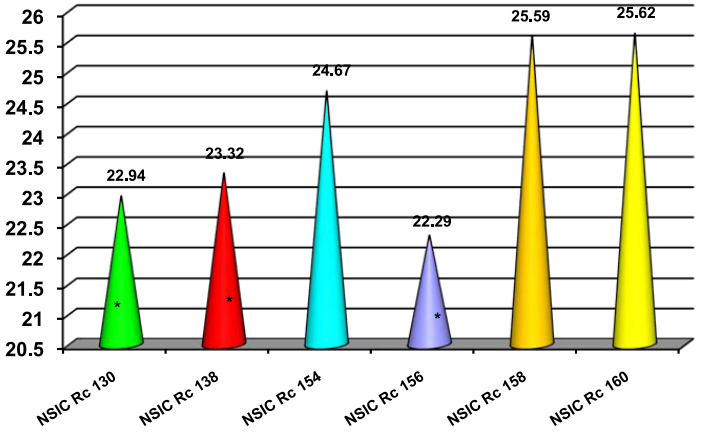

Figure 2. Average Length of Panicle (Cm)

Based on observed means.
* The mean difference is significant at the .05 level LSD.

Weight of 1000 Seeds

Highly significant differences among the varieties tested were observed based on the analysis of variance. NSIC Rc 159 being the genotype that has the longest maturity had the heaviest grain weight. This supports the idea of Onaga, Asea, Lamo, Kikafunda, and Bigirwa (2012) in Uganda that heavier grains have greater dry matter accumulation before heading because of longer vegetative growth. NSIC Rc 130, NSIC Rc 154 and NSIC Rc 156 produced the lightest weight of seeds that were significantly different to NSIC Rc 160 (check variety) (Figure 3). Based on the finding, it may be inferred that the bigger the seeds, the greater the weight.

Table 3. The performance of the different varieties in the different parameters varieties

Parameters	NSIC Rc 130	NSIC Rc 138	NSIC Rc 154	NSIC Rc 156	NSIC Rc 158	NSIC Rc 160
No. of Days to Mature	108[a]	110[b]	108[a]	103[c]	114[d]	106[c]
Height of Plants and Maturity (cm)	89.41[ab]	89[a]	88.84[a]	89.73[ab]	94.58[bc]	96.77[c]
No. of Productive Tillers Per Hill	16[b]	18[b]	17[b]	18[b]	24[a]	18[b]
No. of Filled Grains Per Panicle	111[b]	114[b]	114[b]	108[b]	121[a]	118[b]
No. of Unfilled Grains Per Panicle	20[b]	18[a]	26[c]	32[a]	24[c]	18[a]
Length of Panicle (cm)	22.94[c]	23.32[b]	24.67[ab]	22.29[c]	25.59[a]	25.62[a]
Weight of 1000 seeds (g)	16.20[b]	19.15[ab]	16.73[b]	17.30[b]	20.71[a]	20.08[a]

Note: Means with the same letter are not significant at the 0.05 level LSD.

Harvest Index

NSIC Rc 158 had the highest harvest index with a mean of 44. All the varieties were significantly different from the harvest index produced by the check variety (NSIC Rc 160). The lowest harvest index was being obtained from the NSIC Rc 156 (34.49). Based on the observation, the Tubigan rice varieties have high harvest index which means that they are efficient partitioners of photosynthetic products. The significant variations are due to the characteristics of each variety that include number of filled grains, length of panicle and weight of grains.

Grain Yield

Highly significant differences in yield per plot and per hectare were determined among the Tubigan varieties of rice tested. NSIC Rc 158 gave the highest yield of 3.22 kg per 5 m^2 with 6440 kg per ha which is 1.83% higher than NSIC Rc 160 (check variety) because it had produced more productive tillers, number of filled grains, long panicles and high harvest index. As Priya and Joel (2009) had revealed, plant yield is correlated with the number of tillers, the number of productive tillers, number of primary branches per panicle and number of grains per panicle. This coincides with the statement of Pablico (2007) stating

that NSIC Rc158 had superior yields averaging 7,036 kg/ha when transplanted. The yield of NSIC Rc 138, NSIC Rc 154 and NSIC Rc 130 were statistically similar (Table 3). Comparing the result of the study with that of the statement of PCARRD, the yield of NSIC Rc 130 and NSIC Rc 138 in the study were quite lower with the average national yield. NSIC Rc 156 had the lowest yield of 1.80 kg per 5 m^2 or with 3600 kg per hectare because it produced the least number of filled grains per panicle, shortest panicle, and lowest harvest index determined. This contradicts with the statement of Agriculture Business Week that NSIC Rc 156 yields 7,191 kg/ha. As stated by Hasan, Hossain, Salim, Anwar and Azad (2002), that farmers choose a variety due to its high yield potential, large size panicle, low shattering tendency of grain and good appearance. The yield of all the varieties exceeded the average production of lowland rice in Abra, which is 3.48 t/ha (PhilRice & BAS, 2002). The productivity grains of cultivars is probably related to genetic potential (Onaga, Asea, Lamo, Kikafunda, & Bigirwa, 2012).

Table 4. Average yield of the different varieties

TREATMENT	MEAN YIELD/PLOT* (kg)	YIELD/HECTARE (kg)
NSIC Rc 130	1.95cd	3900
NSIC Rc 138	2.35cb	4700
NSIC Rc 154	2.15cd	4300
NSIC Rc 156	1.80d	3600
NSIC Rc158	3.22a	6440
NSIC Rc 160	2.72b	5440
CV (%)	13.75	

*Means of the same letter are not significantly different at 0.05 level LSD

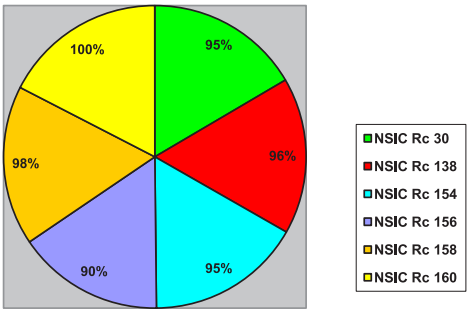

Figure 3. Acceptability of newly cooked and left-overnight rice

Consumer Acceptability

Shown in Figure 3 is the percentage consumer acceptability of both newly cooked and left overnight cooked rice of the different varieties tested. Twenty farmers, housewives, and students were chosen as the testing panel to determine the acceptability of cooked rice.

The result showed that all the Tubigan rice varieties tested by the panel were accepted in terms of their eating quality, whether these are newly cooked or as leftover.

CONCLUSIONS

The following conclusions were drawn based on the following findings: 1) Tubigan rice varieties had significant differences in terms of plant height, maturity, number of days to ripen, number of productive tillers, number of unfilled grains, length of panicle, weight of seeds, harvest index and yield, 2)The varieties were also found resistant to pest and diseases; and 3) NSIC Rc 158 produced the highest yield that is even more than the farmers' variety which is NSIC Rc 160 and surpassed the average production of lowland rice in Abra of 3.38 t/ha.

TRANSLATIONAL RESEARCH

The NSIC Rc 158 rice variety is recommended to be used by farmers because it produced favorable yield, produce more productive tillers, filled grains, produced longer panicles, high harvest index and is accepted by consumers. With these characteristics, it should be grown by farmers in the Philippines as well as farmers of other countries with similar climate. When this variety is not available, the check variety NSIC Rc 160 could still be used because it also gave favorable yield.

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