BIBLIOGRAPHY

VIRGINIA A. TAPAT, April 2012. *Growth and Yield Performance of Rice Varieties Grown under Two Moisture Regimes in Different Agro-ecosystems.*Benguet State University, La Trinidad, Benguet.

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ABSTRACT

The study aimed to compare the growth performance and grain yield of different rice varieties under two moisture regimes in different agro-ecological zones; to determine total water use efficiency of different rice varieties under two moisture regimes in different agro-ecological zones; identify the best variety under two moisture regimes in different agro-ecological zones; evaluate the performance of rice varieties grown organically under two moisture regimes in a mid mountain zone of Benguet; and correlate grain yield with growth parameters of the rice varieties in the three sites.

Between the two soil moisture regimes, plants grown under aerobic condition had lower yield and water use efficiency in the three locations. In Lagangilang, Abra, the varieties were noted to have a lower grain yield per plot and water use efficiency than in the flooded fields. In Luna, Apayao, a similar trend was observed where lower grain yield of the varieties in aerobic condition was obtained. Water use efficiency was similar in both conditions. Similarly in

Kapangan, Benguet, grain yieldand water use efficiency were lower under aerobic condition.

As to the varietal effect, in Lagangilang, Abra, NSIC Rc192 under aerobic condition had the highest grain yield and water use efficiency while NSIC Rc136Hhad the highest yield under flooded condition. In Luna, Apayao, the best performer in terms of grain yield and water use efficiency under aerobic condition was PSB Rc9 and NSIC Rc136H under flooded condition.*Sapaw* was the best performer in Kapangan, Benguet under both aerobic and flooded conditions.

Thereexist varied interaction effect between the soil moisture regimes and varieties in the different sites. In Lagangilang, Abra, plant height at physiological maturity and filled grain ratio in the dry season were significantly affected by the interaction of varieties and soil moisture regimes. In Luna, Apayao, there was a significant interaction effect between the moisture regimes and the rice varieties on plant height and filled grain ratio during the wet season. Likewise, a significant interaction was observed on water use efficiency during the dry season.InKapangan, Benguet, significant interaction was noted between the moisture regimes and the rice varieties in terms of grain yield and number of filled grains per panicle for both cropping seasons; on dry matter weight during the August 2010-February 2011 cropping; and on total grain number per panicle, filled grain ratio, 1000-grain weight, and water use efficiency during the March-November 2011 cropping.

Correlation analysis revealed a significant positive correlation between harvest index and grain yield in Lagangilang, Abra under aerobic condition. Panicle length, total and filled grain number per panicle havea significant positive correlation with grain yield in Luna, Apayao. Plant height at maturity, number of days from seeding to maturity, panicle length, total and filled grain per panicle, and total dry matter weight have a significant positive correlation with grain yield in Kapangan, Benguet under the same soil moisture regime. A significant negative correlation existed on the total dry matter weight with grain yield in Lagangilang, Abra; and on total tiller and panicle number at maturity with grain yield in Kapangan, Benguet.

Under the flooded condition, a significant positive correlation occurred between the total dry matter weight and harvest index with grain yield in Kapangan, Benguet and a significant negative correlation between total tiller and panicle number at maturity with grain yield in Luna, Apayao.

While most of the data gathered are conclusive, it is still recommended that further studies maybe done to verify and confirm the results, particularly on other drought tolerant and upland varieties in other locations.

INTRODUCTION

Background of the Study

Rice (*Oryza sativa* L.*)* is a staple food for over 70% of Asians, majority of whom are below the poverty line (Bayot and Templeton, 2009).Rice receives 24-30% of world's developed fresh water and the biggest single 'user" of such resource (Boumanet *al*., 2007). It requirestwo to three times more water input (rain and irrigation) per unit of grain produced than the major cereal crops, such as wheat and maize (Tuong*et al.*, 2005). In Asia, 90% of all freshwater is used to irrigate crops, 50% of this for rice alone (Barker *et al*., 1999).

Under ideal condition and with good farm management, lowland rice in the Philippines requires around 2,000 li of water to produce one kg of rice at 100 cavans per hectare yield (PhilRice, 2007). In most rice fields in the Philippines, rice experts estimate that up to 4,000 li of water is usually used for a kg of rice.

Water resources have been increasingly getting scarce due to increasing population, which demands more water for industrial and domestic uses. Moreover, drought is currently experienced by various agricultural areas in the Philippines. This means less water for farming, rice production in particular. Therefore, there is pressure of producing more rice with less water. It has been estimated that by 2025, 15 million ha of irrigated rice will suffer 'physical water scarcity', and most of the 22 million ha of irrigated rice grown in South and Southeast Asia will suffer "economic water scarcity' (Tuong and Bouman, 2002).

The aerobic rice production system is a welcome relief to the water-limiting rice production condition. Its especially developed "aerobic rice" varieties are grown in well-drained, non-puddled, and non-saturated soils (IRRI, 2010). Aerobic rice is not ponded and irrigated similar to other crops in water-scarce environments, and can stand periodic flooding conditions (Castaneda *et al*., 2004; Yang *et al*., 2005).

Previous studies on aerobic and other water conserving technologies were undertaken in the vast rice areas of Tarlac, Nueva Ecija and Bulacan (Bayot and Templeton, 2009).In the Cordillera, notwithstanding its small aggregated rice area compared to other regions and in spite serving as the water cradle of adjacent regions like Ilocos Region and Cagayan Valley, there is scarce information on water conserving technologies. Rice farms are not even spared from the problem of water scarcity.

Importance of the Study

The expected research result may provide Cordillera rice farmers relevant information on how to adapt to water scarcity condition with the use of aerobic rice production.

Water requirement for aerobic rice is around 400-700 mm/season (Luo*et al.*, 2008) and is similar to the dry land crops, while it has higher economic value (Bouman*et al.*, 2002). Therefore, shifting gradually from traditional rice production system to growing rice aerobically, especially in water-scarce irrigated lowlands, can mitigate occurrence of water deficit problems. Growing aerobic rice would likewise tremendously help not only to farmers but also to consumers who will be faced with persistent high food (rice) prices if both yield and area continue to decline.

Objectives of the Study

In general, the study was conducted to evaluate the growth and yield performance of rice varieties grown under two moisture regimes in different agro-ecological zones.

Specifically, this study aimed to:

1. compare the growthperformance and grain yield of different rice varieties under two moisture regimes in three agro-ecological zones;
2. determine the water use efficiency of five rice varieties under two moisture regimes in three agro-ecological zones;
3. identify the best variety under two moisture regimes in three agro-ecological zones;

4. evaluate the performance of rice varieties grown organically under two moisture regimes in a high hills zone of Benguet; and
5. correlate grain yield with growth parameters of the rice varieties in the three sites.

Place and Time of the Study

The field experimentswere in three sites for two cropping seasons (wet and dry) and with varied months under each cropping season as follows:

1. In Lagangilang, Abra from July-November 2010 for wet cropping season and December 2010-March 2011 for dry cropping season;
2. In Luna, Apayao from July-November 2010 for wet cropping season and December 2010-March 2011 for dry cropping season; and
3. In Kapangan, Benguet from August 2010-February 2011 and March-November 2011.

REVIEW OF LITERATURE

Rice Water Balance

The water balance of a rice field consists of the inflows by irrigation, rainfall and capillary rise; and the outflows by transpiration, evaporation, overbund flow, seepage and percolation (Bouman*et al*., 2007).

Capillary rise is theupward movement of water from the groundwatertable. In nonflooded (aerobic) soil, this capillaryrise may move into the root zone and provide a cropwith extra water (Bouman*et al*., 2007). However, in flooded rice fields,there is a continuous downward flow of water fromthe puddled layer to below the plow pan that basically preventscapillary rise into the root zone. Therefore, capillaryrise is usually neglected in the water balanceof rice fields.When rainfall raises the level of ponded waterabove the height of bunds, excess rain leaves therice field as surface runoff or overbund flow ((Bouman*et al*., 2007).

Evaporation leaves the rice field directly fromthe ponded water layer. Transpiration by rice plants withdraws water from the puddled layer ((Bouman*et al*., 2007). Typical evapotranspiration rates of rice fields are 4–5 mm d^{-1} in the wet season and 6–7 mm d^{-1} in the dry season, but can be as high as 10–11 mm d^{-1} in subtropical regions (Tabbal*et al.*, 2002). During the crop growth period, about

30–40% of evapotranspiration is evaporation (Bouman*et al.*, 2005, Simpson *et al.*, 1992).

Seepage is the subsurface flow of waterunderneath the bunds of a rice field. Percolation is the vertical flow of water to belowthe root zone.Water losses by seepage and percolation account for about 25–50% of all water inputs in heavy soils with shallow groundwater tables of 20–50-cm depth (Cabangon*et al.*, 2004; Dong *et al.*, 2004), and 50–85% in coarse-textured soils with deep groundwater tables of 1.5-m depth or more (Sharma *et al.*, 2002, Singh *et al.*, 2002).

It is the relatively large water flow by seepage, percolation, and evaporation that makes lowland rice fields heavy "water users" (Bouman*et al.*, 2007). Total seasonal water input to rice fields (rainfall plus irrigation) can be up to two to three times more for other cereals such as wheat or maize (Tuong*et al.*, 2005). Such flow varies from as little as 400 mm in heavy clay soils with shallow groundwater tables (that directly supply water for crop transpiration) to more than 2,000 mm in coarse-textured (sandy or loamy) soils with deep groundwater tables (Bouman and Tuong 2001, Cabangon*et al.*, 2004). Around 1,300–1,500 mm is a typical value for irrigated rice in Asia (Bouman*et al.*, 2007).

The role of groundwater in providing water to rice plants may be large, but has been neglected in most studies of the rice water balance. Recent data collection suggests that through the (decade- to age-old) practice of continuous flooding, the large amounts of percolating water have raised groundwater tables too close to the surface. With shallow groundwater, crop growth with a small irrigation water supply can still be good because of the “hidden” water supply of groundwater ((Bouman*et al.*, 2007).

Water Productivity

Water productivity (WP) is a concept of partial productivityand denotes the amount or value of product (rice grains) over volume or value of water used. Total water productivity (WP_{TOT}) is computed as weight of grains over cumulative weight of all water inputs by irrigation, rain,and capillary rise (Bouman*et al.*,2007).

Water productivity of rice with respect to total water input (irrigation plus rainfall) ranges from 0.2 to 1.2 g grain kg^{-1} water, with 0.4 as the average value, which is about half that of wheat (Tuong*et al.*, 2005).

Target Environments for Aerobic System

Aerobic rice is a production system in which especially developed “aerobic rice” varieties are grown in well-drained, non-puddled, and nonsaturated soils (IRRI, 2010). Aerobic rice can be found or can be a suitable technology, in the following areas: 1) “Favorable uplands”: areas where the land is flat, where rainfall with or without supplemental irrigation is sufficient to frequently bring the soil water content close to field capacity, and where farmers have access to external inputs such as fertilizers; 2) Fields on upper slopes or terraces in undulating, rainfed lowlands. Quite often, soils in these areas are relatively coarse-textured and well-drained, so that ponding of water occurs only briefly or not at all during the growing season; and 3) Water-short irrigated lowlands: areas where farmers do not have access to sufficient water anymore to keep rice fields flooded for a substantial period of time (IRRI, 2009).

Yield Performance Relative to Management Practices

Varieties

It was reported that the following varieties: HD277, HD297 and HD502 in China; Pusa Rice hybrid 10, Proagro611 hybrid, Pusa834 and IR55423-01 (Apo) in India; PSB Rc 9 (Apo), UPLRi5, and PSB Rc80 in the Philippines are suitable for aerobic rice production (Bayot and Templeton, 2009).

Belder*et al.,* (2004) recommended that for future studies comparing aerobic and flooded rice should include an elite lowland cultivar, bred for flooded (well-watered) conditions. Such cultivar includes hybrid varieties. Accordingly, this would enable a more accurate comparison of water use and yield under both flooded and aerobic rice systems. In addition, aerobic rice varieties can yield 4-6 t/ha using significantly less input water than lowland rice (Bayot and Templeton, 2009).

<u>Soil Moisture Regimes</u>

Huaqi*et al.,* (2002) reported that in case studies conducted in northern China, water use in aerobic rice system was about 60% less than that of lowland rice, total water productivity 1.6-1.9 times higher, and net returns to water use two times higher. Aerobic rice yields range from 4.5 to 6.5 tha^{-1}. As earlier stated, this is about twice higher than that of traditional upland varieties and 20-30% lower than that of lowland varieties grown under flooded condition in China.

Castaneda *et al.*, (2004) found that aerobic rice saved 73% of irrigation water for land preparation and 56% during the crop growth stage. They further concluded that the rice effectively used rainfall during the wet season. Aerobic yields were lower by an average of 28% in the dry season and 20% lower in wet season. Magat (a tropical hybrid) and Apo (a traditional upland inbred) showed the highest yield between 5-6 tha^{-1} under aerobic condition.

Belder*et al.*, (2005) reported that in their field experiments conducted in the dry seasons of 2002 and 2003 in the Philippines, water use efficiency under flooded condition was 36 and 41% lower than in aerobic plots in 2002 and 2003, respectively. Apo cultivar grown under aerobic condition had attained yields of 6.3 and 4.2 t ha^{-1} in 2002 and 2003, respectively, and under flooded condition of 15 and 39% lower. In general, the difference in yield between aerobic and flooded rice was greater in DS than in WS. This was associated with difference in the soil water status of aerobic rice between DS and WS (Bouman*et al.*, 2005). The soil was wetter in WS because of more frequent rains than in DS. The yield difference between aerobic and flooded rice was attributed more to biomass production than to harvest index. Among yield components, sink size (spikelets m^{2-1}) contributed more to the yield gap between aerobic and flooded rice than grain filling percentage and 1000-grain weight. In general, flooded rice produced more panicles with more spikelets per panicle than aerobic rice.

Bouman*et al.*,(2005) had grown different tropical upland and lowland rice varieties under aerobic conditions during the six seasons in 2001-2003 at IRRI, Los Banos, Laguna. Total water input was 1240-1880 mm in flooded fields and 790-1430 mm in aerobic fields. On the average, aerobic fields used 190 mm less water in land preparation and had 250-300 mm less seepage and percolation, 80 mm less evaporation, and 25 mm less transpiration than flooded fields. The water productivity of rice under aerobic conditions was 32-88% higher than under flooded conditions. The highest yields under aerobic conditions were realized in the dry season with the improved upland variety Apo (5.7 t ha^{-1}) and the lowland hybrid rice Magat (6 tha^{-1}).

In an eight seasons study by Peng*et al.*, (2006), found that yield difference between aerobic and flooded rice ranged from 8 to 69%, depending on the number of seasons that aerobic rice has been continuously grown, the season and variety. The yield difference between aerobic and flooded rice was attributed more to difference in biomass production than to harvest index. Among the yield components, sink size (spikelets m^{2-1}) contributed more to the yield gap between aerobic and flooded rice than grain filling percentage and 1000-grain weight. Yield decline was observed when aerobic rice was continuously grown and the decline was greater in the dry season than in the wet season.

Seed Rate and Row Spacing

Experiments were conducted on seed rate and row spacing in China, seed rate in India, and row spacing in the Philippines (Bayot and Templeton, 2009). The findings of these experiments as follows: yields of dry-seeded aerobic rice varieties (Apo in the Philippines and HD297 in China) are not very responsive to row spacing between 25 cm to 35 cm or seed rates between 60 to 135 $kgha^{-1}$. In India, the yield of Pusa hybrid rice variety was unresponsive to seed rates between 40 and 80 $kgha^{-1}$ but fell substantially when the seed rate was below 40 $kgha^{-1}$ and there was unresponsiveness to row spacing and seed rates of the varieties. These results may provide farmers with some flexibility considering the fact that higher seed rates may suppress weed growth, however, it will cost more.

Further, some initial management options and guidelines for aerobic rice productionwere provided (Bayot and Templeton, 2009). It is suggested that before seeding, the plot should be plowed and harrowed to obtain smooth seed beds. Seeds can then be dry seeded at a depth of 1-2 cm in clay soils and 3-4 cm in loamy soils. Alternatively, seedlings can be transplanted into saturated clay soils that are kept wet for a few days after transplanting. While the experiments did not show that yields are responsive to seed rate or row spacing (within reason), it is suggested that optimal seed rates are around 70-90 $kgha^{-1}$ and row spacing could be in the order of 25-35 cm (Bayot and Templeton, 2009). If grown in the dry season, the prime irrigation recommendations are to apply 30 mm after sowing to promote emergence and then, depending on rainfall quantity and pattern, irrigate aroundflowering. As aerobic rice is not grown in permanently flooded soils, weeds can be aproblem. To control weeds a pre- and/or post-emergence herbicide (plus some manual ormechanical weeding) is recommended. Fertilizer requirements will depend on the level ofnutrients already available to the crop. Leaf colour charts (LCC) can be used to determinesite-specific nitrogen (N) needs. In the absence of LCCs and the knowledge and skills in sitespecificnutrient management, it is recommended that around 70-90 kg N/ha is a goodstarting point – with adjustments made as necessary. The nitrogen should then be split intothree applications. In the case of direct seeding, the first application should be applied 10-15 days after emergence, the second split at tillering and the third split at panicle initiation. Itmay also be necessary to apply phosphorous (P) and zinc on high pH soils.

Yield Components in Aerobic and Flooded Rice Production

In a two-cropping season-(2002-2003) experiment on crop performance, nitrogen and water use of flooded and aerobic rice which was embedded in a long-term experiment in IRRI, Belder*etal.*,(2005) revealed that sink size, represented by the number of grains m^{2-1}, showed a strong response to N and reflected LAI and biomass growth. Grain filling was significantly affected by regime in both seasons and was below 77% in aerobic plots. In comparison, around 90% of the grains were filled in 0-N flooded plots. Individual grain weight showed slight but significant effect of N in 2002 and water regime in 2003.All three components of yield were lower for aerobic than flooded conditions so that there was no positive feed-back mechanism between yield components. They inferredthat water deficit under aerobic cultivation lasted from around panicle initiation until physiological maturity, and even lowering the threshold of re-irrigation to -10 kPa around flowering still led to reduced grain filling. Flowering in 2003 occurred shorter after the soil water potential reached -30 kPa than in 2002. They reasoned that stress might have caused the lower growth rate between panicle initiation and flowering and the reduction in percentage grain filling and individual grain weight as compared with 2002.

Peng*et al.*, (2006) pointed out that the yield difference between aerobic and flooded rice was attributed more to difference in biomass production than to harvest index. Among the yield components, sink size (spikeletsm$^{2-1}$) contributed more to the yield gap between aerobic and flooded rice than grain filling percentage and 1000-grain weight.

MATERIALS AND METHODS

Materials

Experimental Design and Treatments

The field experiment was laid-out using a split-plot design with four replications with soil moisture regimes as the main plot and rice varieties as the sub-plot.

Main Plot: Soil Moisture Regimes (M)

M_1 – Aerobic

M_2 – Flooded

Subplot: Varieties (V)

Lagangilang,Abra and Luna,Apayao:

V_1 – NSIC Rc9

V_2 - PSB Rc14

V_3 – PSB Rc68

V_4 – NSIC Rc136H

V_5 – NSIC Rc192

Kapangan, Benguet:

V_1 – NSIC Rc9

V_2 - PSB Rc14

V_3 – PSB Rc68

V_4 – NSIC Rc192

V_5 – *Sapaw*

Methods

Cultural Management Practices

Land Preparation. The aerobic field prepared under dry soil condition; plowed twice, harrowed, leveled and furrowed. During the wet season, the flooded plot puddled; flooded a day or two and then plowed, harrowed and leveled.

Crop Establishment.The seeding rate was 320 viable seedsm2^{-1} or 1,920 seeds plot^{-1} (3 m x 2 m) for both aerobic and flooded plots. The seeds were hand-dibbled 2 cm deep and covered with soil in aerobic fields. Each subplot had 6-m^{2}with eight 3-meter rows spaced at 25 cm apart.

In flooded plot, seeds weredirectly-seeded at a planting distance of 25 cm between rows.

Water Management.The aerobic plots wereirrigated immediately after sowing. Subsequent irrigations of about 5 cm depth were applied each time the soil moisture potential at 15 cm depth reached 15cb. At flowering, the threshold for irrigation was reduced to field capacity to avoid spikelet sterility (O’Toole and Garrity, 1984). No ponded water was used except for part of the days of irrigation and during heavy rainfall in the wet season (Bouman*et al.*, 2005).

The standing water was maintained in the flooded plots from seeding until 2 weeks before harvest. The initial water depth was be 2 cm and gradually increased to 10 cm at full crop development.

The main plots were hydrologically separatedto prevent seepage of water from the flooded plots into aerobic plots by establishing a set of double drains 40 cm deep between the main plots. Plastic sheets were at 40 cm depth in the bunds of all main plots.

Nutrient Management.Based on the laboratory results,the fertilizer rates used were as follows: 80-60-45 (wet season) and 90-60-45 (dry season) in Lagangilang, Abra; 40-60-0 (wet season) and 50-60-0 (dry season) in Luna, Apayao. Fertilizers were applied in three splits: 1) 30% N, all P & K 10-14 days after emergence (DAE); 2) 35% N 20-35 DAE; and 3) 35% N 40-50 DAE. The second and third N applicationvaried depending on the maturity of varieties used in the experiment.

The nutrient management in Kapangan site followed the indigenous practices in traditional rice production. There were no external inputs applied to the area in order to sustain the organic production practices. The rice stubbles were plowed under during land preparation to augment internal nutrient supply for the organic rice production.

Pest Management.Observed the occurrence of the following insect pests and diseases in Luna, Apayao: caseworm, leaffolders, stemborers, rat, and rice blast.The plants compensated from the early season damage caused by caseworm and leaffolder by producing new leaves and tillers. Several preventive management strategies were employed such as avoidance of excessive nitrogen fertilizer application in Lagangilang, Abra and Luna, Apayao; and installation of plastic nets and rat baits around the area in Luna, Apayao and Kapangan, Benguet. No chemical pesticide was used in all three sites. Weeds were controlled through manual weeding.

Data Gathered:

A. Agro-physiological Parameters

1. Plant Height at Maturity. This was measured (in cm) from 10 sample plants randomly selected in each plot and taken from the average. At physiological maturity, plant height was the length from the ground level to the tip of the longest panicle, excluding the awns if any.

2. Days to Tillering, Booting, Heading and Ripening. These were recorded by counting the number of days from seeding to maximum tillering, to booting, to heading (emergence of the panicle out of the flag leaf sheath) and to ripening. It was when 50% of the plants in each plot are at maximum tillering, booting, heading stage and 80% physiologically mature.

3. Panicle Number. At physiological maturity, it was counted as the number of panicles from 0.25 m^2 area from each plot.

4. Panicle Length. At maturity, panicle length was taken by measuring from the panicle base to its tip excluding awns if any. Measurements were taken from 10 randomly selected plants per plot.

5. Total Grain Number per Panicle. At harvest, 10 panicles were randomly collected from each plot, threshed and counted both the filled and unfilled.

6. Number of Filled Grains per Panicle. At harvest, 10 panicles were randomly collected from each plot and threshed separately. Filled and unfilled grains from each panicle were separated and counted.

7. Filled Grain Ratio (%). This was computed by using the formula:

$$\text{Filled grain ratio} = \frac{\text{Filled grain number}}{\text{Total grain number}} \times 100$$

8. Weight of 1000-grain. This was taken by measuring the weight of 1000 filled grain adjusted to a 14% moisture basis.

9. Total Dry Matter (Aboveground Total Biomass). This was taken from 0.25 m^2 sample area and computed as the total dry matter of straw and panicles.

10. Harvest Index. This was taken from 0.25 ^{m2} area from each plot and computed by using the formula:

$$\text{Harvest Index} = \frac{\text{Weight of dried filled grains}}{\text{Total weight of aboveground biomass}}$$

11. Grain Yield. The remaining area of each plot ($5.75m^2$) was harvested for grain yield adjusted to a 14% moisture basis.

12. Computed Yield. This was derived by computing the grain yield per plot ($5.75m^2$) to a hectare.

13. Leaf Area Index. The leaf area of ten sample plants was taken from each plot at 75 days after seeding (DAS) using the Tracing Technique method (Saupe, 2006). It was computed by using the formula:

$$\text{Leaf area } (mm^2) = \text{weight of leaf tracing (g)} \times \text{conversion factor } (mm^2\ gm^{-1})$$

$$\text{Leaf area index} = \frac{\text{Total one-sided area of leaf tissue}}{\text{Ground surface area occupied by crop}}$$

B. Other Data

1. Reaction to Insect Pest and Diseases

a. Caseworm. Recordedas the percent of damaged leaves in each plot at 40 days after emergence from 20 randomly selected plants or hills/plot. The damage was estimatedby recording the ratio of damaged over the total number of leaves from randomly selected plants. The following rating scale was used (INGER, 1996):

Scale	Description	Rating
1	1-10% damaged plant	Resistant
3	11-20% damaged plant	Moderately Resistant
5	21-35% damaged plant	Intermediate
7	36-50% damaged plant	Moderately Susceptible
9	51-100% damaged plant	Susceptible

b. Leaffolder. Recordedas the percentage of damaged leaves during the abundance of leaffolders from the twenty plants randomly selected in each plot.It was computed as damaged over total number of leaves. The following rating scale was used (INGER, 1996):

Scale	Description	Rating
1	1-10% damaged plant	Resistant
3	11-20% damaged plant	Moderately Resistant
5	21-35% damaged plant	Intermediate
7	36-50% damaged plant	Moderately Susceptible
9	51-100% damaged plant	Susceptible

c. Stem BorerDamage Evaluation (Whiteheads).Field rating was based on actual infested panicles in a 0.25 m^2 area at the center of each plot. Ten sample plants were selected at random were counted ten days before harvest. Percentage of whiteheads was recorded using the following standard rating scale (INGER, 1996):

Scale	Description	Rating
1	1-5% whiteheads	Resistant
3	6-10% whiteheads	Moderately Resistant
5	11-15% whiteheads	Intermediate
7	16-25% whiteheads	Moderately Susceptible
9	26% and above	Susceptible

d. Rat Damage. Evaluation of rat damage was taken from the damaged plants in a 0.25 m^2 area of each plot. Ten sample plants were selected at random were counted and observed based on the following rating scale (INGER, 1996):

Scale	Description	Rating
1	Less than 5% damage observed	Resistant
5	6-25% damage observed	Intermediate
9	26-100% damage observed	Susceptible

e. Rice Panicle Blast. Assessment of the severity of rice blast was taken from the plants at the 0.25 m^2 area of each plot. Ten sample plants were taken randomly. Computation of percent infection was done using the formula (INGER, 1996):

$$\% \text{ Infection} = \frac{\text{Number of panicle infected}}{\text{Total number of panicles}} \times 100$$

Scale	Description	Rating
1	0-5% are affected by blast	Resistant
3	6-25% are affected by blast	Intermediate
5	26% &above are a ffected by blast	Susceptible

2. Sensory evaluation. This adopted the procedure undertaken by Tad-awan, et al (2010) with some modification. Samples of cooked rice were wrapped

individually with foil. Each person was given 10 samples of cooked rice varieties and a bottled water. A sample score sheet was distributed to each person which contains the following:

a. <u>Aroma</u>

1 - bland

2 - slightly perceptible

3 - moderate

4 - strong

5 - very strong aroma

b. <u>Taste</u>

1 - no taste

2 - slightly tasty

3 - moderate

4 - strongly perceptible

5 - very strong

c. <u>Texture</u>

1 - very soft

2 - moderately soft

3 - slightly hard

4 - moderately hard

5 - very hard texture

d. <u>General Acceptability</u>

1 - dislike extremely

2 - dislike very much

3 - dislike moderately

4 - dislike slightly

5 - neither like nor dislike

6 - like slightly

7 - like moderately

8 - like very much

9 - like extremely

Analysis of Data

The data was analyzed through analysis of variance in RCBD. Significance among treatment means was analyzed using the Duncan's Multiple Range Test (DRMT). Correlation analysis was also done.

The degree of relationship between two variables was measured using the Pearson product moment correlation coefficient (R) which characterizes the independence of X and Y (Amid, 2005). The coefficient R is a parameter which can be estimated from sample data using the formula:

$$R = \frac{N \sum xy - (\sum x)(\sum y)}{\sqrt{[n \sum x^2 - (\sum x)^2]\,[n(\sum y) - (\sum y)^2]}}$$

RESULTS AND DISCUSSION

Study 1. Growth and Yield Performance of Rice Grown under Two Moisture Regimes in Lagangilang, Abra during Wet Season 2010 and Dry Season 2011

AgrometeorologicalConditions

Abra belongs to Type 1 climate which is characterized by two pronounced seasons, dry from November to April and wet during the remaining months of the year. The experimental site in Lagangilang, Abra has an elevation of 65 m asl. It is classified under lowland zone (<100m asl) according to the Research, Development and Extension Agenda and Program for the Cordillera Agro-Forest/Fishery Ecological Zones classification (DA-CAR, 1999). It also falls under the lowland irrigated ecosystem based on rice ecosystem classification (Dobermann and Fairhurst, 2000).

The total rainfall for wet season 2010 and dry season 2011 were at 871.6 mm and 16.5 mm, respectively (Table 1). The minimum and maximum air temperature during the study period ranged from 16.8^{o}C to 23.4^{o}C while the maximum air temperature ranged from 35.5^{o}C-37.7^{o}C, respectively. The temperature range is within the optimum range favorable for rice production of 18-40^{o}C as cited by De Datta (1981). The relative humidity in both cropping seasons ranged from 60.6 to 84.7% which is favorable for rice production.

Table 1. Meteorological data of Lagangilang, Abrafrom July 2010 to April 2011

CROPPING SEASON/ MONTH	RAINFALL[a] (mm)	RELATIVE HUMIDITY %	T_{max}[b] (°C)	T_{min} (°C)	T_{avg} (°C)
Wet Season 2010[c]					
July	257.0	79.9	37.7	23.2	28.6
August	226.1	82.6	37.0	23.4	28.0
September	207.9	84.7	36.8	23.0	27.8
October	180.7	81.4	37.2	20.1	28.1
November	-	77.06		20.3	-
Dry Season 2011					
December 2010	-	69.4	36.0	18.5	26.6
January	-	64.4	36.3	17.1	26.2
February	12.0	62.4	37.0	16.8	27.1
March	4.5	60.6	37.3	19.0	27.9
April	-	58.2	35.5	18.9	29.0

[a]*Rainfall accumulated from July to November 2010 and December 2010 to April 2011.*
[b]*T_{max}, $T_{min}$and T_{avg}refer to the means for the highest, lowest, and average temperature.*
[c]*Temperature and relative humidity data for WS 2010 were taken from PhilRice-Batac, Ilocos Norte*

<u>Soil Properties</u>

The results of the analysis revealed that the soil was slightly acidic. A pH of 6.27 favors the growth of rice plants. De Datta (1981) cited that the optimum pH for rice growth and development ranges from 5.5 to 6.5. The bulk density of

Table 2. Soil physical and chemical properties in Lagangilang, Abra

SOIL PROPERTY	VALUE
Chemical Properties	
pH	6.27
OM (%)	1.50
P_2O_5 (ppm)	4.00
K_20 (ppm)	36.0
Zn (ppm)	0.72
Physical Properties	
Bulk Density (g/cc)	1.71
Water Holding Capacity (ml/g)	0.52

1.71 gcc^{-1} and water holding capacity of 0.52 ml g^{-1} indicates that the soil is moderately compacted which inhibits root penetration in moist soil.

Groundwater and Standing Water Depths

Figure 1 shows the depths of groundwater and standing water for aerobic plots in Lagangilang, Abra during the wet season (WS) 2010 and dry season (DS) 2011. The standing water levels were almost always below the soil surface indicating unponding. The rainfall during the July-October 2010 wet season was supplemented with irrigation water whenever measurements of standing water

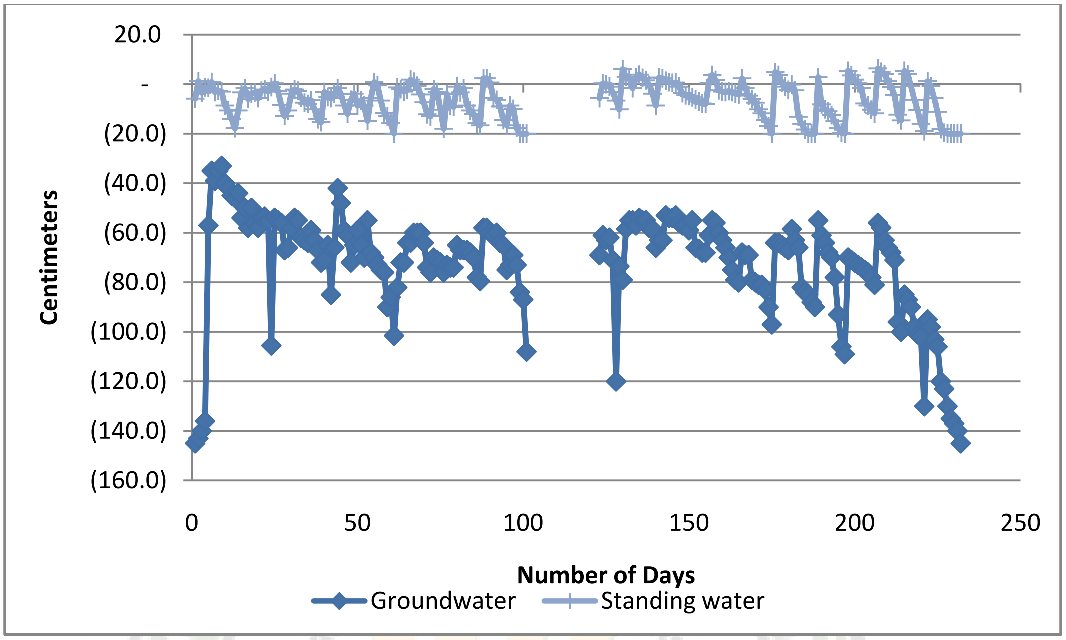

Figure 1. Groundwater and standing water depths (cm) in aerobic fields, Lagangilang, Abra (2010-2011)

depth in two (2) out of the three (3) standing water tubes were at 20 cm below the soil surface. The standing water level indicates the available water supply for crop growth and development. Likewise, when irrigation water is limited a shallow ground water can be a hidden water supply for the rice crop for its growth and development.

Soil Matric Potential

Figure 2 shows the soil matric potential in aerobic fields in Lagangilang, Abra during the DS 2011. There was a series of increased moisture potential for a few days indicating that there was no irrigation or rainfall. The reading was used

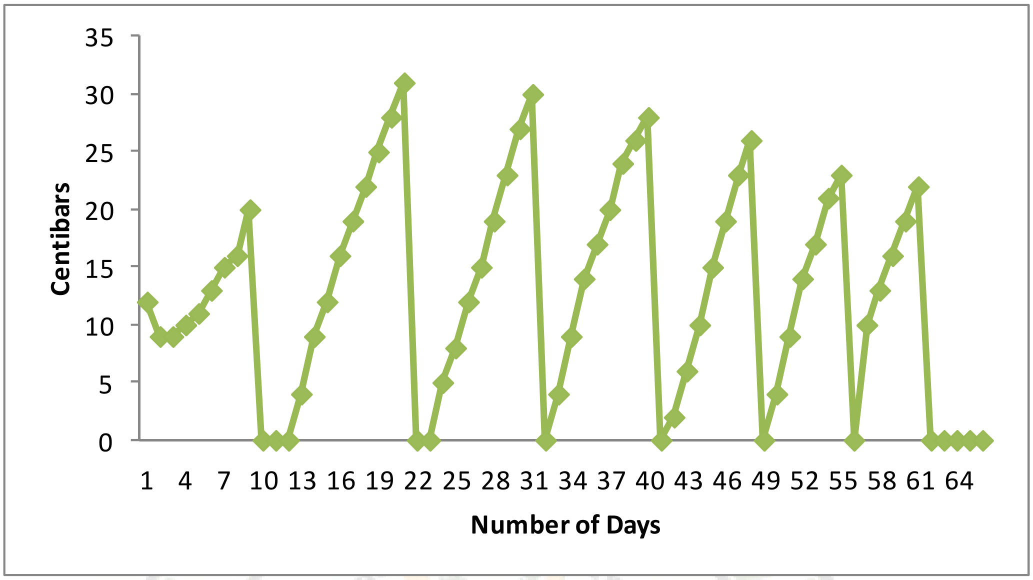

Figure 2. Soil matric potential in Lagangilang, Abra during the DS 2011

to determine schedule of irrigation. When it reached 20-30 cb, the area was irrigated so as not to subject the plants from water deficit stress. The tensiometerreading therefore dropped to 0 cb every time irrigation water was applied. The highest soil matric potential reached 31 cb.

Plant Height

Effect of moisture regime. Rice plants grown under flooded condition were significantly taller than those grown under aerobic condition in both wet season and dry season trials (Table 3). This corroborates the observation of De Datta (1981) that plant height generally increases with increasing water depth under flooded condition trials.

Effect of variety. PSB Rc68 was the tallest but not significantly taller than NSIC Rc192 and NSIC Rc9 in both season trials (Table 3). Said three varieties were significantly taller than NSIC Rc136H and PSBRc14 in both trials.

During the WS 2010 trial, NSIC Rc136H was not significantly taller than PSB Rc14 but was during the dry season 2011 trial.

From the results, it could be inferred that plant height is dependent on variety. These results corroborate with Arraudeau and Vergara (1988) indicating that upland rice varieties like NSIC Rc9, are tall ranging from 120 to 180 cm. This characteristic may contribute to the high biomass and eventually yield.

Vergara (1992) also cited that reduced plant height is the most important factor to increase the grain yield potential of rice. Shorter plants can take up morenitrogen fertilizer without lodging, resulting in higher grain yields. Plants are tall and leafy during the wet season since they shade each other and thisreduces food production in the leaves. During the dry season, plants areshorter and have fewer tillers since more light energy is available.

Interaction effect. There was no significant interaction observed between the moisture regimes and the rice varieties in terms of plant height at maturityduring the WS 2010 in Lagangilang, Abra. However, significant interaction was noted during the DS 2011 (Figure 3). NSIC Rc9 and PSB Rc68 were the tallest at 80.09 cm and 97.61 cm under aerobic and flooded conditions, respectively. This

Table 3. Plant height of rice at physiological maturity in Lagangilang, Abra during the WS 2010 and DS 2011

TREATMENT	PLANT HEIGHT (cm)	
	WS 2010	DS 2011
Moisture Regimes (M)		
Aerobic	115.15[b]	70.35[b]
Flooded	117.50[a]	84.67[a]
Varieties (V)		
NSIC Rc 9	125.75[a]	88.15[a]
PSB Rc 14	95.38[c]	64.57[b]
PSB Rc 68	128.63[a]	87.22[a]
NSIC Rc 136H	106.75[b]	66.16[b]
NSIC Rc192	126.13[a]	81.44[a]
M x V	0.67^{ns}	3.19^{*}
CV_a(%)	1.76	1.11
CV_b(%)	4.76	4.20

For each column, treatment means with different letter are significantly different at 5% probability levels (DMRT).

indicates that these two varieties may reach their inherent characteristic of being tall-statured plants especially when there is ample supply of soil moisture.

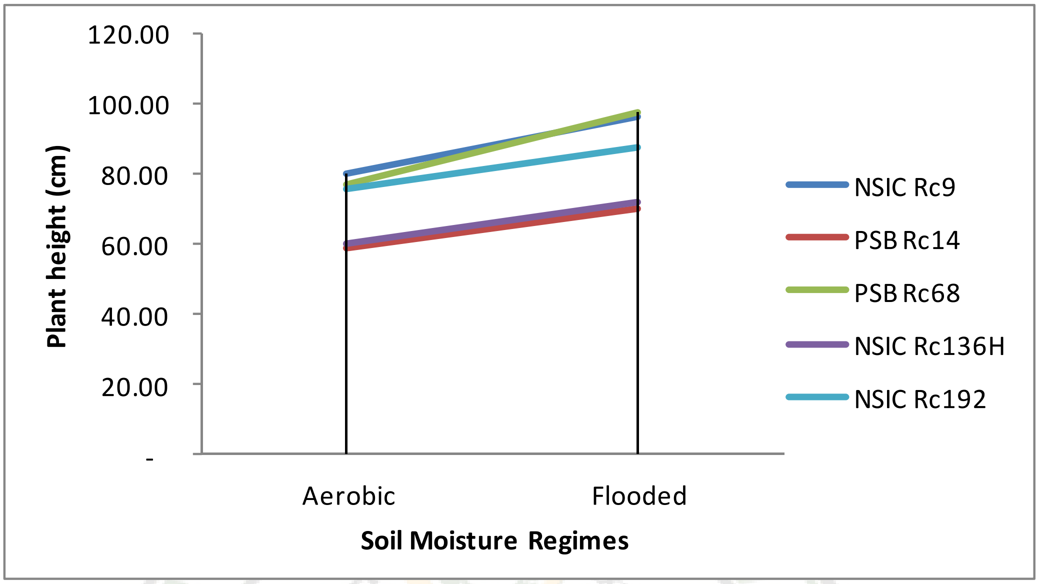

Figure 3. Interaction effect between the moisture regimes and the rice varieties on plant height in Lagangilang, Abra during the DS 2011

Number of Days from Seeding to Maximum Tillering

Effect of moisture regime. Statistical analysis showed no significant difference between the two moisture regimes in terms of number of days from seeding to maximum tilleringduring the wet season2010 (Table 4) but it was significantly different during the dry season 2011 (Table 5). Results showed that under flooded condition, plants reached maximum tillering earlier than those grown under aerobic condition in both cropping seasons.

Effect of variety. Significant differences were noted among the different rice varieties in terms of number of days from seeding to maximum tillering during the wet season and dry season trials. During the wet season, PSB Rc9 produced maximum tillers earliest at 32.25 days and was comparable with

Table 4. Number of days from seeding to maximum tillering, maximum tillering to booting, booting to heading, and heading to maturity of rice in Lagangilang, Abra during the WS 2010

TREATMENT	NUMBER OF DAYS FROM:			
	SEEDING TO MAXIMUM TILLERING	MAXIMUM TILLERING TO BOOTING	BOOTING TO HEADING	HEADING TO MATURITY
Moisture Regimes (M)				
Aerobic	34.00	28.90	8.60	31.60
Flooded	33.85	28.65	8.70	31.80
Varieties (V)				
NSIC Rc 9	32.25[a]	30.88[c]	10.63[c]	33.25[c]
PSB Rc 14	33.63[ab]	28.63[b]	7.75[b]	29.00[b]
PSB Rc 68	34.50[b]	28.88[b]	10.63[b]	42.00[d]
NSIC Rc 136H	33.88[ab]	28.38[b]	7.75[b]	28.25[b]
NSIC Rc192	35.38[c]	27.13[a]	6.50[a]	26.00[a]
M x V	1.24[ns]	2.71[ns]	0.14[ns]	2.23[ns]
CV_a (%)	1.17	1.88	2.10	1.82
CV_b (%)	2.5	3.80	6.10	2.27

For each column, treatment means with different letter are significantly different at 5% probability levels (DMRT).

Table 5. Number of days from seeding to maximum tillering, maximum tillering to booting, booting to heading, and heading to maturity of rice in Lagangilang, Abra during the DS 2011

TREATMENT	NUMBER OF DAYS FROM:			
	SEEDING TO MAXIMUM TILLERING	MAXIMUM TILLERING TO BOOTING	BOOTING TO HEADING	HEADING TO MATURITY
Moisture Regimes (M)				
Aerobic	42.25^{a}	30.95	8.40	26.70
Flooded	39.20^{b}	31.35	8.65	26.40
Varieties (V)				
NSIC Rc 9	40.88^{a}	33.25^{c}	10.38^{c}	38.00^{d}
PSB Rc 14	41.75^{b}	29.63^{b}	7.63^{b}	24.00^{b}
PSB Rc 68	40.00^{a}	35.50^{d}	10.50^{c}	19.38^{a}
NSIC Rc 136H	40.88^{a}	29.38^{b}	7.75^{b}	23.13^{b}
NSIC Rc192	40.13^{a}	28.00^{a}	6.38^{a}	28.25^{c}
M x V	7.56**	2.01^{ns}	0.27^{ns}	8.22**
CV_a (%)	1.33	1.44	7.01	5.71
CV_b (%)	2.30	2.20	5.70	6.77

For each column, treatment means with different letter are significantly different at 5% probability levels (DMRT).

PSB Rc14 and NSIC Rc136H at 33.63 days and 33.88 days, respectively. The latest to reach maximum tillering was NSIC Rc192 at 35.38 days (Table 4).

During the dry season study, PSB Rc68 reached the earliest maximum tillering stage at 40.00 days but was not significantly earlier than NSIC Rc192, NSIC Rc136H and NSIC Rc9. PSB Rc14 had the latest maximum tillering(Table 5).

The seeding to maximum tilleringstagseare part of the vegetative phase which mainly determines the differences in growth duration of varieties. As cited by Arraudeau and Vergara (1988), the duration of vegetative phase differs with variety.

Interaction effect. There was no significant interaction observed between the soil moisture regimes and the rice varieties on number of days from seeding to maximum tillering stage during the wet season 2010 but had highly significant interaction effect during the dry season 2011 (Figure 4).This result implies that variety trials for aerobic rice production have to be conducted during the dry season.

NSIC Rc136H had varied response during the DS 2011 under the two soil moisture regimes. It was the latest to reach the maximum tillering stage from seeding under aerobic at 44 days but the earliest under flooded condition at 37.75 days. Such trend goes to show that growth duration of NSIC Rc136H could be shortened by ensuring available water supply in the field. PSB Rc68 reached earliest the maximum tillering from seeding at 41.25 days under aerobic condition.

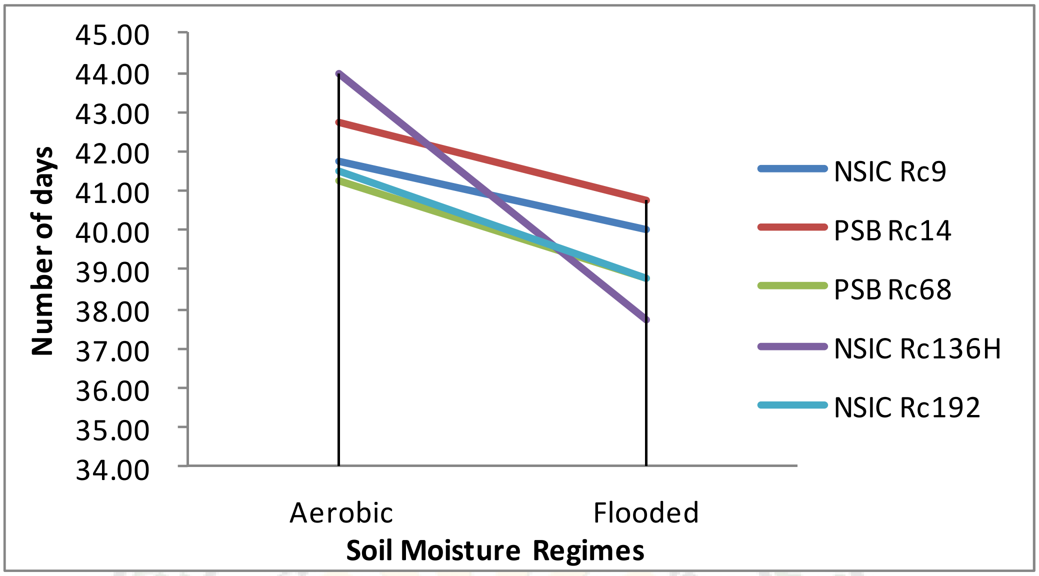

Figure 4. Interaction effect between the soil moisture regimes and the rice varieties on number of days from seeding to maximum tillering in Lagangilang, Abra during the DS 2011

Number of Days from Maximum Tillering to Booting

Effect of moisture regime. The two moisture regimes did not significantly affect the number of days from seeding to tilleringboth during the wet season2010 and dry season 2011 (Table 4 and 5).

Effect of variety. Significant differences were noted among the different rice varieties in terms of number of days from maximum tillering to booting during the wet season and dry season (Tables 4 and 5). During the wet season, NSIC Rc192 reached booting stage earliest at 27.13 days and NSIC Rc9 the latest at 30.88 days. During the dry season, NSIC Rc192 booted earliest at 28 days and PSB Rc68 latest at 35.50 days.

From the results it could be inferred that the duration of maximum tillering stage which is part of the vegetative phase differs with variety as confirmed by Arraudeau and Vergara (1988).The determination of the panicle initiation stage, which is prior to booting, is critical in nutrient management where nitrogen fertilizer should be applied for panicle development.

Interaction effect. There was no significant interaction observed between the soil moisture regimes and the rice varieties on number of days from maximum tilleringto booting stage both during the wet season2010 and dry season 2011 (Table 4 and 5).

Number of Days from Booting to Heading

Effect of moisture regime. The was no significant difference between the two moisture regimes in terms of number of days from booting to heading stage in Lagangilang, Abra both during the WS 2010and DS 2011 (Table 4 and 5).

Effect of variety. The number of days from booting to heading stage significantly affected by the kind of variety during the wet season 2010 and dry season2011 (Tables 4 and 5). During the wet season, NSIC Rc192 reached the earliest heading stage while NSIC Rc9 and PSB Rc68reached the latest both. During the dry season trial, NSIC Rc192 was the earliest to reach the heading stagewhile PSB Rc68 reached the latest.Varieties differed also in the duration of the reproductive phase particularly from booting to heading stage.Variation in growth stage duration among varieties could also mean employment of varied intervention especially water application.

Interaction effect. There was no significant interaction observed between the soil moisture regimes and the rice varieties on number of days from booting to heading stage (Table 4 and 5).

Number of Days from Heading to Maturity

Effect of moisture regime. The two moisture regimes did not have significant effect on the number of days from heading to maturityboth at the wet season2010 and dry season2011 (Table 4 and 5).

Effect of variety. Significant differences were observed among the different rice varieties in terms of number of days from heading to maturity. NSIC Rc192 was the earliest to mature from heading during the wet season and PSB Rc68 was the latest to mature (Table 4). However, during the dry season, PSB Rc14 was the earliest to mature and NSIC Rc9 was the latest (Table 5).

The results indicate that maturity of varieties vary depending on the cropping season. Nevertheless, maturity days of NSIC Rc9 and PSB Rc68 were consistent with PhilRice's Catalogue of PSB/NSIC Varieties (2009) as the latest to mature among the varieties.

Interaction effect. There was no significant interaction observed between moisture regimes and rice varieties on the number of days from heading to maturityduring the wet season trial (Table 4). Conversely, there was significant interaction between the two during the dry season (Table 5). PSB Rc68 was the earliest to mature from heading under aerobic and flooded conditions during the dry season trial. In the same cropping season, NSIC Rc9 was the latest to mature in both soil moisture regimes which is consistent with the PhilRice's Catalogue of PSB/NSIC Rice Varieties (2009).

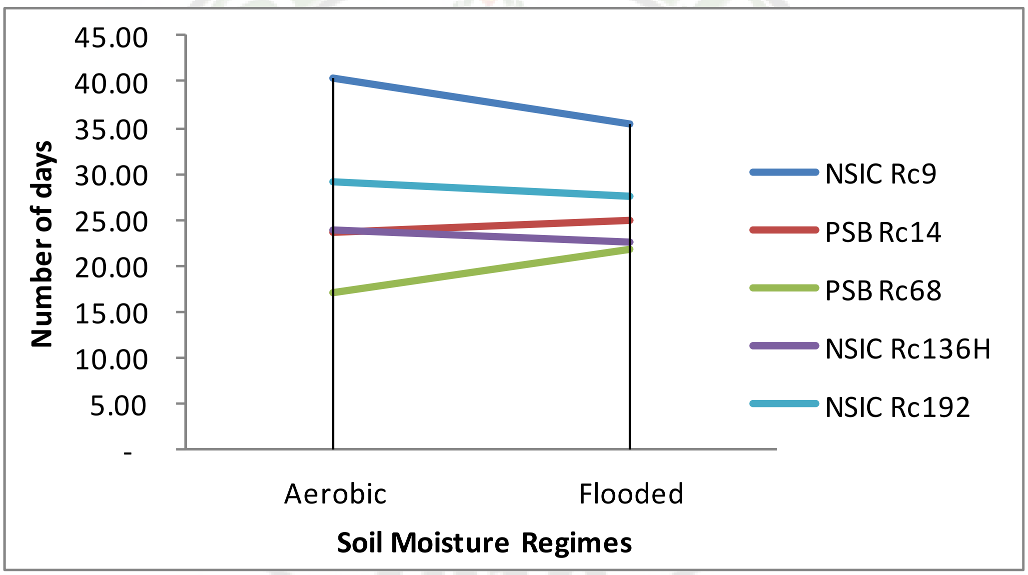

Figure 5. Interaction effect between the moisture regimes and the varieties on the number of days from heading to maturity in Lagangilang, Abra during the DS 2011

Leaf Area Index at 75 DAS

Effect of moisture regime. No significant differences were observed between the moisture regimes on leaf area index during the wet season 2010 (Table 6). During the dry season, however, a significant difference was noted.

Plants grown under flooded fields had significantly higher leaf area index than under aerobic condition (Bouman e*t al.*, 2005).The availability of sufficient water supply in the soil in flooded plots combined with highersolar radiation during the dry season may produce a significantly larger leaf area than those plants with regulated soil moisture supply in aerobic fields. Further, Yabes, *et al.*,(2008) cited that reduction of photosynthetically active leaf area should be prevented atpanicle initiation to booting which is about 75 DAS as this will affect attainment of yield potential.

The result also corroborated with the results of Bouman, et al (2005) that there is a reduced leaf area in rice plants under aerobic than flooded condition.

Effect of variety. Leaf area index wassignificantly affected by the kind of variety during both season trials (Table 6). NSIC Rc192 had the highest LAI during the wet season which was comparable with PSB Rc68. During the dry season, NSIC Rc192 maintained the highest leaf area index but which was not significantly different with NSIC Rc9. PSB Rc14 had the lowest LAI for both seasons. The difference in LAI among the varieties maybe due to their genetic characteristic.

The importance of LAI was noted in rice. De Datta (1981) cited that the total leaf area of a rice population is a factor closely related to grain production because the total leaf area at flowering greatly affects the amount of photosynthates available to the panicle.

Table 6. Leaf area index at 75 DAS in Lagangilang, Abra during the WS 2010 and DS 2011

TREATMENT	LEAF AREA INDEX	
	WS 2010	DS 2011
Moisture Regimes (M)		
Aerobic	2.57	2.44^{b}
Flooded	2.54	4.40^{a}
Varieties (V)		
NSIC Rc9	2.89^{b}	4.00^{a}
PSB Rc14	1.83^{c}	2.76^{b}
PSB Rc68	2.95^{a}	3.06^{ab}
NSIC Rc136H	2.13^{bc}	3.10^{ab}
NSIC Rc192	2.96^{a}	4.19^{a}
M x V	0.22^{ns}	2.36^{ns}
CV_a(%)	6.02	5.85
CV_a(%)	5.30	4.93

For each column, treatment means with different letter are significantly different at 5% probability levels (DMRT).

<u>Interaction effect</u>. No significant interaction was observed between the moisture regimes and the different rice varieties in terms of leaf area index in Lagangilang, Abra during the WS 2010 and DS 2011.

Panicle Number at Maturity

Effect of moisture regime. Table 7 shows the panicle number at maturity. Significant differences were observed between the moisture regimes in terms of panicle number at maturity in Lagangilang, Abraduring the wet and dry season trials. Plants grown in flooded fields (92 and 103) produced more panicles than the plants grown in aerobic plots (72 and 86) at both the wet and dry cropping seasons, respectively.

The results agree with that of Peng*et al.*, (2006) that flooded rice produced more panicles with more spikelets per panicle than aerobic rice. The results also agree with that of Kato *et al.*, (2006b) that there was a sharp reduction in panicle number of some cultivars produced under suboptimal water condition like in aerobic. However, the resultof this study contradictsthat of Abbasi and Sepaskhah (2010) that the effect of water stressprolonged the growth duration of rice cultivars in intermittent flood irrigation similar with aerobic rice that resulted in higher number of panicles.

Effect of variety. No significant differences were observed among varieties in terms of panicle number at maturity during the wet season trial (Table 7). During the dry season trial, however, significant differenceswere noted. NSIC Rc192 produced the highest number of productive tillers during the wet season trial while PSB Rc14 had the highest number of productive tiller during the dry season trial. PSB Rc14 had the shortest but with the highest panicleper

Table 7. Panicle number of rice plants at physiological maturity in Lagangilang, Abra during the WS 2010 and DS 2011

TREATMENT	PANICLE NUMBER AT PHYSIOLOGICAL MATURITY	
	WS 2010	DS 2011
Moisture Regimes (M)		
Aerobic	72^{b}	86^{b}
Flooded	92^{a}	103^{a}
Varieties (V)		
NSIC Rc 9	79	95^{b}
PSB Rc 14	86	130^{a}
PSB Rc 68	72	80^{b}
NSIC Rc 136H	81	92^{b}
NSIC Rc192	92	79^{b}
M x V	1.38^{ns}	0.30^{ns}
CV_a(%)	3.58	2.37
CV_a(%)	3.46	3.47

For each column, treatment means with different letter are significantly different at 5% probability levels (DMRT).

unit area. On the other hand, PSB Rc68 had the longest yet with the least number of panicles per unit area.

Vergara (1992) foundthat rice varieties differ in tillering ability. The number of tillers determines the number of panicles and is the most important factor in achieving high grain yield.

Interaction effect. Statistical analysis showed no significant interaction between the moisture regimes and the rice varieties on the panicle number at maturity for both season trials (Table 7).

Panicle Length

Effect of moisture regime.Panicle length at physiological maturity was not significantly affectedby moisture regimes during the wet season trial but was significantlyaffected during the dry season trial (Table 8). Plants grown under flooded condition produced longer panicles than plants in aerobic condition. Longer panicles in flooded rice varieties had likewise more grain number than under aerobic field.

Effect of variety. Highly significant differences were observed among varieties in terms of panicle length (Table 8). PSB Rc68 produced the longest panicleduring the wet season but was comparable with NSIC Rc136H and NSIC Rc9. During the dry season, NSIC Rc9 had the longest panicle but not significantly different with PSB Rc68, NSIC Rc192 and NSIC Rc136H.

PSB Rc68 had the longest panicle but it also had the least panicles per unit area. In contrast, the PSB Rc14 which had the shortest panicles and the greatest number of panicles per plot. The result implies that panicle length could be

Table 8. Panicle length (cm) of rice plants at physiological maturity in Lagangilang, Abra during the WS 2010 and DS 2011

TREATMENT	PANICLE LENGTH ATPHYSIOLOGICAL MATURITY (cm)	
	WS 2010	DS 2011
Moisture Regimes (M)		
Aerobic	24.67	19.67^{b}
Flooded	24.82	21.77^{a}
Variety (V)		
NSIC Rc 9	25.24^{ab}	22.05^{a}
PSB Rc14	23.00^{c}	18.60^{b}
PSB Rc68	26.48^{a}	21.40^{a}
NSIC Rc 136H	25.26^{ab}	20.73^{a}
NSIC Rc192	23.74^{bc}	20.82^{a}
M x V	2.40^{ns}	1.89^{ns}
CV_a (%)	4.50	6.00
CV_b (%)	3.08	3.49

For each column, treatment means with different letter are significantly different at 5% probability levels (DMRT).

influenced by the genetic make-up of the varieties.

Interaction effect. Statistical analysis showed no significant interaction between the moisture regimes and the rice varieties on the length of panicle at harvest during both season trials(Table 8).

Total Grain Number per Panicle

Effect of moisture regime. While no significant differences were noted on the number of grains per panicle during the wet season trial, the number of grains per panicle markedly differ during the dry season (Table 9). Plants grown under aerobic plots produced more grains per panicle during the wet season. On the contrary, the number of grains per panicle is significantly higher under flooded than aerobic fields.

The results agreed with the results of Kato*et al*., (2006b) and Peng*et al.*, (2006) that flooded rice produced more panicles with more grains (spikelets) than aerobic rice.Kato *et al*., (2006a) deduced that reduced panicle production might be due to shallower roots of aerobic rice that resulted in reduced nitrogen uptake and decreased dry matter production.

Effect of variety. Significant differences were found among the rice varieties in terms of the number of grains per panicle (Table 9). NSIC Rc9 produced the highest number of grains per panicle during both season trials. This variety also had the longest panicle during the dry season trial but was comparable with PSB Rc68 which had the longest panicle during the wet season trial. This variety also had highest number of grains per panicle. Conversely, PSB Rc14 consistently produced the least number of grains per panicle since it had the shortest panicle at both cropping seasons.

Table 9. Grain number of panicle in Lagangilang, Abra during the WS 2010 and DS 2011

TREATMENT	GRAIN NUMBER PER PANICLE	
	WS 2010	DS 2011
Moisture Regimes (M)		
Aerobic	149.00	78.00[b]
Flooded	142.00	107.00[a]
Varieties (V)		
NSIC Rc 9	182.00[a]	115.00[a]
PSB Rc 14	101.00[d]	66.00[b]
PSB Rc 68	168.00[a]	101.00[a]
NSIC Rc 136H	128.00[c]	79.00[b]
NSIC Rc192	148.00[b]	100.00[a]
M x V	1.75[ns]	1.47[ns]
CV_a (%)	9.11	0.00
CV_b (%)	8.35	3.65

For each column, treatment means with different letter are significantly different at 5% probability levels (DMRT).

The foregoingresults imply that yield parameters such as panicle length and total number of grains per panicle could be some characteristics inherent to the variety. Moreover, the yield of varieties with the most number of grains (NSIC Rc9 and PSB Rc68) may still be further improved by avoidance of water stress during flowering and by employing appropriate cultural management practices like proper timing of fertilizer application at panicle initiation and flowering stages.

Interaction effect. Statistical analysis revealed no significant interaction between the moisture regimes and the different rice varieties in relation to grain number per panicle during the wet and dry season trials(Table 9).

Number of Filled Grains per Panicle

Effect of moisture regime.The number of filled grains per panicle did not significantlydiffer between the two moisture regimes during the wet season trial but significantly differed during the dry season trial. Plants grown under flooded plots had produced a higher number of filled grains per panicle during the dry season.

Effect of variety. Significant differences were found among the rice varieties in terms of the number of filled grains per panicle (Table 10). NSIC Rc 9 had the highest number of filled grains per panicle for both season trials. This variety consistently had the longest panicle with the most total and filled grains per panicle.In contrast, PSB Rc14 had the lowest number of filled grains per panicle in both cropping seasons. It had likewise the shortest and least total grain number per panicle.

Proper timing of fertilizer application at panicle initiation and flowering stages may increase the number of filled grain per panicle in varieties with large

Table 10. Number of filled grains per panicle in Lagangilang, Abra during the WS 2010 and DS 2011

TREATMENT	NUMBER OF FILLED GRAINS PER PANICLE	
	WS 2010	DS 2011
Moisture Regimes (M)		
Aerobic	115	60^{b}
Flooded	115	82^{a}
Variety (V)		
NSIC Rc 9	150^{a}	91^{a}
PSB Rc 14	78^{d}	52^{c}
PSB Rc 68	117^{b}	79^{b}
NSIC Rc 136H	100^{c}	56^{c}
NSIC Rc192	130^{b}	78^{b}
M x V	1.66^{ns}	1.62^{ns}
CV_a (%)	9.18	4.92
CV_b (%)	8.42	3.09

For each column, treatment means with different letter are significantly different at 5% probability levels (DMRT).

panicle size. Likewise, the occurrence of water stress during the flowering stage can reduce filled grains per panicle (Abbasi and Sepaskhah, 2010) and therefore should be avoided.

Interaction effect. There was no significant interaction noted between the moisture regimes and the different rice varieties in relation to grain number per panicle during both season trials (Table 10).

Filled Grain Ratio

Effect of moisture regime. Results showed that during the wet season trial, the different rice varieties grown under flooded fields had a higher filled grain ratio as compared tothose grown under aerobic plots. However, during the dry season trial, higher filled grain ratio was observed to the plants that were grown under aerobic plots as compared to the plants grown under flooded fields.

PhilRice (2001) reported that large amount of unfilled grains is due to lack of water.

Effect of variety. There were significant differences noted among the rice varieties in terms of filled grain ratio (Table 11). During the wet season trial, NSIC Rc192 had the highest filled grain ratio at 88.00and PSB Rc68 had the lowest with a mean of 70.00. During the DS, NSIC Rc9 had a highest filled grain ratio at 78.80 which was comparable with PSB Rc14with a mean of 78.06. NSIC Rc 136H had the lowest filled grain ratio of 72.11.

Both NSIC Rc9 and NSIC Rc192 performed wellin terms of filled grain ratio regardless of soil moisture condition. This implies that these varieties are adapted to irrigated, upland and lowland rainfed ecosystems. Furthermore, highly significant differences could be due to the compactness of grains in the panicle.

Table 11. Filled grain ratio of rice plants in LagangilangAbra during the WS 2010 and DS 2011

TREATMENT	FILLED GRAIN RATIO (%)	
	WS 2010	DS 2011
Moisture Regimes (M)		
Aerobic	77.50	77.27
Flooded	80.65	76.34
Variety (V)		
NSIC Rc 9	83.13[b]	78.80[a]
PSB Rc 14	76.63[c]	78.06[a]
PSB Rc 68	70.00[d]	77.21[b]
NSIC Rc 136H	77.63[c]	72.11[b]
NSIC Rc192	88.00[a]	77.87[b]
M x V	1.49 [ns]	3.04*
CV_a (%)	4.36	6.44
CV_b (%)	4.66	5.27

For each column, treatment means with different letter are significantly different at 5% probability levels (DMRT).

Interaction effect. There were no significant interactions noted between the moisture regimes and the rice varieties in terms of filled grain ratio during the wet season trial but significant interaction was observedduring the dry season trial (Figure 6). NSIC Rc9 under aerobic condition produced the highest filled grain ratio during the dry season trial and PSB Rc68 had the highest in flooded condition. The result impliesthe suitability of a particular variety to a specific soil moisture condition in Lagangilang, Abra as far as filled grain ratio is concerned.

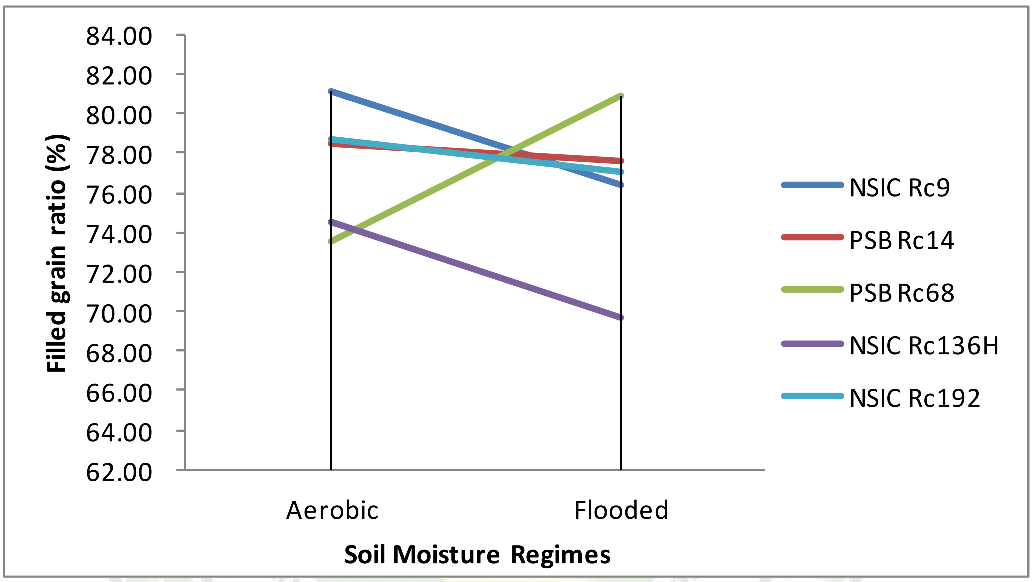

Figure 6. Interaction between the moisture regimes and the rice varieties on filled grain ratio in Lagangilang, Abra during the DS 2011.

Weight of 1000 Filled Grains

Effect of moisture regime. Statistical analysis revealed no significant differences between the two moisture regimes on the weight of 1000 grains at both season trials (Table 12). Plants grown under aerobic condition had higher weight of 1000 grains during the wet season but lower during the dry season trial.

Table 12. Weight of 1000 filled grains in Lagangilang, Abra during WS 2010 and DS 2011

TREATMENT	WEIGHT OF 1000 FILLED GRAINS (g)	
	WS 2010	DS 2011
Moisture Regimes (M)		
Aerobic	26.85	22.88
Flooded	26.62	24.30
Variety (V)		
NSIC Rc 9	23.89[c]	21.59[c]
PSB Rc 14	24.65[c]	21.49[c]
PSB Rc 68	30.34[a]	27.45[a]
NSIC Rc 136H	27.51[b]	25.16[b]
NSIC Rc192	27.28[b]	22.26[c]
M x V	1.21 [ns]	1.58[ns]
CV_a (%)	1.30	6.07
CV_b (%)	3.89	3.25

For each column, treatment means with different letter are significantly different at 5% probability levels (DMRT).

<u>Effect of variety</u>. Highly significant differences among the varieties in terms of weight of 1000 grains were noted (Table 12). PSB Rc68 had the heaviest weight of 1000 grains in both season trials. The lowest weight was recorded from NSIC Rc9 during the wet season trial and PSB Rc14 during the dry season. These results supports the PhilRice's PSB/NSIC Rice Catalogue (2009) that among the

five varieties, PSB Rc68 has the largest grain size. As other yield parameters may be enhanced with improved cultural management practices, the weight of 1000-graincould begenetically influenced and maybe considered as an important parameter in the selection of a variety with high yield potential.

Interaction effect. No significant interaction was observed between the moisture regimes and the rice varieties on the weight of 1000 grains (Table 12). This contradicts the result of the study of Abbasi and Sepaskhah (2011) that there was a significant interaction effect between cultivars and irrigation regimes on 1000 grain weight.

Total Dry Matter Weight

Effect of moisture regime. Results show that there was no significant differences observed between the moisture regimes in terms of total dry matter weight during the wet season trial but it had highly significant difference during the dry season trial (Table 13). In both seasons, plants grown under flooded plots had a higher dry matter weight.

The dry season trial results agree with the results of Kato*et al.,* (2006a) that some cultivars under adequate water supply produced the largest total dry matter and the least under low water supply. Further he cited that in general, total dry matter increased with increasing water supply. Likewise, Lafitte and Benett (2002) suggested that the reason for lower total dry mater weight under aerobic

Table 13. Total dry matter weight of rice plants in Lagangilang, Abra during the WS 2010 and DS 2011

TREATMENT	TOTAL DRY MATTER WEIGHT (g)	
	WS 2010	DS 2011
Moisture Regimes (M)		
Aerobic	266.75	129.03[b]
Flooded	267.10	200.38[a]
Variety (V)		
NSIC Rc9	301.19[b]	182.63[a]
PSB Rc14	231.44[c]	164.31[ab]
PSB Rc68	382.88[a]	185.25[a]
NSIC Rc136H	213.00[c]	154.63[bc]
NSIC Rc192	206.13[c]	136.69[c]
M x V	0.41 [ns]	2.09[ns]
CV_a (%)	0.13	1.88
CV_b (%)	2.83	4.01

For each column, treatment means with different letter are significantly different at 5% probability levels (DMRT).

condition may be related to the relatively shallow root system and stomata closure and reduced photosynthesis in response to surface soil drying.

Effect of variety There were highly significant differences noted among the rice varieties in terms of total dry matter weight in both cropping seasons (Table 13). PSB Rc68 had the heaviest total dry matter weight in both season trials.PSB Rc68 was also the tallest in wet season trialbut not significantly different with NSIC Rc9, the tallest during the dry season trial. From the foregoing results, it could be inferred that tall varieties have high total dry matter weight. Furthermore, PSB Rc68 also had the heaviest 1000-grain weight under both moisture regimes and in both growing periods.

Interaction effect. There was no significant interaction observed between the moisture regimes and the varieties in terms of total dry matter weight (Table 13).The results contradict with the results of Kato *et al.*, (2006a) that cultivar-water regime interaction in total dry matter weight is significant. Results revealed that different cultivars responded differently to the water conditions and that the local water supply greatly affected total dry matter in upland conditions through its effects on the amount of N uptake, which was associated with the depth of root development.

Harvest Index

Effect of moisture regime. Statistical analysis revealed that there was no significant difference observed between the two moisture regimes on harvest index during the wet season trial but highly significant difference was observed during the dry season trial (Table 14). The significantly higher harvest index in

Table 14. Harvest index of rice plants in Lagangilang,Abra during the WS 2010 and DS 2011

TREATMENT	HARVEST INDEX	
	WS 2010	DS 2011
Moisture Regimes (M)		
Aerobic	0.51	0.41^{b}
Flooded	0.52	0.50^{a}
Varieties (V)		
NSIC Rc9	0.51^{b}	0.39^{c}
PSB Rc14	0.55^{a}	0.49^{b}
PSB Rc68	0.43^{c}	0.32^{d}
NSIC Rc136H	0.55^{a}	0.53^{a}
NSIC Rc192	0.52^{ab}	0.54^{a}
M x V	0.34^{ns}	0.77^{ns}
CV_a (%)	6.38	3.99
CV_b (%)	7.25	5.95

For each column, treatment means with different letter are significantly different at 5% probability levels (DMRT).

flooded condition than in aerobic during the dry season may be attributed to a higher assimilation rate of rice plants in plots with sufficient moisture supply in the soil.

Effect of variety. There were highly significant differences noted among the varieties in terms of harvest index (Table 14). Results show that during the wet season trial, NSIC Rc136H and PSB Rc14 had the highest harvest index but comparable with NSIC Rc192.In the same season, PSB Rc 68 had the lowest harvest index.

During the dry season trial, NSIC Rc192 had the highest harvest index but not significantly different with NSIC Rc136H. PSB Rc68 had maintained as the lowest with a mean harvest index.

In both cropping season trials, both NSIC Rc136H and NSIC Rc192 attained the highest grain yield and harvest index which could be inferred that these varieties had higher assimilation rate as manifested by their high economic (grain) over the biological (biomass) yield. The higher the harvest index, the higher the economic yield. A high harvest index maybe a manifestation of the superiority of these varieties over the others.

On the other hand, PSB Rc68 had the lowest harvest index for both season trials but was also the tallest during the wet season trial. This supports De Data (1981) that tall plants have reduced harvest index.

Interaction effect. Statistical analysis revealed no significant interaction between the moisture regimes and the rice varieties in terms of harvest index (Table 14).

Grain Yield

Effect of moisture regime. Significant differences were observed between the two moisture regimes on the weight of grain yield in both the season trials (Table 15).

Results show that plants grown under aerobic condition were 0.25 g (7%) and 1.59 g (46%) lower than those under flooded fields during the wet season and dry season trials, respectively. The significant differences between the two moisture regimes could be attributed by the amount of water used by plants. Lack of water at any growth stage may reduce grain yield. In general, the difference in yield between aerobic and flooded rice was greater in dry season than in wet season trial. The yield difference was associated with variability in the soil water status of aerobic rice between dry and wet season trial (Bouman*et al.*,2005).

Further, low temperature of 16.8-17.1^{0}C was experienced in January-February 2011 in Lagangilang, Abra which might have affected the reproductive phase of the rice plants eventually producing a lower grain yield during dry season than the wet season trial.

Effect of variety. Statistical analysis shows significant differences among the varieties on grain yield. Results show that NSIC Rc136H had the highest grain yield but comparable with NSIC Rc192 during both season trials. On the other hand, the lowest grain yield was obtained from PSB Rc14 during the wet season trial and PSB Rc68 during the dry season trial.

Table 15. Grain yield (g) in Lagangilang,Abra during the WS 2010 and DS 2011

TREATMENT	GRAIN YIELD (kg/5.75 m^2)	
	WS 2010	DS 2011
Moisture Regimes (M)		
Aerobic	3.45^{b}	1.86^{b}
Flooded	3.69^{a}	3.45^{a}
Variety (V)		
NSIC Rc 9	3.53^{b}	2.44^{bc}
PSB Rc 14	3.10^{b}	2.90^{a}
PSB Rc 68	3.17^{b}	2.19^{c}
NSIC Rc 136H	4.11^{a}	2.96^{a}
NSIC Rc192	3.95^{ab}	2.76^{ab}
M x V	0.74^{ns}	0.41^{ns}
CV_a (%)	0.89	7.86
CV_b (%)	2.13	12.50

For each column, treatment means with different letter are significantly different at 5% probability levels (DMRT).

The highest mean grain yield under aerobic condition was NSIC Rc192 at 3.10 kg 5.75 m^{2-1} and the lowest from PSB Rc68 with 2.16 kg 5.75 m^{2-1}. The highest grain yield of NSIC Rc192 was attributed by its high mean filled grain ratio (82%) and high harvest index (0.51). Its early maturity is likewise a positive trait.

Under flooded condition, NSIC Rc136H outyielded the other varieties. NSIC Rc136H had the highest yield under this soil moisture regime due to its high harvest index of 0.56.

The results confirm the high yielding ability of NSIC Rc192 under water deficit condition and of NSIC R136H, a hybrid variety, under a favorable condition as far as soil moisture is concerned (PhilRice, 2009).

Interaction effect. There were no significant interactions between the moisture regimes and the different rice varieties in terms of grain yield for both cropping seasons.

Computed Yield per Hectare

Effect of moisture regime. Significant differences were observed between the two moisture regimes on the weight of grain yield (Table 16).

Results show that plants grown under flooded fields had a higher computed yield as compared to the plants grown under aerobic plots. There was a yield reduction of 0.42 tha^{-1} (7%) and 2.77 $tonsha^{-1}$ (46%) in aerobic plots over flooded fields during the wet season and dry season trials, respectively. There was a smaller yield difference between the two moisture regimes during the wet season because of the readily available water supply from rainfall in aerobic plots as compared to the dry season. During the wet season, the water usage between

Table 16. Computed yield (t ha^{-1}) in Lagangilang, Abra during the WS 2010 and DS 2011

TREATMENT	COMPUTED YIELD (t ha^{-1})	
	WS 2010	DS 2011
Moisture Regimes (M)		
Aerobic	6.00^{b}	3.23^{b}
Flooded	6.42^{a}	6.00^{a}
Variety (V)		
NSIC Rc9	6.15^{a}	4.25^{b}
PSB Rc14	5.40^{b}	5.05^{a}
PSB Rc68	5.49^{b}	3.81^{b}
NSIC Rc136H	7.14^{a}	5.16^{a}
NSIC Rc192	6.86^{a}	4.81^{a}
M x V	0.76^{ns}	0.41^{ns}
CV_a (%)	2.88	12.50
CV_b (%)	8.58	8.36

For each column, treatment means with different letter are significantly different at 5% probability levels (DMRT).

aerobic and flooded was almost similar. On the other hand, yield gap was larger during the dry season since aerobic condition was almost strictly imposed in aerobic plots with minimal rainfall only in February and March 2011. Soil moisture was generally supplied by irrigation water.

Effect of variety. Statistical analysis showed significant differences among the varieties in terms of grain yield during the wet season and dry season trials (Table 18). NSIC Rc136H outyielded the other varieties in both seasons with a mean of computed yield of 7.14 tons ha^{-1} and 5.16 tons ha^{-1}, respectively.Lowest computed yield was obtained from PSB Rc14 (5.40 $tonsha^{-1}$) during the wet seasontrial and PSB Rc68 (3.81 tons ha^{-1}) during the dry season trial.

The results show that the highest mean computed yield across seasons was from NSIC Rc192 (5.39 t ha^{-1}) and NSIC Rc136H (7.11 t ha^{-1}) under aerobic and flooded conditions, respectively. High filled grain ratio and harvest index contributed to such high computed yield of these varieties. This confirms the adaptability of NSIC Rc192 under aerobic condition and NSIC Rc136H under flooded condition in Lagangilang, Abra.

Interaction effect. There was no significant interaction between the moisture regimes and the different rice varieties on computed yield (Table 16).

Water Use Efficiency

Effect of moisture regime. Table 17shows the water use efficiency with respect to total water input (irrigation + rainfall). Significant differences between the moisture regimes on water use efficiency were noted both during the wet and cropping seasons. Under aerobic condition, water use efficiency was 0.64g grains l^{-1} and 0.82g grains l^{-1} in WS 2010 and DS 2011, respectively. This is 0.04g

Table 17. Water use efficiency (g grains/liter) of rice in Lagangilang, Abra during WS 2010 and DS 2011

TREATMENT	WATER USE EFFICIENCY (g grains l^{-1})	
	WS 2010	DS 2011
Moisture Regimes (M)		
Aerobic	0.64^{b}	0.82^{b}
Flooded	0.68^{a}	1.44^{a}
Variety (V)		
NSIC Rc 9	0.66^{ab}	1.04^{bc}
PSB Rc 14	0.58^{b}	1.24^{a}
PSB Rc 68	0.59^{b}	0.93^{c}
NSIC Rc 136H	0.76^{a}	1.26^{a}
NSIC Rc192	0.74^{a}	1.18^{ab}
M x V	0.72^{ns}	0.34^{ns}
CV_a (%)	0.00	0.08
CV_b (%)	2.40	12.80

For each column, treatment means with different letter are significantly different at 5% probability levels (DMRT).

grains l^{-1} (6%) and 0.62 g grains l^{-1} (43%)lower than the flooded plots for same study period. Further, the water use efficiency in flooded plots (1.44 g grains l^{-1}) is 75% higher than in aerobic plots during the dry season trial. This may be due to a much higher (85%) grain yield in flooded than in aerobic condition.

The results contradict with the results of Belder*et al.,* (2005)in 2002 and 2003 that water use efficiency under flooded condition in 2002 and 2003 was 36 and 41% lower than in aerobic plots, respectively.

Under a water scarce condition in rice production, the ability of a rice variety to produce a high yield or maintain its yield level under a favorable soil moisture condition such as flooded (water use efficiency) is now a much sought after character. It is now becoming a key consideration in the selection of variety for upland and lowland rainfed rice ecosystems. As a water saving technology, aerobic rice has been claimed by rice experts of having a high water use efficiency.

Effect of variety. Significant differences among the varieties in terms of water use efficiency were noted (Table 17). During the wet season trial, NSIC Rc136H had the highest water useefficiency at 0.76g grains l^{-1} but not significantly different with NSIC Rc192 at 0.74 g grains $l^{-1}$and comparable with PSB Rc9 at 0.66g grains l^{-1}. The lowest water use efficiency was registered from PSB Rc14 at 0.58 g grains l^{-1}.

Further, during the dry season, NSIC Rc136H had maintained the highest water use efficiency but not significantly different with PSB Rc14 and comparable with NSIC Rc192. The lowest water use efficiency was obtained from PSB Rc68 with a mean of 0.93g grains l^{-1}.

The results imply that NSIC Rc192 and NSIC Rc136H are adapted under aerobic condition in Lagangilang, Abrain terms of water use efficiency.

Interaction effect. Statistical analysis revealed that there was no significant interaction between the moisture regimes and different rice varieties on water use efficiency. The results show that although there was a reduction in yield in aerobic than in flooded condition, such scenario is compensated by a relatively lower reduction in water use efficiency.

Reaction to Insect Pests and Diseases

In Lagangilang, Abra, all varieties in both moisture regimes were found to be resistant to defoliators, stemborer (deadhearts and whiteheads), blast and rat damages. This could be attributed to the favorable weather conditions during the growing periods.

Sensory Evaluation

Aroma. PSB Rc68 in both soil moisture regimes had bland aroma while the rest had moderate aroma (Table 18).

Taste. PSB Rc68 and NSIC Rc136H had slightly tasty grains while the grains of other varieties had varied tastes with respect to soil moisture regimes.

Texture. All four varieties, except PSB Rc68, in both soil moisture regimes, had moderately soft grains. PSB Rc68 in aerobic fields had moderately soft but had slightly hard grains in flooded plots.

Table 18. Sensory evaluation of rice varieties in Lagangilang, Abraduring the WS 2010 and DS 2011

SOIL MOISTURE REGIMES	VARIETY	AROMA	TASTE	TEXTURE	GENERAL ACCEPTABILITY
AEROBIC	NSIC Rc9	Moderate	Slightly tasty	Moderately Soft	Like moderately
	PSB Rc14	Moderate	Slightly tasty	Moderately Soft	Like slightly
	PSB Rc68	Bland	No taste	Moderately Soft	Like slightly
	NSIC Rc136H	Moderate	Slightly tasty	Moderately Soft	Like moderately
	NSIC Rc192	Moderate	Slightly tasty	Moderately Soft	Like very much
FLOODED	NSIC Rc9	Moderate	Moderate	Moderately Soft	Like slightly
	PSB Rc14	Moderate	Slightly tasty	Moderately Soft	Like slightly
	PSB Rc68	Bland	Slightly tasty	Slightly hard	Like slightly
	NSIC Rc136H	Moderate	Slightly tasty	Moderately Soft	Like slightly
	NSIC Rc192	Moderate	Moderate	Moderately Soft	Like slightly

General Acceptability. NSIC Rc192 in aerobic plots was liked very much by the evaluators. This variety grown under aerobic condition had both moderate aroma and moderately soft texture.

Study 2: Growth and Yield Performance of Rice Grown under Two Moisture Regimes in Luna, Apayao during the Wet Season 2010 and Dry Season 2011

Agrometeorological Conditions

The climate in Apayao has a Type III classification characterized by not very pronounced dry and wet season, relatively from the months of December to April and wet during the rest of the year. Heaviest rain occurs during the months of August or September.

Luna, Apayao has an elevation of 5 m asl. It is classified under lowland zone (<100m asl) according to the Research, Development and Extension Agenda and Program for the Cordillera Agro-Forest/Fishery Ecological Zones classification (DA-CAR, 1999). It also falls under the lowland rainfed ecosystem based on rice ecosystem classification (Dobermann and Fairhurst, 2000).

The total rainfall for wet season 2010 and dry season 2011 were at 1,310.1 mm and 2,070.5 mm, respectively (Table 19). The minimum air temperature during the study period ranged from 16.9^{o}C to 22.6^{o}C while the maximum air temperature ranged from 27.4^{o}C to34.2^{o}C. The temperature range is within the optimum range favorable for rice production as cited by De Datta (1981) of 18-40^{o}C. The relative humidity in both cropping seasons ranged from 75.0% to 88.2% which is favorable for rice production. These environmental conditions namely rainfall, temperature and relative humidity greatly affect the growth and development of rice crops.

Table 19. Meteorological data of Luna, Apayao from July 2010 to April 2011

CROPPING SEASON/ MONTH	RAINFALL[a] (mm)	RELATIVE HUMIDITY %	T_{max}[b] (°C)	T_{min} (°C)	T_{avg} (°C)
Wet Season 2010[c]					
July	73.1	75.0	34.2	22.6	28.4
August	273.3	75.0	34.0	22.3	28.2
September	72.2	77.0	33.3	21.9	27.6
October	187.1	77.0	32.8	21.9	27.4
November	704.4	82.0	29.5	21.1	25.3
Dry Season 2011					
December 2010	411.6	86.5	28.0	20.8	24.1
January	515.2	88.2	27.4	18.9	23.0
February	81.3	83.2	28.8	16.9	23.8
March	518.3	84.0	30.7	19.8	24.2
April	103.7	80.5	31.7	20.3	25.8

[a] *Rainfall accumulated from July to November 2010 and December 2010 to April 2011.*
[b] *T_{max}, T_{min} and T_{avg} refer to the means for the highest, lowest, and average temperature.*
[c] *Temperature and relative humidity data for WS 2010 were taken from PAGASA Tuguegarao City*

Soil Properties

The results of the analysis revealed that the soil was moderately acidic at pH of 5.7. De Datta (1981) cited that the optimum pH for rice growth and development ranges from 5.5 to 6.5. The fertilizer applied was based on this fertility level and in consideration with the required nutrient requirement of a rice crop.

Table 20. Soil physical and chemical properties in Luna, Apayao

SOIL PROPERTY	VALUE
Chemical Properties	
pH	5.70
OM (%)	4.00
P_2O_5 (ppm)	5.00
K_20 (ppm)	140.0
Zn (ppm)	2.41
Physical Properties	
Bulk Density (g cc^{-1})	1.72
Water Holding Capacity (ml g^{-1})	1.10

The bulk density of 1.72 g cc^{-1} and water holding capacity of 0.52 ml g^{-1} indicates that the soil is moderately compacted which inhibits root penetration in moist soil.

Groundwater and Standing Water Depths

Figure 7 shows the depths of groundwater and standing water for aerobic plots in Luna, Apayao in wet season and dry season trials. The water levels were almost always below the soil surface indicating unponding. The standing water depths during the wet season were more erratic than during the dry season which indicated that there were more rainfall and frequent rainy days during the latter season (December 2010-March 2011). The ground water levelsin November 2010 and March 2011 were shallow since recorded rainfall during these months were high.Water supply in aerobic fields was supplemented with irrigation water whenever measurements of standing water depth in two (2) out of the three (3) standing water tubes were at 20 cm below the soil surface. A relatively higher irrigation input was applied during the July-November 2010 cropping season than during the December 2010-March 2011 with a recorded rainfall of 1,310.10 mm and 1,526.40 mm, respectively.

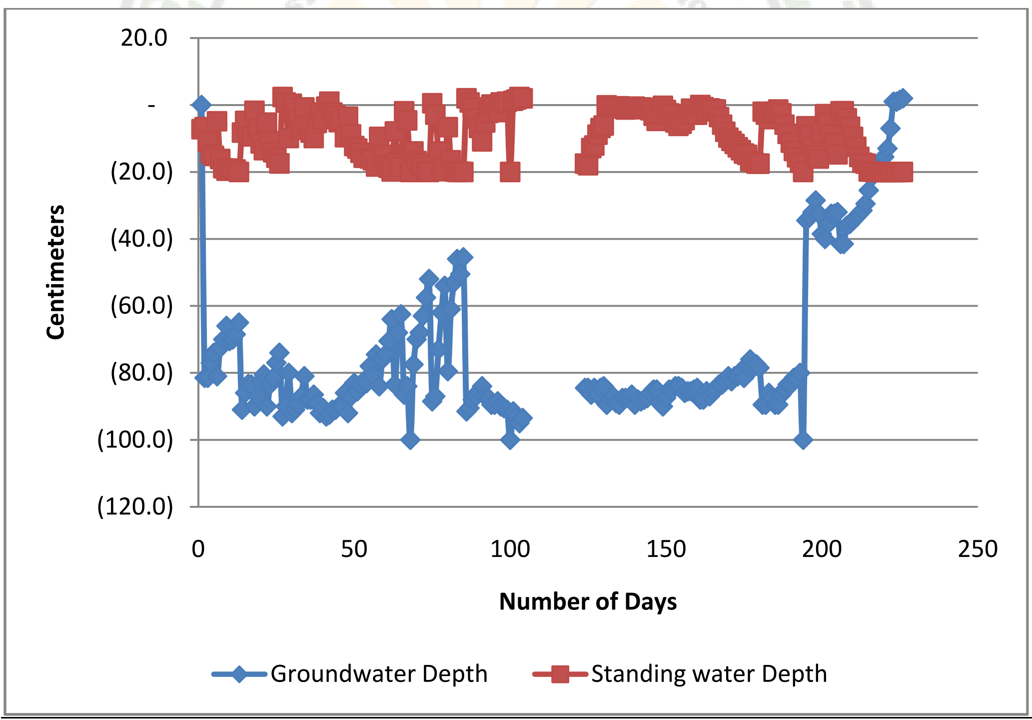

Figure 7. Groundwater and standing water depths (cm) in aerobic fields, Luna, Apayao (2010-2011)

Soil Matric Potential

The soil matric potential in Luna, Apayao during the early growth stage of the rice plant in dry cropping seasonwas almost close to zero signifying that the soil is wet (Figure 8). De Data (1981) cited that when the matric potential is close to zero, the soil is said to be water-saturated and at its maximum retentive capacity.

The fluctuation in tensiometer readingwas attributed by the amount of rainfall and application of irrigation water during the cropping season.

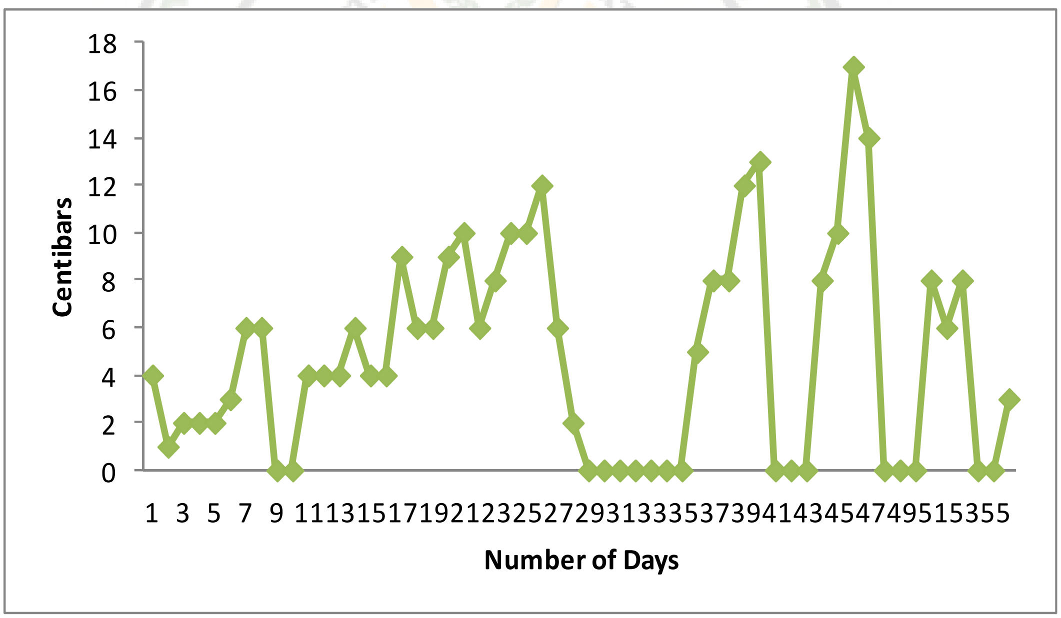

Figure 8. Soil matric potential in Luna, Apayao during the DS 2011

Plant Height

Effect of moisture regime. Rice plants grown under flooded condition were significantly taller than those grown under aerobic condition in wet season but not in dry season trial (Table 21). This corroborates the observation of De Datta (1981) that plant height generally increases with increasing water depth under flooded condition trials.

Effect of variety. NSIC Rc9 was the tallest but not significantly taller than NSIC Rc192 and PSB Rc68 in both season trials (Table 23). PSB Rc14 was the shortest variety also in both cropping seasons. Varieties differ in plant height due to their inherent or genetic characters.

These results confirmed by Arraudeau and Vergara (1988) that upland rice varieties, like NSIC Rc9, are tall ranging from 120 to 180 cm. This characteristic enables the upland varieties produce high biomass and yield.

Interaction effect. The interaction of soil moisture regimes and varieties had significantly affected the height of the rice plants in Luna, Apayao during the wet season trial but none during the dry season trial (Figure 8). NSIC Rc 9 and NSIC Rc192 were recorded as the tallest both under aerobic and flooded conditions. This result shows consistency of these varieties in terms of plant height under both soil moisture regimes. On the other hand, the result contradicts the study of Abbasi and Sepaskhah (2011) indicating that cultivars and irrigation regimes had no interaction effect.

Table 21. Plant height of rice at maturity in Luna, Apayao during the WS 2010 and DS 2011

TREATMENT	PLANT HEIGHT (cm)	
	WS 2010	DS 2011
Moisture Regimes (M)		
Aerobic	106.25^{b}	94.92
Flooded	122.20^{a}	99.84
Variety (V)		
NSIC Rc 9	128.25^{a}	114.12^{a}
PSB Rc 14	89.88^{c}	74.06^{d}
PSB Rc 68	122.75^{a}	113.58^{a}
NSIC Rc 136H	102.75^{b}	83.59^{c}
NSIC Rc192	127.50^{a}	101.28^{b}
M x V	3.0*	0.73^{ns}
CV_a (%)	3.69	7.25
CV_b (%)	4.11	3.91

For each column, treatment means with different letter are significantly different at 5% probability levels (DMRT).

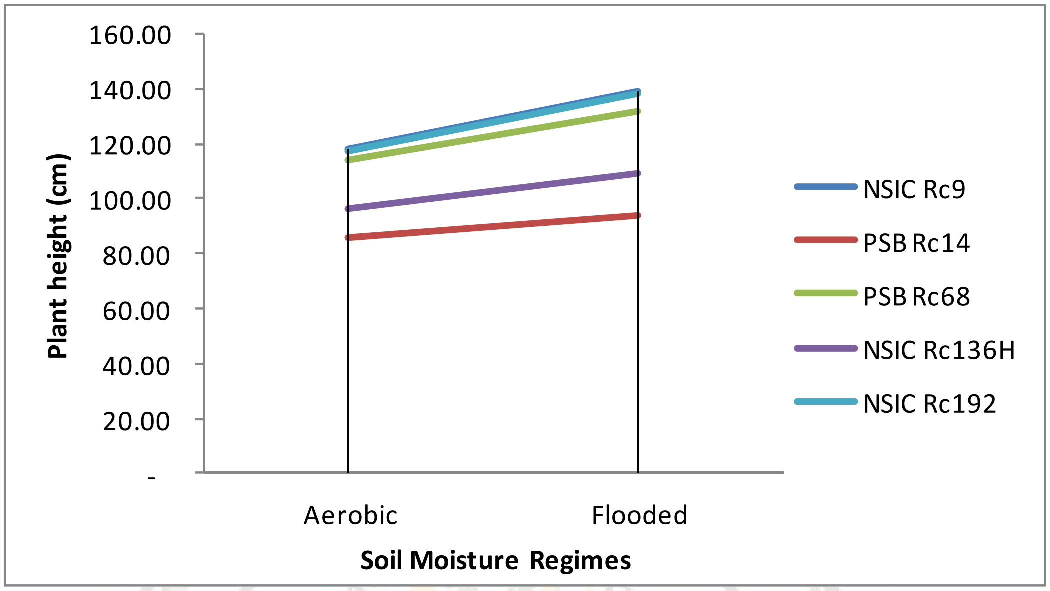

Figure 9. Interaction effect between the moisture regimes and the varieties on plant height in Luna, Apayao during the WS 2010

Number of Days from Seeding to Maximum Tillering

Effect of moisture regime. Statistical analysis showed a significant difference between the two moisture regimes in terms of number of days from seeding to tillering during the wet season trialbut not significantly different during the dry season trial (Table 22). Results showed that under flooded condition, plants reached maximum tillering earlier than those grown under aerobic condition in both cropping seasons.

Effect of variety. Significant differences were noted among the different rice varieties in terms of number of days from seeding to maximum tillering during the wet and dry season trials. During the wet season trial, PSB Rc14 produced maximum tillers earliest at 33.63 days which was not significantly earlier

Table 22. Number of days from seeding to maximum tillering, maximum tillering to booting, booting to heading, and heading to maturity of rice in Luna, Apayao during the WS 2010

TREATMENT	NUMBER OF DAYS FROM:			
	SEEDING TO MAXIMUM TILLERING	MAXIMUM TILLERING TO BOOTING	BOOTING TO HEADING	HEADING TO MATURITY
Moisture Regimes (M)				
Aerobic	37.15^{b}	32.75^{a}	6.90	22.10^{a}
Flooded	35.10^{a}	29.50^{b}	7.35	25.05^{b}
Varieties (V)				
NSIC Rc 9	35.15^{a}	31.88^{b}	8.63^{b}	23.13^{ab}
PSB Rc 14	33.63^{a}	31.50^{b}	6.25^{a}	21.88^{a}
PSB Rc 68	42.13^{b}	34.50^{c}	8.63^{b}	25.38^{c}
NSIC Rc 136H	34.38^{a}	30.50^{b}	6.13^{a}	23.63^{b}
NSIC Rc192	35.38^{a}	27.25^{a}	6.00^{a}	23.88^{bc}
M x V	4.05*	14.19**	1.12^{ns}	3.44*
CV_a (%)	0.44	5.07	6.65	6.04
CV_b (%)	4.00	3.70	7.70	4.93

For each column, treatment means with different letter are significantly different at 5% probability levels (DMRT).

Table 23. Number of days from seeding to maximum tillering, maximum tillering to booting, booting to heading, and heading to maturity of rice in Luna, Apayao during the DS 2011

TREATMENT	NUMBER OF DAYS FROM:			
	SEEDING TO MAXIMUM TILLERING	MAXIMUM TILLERING TO BOOTING	BOOTING TO HEADING	HEADING TO MATURITY
Moisture Regimes (M)				
Aerobic	42.25	35.95	10.30	32.25
Flooded	41.85	35.00	10.35	32.25
Varieties (V)				
NSIC Rc 9	38.00^{b}	34.25^{a}	11.75^{c}	37.50^{c}
PSB Rc 14	43.75^{c}	33.63^{a}	9.63^{b}	28.63^{a}
PSB Rc 68	50.38^{d}	42.13^{b}	12.13^{c}	31.63^{b}
NSIC Rc 136H	42.75^{c}	34.38^{a}	9.75^{b}	31.25^{ab}
NSIC Rc192	35.38^{a}	33.00^{a}	8.38^{a}	32.25^{b}
M x V	2.0^{ns}	3.32*	0.43^{ns}	3.77*
CV_a (%)	4.87	4.50	6.31	9.30
CV_b (%)	4.50	5.30	4.40	6.15

For each column, treatment means with different letter are significantly different at 5% probability levels (DMRT).

than NSIC Rc136H, NSIC Rc9 and NSIC Rc192. PSB Rc68 had the latest tillering (Table 22). During the dry season trial, NSIC Rc192 had reached earliest the maximum tillering stage and PSB Rc68 again had the latest maximum tillering.

The seeding to maximum tillering stage is part of the vegetative phase which mainly determines the differences in growth duration of varieties. As cited by Arraudeau and Vergara (1988), the duration of vegetative phase differs with variety.

Interaction effect. There was a significant interaction observed between the soil moisture regimes and the rice varieties on number of days from seeding to maximum tillering stage during the wet season trial (Figure 10) but none during the dry season trial.

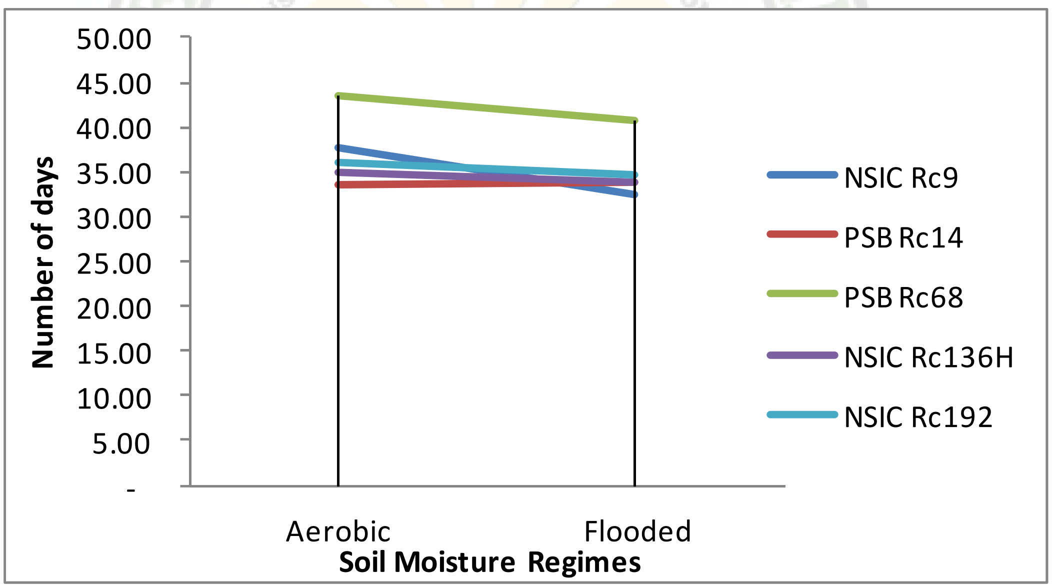

Figure 10. Interaction effect between the soil moisture regimes and the rice varieties on number of days from seeding to maximum tillering in Luna, Apayao during the WS 2010

PSB Rc14 reached earliest the maximum tillering stage under aerobic condition and NSIC Rc9 under flooded condition. The results implied that the vegetative growth phase of the rice varieties differed depending on the soil moisture regime in Luna, Apayao.

Number of Days from Maximum Tillering to Booting

Effect of moisture regime. There was a significant difference between the two moisture regimes in terms of number of days from maximum tillering to booting during the wet season trial but not significantly different during the dry season trial (Table 23). Results show that under flooded condition, plants booted earlier than those grown under aerobic condition in both cropping seasons.

Effect of variety. Significant differences were noted among the different rice varieties in terms of number of days from maximum tillering to booting (Tables 23). During the wet season trial, NSIC Rc192 reached earliest the booting stage and PSB Rc68 the latest. For dry season trial, NSIC Rc192 had the earliest booting stage but not significantly different with PSB Rc14, NSIC Rc9 and NSIC Rc136H. PSB Rc68 was the latest to reach the booting stage.

From the results, it could be inferred that the duration of maximum tillering which is part of the vegetative phase differ with variety as confirmed by Arraudeau and Vergara (1988). The determination of the panicle initiation stage, which is prior to booting, is critical in nutrient management where nitrogen fertilizer application should be undertaken as it is one of the growth stages where rice needs nitrogen for panicle development.

Interaction effect. There was a significant interaction observed between the soil moisture regimes and the rice varieties on number of days from maximum tillering to booting stage both during the wet season trial(Figure 11) and dry season trial (Figure 12).

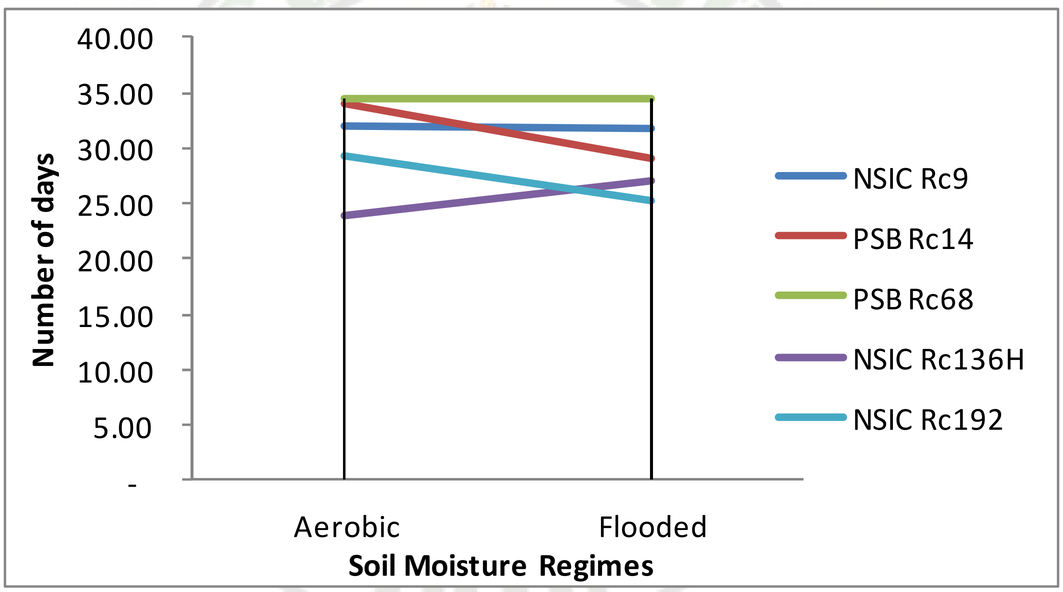

Figure 11. Interaction effect between the soil moisture regimes and the rice varieties on number of days from maximum tillering to booting in Luna, Apayao during the WS 2010

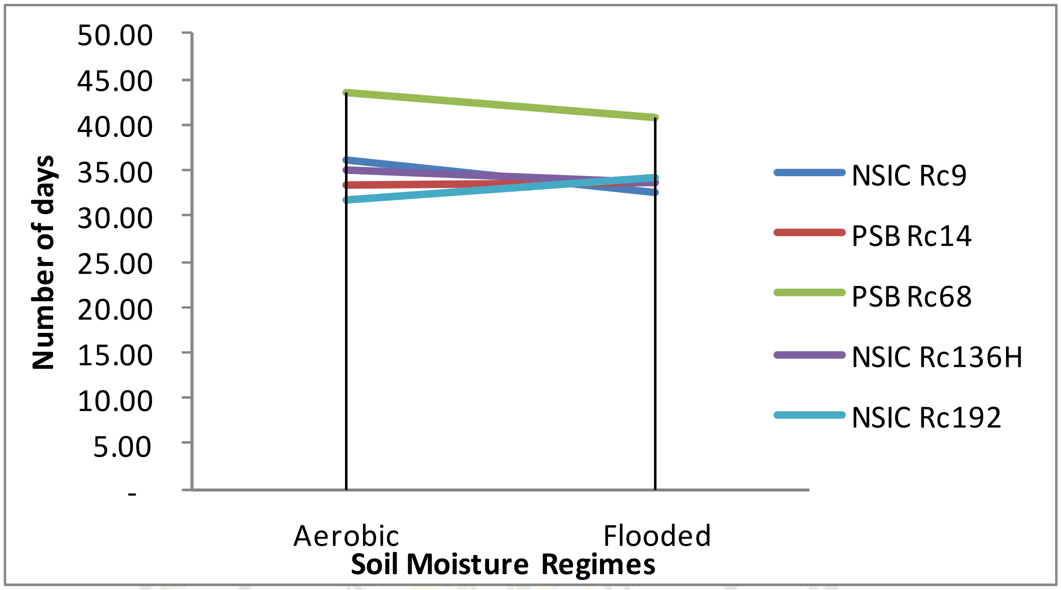

Figure 12. Interaction effect between the soil moisture regimes and the rice varieties on number of days from maximum tillering to booting in Luna, Apayao during the DS 2011

During the wet season trial, NSIC Rc136H reached earliest the booting stage in aerobic plots and NSIC Rc192 in flooded fields (Figure 11). During the dry season, NSIC Rc192 was the earliest under aerobic and NSIC Rc9the earliest under flooded condition (Figure 12).

The results show that the varieties differed also in the duration of the reproductive phase specially from booting to heading. Variation in growth stage duration among varieties could also mean employment of varied intervention such as water management.

Number of Days from Booting to Heading

Effect of moisture regime. There was no significant difference between the two moisture regimes in terms of number of days from booting to heading (Table 23). Plants under aerobic condition reached the earlier heading stage than those grown under flooded condition in both cropping seasons.

Effect of variety. The number of days from booting to heading stagewas significantly affected by the kind of variety (Tables 24 and 25). During the wet season trial, NSIC Rc192 reached the earliest heading stage but not significantly earlier than NSIC Rc136H and PSB Rc14.NSIC Rc9 and PSB Rc68 both reached the latest.During the dry season trial, NSIC Rc192 was the earliest to reach the heading stage while PSB Rc68 reached the latest.

Interaction effect. There was no significant interaction observed between the soil moisture regimes and the rice varieties on number of days from booting to heading stage (Table 23).

Number of Days from Heading to Maturity

Effect of moisture regime. The two moisture regimes had significant effect on the number of days from heading to maturity during the wet season trial but none during the dry season trial (Table 22& 23). Plants under aerobic plots matured earlier than under in the flooded fields during the wet season. Varieties during the dry season trial had similar duration from heading to maturity stage in both soil moisture regimes.

Effect of variety. Significant differences were noted among the different rice varieties in terms of number of days from heading to maturity (Table 22 and 23). PSB Rc14 was the earliest to mature in both season trials. This variety was comparable with NSIC Rc9 during the wet season study. PSB Rc68 was the latest to mature during the same season. For dry season trial, PSB Rc14 was comparable with NSIC Rc136H. The latest to reach the maturity from heading stage was NSIC Rc9.

From the results, it could be inferred that maturityof varieties differs depending on the cropping season. Nevertheless, maturity days of NSIC Rc9 and PSB Rc68 were consistent with PhilRice's Catalogue of PSB/NSIC Varieties (2009) as the latest to mature among the varieties.

Interaction effect. There was a significant interaction observed between the moisture regimes and the rice varieties on the number of days from heading to maturity(Figure 13 and 14).

During the wet season trial, NSIC Rc192 was earliest to mature in aerobic plots and PSB Rc14 earliest in flooded fields (Figure 13). During the dry season study, PSB Rc14 was earliest to mature under both soil moisture regimes (Figure 14). These results indicate the consistency of PSB Rc14 on the duration of heading to maturity stages regardless of moisture regime.

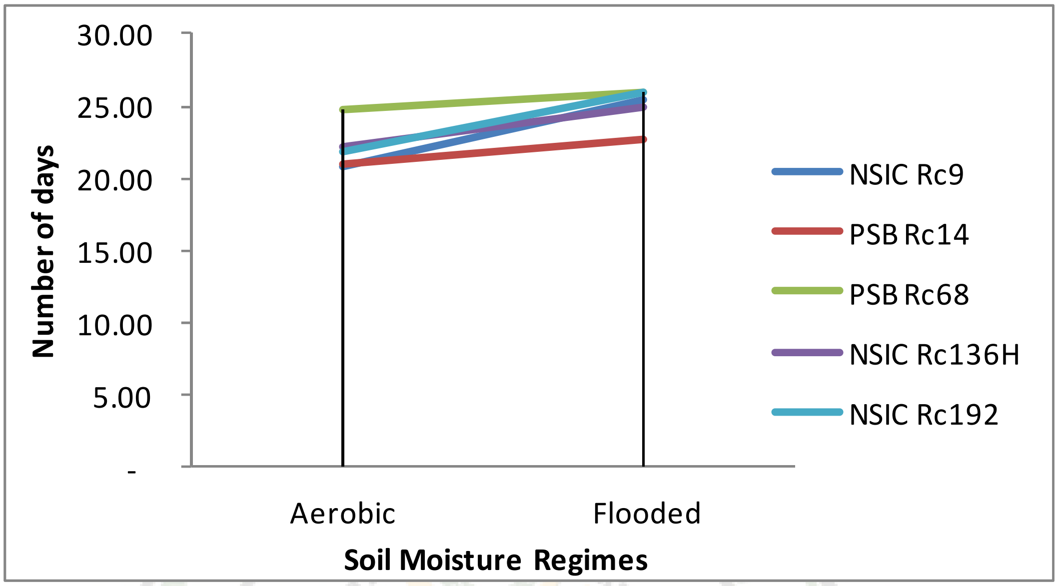

Figure 13. Interaction effect between the moisture regimes and the rice varieties on number of days from heading to maturity in Luna, Apayao during the WS 2010

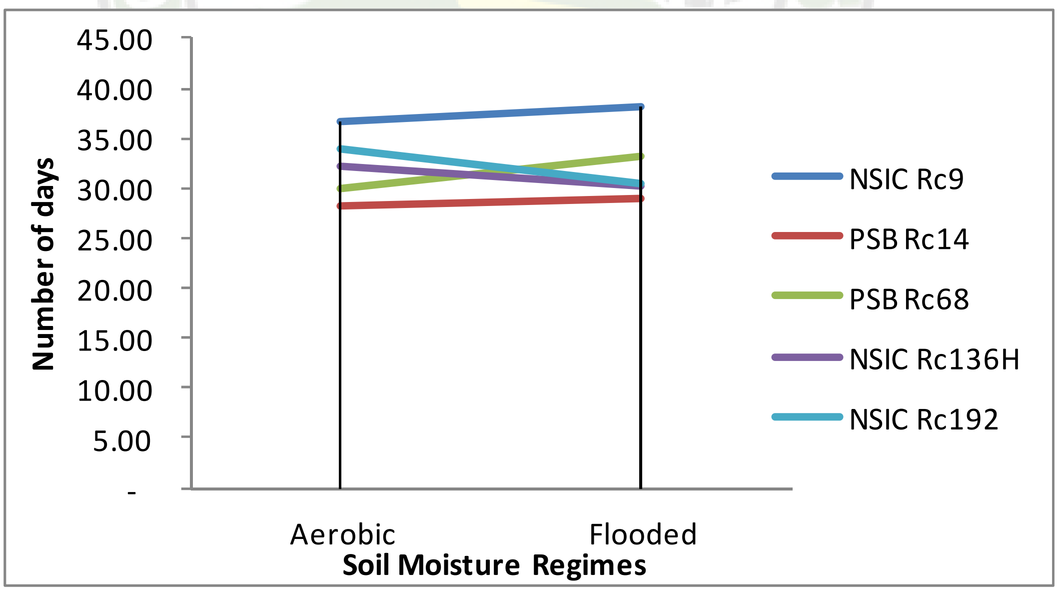

Figure 14. Interaction effect between the moisture regimes and the rice varieties on the number of days from heading to maturity in Luna, Apayao during the DS 2011

Leaf Area Index (LAI) at 75 Days After Seeding (DAS)

Effect of moisture regime. No significant differences were noted between the two moisture regimes on leaf area index for both wet and dry season trials (Table 24). Plants grown under flooded field had higher leaf area index than plants under the aerobic plots.

Effect of variety. Leaf area index was significantly affected by the kind of variety during both season trials (Table 24). During the wet season trial, NSIC Rc192 had the highest LAI while PSB Rc68 had the lowest. During the dry season, NSIC Rc9 had the highest LAI but comparable with NSIC Rc192. PSB Rc14 had the lowest LAI during the same season.

The importance of LAI was likewise noted in rice. De data (1981) reported that the total leaf area of a rice population is a factor closely related to grain production because the total leaf area at flowering greatly affects the amount of photosynthates available to the panicle. Close correlation between grain yield and leaf area index at heading.

Interaction effect. No significant interaction was observed between the moisture regimes and the different rice varieties in terms of leaf area index (Table 24).

Table 24. Leaf area index at 75 days after seeding (DAS) in Luna, Apayao during the WS 2010 and DS 2011

TREATMENT	LEAF AREA INDEX	
	WS 2010	DS 2011
Moisture Regimes (M)		
Aerobic	3.24	9.95
Flooded	4.78	11.27
Varieties (V)		
NSIC Rc9	4.3 4[b]	12.75[a]
PSB Rc14	3.45[bc]	8.15[c]
PSB Rc68	2.68[c]	9.98[abc]
NSIC Rc136H	3.75[bc]	9.69[bc]
NSIC Rc192	5.84[a]	12.48[ab]
M x V	0.68[ns]	0.11[ns]
CV_a (%)	9.07	5.42
CV_b (%)	5.16	10.68

For each column, treatment means with different letter are significantly different at 5% probability levels (DMRT).

Panicle Number at Maturity

Effect of moisture regime.There was no significant difference observed between the moisture regimes in terms of panicle number at maturity for both wet and dry season trials (Table 25). During the wet season trial, plants grown in

Table 25.Panicle number at physiological maturity in Luna, Apayao during the WS 2010 and DS 2011

TREATMENT	PANICLE NUMBER AT PHYSIOLOGICAL MATURITY	
	WS 2010	DS 2011
Moisture Regimes (M)		
Aerobic	115	99
Flooded	118	97
Variety (V)		
NSIC Rc 9	153[a]	82[b]
PSB Rc 14	80[d]	130[a]
PSB Rc 68	107[c]	87[b]
NSIC Rc 136H	113[c]	95[b]
NSIC Rc192	130[b]	88[b]
M x V	1.5[ns]	0.92[ns]
CV_a (%)	8.50	3.94
CV_b (%)	10.10	3.50

For each column, treatment means with different letter are significantly different at 5% probability levels (DMRT).

flooded field produced more panicles than under aerobic plots. In contrast, plants grown under aerobic plots produced more panicles than under flooded fields during the dry season trial.

The results agree with that of Peng, *et a.,l* (2006) that flooded rice produced more panicles with more spikelets per panicle than aerobic rice. The result also agree with that of Kato *et al.,* (2006b) that there was a sharp reduction in panicle number of some cultivars produced under suboptimal water condition like in aerobic. However, the result of this study contradicts that of Abbasi and Sepaskhah (2010) that the effect of water stress prolonged the growth duration of rice cultivars in intermittent flood irrigation similar with aerobic rice that resulted in higher number of panicles.

Effect of variety. The different varieties significantly differed on panicle number at maturity both during the wet and dry season trials (Table 25). NSIC Rc9 produced the highest number of panicles during the wet season trial but it had produced the lowest number of panicles during the dry season. Conversely, PSB Rc14 had the lowest number of panicles during the wet season trial but it had the highest number during the dry season trial.

Vergara (1992) cited that rice varieties differ in tillering ability. The number of tillers determines the number of panicles and it is the most important factor in achieving high grain yield.

Interaction effect. Statistical analysis showed no significant interaction between the moisture regimes and the rice varieties on the panicle number at maturity for both season trials (Table 25).

Panicle Length

Effect of soil moisture regime. Panicle length at physiological maturity was significantly affected by moisture regimes during the wet season trial but not during the dry season trial (Table 26). In both seasons, results showed that plants grown under flooded condition produced longer panicles than plants in aerobic condition. Longer panicles in flooded fields had more grain number per panicle.

Effect of variety. Highly significant differences were observed among varieties in terms of panicle length (Table 26). During the wet season trial, NSIC Rc9 had the longest panicle but not significantly different with NSIC Rc136H and PSB Rc68. During the dry season trial, PSB Rc68 had significantly the longest panicle while PSB Rc14 had the shortest panicle in both seasons.

The results imply that across seasons PSB Rc68 and PSB Rc14 consistently produced the longest and shortest panicles, respectively. This may be due to their inherent characters.

Interaction effect. Statistical analysis showed no significant interaction between the moisture regimes and the rice varieties on the length of panicle at physiological maturity (Table 26).

Total Grain Number Per Panicle

Effect of moisture regime. There was no significant difference between the two moisture regimes on number of grains per panicle during the wet season trial

Table 26.Panicle length (cm) of rice in Luna, Apayao during the WS 2010 and DS 2011

TREATMENT	PANICLE LENGTH (cm)	
	WS 2010	DS 2011
Moisture Regimes (M)		
Flooded	23.37[a]	21.50
Variety (V)		
NSIC Rc 9	24.40[a]	21.57[b]
PSB Rc 14	20.93[b]	19.93[d]
PSB Rc 68	23.75[a]	23.06[a]
NSIC Rc 136H	24.23[a]	20.97[c]
NSIC Rc192	21.55[b]	20.03[d]
M x V	1.17[ns]	2.08[ns]
CV_a (%)	2.93	0.81
CV_b (%)	3.88	2.66

For each column, treatment means with different letter are significantly different at 5% probability levels (DMRT).

but a significant difference was noted during the dry season trial (Table 27). Plants grown. Plants grown under flooded fields produced more grains per panicle for both season trials.

The results agree with Kato*et al.,* (2006b) and Peng*et al.,* (2006) that flooded rice produced more panicles with more grains (spikelets) than aerobic rice.Kato*et al.*, (2006a) deduced that reduced panicle production might be due to shallower roots of aerobic rice that resulted in reduced nitrogen uptake and decreased dry matter production.

Effect of variety. Highly significant differences were found among the varieties in terms of the number of grains per panicle for both cropping seasons (Table 27). NSIC Rc9 had the highest grain number per panicle during the wet season trial and PSB Rc68 during the dry season trial. The latter (PSB Rc68) was not significantly different with PSB Rc9 on grains per panicle during the dry season trial. PSB Rc14 had the shortest panicles with the lowest number of grains per panicle in both seasons.

The foregoing results indicate that varieties with the longest panicle in a cropping season had likewise the most grains in a panicle; NSIC Rc9 for wet season trial and PSB Rc68for dry season trial.

The foregoing results imply that yield parameters such as panicle length and total number of grains per panicle could be some characteristics inherent to the variety. Moreover, the yield of varieties with the most number of grains (NSIC Rc9 and PSB Rc68) may still be further improved by avoidance of water stress during flowering and by employing appropriate cultural management practices like proper timing of fertilizer application at panicle initiation and flowering stages.

Table 27.Total grain number per panicle in Luna, Apayao during the WS 2010 and DS 2011

TREATMENT	TOTAL GRAIN NUMBER PER PANICLE	
	WS 2010	DS 2011
Moisture Regimes (M)		
Aerobic	115.00[a]	126.00[b]
Flooded	118.00[a]	143.00[a]
Variety (V)		
NSIC Rc 9	153.00[a]	151.00[a]
PSB Rc 14	79.00[d]	98.00[b]
PSB Rc 68	107.00[c]	153.00[a]
NSIC Rc 136H	113.00[c]	149.00[a]
NSIC Rc192	130.00[b]	120.00[b]
M x V	1.44[ns]	2.00[ns]
CV_a (%)	8.42	11.82
CV_b (%)	10.15	13.16

For each column, treatment means with different letter are significantly different at 5% probability levels (DMRT).

Interaction effect. Statistical analysis revealed no significant interaction between the moisture regimes and the different rice varieties in relation to grain number per panicle in both season trials (Table 27).

Number of Filled Grains per Panicle

Effect of moisture regime.The number of filled grains per panicle did not significantly differ between the moisture regimes during the wet season trial but significantly differed during the dry season trial (Table 28). Plants grown under flooded fields produced higher number of filled grains per panicle for both seasons.

Vergara (1992) cited that lack of water at flowering can cause low percentage of filled spikelets or grains.

Effect of variety. Highly significant differences were found among the varieties on number of filled grains per panicle (Table 28).NSIC Rc9 had the highest while PSB Rc14 had the lowest number of filled grains per panicle in both season trials.

NSIC Rc9 had the longest panicle with the most grains per panicle and the highest number of filled grains per panicle across seasons. In contrast, PSB Rc14 had the shortest panicle with the lowest number of filled grains per panicle in both season trials.

Proper timing of fertilizer application at panicle initiation and flowering stages could increase the number of filled grain per panicle in varieties with large panicle size. Likewise, the occurrence of water stress during the flowering stage can reduce filled grains per panicle (Abbasi and Sepaskhah, 2010).

Table 28.Number of filled grains per panicle in Luna, Apayao during the WS 2010 and DS 2011

TREATMENT	NUMBER OF FILLED GRAINS PER PANICLE	
	WS 2010	DS 2011
Moisture Regimes (M)		
Aerobic	76	89[b]
Flooded	83	102[a]
Variety (V)		
NSIC Rc 9	106[a]	124[a]
PSB Rc 14	57[b]	68[c]
PSB Rc 68	63[b]	115[a]
NSIC Rc 136H	71[b]	92[b]
NSIC Rc192	101[a]	76[c]
M x V	0.97[ns]	1.77[ns]
CV_a (%)	2.29	8.96
CV_b (%)	2.86	8.52

For each column, treatment means with different letter are significantly different at 5% probability levels (DMRT).

Interaction effect. There was no significant interaction noted between the moisture regimes and the different rice varieties in relation to grain number per panicle in both season trials (Table 28).

Filled Grain Ratio

Effect of moisture regime.Filled grain ratio was significantly affected by the two moisture regimes during the wet season trialbut was not significantly affected during the dry season trial (Table 29). Results show that during the wet season, the different rice varieties grown under flooded fields had a higher filled grain ratio as compared to the plants grown under aerobic plots.

PhilRice (2001) reported that large amount of unfilled grains is due to lack of water.

Effect of variety. Highly significant differences were observed among varieties on filled grain ratio for both wet and dry season trials (Table 29). Results show that NSIC Rc192 had the highest filled grain ratio during the wet season cropping and NSIC Rc9 during the dry season trial.This trend is similar with the filled grain ratio during the wet and dry season in Lagangilang, Abra. From the results, it could be inferred that these varieties are adapted both in Luna, Apayao and Lagangilang, Abra based on filled grain ratio.

Interaction effect. There was a significant interaction observed between the moisture regimes and the rice varieties during the wet season trial but there was none during the dry season trial (Figure 15). NSIC Rc192 had the highest filled grain ratio both under aerobic and flooded conditions during the wet season trial. The result implies that NSIC Rc192 could perform well in terms of filled grain ratio regardless of soil moisture status during the wet season cropping in Luna, Apayao.

Table 29.Filled grain ratio in Luna, Apayao during the WS 2010 and DS 2011

TREATMENT	FILLED GRAIN RATIO (%)	
	WS 2010	DS 2011
Moisture Regimes (M)		
Aerobic	65.70[a]	69.31
Flooded	70.30[b]	71.19
Variety (V)		
NSIC Rc 9	69.25[b]	81.90[a]
PSB Rc 14	71.75[ab]	69.82[b]
PSB Rc 68	59.13[c]	75.59[ab]
NSIC Rc 136H	62.38[c]	62.44[c]
NSIC Rc192	77.50[a]	61.53[c]
M x V	3.76*	0.94[ns]
CV_a (%)	4.84	8.86
CV_b (%)	6.40	9.84

For each column, treatment means with different letter are significantly different at 5% probability levels (DMRT).

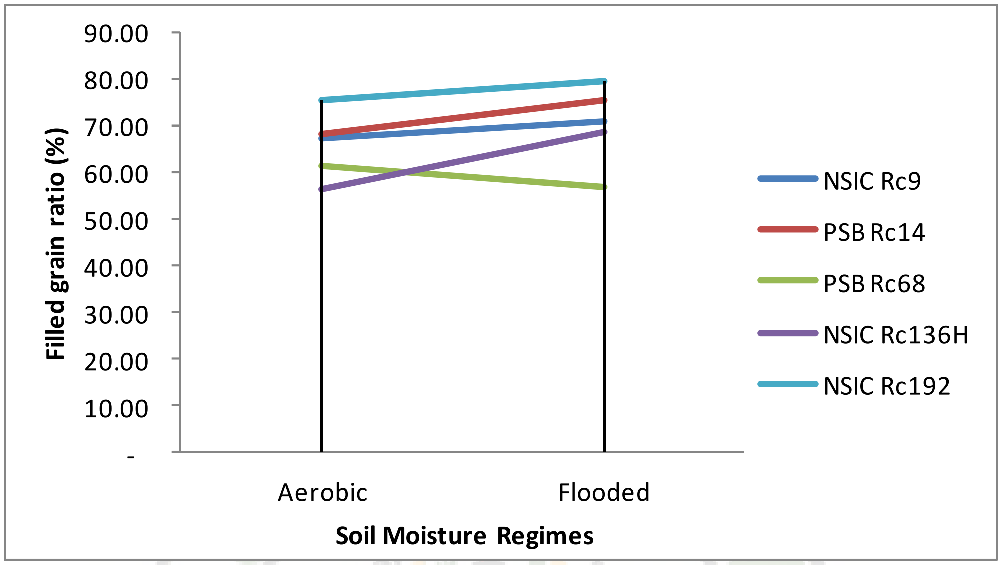

Figure 15. Interaction between the moisture regimes and the rice varieties onfilled grain ratio in Luna, Apayao during the WS2010

Weight of 1000 Filled Grains

Effect of moisture regime. Statistical analysis revealed no significant differences between the moisture regimes on the weight of 1000 grains in both season trials (Table 30). Plants had heavier 1000 filled grains under flooded condition during the wet season trialand under aerobic condition during the dry season.

Effect of variety. Highly significant differences among the rice varieties in terms of weight of 1000 grains were noted in both wet and dry season trials (Table 30). PSB Rc68 had the heaviest 1000-grain weight and PSB Rc14 had the lightest across cropping seasons. These results in Luna, Apayao are similar with the data in Lagangilang, Abra on weight of 1000 filled grains.

Table 30. Weight of 1000 filled grains (g) in Luna, Apayao during the WS 2010 and DS 2011

TREATMENT	WEIGHT OF 1000 FILLED GRAINS (g)	
	WS 2010	DS 2011
Moisture Regimes (M)		
Aerobic	25.96	25.15
Flooded	26.17	24.70
Variety (V)		
NSIC Rc 9	24.93[c]	22.80[c]
PSB Rc 14	24.13[d]	22.54[c]
PSB Rc 68	30.53[a]	29.93[a]
NSIC Rc 136H	26.19[b]	25.78[b]
NSIC Rc192	24.56[cd]	23.58[c]
M x V	1.24[ns]	0.51[ns]
CV_a (%)	1.24	8.47
CV_b (%)	2.57	7.40

For each column, treatment means with different letter are significantly different at 5% probability levels (DMRT).

Likewise, these results support PhilRice's PSB/NSIC Rice Catalogue (2009) that among the five varieties, PSB Rc68 has the largest grain size. As other yield parameters can be enhanced with improved cultural management practices, the weight 0f 1000-grain is could be genetically influenced and maybe considered as an important parameter in the selection of a variety with high yield potential.

Interaction effect. No significant interaction was observed between the moisture regimes and the rice varieties on the weight of 1000 grains both during the wet and dry season trials (Table 30). This contradicts the result of the study of Abbasi and Sepaskhah (2011) that there was a significant interaction effect between cultivars and irrigation regimes on 1000 grain weight.

Total Dry Matter Weight

Effect of moisture regime. Dry matter weight was significantly affected by the two moisture regimes during the wet season trial but was not significantly affected during the dry season trial (Table 31). Statistical analysis showed that plants grown under flooded fields had higher dry matter weight as compared to the plants grown under aerobic plots during wet season trial.

The wet season result agrees with Kato *et al.*, (2006a) that some cultivars under adequate water supply produced the largest total dry matter and the least under low water supply. He further cited that in general, total dry matter increased with increasing water supply. Likewise, Lafitte and Benett (2002) suggested that the reason for lower total dry mater weight under aerobic condition may be related to the relatively shallow root system and stomata closure and reduced photosynthesis in response to surface soil drying.

Table 31. Total dry matter weight of rice in Luna, Apayao during the WS 2010 and DS 2011

TREATMENT	TOTAL DRY MATTER WEIGHT(g)	
	WS 2010	DS 2011
Moisture Regimes (M)		
Aerobic	268.38[b]	272.30
Flooded	329.28[a]	275.84
Varieties (V)		
NSIC Rc 9	338.32[a]	282.44[ab]
PSB Rc 14	249.38[c]	224.38[b]
PSB Rc 68	312.13[ab]	339.50[a]
NSIC Rc 136H	288.63[bc]	255.44[b]
NSIC Rc192	305.69[ab]	261.19[b]
M x V	0.05[ns]	0.33[ns]
CV_a (%)	6.07	0.00
CV_b (%)	12.90	2.19

For each column, treatment means with different letter are significantly different at 5% probability levels (DMRT).

Further, Peng *et al*., (2006) cited that yield difference between aerobic and flooded rice was attributed more to difference in biomass production than to harvest index.

Effect of variety. There were highly significant differences noted among the rice varieties in terms of total dry matter weightduring both season trials (Table 31). NSIC Rc9 had the highest weight of total dry matter during the wet season trial but comparable with PSB Rc68 and NSIC Rc192. During the dry season trial, PSB Rc68 had the highest total dry matter but comparable with NSIC Rc9. Lowest weight of total dry matter was obtained from PSB Rc14 for both WS and DS with a mean of 249.38 g and 224.31 g, respectively.

NSIC Rc9 and PSB Rc68 were the tallest in Luna, Apayao in both growing seasons and had likewise the highest total dry matter weight. It could be inferred that tall varieties have high dry matter weight.

Interaction effect. There was no significant interaction observed between the moisture regimes and the rice varieties on total dry matter weight during wet and dry season trials (Table 31).

Harvest index

Effect of moisture regime. No significant difference was observed between the two moisture regimes in terms of harvest index during the wet season trial but was significantly different during the dry season trial (Table 32). Results show that plants grown under flooded condition had higher harvest index in both cropping seasons.

Effect of variety. There were highly significant differences noted among the rice varieties in terms of harvest index (Table 32). Results show that during the wet

Table 32. Harvest index of rice in Luna, Apayao during the WS 2010 and DS 2011

TREATMENT	HARVEST INDEX	
	WS 2010	DS 2011
Moisture Regimes (M)		
Aerobic	0.35	0.41[b]
Flooded	0.38	0.46[a]
Varieties (V)		
NSIC Rc 9	0.37[b]	0.43[b]
PSB Rc 14	0.41[a]	0.38[c]
PSB Rc 68	0.24[c]	0.42[bc]
NSIC Rc 136H	0.41[a]	0.53[a]
NSIC Rc192	0.42[a]	0.43[b]
M x V	1.34[ns]	1.69[ns]
CV_a (%)	10.21	5.36
CV_a (%)	7.32	8.72

For each column, treatment means with different letter are significantly different at 5% probability levels (DMRT).

season trial, NSIC Rc192 had the highest index but not significantly different with NSIC Rc136 and PSB Rc14. PSB Rc68 had the lowest harvest index during the same cropping season. NSIC Rc136H had the highest harvest index and PSB Rc14 had lowest during the dry season trial. From the results, it could be inferred that

NSIC Rc136H exhibited its superiority over the other varieties across seasons based on its high harvest index.

Interaction effect. Statistical analysis revealed no significant interaction between the moisture regimes and the rice varieties in terms of harvest indexduring both season trials (Table 32).

Grain Yield

Effect of moisture regime. Significant differences were observed between the two moisture regimes on the weight of grain yield during the wet and dry season trials. Results show that plants grown under aerobic fields had 9-31% (0.24-0.89 kg) lower grain yield than the plants grown under flooded plots.

Yield variation is associated with the difference in the soil water status between aerobic and flooded fields as cited by Bouman et al (2005). Further, they reported that the difference in yield between aerobic and flooded rice is greater in dry season than in wet season trial.

Effect of variety. Statistical analysis show significant differences among the varieties in terms of grain yield both during the wet season and dry season trials (Table 33).During the wet season, NSIC Rc9 produced the highest yield with a mean of 3.02 kg and it had the lowest yield reduction in aerobic plots as compared to flooded fields of 22% (0.75 kg) (Table 33). PSB Rc68 produced the lowest grain yield of 1.24 kg and 1.99 kg under aerobic and flooded plots, respectively. Its grain yield under aerobic was 38% (0.75 kg) lower than the flooded fields.

Table 33. Grain yield (kg) in Luna, Apayao during the WS 2010 and DS 2011

TREATMENT	GRAIN YIELD PER (kg5.75 m^{2-1})	
	WS 2010	DS 2011
Moisture Regimes (M)		
Aerobic	2.03^{b}	2.45
Flooded	2.92^{a}	2.71
Variety (V)		
NSIC Rc 9	3.02^{a}	3.11^{b}
PSB Rc 14	2.23^{b}	1.39^{c}
PSB Rc 68	1.62^{c}	3.80^{a}
NSIC Rc 136H	2.67^{ab}	3.06^{b}
NSIC Rc192	2.85^{ab}	1.62^{c}
M x V	0.58^{ns}	0.94^{ns}
CV_a (%)	4.44	6.38
CV_b (%)	9.27	12.96

For each column, treatment means with different letter are significantly different at 5% probability levels (DMRT).

During the dry season trial, PSB Rc68 attained the highest mean grain yield of 3.77 kg; under aerobic and flooded conditions of 3.54 kg and 4.01 kg, respectively (Table 37). However, its grain yield in aerobic plot was 12% (0.47 kg) lower than in flooded plots. A 5% (0.16 kg) increased in grain yield under aerobic conditiononly in PSB Rc9 plants. The rest of the varieties had yield reduction in aerobic plots from 5-29% as compared to flooded fields.

Based on mean grain yield for two cropping seasons under aerobic condition, NSIC Rc9outyielded the other varieties brought about by its long panicle, high grain number per panicle, high filled grain ratio, and high total dry matter weight. In flooded fields, NSIC Rc136H had the highest mean grain yield as brought about by a high harvest index.

The results confirm the high yielding ability of NSIC Rc9 under water deficit condition and of NSIC R136H, a hybrid variety, under a favorable condition as far as soil moisture is concerned (PhilRice, 2009).

Interaction effect. There were no significant interaction between the moisture regimes and the different rice varieties in terms of grain yieldduring the wet and dry season trials (Table 33).

Computed Yield

Effect of moisture regime. Highly significant differences were noted betweenthe moisture regimes in terms of computed yield per hectare of the different rice varieties during the wet and dry season trials (Table 34). Results show that plants grown under flooded fields had higher yield as compared to the plants grown under aerobic plots. There was a yield reduction of 1.55 t (33%) in aerobic plots compared to flooded fields during the wet season trial and 0.43 t (9%) during the dry season trial.

Table 34. Computed yield of rice production in Luna Apayao during the WS 2010 and DS 2011

TREATMENT	COMPUTED YIELD (t ha^{-1})	
	WS 2010	DS 2011
Moisture Regimes (M)		
Aerobic	3.54^{b}	4.29^{b}
Flooded	5.09^{a}	4.72^{a}
Varieties (V)		
NSIC Rc 9	5.24^{a}	5.41^{b}
PSB Rc 14	3.89^{ab}	2.41^{c}
PSB Rc 68	2.83^{b}	6.56^{a}
NSIC Rc 136H	4.65^{a}	5.32^{b}
NSIC Rc192	4.95^{a}	2.82^{c}
M x V	0.59^{ns}	0.83^{ns}
CV_a (%)	10.03	0.00
CV_b (%)	9.86	4.26

For each column, treatment means with different letter are significantly different at 5% probability levels (DMRT).

In general terms, computed yields in Luna, Apayao were lower than in Lagangilang, Abra since the latter had a more favorable weather condition during the wet season and dry season trials. Higher recorded rainfall and more frequent rainy days in Luna, Apayao caused the caseworm and cutworm infestation and panicle blast infection.

Effect of variety. There were significant differences observed among the different rice varieties on computed yieldduring the wet season and dry season trials (Table 34). Highest grain yield was obtained from NSICRc 9 during the wet season with a mean of 5.24 $tonha^{-1}$ while the lowest grain yield (2.83 $tonsha^{-1}$) was from PSB Rc68. During the dry season trial, PSB Rc68 had the highest computed yield with a mean of 6.56 tons ha^{-1}.

Interaction effect. There was no significant interaction between the moisture regimes and the different rice varieties on computed yield (Table 34).

Water Use Efficiency

Effect of moisture regime. Table 35 shows the water use efficiency (WUE) with respect to total water input (irrigation + rainfall). Statistical analysis revealed highly significant differences in Luna, Apayao both during the wet season and dry season trials. WUE in aerobic field was 0.06 g grains l^{-1} (43%)higher than in the flooded fields during the dry season despite the former's lower grain yield.

The results in Luna, Apayao for wet season contradict with Belder *et al.*, (2005) that water use efficiency under flooded condition in 2002 and 2003 was 36 and 41% lower than in aerobic plots, respectively. The dry season trial result, however, supports the findings of Belder*et al.*, (2005) and Bouman *et al.*, (2005) that water use efficiencyfor rice under aerobic condition ranges from 32-88%.

<u>Effect of variety</u>. Statistical analysis showed highly significant differences among the rice varieties in terms of WUE during both seasons (Table 35). NSIC Rc9 had the highest WUE during the wet season trialbut not significantly different with NSIC Rc192 and NSIC Rc136H and comparable with PSB Rc14.

Table 35. Water use efficiency of rice in Luna, Apayao during the WS 2010 and DS 2011

TREATMENT	WATER USE EFFICIENCY (g grains/l)	
	WS 2010	DS 2011
Moisture Regimes (M)		
Aerobic	0.17^{a}	0.20^{a}
Flooded	0.23^{b}	0.14^{b}
Varieties (V)		
NSIC Rc 9	0.24^{a}	0.21^{a}
PSB Rc 14	0.18^{ab}	0.09^{b}
PSB Rc 68	0.13^{b}	0.24^{a}
NSIC Rc 136H	0.22^{a}	0.20^{a}
NSIC Rc192	0.23^{a}	0.11^{b}
M x V	0.62^{ns}	2.84^{*}
CV_a (%)	3.19	0.00
CV_b (%)	3.24	4.20

For each column, treatment means with different letter are significantly different at 5% probability levels (DMRT).

Effect of variety. Statistical analysis showed highly significant differences among the rice varieties in terms of WUE during both seasons (Table 35). NSIC Rc9 had the highest WUE during the wet season trialbut not significantly different with NSIC Rc192 and NSIC Rc136H and comparable with PSB Rc14. PSB Rc68 had the lowest WUE.

During the dry season trial, PSB Rc68 had the highest water use efficiency but not significantly different with NSIC Rc9 and NSIC Rc136H. PSB Rc14 had the lowest water use efficiency.

Interaction effect. Statistical analysis revealed that there was no significant interaction between the moisture regimes and the different rice varieties in terms of water use efficiency during the wet season but a significant difference was noted during the dry season trial (Table 35 and Figure 16). PSB Rc68 had the highest water use efficiency both under aerobic and flooded conditions during the dry season trial. The result implies that growing this variety under aerobic condition has the ability of saving water without necessarily sacrificing yield.

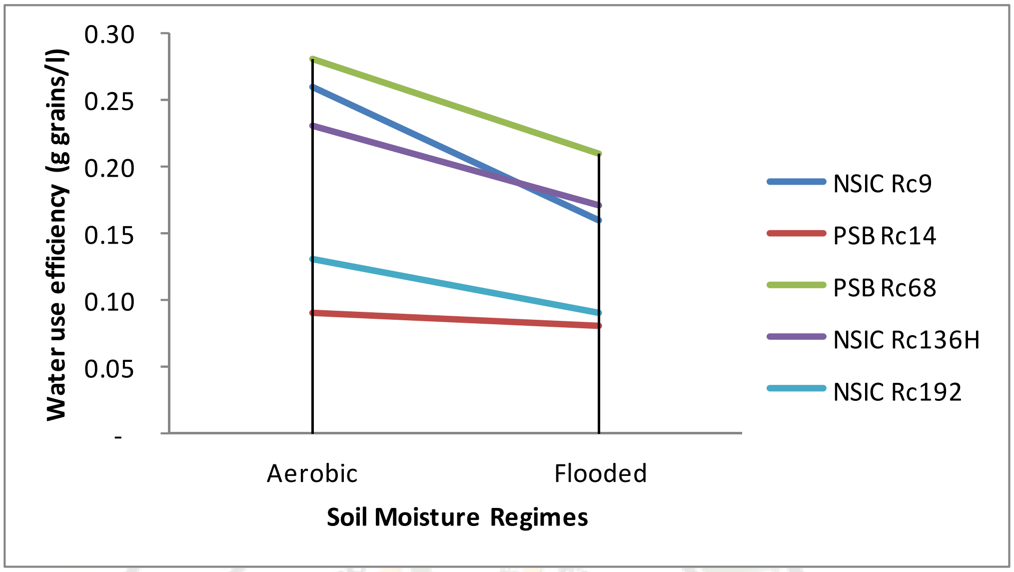

Figure 16. Interaction effect between the moisture regimes and the rice varieties on water use efficiency in Luna, Apayao during the DS 2011

Reaction to Insect Pests and Diseases

Table 36 shows the insect and disease reaction in Luna, Apayao during the wet season trial. Results show that all varieties grown under aerobic condition were resistant to defoliators (caseworm and cutworm), stemborer, blast, and rat damages. In flooded fields, all varieties were likewise resistant to stem borer and blast. PSB Rc68 plants had intermediate resistance to both defoliators (caseworm and cutworm) and rat damages.

During the dry season 2011, all varieties in both soil moisture regimes were also resistant to defoliators (caseworm and cutworm) and stem borers (Table 37). PSB Rc14 and NSIC Rc192 both in aerobic and flooded fields had shown

Table 36. Reaction to pests of rice in Luna, Apayao during the WS 2010

SOIL MOISTURE REGIMES	VARIETY	DEFOLIA-TORS	DEAD-HEARTS	WHITE-HEADS	BLAST	RAT DAMAGE
AEROBIC	NSIC Rc 9	Resistant	Resistant	Resistant	Resistant	Resistant
	PSB Rc 14	Resistant	Resistant	Resistant	Resistant	Resistant
	PSB Rc 68	Resistant	Resistant	Resistant	Resistant	Resistant
	NSIC Rc 136H	Resistant	Resistant	Resistant	Resistant	Resistant
	NSIC Rc 192	Resistant	Resistant	Resistant	Resistant	Resistant
FLOODED	NSIC Rc 9	Moderately Resistant	Resistant	Resistant	Resistant	Resistant
	PSB Rc 14	Moderately Resistant	Resistant	Resistant	Resistant	Resistant
	PSB Rc 68	Intermediate	Resistant	Resistant	Resistant	Resistant
	NSIC Rc 136H	Moderately Resistant	Resistant	Resistant	Resistant	Resistant
	NSIC Rc 192	Moderately Resistant	Resistant	Resistant	Resistant	Resistant

susceptibility to rice blast and rat damage, respectively. This could be attributed by the amount of rainfall (2,070.5mm) and rainy days (15 days) during the dry season. The early maturity of these varieties in relation to the others in the whole likewise made these vulnerable to such pests.

Table 37. Reaction to pests of rice in Luna, Apayao during the DS 2011

SOIL MOISTURE REGIMES	VARIETY	DEFOLIA-TORS	DEAD-HEARTS	WHITE-HEADS	BLAST	RAT DAMAGE
	NSIC Rc9	Resistant	Resistant	Resistant	Resistant	Resistant
	PSB Rc14	Resistant	Resistant	Resistant	Susceptible	Intermediate
AEROBIC	PSB Rc68	Resistant	Resistant	Resistant	Resistant	Resistant
	NSIC Rc136H	Resistant	Resistant	Resistant	Resistant	Intermediate
	NSIC Rc 192	Resistant	Resistant	Resistant	Resistant	Susceptible
	NSIC Rc 9	Resistant	Resistant	Resistant	Resistant	Resistant
	PSB Rc14	Resistant	Resistant	Resistant	Susceptible	Intermediate
FLOODED	PSB Rc 68	Resistant	Resistant	Resistant	Resistant	Resistant
	NSIC Rc136H	Resistant	Resistant	Resistant	Resistant	Resistant
	NSIC Rc 192	Resistant	Resistant	Resistant	Resistant	Susceptible

Sensory Evaluation

Aroma. PSB Rc14 and NSIC Rc 136H had moderate aroma; PSB Rc68, NSIC Rc192, and PSB Rc9 had slightly perceptible aroma (Table 38).

Taste. PSB Rc9, PSB Rc14, and NSIC Rc192 in both aerobic and flooded fields had moderate taste. The rest had slightly tasty.

Texture. All four varieties, except PSB Rc68 in both soil moisture regimes, had moderately soft grains. PSB Rc68 in aerobic fields had moderately soft but had slightly hard grains in flooded plots.

Table 38. Sensory evaluation of rice in Luna, Apayao (2010-2011)

SOIL MOISTURE REGIMES	VARIETY	AROMA	TASTE	TEXTURE	GENERAL ACCEPTABILITY
AEROBIC	NSIC Rc 9	Slightly perceptible	Moderate	Moderately Soft	Like slightly
	PSB Rc 14	Moderate	Moderate	Moderately Soft	Like very much
	PSB Rc 68	Slightly perceptible	Slightly tasty	Moderately Soft	Like moderately
	NSIC Rc 136H	Moderate	Slightly tasty	Moderately Soft	Like slightly
	NSIC Rc 192	Slightly perceptible	Moderate	Moderately Soft	Like moderately
FLOODED	NSIC Rc 9	Moderate	Moderate	Moderately Soft	Like slightly
	PSB Rc 14	Moderate	Moderate	Moderately Soft	Like moderately
	PSB Rc 68	Slightly perceptible	Slightly tasty	Slightly hard	Like slightly
	NSIC Rc 136H	Moderate	Moderate	Moderately Soft	Like slightly
	NSIC Rc 192	Slightly perceptible	Moderate	Moderately Soft	Like moderately

General Acceptability. PSB Rc14 in aerobic fields was liked very much by evaluators. This variety grown under aerobic condition had moderate aroma and moderately soft texture.

Study 3: Growth and Yield Performance of Rice Grown under Organic Production Two Moisture Regimes inKapangan, Benguet

Agrometeorological Condition

Benguet province belongs to Type 1 climate which is characterized by two pronounced seasons, dry from November to April and wet during the remaining months of the year. The experiment site in Kapangan, Benguet has an elevation of 1,000 m asl. It is classified under high hills zone (500-1,000 m asl) according to the Research, Development and Extension Agenda and Program for the Cordillera Agro-Forest/Fishery Ecological Zones classification (DA-CAR, 1999). It also falls under the irrigated (terraces) ecosystem based on rice ecosystem classification (Dobermann and Fairhurst, 2000).

The total rainfall for wet season 2010 and dry season 2011 were 1,421.3 mm and 3,271.4 mm, respectively (Table 39 and 40). The minimum air temperature during the study period ranged from 16.0^{o}C-18.4^{o}Cwhile maximum air temperature ranged from 24.9^{o}C to 30.2^{o}C. The temperature is within the optimum range favorable for rice production of 18-40^{o}C as cited by De Datta (1981). The relative humidity in both cropping seasons ranged from 61.5 to 92.7%.

Table 39. Meteorological data in Kapangan, Benguet from October 2010 to January 2011

CROPPING SEASON/ MONTH	RAINFALL[a] (mm)	RELATIVE HUMIDITY %	T_{avg} (°C)
October	261	71.5	30.0
November	333	75.0	30.5
December	25	61.5	31.0
January	97	72.5	28.5

[a] Rainfall accumulated from October 2010 to March 2011.

Table 40. Meteorological data in Kapangan, Benguet from March to October 2011

CROPPING SEASON/ MONTH	RAINFALL[a] (mm)	RELATIVE HUMIDITY %	T_{max}[b] (°C)	T_{min} (°C)	T_{avg} (°C)
March	61.9	86.7	24.9	16.5	21.1
April	16.5	79.2	30.2	16.0	22.7
May	451.9	84.8	30.1	16.5	23.0
June	316.8	87.6	27.9	18.4	22.4
July	514.9	92.7	26.7	18.1	20.9
August	967.8	91.5	28.3	17.7	21.8
September	553.7	91.7	27.2	17.9	21.8
October	345.5	85.6	28.6	16.8	22.6

[a] Rainfall accumulated from July to March - October 2011.
[b]T_{max}, T_{min} and T_{avg} refer to the means for the highest, lowest, and average temperature.

Soil Properties

The the soil was slightly acidic at pH 6.1 (Table 40). De Datta (1981) cited that the optimum pH for rice growth and development ranges from 5.5 to 6.5.

The soil in the site has a bulk density of 1.50 gcc^{-1} and water holding capacity of 0.84 mlg^{-1}. This bulk density is a typical characteristic of cultivated sand loams and sands (Brady and Weil, 2002). It was stated further that root growth into moist soil is generally limited by bulk densities ranging from 1.45 g/cc in clays to 1.85 g/cc in loamy sands.

Groundwater and Standing Water Depths

Figure 17 shows the depths of groundwater and standing water for aerobic plots in Benguet from August 2010-October 2011. The water levels were almost always below the soil surface indicating unponding. Rainfall during the two cropping periods was supplemented with irrigation water whenever measurements of standing water depth in two (2) out of the three (3) standing water tubes were at 20 cm below the soil surface. On the other hand, the groundwater depths were measured using the 2-m tube installed in the aerobic plot. As cited by Brady and Weil (2002), groundwater through capillary movement can provide a steady and significant supply of water that enables plants to survive during periods of low rainfallor when fields are not flooded (Bouman*et al.*, 2007). Further, Bouman, *et al.*, (2007) cited that groundwater of less than 20 cm deep can provide a "hidden"

Table 45. Soil physical and chemical properties in Kapangan, Benguet

SOIL PROPERTY	VALUE
Chemical Properties	
pH	6.01
OM (%)	1.50
P_2O_5(ppm)	15.00
K_20 (ppm)	98.0
Physical Properties	
Bulk Density (g/cc)	1.50
Water Holding Capacity (ml/g)	0.84

et al., (2007) cited that groundwater of less than 20 cm deep can provide a "hidden" source of water to the rice crop as the roots of the plants can directly take up water from the ground.

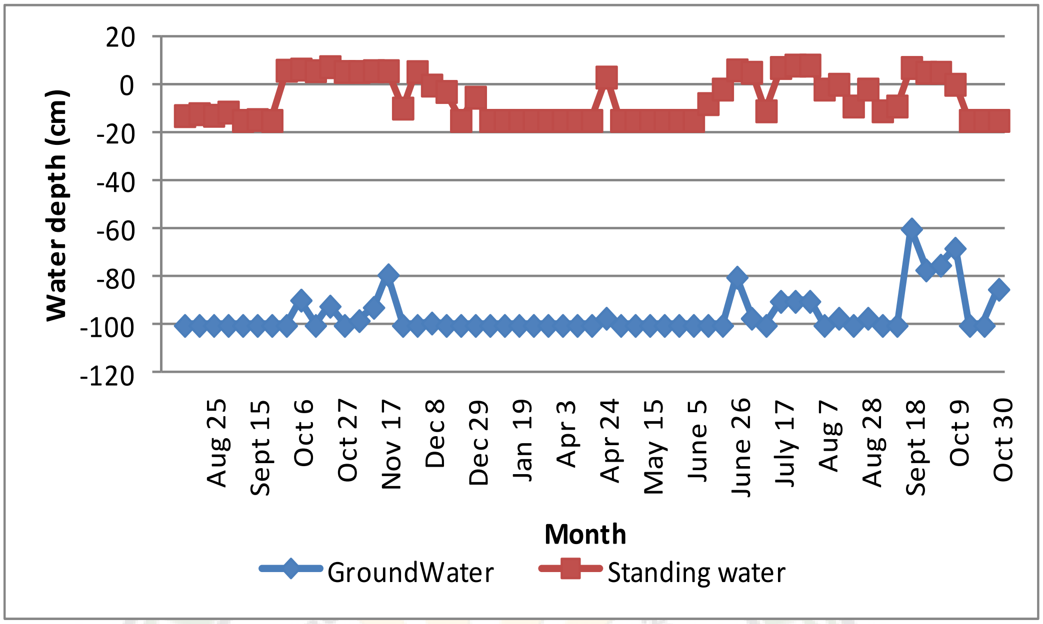

Figure 17. Groundwater and standing water depths (cm) in aerobic fields in Kapangan, Benguet (2010-2011)

Soil Matric Potential

The tensiometer reading started 3 weeks after seeding for the March-November 2011 cropping season (Figure 18). When soil matric potential reached 10 cb, the aerobic plots were irrigated to a saturation point. During rainy months, rainfall was supplemented with irrigation water. Therefore, the drop lines in the figure indicate application of water either through irrigation or by rainfall.

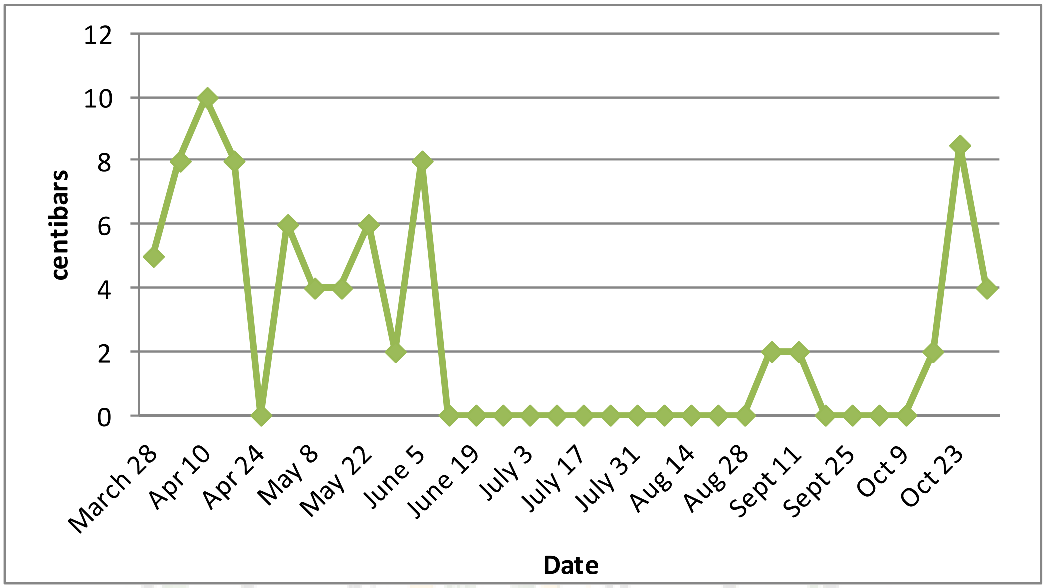

Figure 18. Soil matric potential (cb) in Kapangan,Benguet during the DS 2011

Plant Height at Maturity

Effect of water regimes. The water regimes significantly affected the plant height at maturity (Table 42). Flooded plants were taller than the plants under aerobic condition during the August 2010-February 2011 and March-November 2011growing periods.

Given the adequate water supply as reported by PhilRice (2007), good crop establishment, normal crop growth and development and yield are ensured. Further, De Datta (1981) cited that plant height generally increases with increasing water depth.

Effect of variety. Plant height at physiological maturity differed significantly among the varieties (Table 42). *Sapaw* (check variety) had the

Table 42. Plant height of rice at maturity in Kapangan, Benguet during August 2010-February 2011 and March-November 2011

TREATMENT	PLANT HEIGHT AT MATURITY (cm)	
	Aug 2010-Feb 2011	Mar-Nov 2011
Soil Moisture Regimes (M)		
Aerobic	73.51[b]	85.50[b]
Flooded	82.60[a]	102.67[a]
Varieties (V)		
NSIC Rc 9	72.61[b]	90.65[b]
PSB Rc 14	63.48[b]	64.33[e]
PSB Rc 68	76.74[b]	87.49[c]
NSIC Rc 192	67.08[b]	73.91[d]
Sapaw	110.37[a]	154.04[a]
M x V	1.65[ns]	17.94**
CV_a(%)	7.08	6.14
CV_b(%)	12.12	2.40

For each column, treatment means with different letter are significantly different at 5% probability levels (DMRT).

tallest plants on the August 2010-February 2011 and March-November 2011 at 110.38 cm and 154.04 cm, respectively. These results differed with that of Tad-awan, *et al.,* (2010) on*Sapaw*'s height at maturity which measured 88.33 cm and 131.60 cm in Kapangan, Benguet during the 2009-2010 and 2010-2011 cropping years, respectively.

PSB Rc14 was consistently the shortest (63.38 and 64.33 cm) in both growing periods which indicate that this is an inherent character of the variety.

Interaction effect. There was no interaction effect between the soil moisture regimes and the rice varieties in terms of plant height on the WS but there was significant interaction on the DS (Figure 19).*Sapaw* was the tallest in both aerobic and flooded conditions. This indicates the adaptability of the traditional variety to the area.

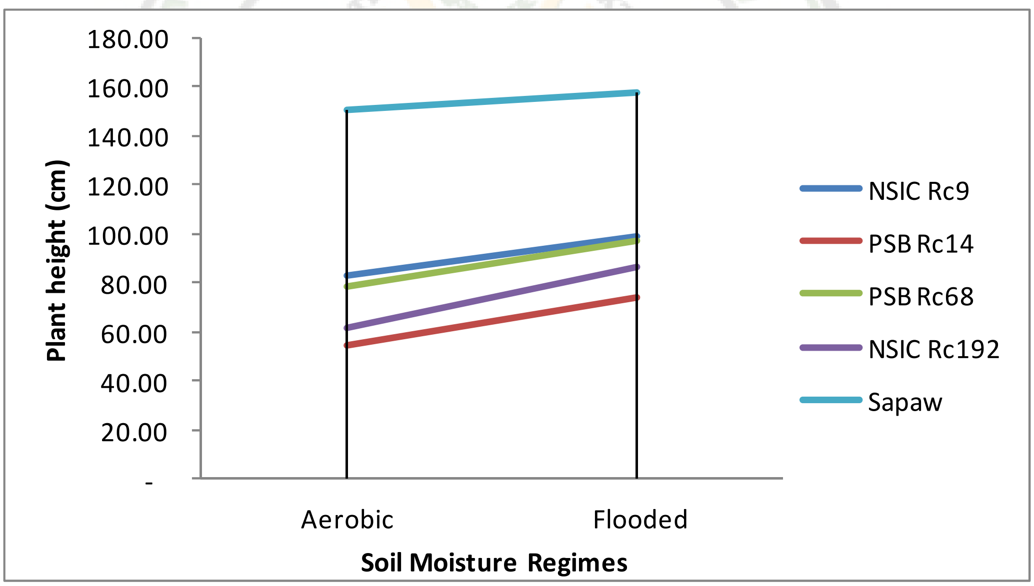

Figure 19. Interaction effect between the moisture regimes and the rice varieties on plant height in Kapangan, Benguet during the DS

Number of Days from Seeding to Maximum Tillering,

Effect of moisture regime. Statistical analysis showed no significant difference between the two moisture regimes in terms of number of days from seeding to maximum tillering during the August 2010-February 2011 cropping season(Table 43) and significantly differed during March-November 2011 season (Table 44). Results during the latter's growing period show that under flooded condition, plants produced the earlier maximum tiller than those grown under aerobic condition.

Effect of variety. Highly significant differences were noted among the different rice varieties in terms of number of days from seeding to maximum tillering. NSIC Rc192 reached earliest the maximum tillering stage during the August 2010-February 2011 and March-November 2011. The latest to produce maximum tillers was *Sapaw* (Table 43 and 44).

The seeding to maximum stages are part of the vegetative phase of a rice plant which mainly determines the differences in growth duration of varieties. As cited by Arraudeau and Vergara (1988), the duration of vegetative phase differs with variety.

Interaction effect. There was no significant interaction observed during the August 2010-February 2011 cropping season in Kapangan, Benguet but had significant interaction effect in March-November 2011 season(Figure 19). Under both soil moisture regimes, NSIC Rc192 produced maximum tillers earliest. The result confirmed that NSIC Rc192 is an early maturing variety (PhilRice, 2009).

Table 43. Number of days from seeding to maximum tillering, maximum tillering to booting, booting to heading, and heading to maturity of rice in Kapangan, Benguet during the August 2010-February 2011

TREATMENT	NUMBER OF DAYS FROM:			
	SEEDING TO MAXIMUM TILLERING	MAXIMUM TILLERING TO BOOTING	BOOTING TO HEADING	HEADING TO MATURITY
Moisture Regimes (M)				
Aerobic	60.85	28.75	14.45	49.75[b]
Flooded	60.85	28.55	14.65	36.60[a]
Varieties (V)				
NSIC Rc 9	56.75	28.50[b]	14.75[b]	42.00
PSB Rc 14	56.70	26.88[b]	12.63[a]	41.00
PSB Rc 68	66.50	30.63[c]	14.88[b]	44.00
NSIC Rc 192	55.25	21.50[a]	12.25[a]	41.50
Sapaw	70.25	35.75[d]	18.25[c]	47.38
M x V	0.00	0.31[ns]	2.39[ns]	1.28[ns]
CV_a (%)	0.00	2.38	4.70	13.12
CV_b (%)	2.30	5.70	4.10	11.47

For each column, treatment means with different letter are significantly different at 5% probability levels (DMRT).

Table 44. Number of days from seeding to maximum tillering, maximum tillering to booting, booting to heading, and heading to maturity of rice in Kapangan, Benguet during the March-November 2011

TREATMENT	NUMBER OF DAYS FROM: SEEDING TO MAXIMUM TILLERING	MAXIMUM TILLERING TO BOOTING	BOOTING TO HEADING	HEADING TO MATURITY
Moisture Regimes (M)				
Aerobic	85.85[b]	34.50[b]	16.50	47.80[a]
Flooded	76.55[a]	30.30[a]	16.70	52.70[b]
Varieties (V)				
NSIC Rc 9	74.25[c]	33.38[b]	16.75[b]	51.50[c]
PSB Rc 14	70.75[b]	27.38[a]	14.75[a]	44.13[a]
PSB Rc 68	81.50[d]	32.75[b]	16.88[b]	48.38[b]
NSIC Rc192	64.25[a]	25.75[a]	14.38[a]	52.63[cd]
Sapaw	115.25[e]	42.75[c]	20.25[c]	54.75[d]
M x V	52.33**	1.80[ns]	2.38[ns]	7.39**
CV_a (%)	0.39	11.32	3.81	4.80
CV_b (%)	1.80	8.00	3.30	3.86

For each column, treatment means with different letter are significantly different at 5% probability levels (DMRT).

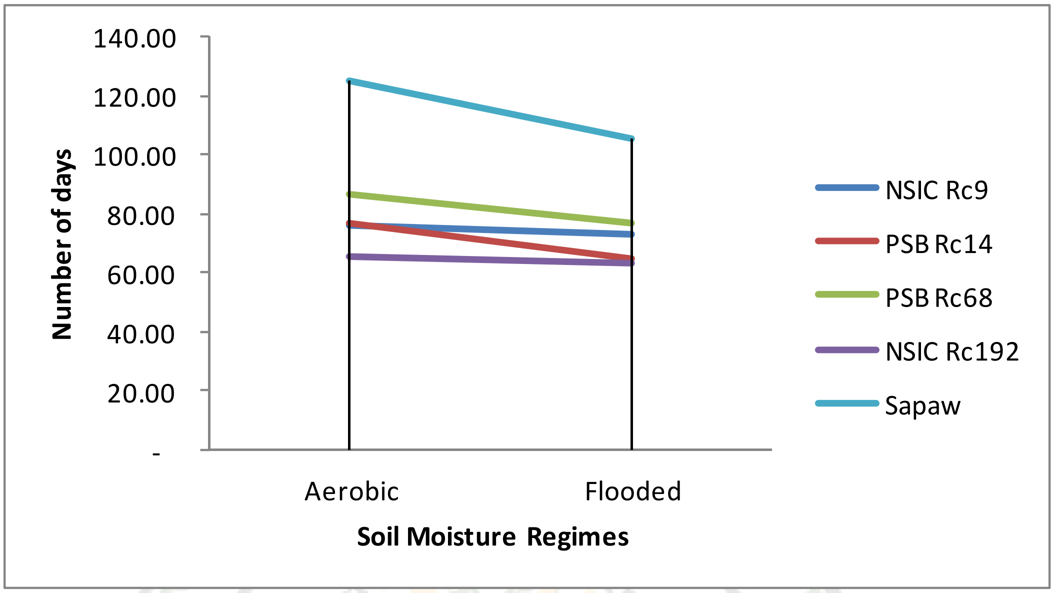

Figure 19. Interaction effect between the soil moisture regimes and the rice varieties on number of days from seeding to maximum tillering in Kapangan, Benguet during the DS 2011

Number of Days from Maximum Tillering to Booting

Effect of moisture regime. Statistical analysis showed no significant difference between the two moisture regimes in terms of number of days from maximum tillering to booting stage in Kapangan, Benguet during the August 2010-February 2011 (Table 43) and significantly differed during the March-November 2011 (Table 44). Results showed that under flooded condition, plants had booting stage earlier than those grown under aerobic condition both during the two growing periods.

Effect of variety. Significant differences were noted among the different rice varieties in terms of number of days from maximum tillering to booting stage.

NSIC Rc192 reached booting stage from maximum tillering earliest during the August 2010-February 2011 and March-November 2011 with a mean of 21.50 days and 25.75 days, respectively. PSB Rc14 (27.38 days) was not significantly different with NSIC Rc192 in August 2010-February 2011. The latest to reach booting stage was *Sapaw* at 35.75 days and 42.75 days for the August 2010-February 2011 and March-November 2011 growing seasons, respectively (Table 43 and 44).

Interaction effect. There was no significant interaction observed between the soil moisture regimes and the rice varieties both during the two cropping seasons in Kapangan, Benguet (Table 43 and 44).

Number of Days from Booting to Heading

Effect of moisture regime. Statistical analysis showed no significant difference between the two moisture regimes in terms of number of days from booting to heading stage in Kapangan, Benguet both during the August 2010-February 2011 and March-November 2011 (Table 43 and 44).

Effect of variety. Significant differences were noted among the different rice varieties in terms of number of days from booting to heading stage (Table 43and 44). NSIC Rc192 reached heading from booting stage earliest during the August 2010-February 2011cropping season with a mean of 12.25 days which was not significantly different with PSB Rc14 at 12.63 days. For March-November 2011 growing period, NSIC Rc192 likewise had the shortest days to heading at 14.38 which was not significantly different with PSB Rc14 at 14.75 days. The *Sapaw* was the latest during the August 2010-February 2011 and March-November 2011growing periods at 18.2 days and 20.25 days, respectively. The results indicated that NSIC Rc192 and *Sapaw* had consistently the earliest and latest vegetative and reproductive phases in Kapangan, Benguet, respectively.

Interaction effect. There was no significant interaction observed between the soil moisture regimes and the rice vareties both during the August 2010-February 2011 and March-November 2011 cropping seasons in Kapangan, Benguet (Table 43 and 44).

Number of Days from Heading to Maturity

Effect of water regime.Plants under flooded conditionmatured earlier than under aerobic plots during the August 2010-February 2011 growing period (Table 43 and 44). Conversely, plants matured earlier from heading in aerobicthan in the flooded plots during the March-November 2011 cropping season.

Effect of variety. It was observed that there was no significant difference among the varieties on the number of days from heading to maturity during the August 2010-February 2011but did not significantly differamong the varieties during the March-November 2011 cropping season(Table 43 and 44). For the March-November 2011 cropping season, PSB Rc14 matured earliest than the rest of the varieties from heading stage while*Sapaw*matured latest.

Interaction effect. There was no significant interaction on the August 2010-February 2011cropping season but on March-November 2011, it was observed that there was a high interaction between the soil moisture regimes and the rice varieties on number of days from heading to maturity (Figure 21). The result shows that PSB Rc14 matured from heading stage earliest under both soil regimes in Kapangan, Benguet.

Leaf Area Index (LAI) at 75 Days After Sowing (DAS)

Effect of moisture regime. Plants grown under flooded plots had higher LAI than plants grown under aerobic plots in both cropping seasons (Table 45).

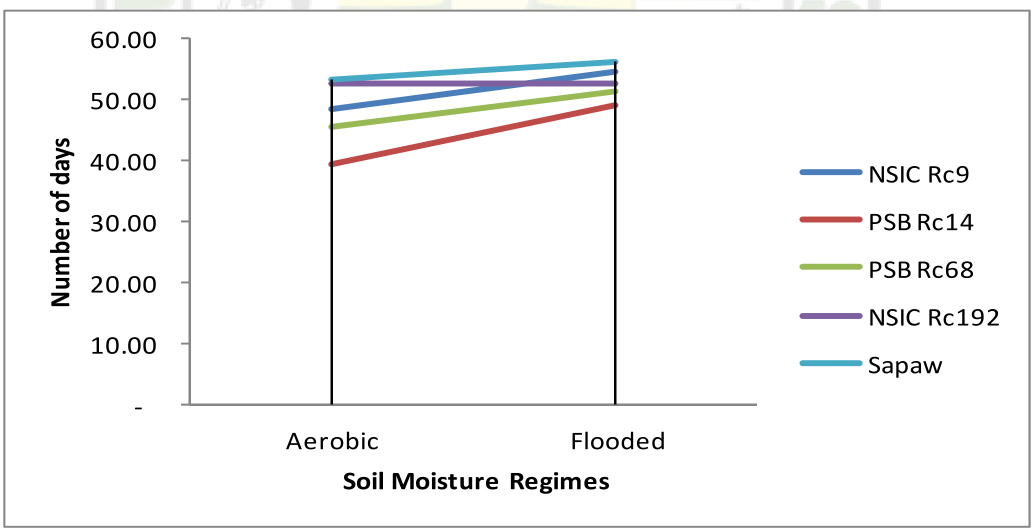

Figure 21. Interaction effect between the moisture regimes and the rice varieties on number of days from heading to maturity in Kapangan, Benguet during the March-November 2011 growing season

Table45. Leaf area index of rice at 75 DAS in Kapangan, Benguet during the WS 2010 and DS 2011

TREATMENT	LEAF AREA INDEX AT 75 DAS	
	Aug 2010-Feb 2011	Mar-Nov 2011
Soil Moisture Regimes (M)		
Aerobic	0.63^{b}	3.24^{b}
Flooded	1.25^{a}	5.25^{a}
Varieties (v)		
NSIC Rc 9	0.97	4.26
PSB Rc 14	1.01	3.41
PSB Rc 68	0.95	4.54
NSIC Rc 192	1.01	4.27
Sapaw	0.76	4.76
M x V	1.13^{ns}	0.23^{ns}
CV_a (%)	13.95	10.18
CV_b (%)	10.81	12.77

For each column, treatment means with different letter are significantly different at 5% probability levels (DMRT).

The result agrees with that of Bouman *et al.*, (2005) that there is a reduced leaf area in rice plants under aerobic than flooded condition.

Effect of variety. Table 45 shows no significant difference among the rice varieties in terms of LAI at 75 DAS on both cropping seasons. Plants of PSBRc14 and NSIC Rc192 had the highest LAI on August 2010-February 2011 each at 1.01. *Sapaw* had the lowest LAI during the August 2010-February 2011 cropping season and highest during the March-November 2011 at 0.76 and 4.76, respectively.

Interaction effect. There was no significant interaction between the soil moisture regimes and the rice varieties on LAI at 75 DAS for both cropping seasons (Table 45).

Panicle Number at Maturity

Effect of moisture regime.There was a significant difference observed between the moisture regimes in terms of panicle number at maturity in Kapangan, Benguet during the August 2010-February 2011, while there was no significant differencenoted during the March-November 2011 (Table 46). Plants grown in flooded fields produced more panicles than the plants grown in aerobic plots for both cropping seasons.

The results agree with the findings in Lagangilang, Abra and Luna, Apayao (for WS 2010) that panicle number in aerobic plots are higher than in flooded fields. The foregoing results agree with that of Kato, et. al (2006) that there was a reduction in panicle number of some cultivars produced under suboptimal water condition like in aerobic rice. However, Abbasi and Sepaskhah (2010) noted that the effect of water stress prolonged the growth duration of rice cultivars in intermittent flood irrigation similar with aerobic rice resulted in higher number of panicles.

Table 46. Panicle number at maturity in Kapangan, Benguet during the August 2010-February 2011 and March-November 2011cropping periods

TREATMENT	PANICLE NUMBER AT MATURITY	
	Aug 2010-Feb 2011	Mar-Nov 2011
Soil Moisture Regimes (M)		
Aerobic	28.00[b]	42.80
Flooded	36.40[a]	52.75
Varieties (V)		
NSIC Rc 9	33.00	46.25[ab]
PSB Rc 14	36.25	60.13[a]
PSB Rc 68	35.13	41.00[bc]
NSIC Rc 192	29.50	61.38[a]
Sapaw	27.25	30.13[c]
M x V	2.28[ns]	1.57[ns]
CV_a (%)	3.67	6.35
CV_a (%)	6.62	6.07

For each column, treatment means with different letter are significantly different at 5% probability levels (DMRT).

Effect of variety. There was no significant difference among the rice varieties on panicle number at maturity during the August 2010-February 2011 as observed in Table 46 but differed significantly during the March-November 2011 cropping period. NSIC Rc192 produced the highest panicles but comparable with PSB Rc14. *Sapaw* produced the least number of panicles. The results show the tillering ability of the high yielding varieties like NSIC Rc192 and PSB Rc14 over the traditional variety *Sapaw*under organic rice production system.

Interaction effect. Table 46 shows that there was no significant interaction between the moisture regimes and the varieties in terms of panicle number in Kapangan, Benguet both during the two cropping seasons (2010-2011).

Panicle Length

Effect of soil moisture regime. Statistical analysis showed no significant differences between the two moisture regimes in terms of panicle length in Kapangan, Benguet during the August 2010-February 2011 and March-November 2011cropping periods (Table 47). Plants grown under flooded condition produced longer panicles than plants under aerobic condition during the August 2010-February 2011 and March-November 2011cropping season at 19.31 cm and 19.72 cm, respectively.

Effect of variety. Significant differences were observed among the rice varieties in terms of panicle length in Kapangan, Benguet during August 2010-February 2011 and March-November 2011 (Table 47). *Sapaw* significantly produced the longest panicles during the August 2010-February 2011 and March-November 2011cropping seasons with a mean of 23.79 and 24.11 cm, respectively. NSIC Rc192 produced the shortest panicles with a mean of 15.89 cm and 17.26 cm for August 2010-February 2011 and March-November 2011cropping seasons, respectively.

Table 47. Panicle length (cm) of rice in Kapangan, Benguet during the August 2010-February 2011 and March-November 2011cropping periods

TREATMENT	PANICLE LENGTH (cm)	
	Aug 2010-Feb 2011	Mar-Nov 2011
Soil Moisture Regimes (M)		
Aerobic	18.28	19.33
Flooded	19.31	19.72
Varieties (V)		
NSIC Rc 9	18.94[b]	20.21[b]
PSB Rc 14	17.56[b]	17.76[b]
PSB Rc 68	17.80[b]	18.28[b]
NSIC Rc 192	15.89[c]	17.27[b]
SAPAW	23.79[a]	24.11[a]
M x V	3.33[ns]	2.02[ns]
CV_a (%)	10.11	12.64
CV_b (%)	5.24	10.14

For each column, treatment means with different letter are significantly different at 5% probability levels (DMRT).

<u>Interaction effect</u>. Statistical analysis showed no significant interaction between the soil moisture regimes and the rice varietieson panicle length (Table 47).

Total Number of Grains per Panicle

Effect of water regimes. Table 48 shows the total number of grains per panicle in Kapangan, Benguet. On both cropping seasons, there was no significant difference observed between the two moisture regimes on number of filled grains per panicle.

Effect of variety. The total number of grains per panicle was significantly different among the rice varieties(Table 48). *Sapaw* had the highest number of grains per panicle for both August 2010-February 2011 and March-November 2011 cropping periods. For the former season, *Sapaw* was comparable with PSB Rc14, NSIC Rc192 and NSIC Rc9. During the March-November 2011 cropping, grain number of*Sapaw* was comparable with NSIC Rc9.PSB Rc68 and PSB Rc14 had the lowest number of grains per panicle during the August 2010-February 2011 and March-November 2011cropping seasons, respectively.

Interaction effect. No significant interaction between the moisture regimes and the rice varieties in terms of total number of grains per panicleduring the August 2010-February 2011 butdiffered significantly during the March-November 2011cropping season (Figure 22). The foregoing result shows that *Sapaw* had the most grains per panicle under both soil moisture regimes. This implies the adaptability of *Sapaw* in the locality and its superiority over the high yielding varieties regardless of soil moisture regimes and under organic production system.

Table 48. Total number of grains per panicle in Kapangan, Benguet during the August 2010-February 2011 and March-November 2011 cropping periods

TREATMENT	TOTAL NUMBER OF GRAINS PER PANICLE	
	AUG 2010-FEB 2011	MAR-NOV 2011
Soil Moisture Regimes (M)		
Aerobic	116.05	98.90
Flooded	126.35	96.90
Varieties (V)		
NSIC Rc 9	118.13[ab]	110.00[ab]
PSB Rc 14	121.25[ab]	77.50[c]
PSB Rc 68	107.50[b]	82.50[c]
NSIC Rc 192	118.25[ab]	94.00[bc]
Sapaw	140.88[a]	125.50[a]
M x V	1.08[ns]	24.20**
CV_a (%)	4.82	6.46
CV_b (%)	3.42	11.58

For each column, treatment means with different letter are significantly different at 5% probability levels (DMRT).

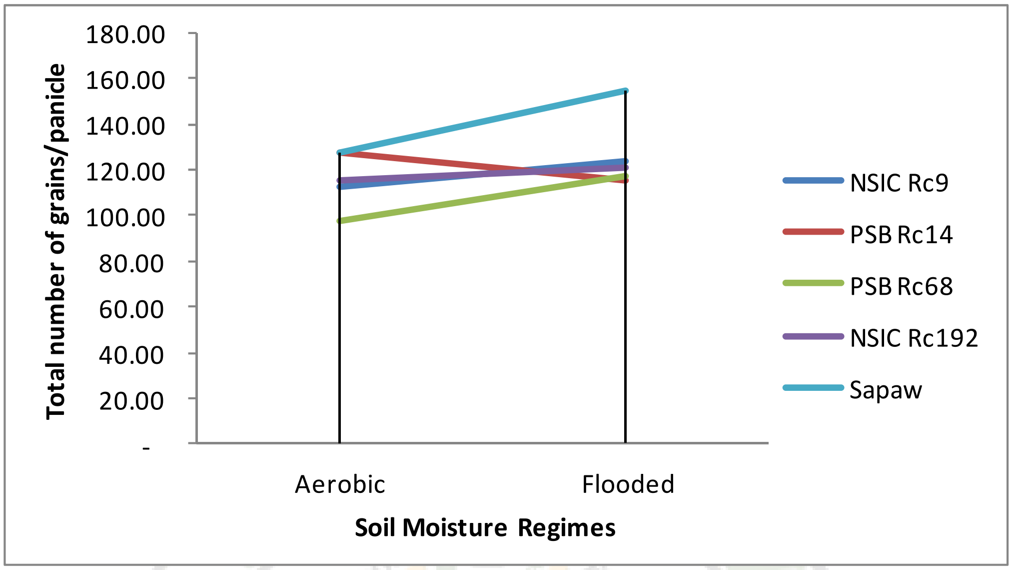

Figure 22. Interaction effect between the moisture regimes and the varieties on total number of grains per panicle in Kapangan, Benguet during the March-November 2011

Number of Filled Grains per Panicle

Effect of water regimes. Table 49 shows the number of filled grains per panicle in Kapangan, Benguet during the August 2010-February 2011 and March-November 2011cropping seasons. On both seasons, there was no significant difference observed between the two moisture regimes on number of filled grains per panicle. Higher filled grain ratio was observed in plants under flooded condition during the August 2010-February 2011 but higher under aerobic than flooded plots during the March-November 2011.

Effect of variety. Significant differences were found among the rice varieties in terms of the number of filled grains per panicle (Table48). *Sapaw* had the most filled grains per panicle for both August 2010-February 2011 and

Table 49. Number of filled grains per panicle inKapangan, Benguet during the August 2010-February 2011 and March-November 2011 cropping periods

TREATMENT	NUMBER OF FILLED GRAINS PER PANICLE	
	AUG 2010-FEB 2011	MAR-NOV 2011
Soil Moisture Regimes (M)		
Aerobic	88.00	72.00
Flooded	93.00	59.00
Varieties (V)		
NSIC Rc 9	95.00[b]	86.00[a]
PSB Rc 14	80.00[b]	45.00[b]
PSB Rc 68	83.00[b]	57.00[b]
NSIC Rc 192	78.00[b]	55.00[b]
SAPAW	118.00[a]	86.00[a]
M x V	5.79**	40.04**
CV_a (%)	4.87	3.96
CV_b (%)	2.98	2.60

For each column, treatment means with different letter are significantly different at 5% probability levels (DMRT).

March-November 2011cropping season at 118 and 86, respectively. NSIC Rc192 and PSB Rc14 had the lowest number of filled grains per panicle in Kapangan, Benguet during the August 2010-February 2011 and March-November 2011cropping season, respectively.

Interaction effect. There were significant interactions noted between the moisture regimes and the rice varieties in terms of number of filled grain per panicle in Kapangan, Benguet on both cropping seasons (Figure 23 and 24). For August 2010-February 2011, *Sapaw* had the most filled grains per panicle under both soil moisture regimes. During the March-November 2011 cropping period, *Sapaw* maintained as the highest on number of filled grains per panicle under aerobic condition and NSIC Rc9 in flooded plots. These results showed the adaptability of the traditional variety *Sapaw* over the high yielding varieties.

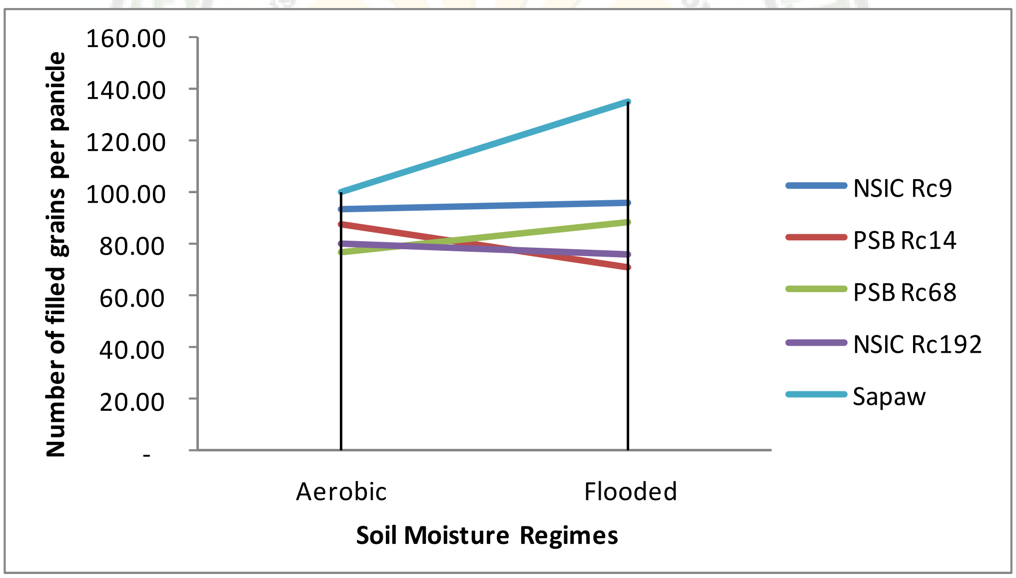

Figure 23. Interaction effect between the moisture regimes and the varieties on number of filled grains per panicle in Kapangan, Benguet during the August 2010-February 2011

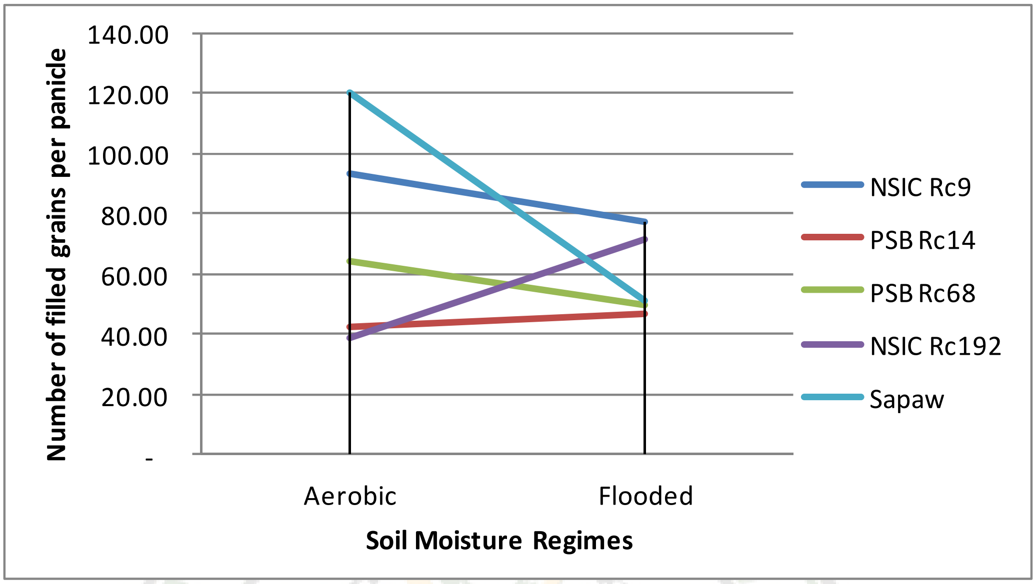

Figure 24. Interaction effect between the moisture regimes and the rice varieties on number of filled grains per panicle in Kapangan, Benguet during the March-November 2011

Filled Grain Ratio

Effect of moisture regime.Table50 shows no significant differences between the two moisture regimes on the filled grain ratio during theAugust 2010-February 2011 but had differed significantly during the March-November 2011in Kapangan, Benguet. The different rice varieties grown under aerobic fields had higher filled grainratio as compared to the plants grown under flooded plots. The results contradicted with the filled grain ratio in Luna, Apayao where higher rate was noted under flooded than under aerobic condition.

Effect of variety. Results showed that there were no significant differences among the varieties during the August 2010-February 2011 cropping season on

Table 50. Filled grain ratio (%) of ricein Kapangan, Benguet during the August 2010-February 2011 and March-November 2011 cropping periods

TREATMENT	FILLED GRAIN RATIO (%)	
	AUG 2010-FEB 2011	MAR-NOV 2011
Soil Moisture Regimes (M)		
Aerobic	76.61	70.29[a]
Flooded	68.55	61.36[b]
Varieties (V)		
NSIC Rc 9	80.25	77.65[a]
PSB Rc 14	65.81	58.84[c]
PSB Rc 68	77.05	69.39[b]
NSIC Rc 192	66.38	57.84[c]
Sapaw	73.41	65.40[bc]
M x V	0.24[ns]	8.76**
CV_a (%)	15.99	6.76
CV_b (%)	17.10	8.18

For each column, treatment means with different letter are significantly different at 5% probability levels (DMRT).

the filled grain ratio (Table 50). For the March-November 2011 growing period, there were significant differences among the varieties on the filled grain ratio. NSIC Rc9 had the highest filled grain ratio of 80.25% and 77.65 % during the August 2010-February 2011andMarch-November 2011, respectively. On the other hand, PSB Rc14 and NSIC Rc192 obtained the lowest filled grain ratio with a mean of 65.81% and 57.84% for the August 2010-February 2011andMarch-November 2011, respectively.

These results were consistent with the outcome during the dry season 2011 in Lagangilang, Abra and Luna, Apayao that NSIC Rc9 has the highest filled grain ratio. This implies that NSIC Rc9 has inherent character of having a high filled grain ratio even under organic production system.

Interaction effect. There was no significant interaction effect between moisture regimes and varieties in terms of filled grain ratio in Kapangan, Benguet during the August 2010-February 2011 cropping season but there was a highly significant interaction on March-November 2011 (Table 50). NSIC Rc9 had the highest filled grain ratio (81.33% and 73.98%) under aerobic and flooded condition, respectively (Figure 25). This implies that NSIC Rc9 can be grown under both soil moisture regimes in Kapangan, Benguet even under organic production system.

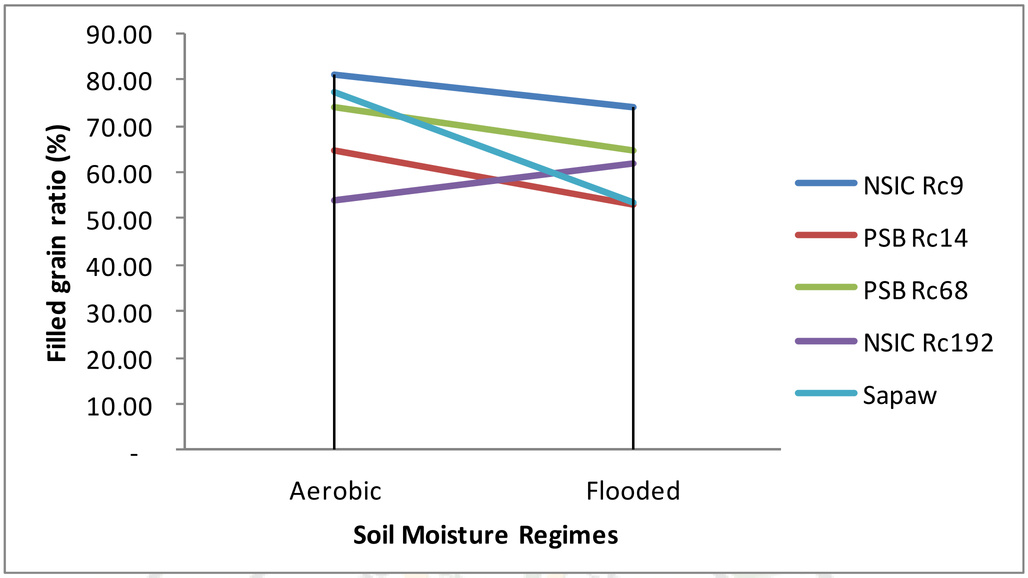

Figure 25. Interaction effect between the moisture regimes and the varieties on filled grain ratio in Kapangan, Benguet during the March-November 2011 cropping season

1000 Grain Weight

Effect of moisture regime. There was no significant difference between the two water regimes on the 1000-grain weight during the August 2010-February 2011 and March-November 2011 cropping seasons (Table 51).

Effect of variety. Results showed that there were significant differences among the rice varieties in terms of 1000-grain weight during the August 2010-February 2011 and March-November 2011 cropping period (Table 51). *Sapaw* produced the highest grain weight in both cropping periods. *Sapaw* is comparable with PSB Rc 68 during the August 2010-February 2011 only but the lowest weight was obtained from NSIC Rc192 on the August-February 2012 season and

Table 51. 1000-grain weight (g)of rice inKapangan, Benguet during the August 2010-February 2011 and March-November 2011 cropping periods

TREATMENT	1000 GRAIN WEIGHT(g)	
	AUG 2010-FEB 2011	MAR-NOV 2011
Soil Moisture Regimes (M)		
Aerobic	25.60	18.44
Flooded	25.53	18.57
Varieties (M)		
NSIC Rc 9	23.00[b]	16.66[c]
PSB Rc 14	23.66[b]	14.41[d]
PSB Rc 68	29.11[a]	19.76[b]
NSIC Rc 192	22.88[b]	16.73[c]
Sapaw	29.18[a]	24.95[a]
M x V	1.33[ns]	9.54**
CV_a (%)	0.76	13.30
CV_b (%)	3.98	5.96

For each column, treatment means with different letter are significantly different at 5% probability levels (DMRT).

PSB Rc14 on the March-November 2011 season with a mean of 22.88 g and 14.41g, respectively. The results implied that on the basis of 1000-grain weight as a selection index, *Sapaw* and NSIC Rc68 can be grown under organic rice production system in Kapangan, Benguet.

Interaction effect. There was no interaction effect between water regimes and varieties on the 1000 grain weight in Benguet during the August 2010-February 2011 cropping periodbut had significant interaction effect during theMarch-November 2011cropping season (Figure 26).*Sapaw* produced the heaviest 1000 filled grains both under aerobic and flooded condition. This implies that *Sapaw* produces high grain weight even under organic rice production.

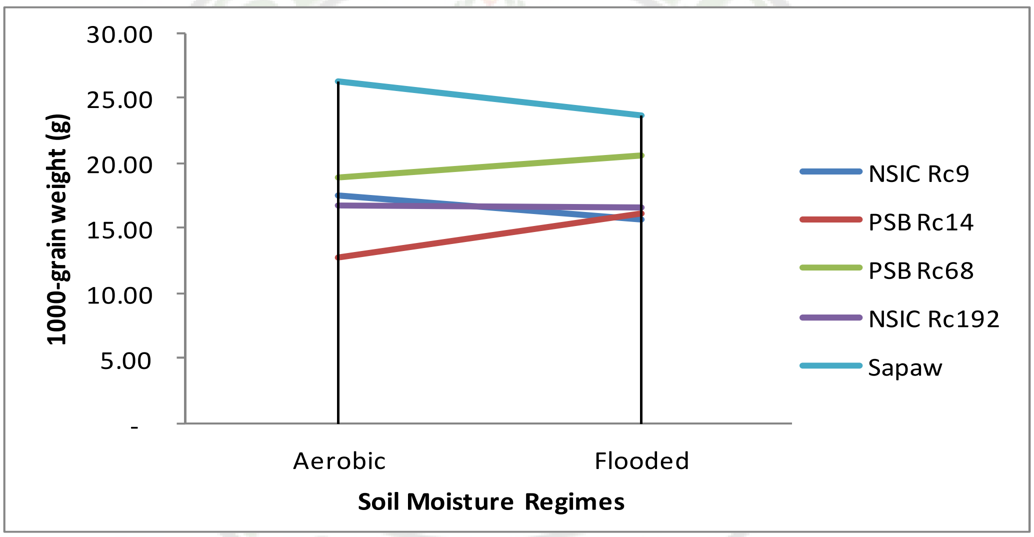

Figure 26. Interaction effect between the moisture regime and variety on 1000-grain weight in Kapangan, Benguet during the March-November 2011 cropping period

Total Dry Matter Weight

Effect of moisture regime. There was a significant difference between the two moisture regimes on the dry matter weight during the August 2010-February 2011 and March-November 2011 cropping periods (Table 52). Flooded plants significantly recorded a higher dry matter weight during the August 2010-February 2011 and March-November 2011 cropping periodat 94.23 g and 135.04 g, respectively.

The results agree with the findings of Lafitte and Benett (2002) that low dry matter weight under aerobic condition may be related to the relatively shallow root system and stomata closure which consequently reduced photosynthesis in response to surface soil drying. Further, Kato *et al.*, (2006a) also cited that in general, the total dry matter increases with increasing water supply.

Effect of variety. Dry matter weight during the August 2010-February 2011 and March-November 2011 cropping periods were significantly influenced by the varieties (Table 52). For the August 2010-February 2011 season, PSB Rc68 obtained the highest dry matter weight of 83.94 g which was comparable with *Sapaw*at 81.31 g. The lowest dry matter weight was observed on NSIC Rc192 with a mean of 55.44g. For the dry March-November 2011 cropping period, *Sapaw* produced the highest dry matter weight of 146.41g which was comparable with NSIC Rc9 at 118.54g. The lowest dry matter weight was obtained from PSB Rc 14 with a mean of 70.55g.

It can be noted that *Sapaw* and NSIC Rc9 were tall varieties in both cropping periods. The same varieties had high total dry matter weight. This therefore implies that tall varieties have high dry matter.

Table 52. Dry matter weight (g) of rice in Kapangan, Benguet during the August 2010-February 2011 and March-November 2011 cropping periods

TREATMENT	DRY MATTER WEIGHT (g)	
	AUG 2010-FEB 2011	MAR-NOV 2011
Soil Moisture Regimes (M)		
Aerobic	49.98[b]	73.42[b]
Flooded	94.23[a]	135.04[a]
Varieties		
NSIC Rc 9	68.06[b]	118.54[ab]
PSB Rc 14	71.75[ab]	70.55[b]
PSB Rc 68	83.94[a]	96.91[ab]
NSIC Rc 192	55.44[c]	88.73[ab]
Sapaw	81.31[a]	146.41[a]
M x V	10.26**	0.42[ns]
CV_a (%)	16.99	3.93
CV_b (%)	11.43	5.46

For each column, treatment means with different letter are significantly different at 5% probability levels (DMRT).

Interaction effect. For the August 2010-February 2011 season March-November 2011 cropping period, results showed that there was significant interaction between the moisture regimes and the rice varieties on the dry matter weight (Figure 27) but had no significant interaction during the March-November 2011 cropping period (Table 52). *Sapaw* had the highest total dry matter weight under aerobic condition and PSB Rc68 under flooded condition during the August 2010-February 2011 cropping period.

The result corroborates that of Kato et al (2006a) that a cultivar-water regime interaction in total dry matter weight exists. It wasearlier shown that different cultivars responded differently to the water conditions and that the local water supply greatly affected the total dry matter in upland conditions through its effects on the amount of N uptake, which was associated with the depth of root development.

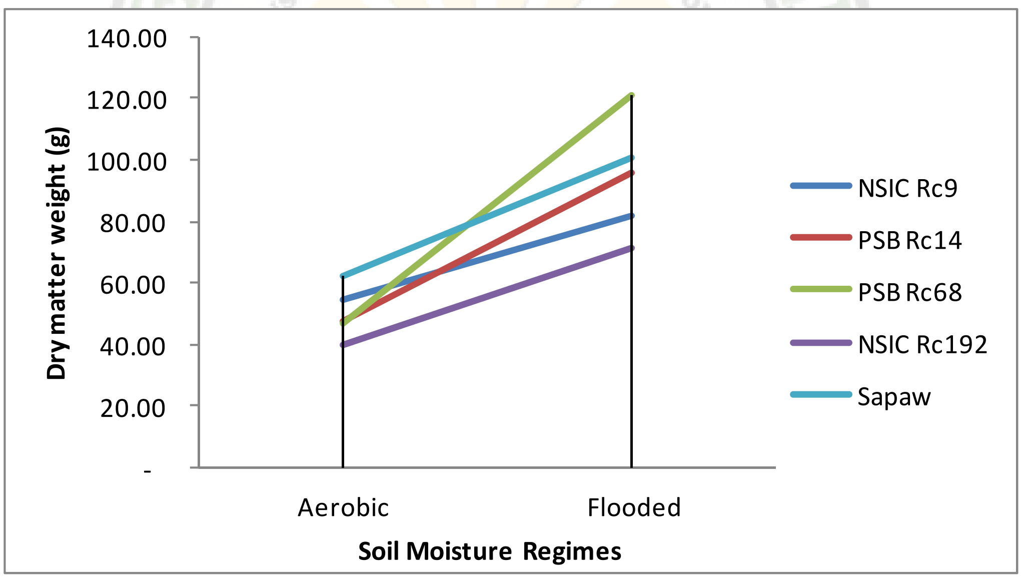

Figure 27. Interaction effect between the moisture regimes and the varieties on dry matter weight in Kapangan, Benguet during the WS 2010

Harvest Index

Effect of moisture regime. There was no significant difference between the two moisture regimes on harvest index during the August 2010-February 2011 but significantly influenced the harvest index on the March-November 2011 cropping period (Table 53). Plants under aerobic obtained a higher harvest index during the August 2010-February 2011 and March-November 2011 cropping seasons at 34.79 and 27.12, respectively.

The resultsare in agreement of various researchers (Yang *et al.*, 2000; Guo *et al.,* 2004; Kemanian *et al.,* 2007; D'Andrea *et al.,* 2008; Pelton-Sainio *et al.,* 2008; Xue *et al.*, 2006; Zhang *et al.*, 2008b; Bueno and Lafarge, 2009; Fletcher and Jamieson, 2009; Ju *et al.,* 2009) as cited by Yang and Zhang (2010) that variations in harvest index within a crop are mainly attributed to differences in crop management such as water and/or nitrogen management system that could increase growth rate during grain growth and/or enhance the remobilization of assimilates from vegetative tissues to grains during the grain-filling period usually leads to a higher harvest index. Among the water management systems cited were alternate wetting and moderate soil drying regimes during the whole growing season similar to aerobic rice.

Effect of variety. Results show that there were significant differences among the rice varieties in terms of harvest index during the August 2010-

Table 53. Harvest index of rice in Kapangan, Benguet during the August 2010-February 2011 and March-November 2011 cropping periods

TREATMENT	HARVEST INDEX	
	AUG 2010-FEB 2011	MAR-NOV 2011
Soil Moisture Regimes (M)		
Aerobic	0.35	0.27^{a}
Flooded	0.33	0.15^{b}
Varieties (V)		
NSIC Rc 9	0.34^{ab}	0.18^{b}
PSB Rc 14	0.31^{b}	0.22^{ab}
PSB Rc 68	0.37^{a}	0.24^{a}
NSIC Rc 192	0.31^{b}	0.21^{ab}
Sapaw	0.38^{a}	0.22^{ab}
M x V	2.32^{ns}	1.15^{ns}
CV_a (%)	11.78	5.39
CV_b (%)	11.22	5.64

For each column, treatment means with different letter are significantly different at 5% probability levels (DMRT).

February 2011 and March-November 2011 cropping seasons (Table 53). For the August 2010-February 2011 season, *Sapaw* obtained the highest harvest indexof 0.38 which is comparable with PSB Rc68 at 0.37. ForMarch-November 2011 cropping period, PSB Rc68 produced the highest harvest index (0.24) comparable with *Sapaw* (0.22), PSB Rc14 (0.22) and NSIC Rc192 (0.21).

The results indicate that both *Sapaw* and PSB Rc68 had consistently high harvest index for the two cropping seasons under organic production system. This implies that the grain yield of these varieties can be enhanced further by improving their harvest indices through the application of soil nutrient amendments following the organic approach.

Interaction effect. There was no significant interaction effect between water regimes and varieties on the harvest index during both cropping periods (Table 53).

Grain Yield

Effect of moisture regime. There was a significant difference between the two water regimes on the grain yieldin Kapangan, Benguet during the August 2010-February 2011 season but noneduring the March-November 2011(Table 54). Flooded recorded a higher grain yield on the August 2010-February 2011 season with a mean of 1.43 kg/5.75 m^2 but a higher yield under aerobic plots during theMarch-November 2011season at 0.15 kg/5.75 m^2.

Effect of the variety. Significant differences exist among the varieties on both the August 2010-February 2011and March-November 2011cropping seasons (Table 54). PSB Rc68 significantly produced the highest yield of 1.29 kg/5.75 m^2on August 2010-February 2011season which was comparable with NSIC Rc9 (1.16 kg/5.75 m^2) and *Sapaw* (1.15 kg/5.75 m^2). The lowest yield was obtained from NSIC Rc192 with a mean of 0.68 kg/5.75 m^2. For the March-

Table 54 Grain yield in rice production in Kapangan, Benguet during the August 2010-February 2011 and March-November 2011 cropping periods

TREATMENT	GRAIN YIELD (kg/5.75 m$^{2-1}$)	
	AUG 2010-FEB 2011	MAR-NOV 2011
Soil Moisture Regimes (M)		
Aerobic	0.61^{b}	0.15
Flooded	1.43^{a}	010
Varieties (V)		
NSIC Rc 9	1.15^{ab}	0.08^{b}
PSB Rc 14	0.83^{bc}	0.08^{b}
PSB Rc 68	1.29^{a}	0.04^{b}
NSIC Rc 192	0.67^{c}	0.09^{b}
Sapaw	1.15^{ab}	0.35^{a}
M x V	3.56*	7.11**
CV_a (%)	2.50	7.64
CV_b (%)	4.14	8.28

For each column, treatment means with different letter are significantly different at 5% probability levels (DMRT).

November 2011cropping season, *Sapaw* recorded the highest yield while PSB Rc68 had the lowest.

Interaction effect. The interaction effect between water regimes and varieties was significant on both the August 2010-February 2011and March-November 2011cropping seasons (Figures28 and29). For August 2010-February

2011 season, NSIC Rc9 produced the highest grain yield of 0.74 kg 5.75 m^{2-1} under aerobic condition and PSB Rc68 at 1.85 kg 5.75 m^{2-1} under flooded condition (Figure 28). During the March-November 2011 cropping period, *Sapaw* attained the highest grain yield at 0.48 kg 5.75 m^{2-1} and 0.23 kg 5.75 m^{2-1} under aerobic and flooded fields (Figure 29).

The results imply seasonality of varieties based on grain yield under both soil moisture regimes grown under organic production in Kapangan, Benguet namely NSIC Rc9 and PSB Rc68 for August-February and *Sapaw* during the March-November cropping period. This likewise indicated the adaptability of these varieties to the locality.

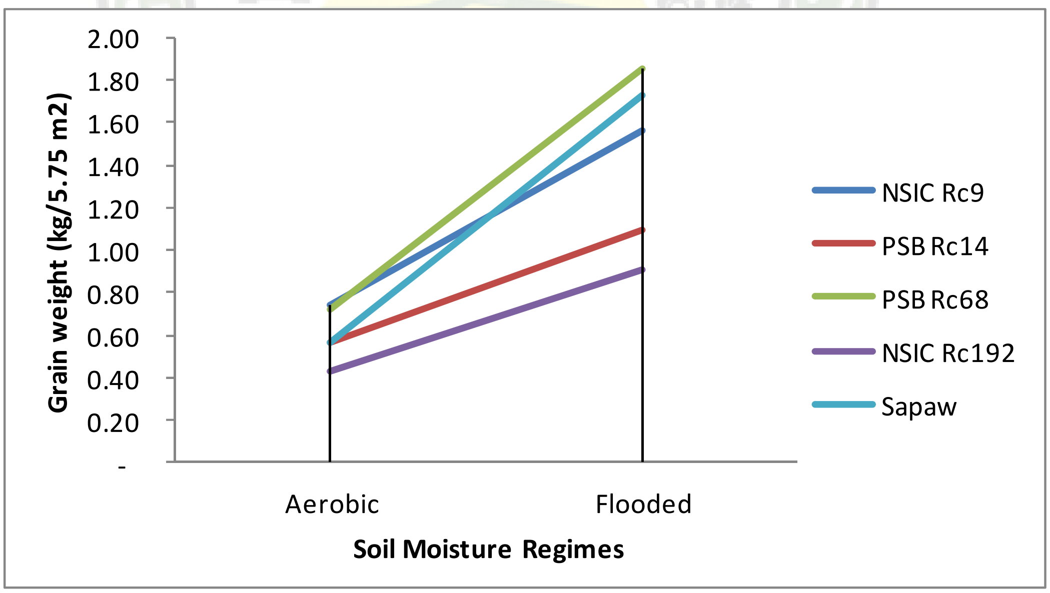

Figure 28. Interaction effect between the moisture regimes and the rice varieties on grain yield in Kapangan, Benguet during the August 2010-February 2011 cropping period

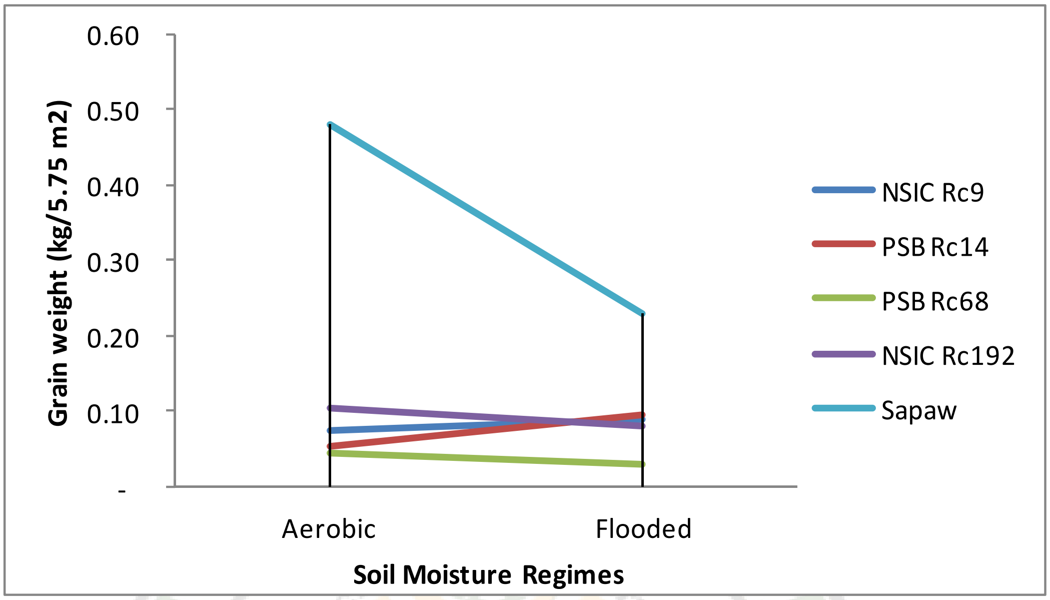

Figure 29. Interaction effect between the moisture regimes and the varieties on grain yield in Kapangan, Benguet during the March-November 2011 cropping period

Computed Yield

Effect of moisture regime. The computed yield per hectare during the August 2010-February 2011 cropping period was significantly influenced by the moisture regimes as shown in Table 55. Computed yield from flooded field was higher at 2.38 t/ha than in aerobic plots at 1.05 t/ha.For the March-November 2011 cropping season, results showed that there was no significant effect between the two moisture regimes on the computed yield per hectare.

Effect of variety. Yield significantly differed among the varieties during both cropping seasons(Table 55). On the August 2010-February 2011, PSB Rc68 significantly produced the highest computed yield of 2.24 t ha^{-1} which was

Table 55. Computed yield (t ha^{-1}) of rice inKapangan, Benguet during the August 2010-February 2011 and March-November 2011 cropping periods

TREATMENT	COMPUTED YIELD (t ha^{-1})	
	AUG 2010-FEB 2011	MAR-NOV 2011
Soil Moisture Regimes (M)		
Aerobic	1.05^{b}	0.26
Flooded	2.48^{a}	0.18
Varieties (V)		
NSIC Rc 9	1.99^{ab}	0.15^{b}
PSB Rc 14	1.43^{bc}	0.13^{b}
PSB Rc 68	2.24^{a}	0.07^{b}
NSIC Rc 192	1.16^{c}	0.16^{b}
SAPAW	2.01^{ab}	0.62^{a}
M x V	3.61*	7.21**
CV_a(%)	9.76	3.84
CV_b(%)	9.71	4.27

For each column, treatment means with different letter are significantly different at 5% probability levels (DMRT).

was comparable with *Sapaw* (2.01 t ha^{-1}) and NSIC Rc9 (1.99 tha^{-1}). For the March-November 2011 cropping season, *Sapaw* produced the highest computed yield with a mean of 0.62 tha^{-1} while the lowest was obtained from PSB Rc68 at 0.07 t ha^{-1}.

These results imply that PSB Rc68, *Sapaw*, and NSIC Rc9 can be grown under organic production during the August-February cropping period. With improved cultural management practices such as the application of soil nutrient amendments to further enhance harvest index and eventually yield levels under Kapangan, Benguet condition.

Interaction effect. There was significant interaction effect between moisture regimes and varieties evaluated on the computed yield per hectare for both cropping seasons. During the August 2010-February 2011, NSIC Rc9 and PSB Rc68 produced the highest computed yield under aerobic and flooded conditions, respectively(Figure 30).For March-November 2011, *Sapaw* had the highest yield on both soil moisture regimes.

The results indicate that NSIC Rc9 and PSB Rc68 can be grown under organic production in Kapangan, Benguet during the August-February cropping period; and *Sapaw* during the March-November growing season. The current yield levels can still be improved by using soil amendments in accordance with the principles of organic production system.

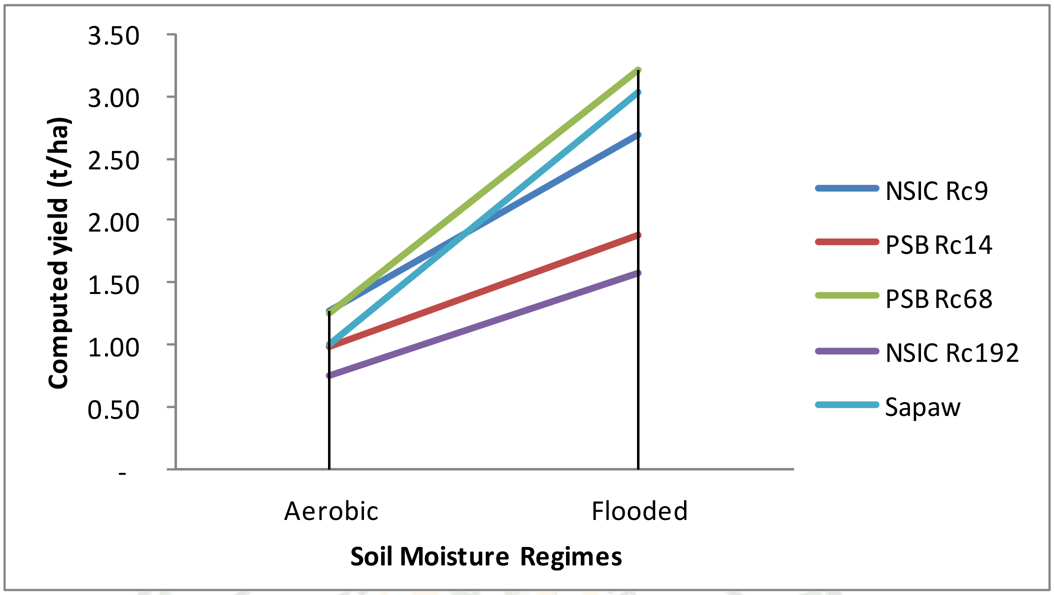

Figure30. Interaction effect between the moisture regimes and the varieties on computed yield per hectare in Kapangan, Benguet during theAugust 2010-February 2011 season

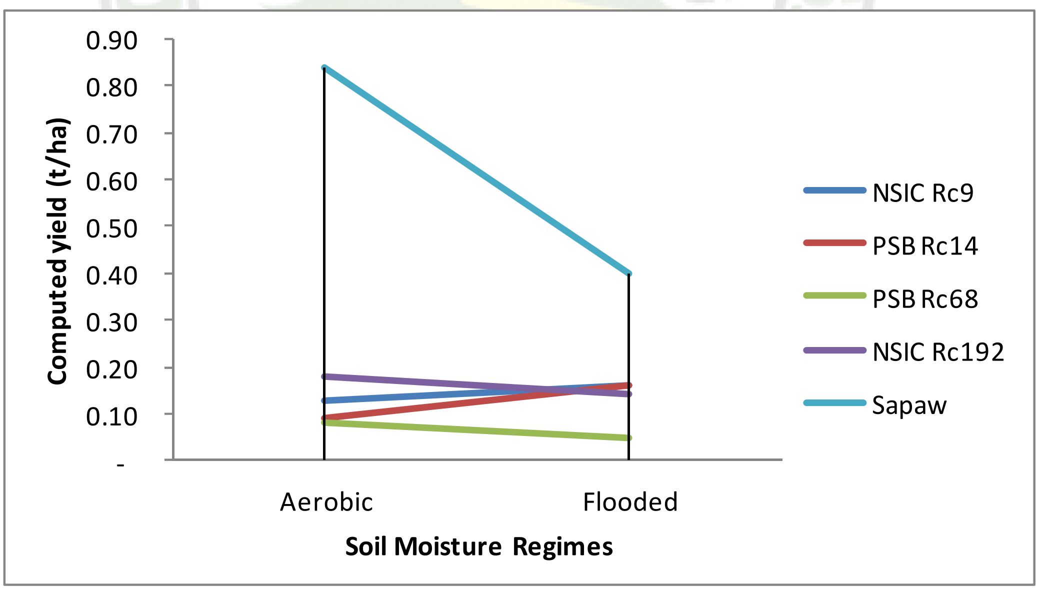

Figure 31. Interaction effect between the moisture regimes and the varieties on computed yield per hectare in Kapangan, Benguet during the March-November 2011 cropping period

Water use efficiency

Effect of water regimes. There was no significant difference observed between soil moisture regimes in terms of water use efficiency during both on the cropping seasons in Kapangan, Benguet (Table 56). Flooded plots obtained a higher water use efficiency of 0.25g grain/l during the wet season trial. Conversely, aerobic plots registered a higher water use efficiency.

Effect of variety. While no significant differences on water use efficiency was observed among the varieties on the August 2010-February 2011 season there was significant differenceduring the March-November 2011 season (Table 56).

Sapaw recorded the highest water use efficiency on both seasons while NSIC Rc 192 had the lowest on the August 2010-February 2011 season and PSB Rc 68 on the March-November 2011cropping season.

Interaction effect. There were no significant interaction during the August 2010-February 2011 season but had a significant interaction between moisture regimes and the varieties on the water use efficiency during the March-November 2011 growing period (Figure 32). The result showed that *Sapaw* had the highest water use efficiency under aerobic and flooded conditions.

Table56. Water use efficiency of rice in Kapangan, Benguet during the August 2010-February 2011 and March-November 2011 cropping periods

TREATMENT	WATER USE EFFICIENCY (g grain/l)	
	AUG 2010-FEB 2011	MAR-NOV 2011
Soil Moisture Regimes (M)		
Aerobic	0.210	0.013
Flooded	0.250	0.010
Varieties (V)		
NSIC Rc 9	0.210	0.009^{b}
PSB Rc 14	0.150	0.008^{b}
PSB Rc 68	0.240	0.004^{b}
NSIC Rc 192	0.120	0.010^{b}
Sapaw	0.430	0.027^{a}
M x V	0.78^{ns}	7.06**
CV_a (%)	5.43	0.000
CV_b (%)	4.37	0.000

For each column, treatment means with different letter are significantly different at 5% probability levels (DMRT).

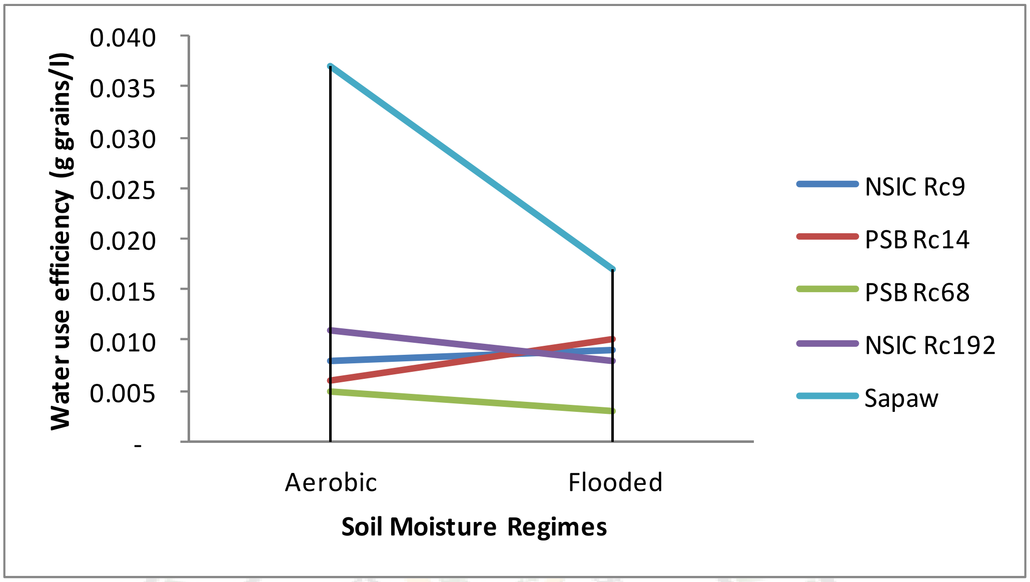

Figure 32. Interaction effect between the moisture regimes and the varietieson water use efficiency in Kapangan, Benguet during the March-November 2011 growing season

Sensory Evaluation

Aroma. PSB Rc 14, 68 and *Sapaw* in both soil moisture regimes had moderate aroma (Table 57). NSIC Rc 9 and 192 had also moderate aroma in aerobic but had bland and slightly perceptible in flooded, respectively.

Taste. NSIC Rc 9 were rated slightly tasty in both soil moisture regimes. The rest of the varieties were moderate in taste also in both aerobic and flooded.

Texture. PSB Rc 14 had moderately soft grains and NSIC Rc 192 had slightly hard grains in both soil moisture regimes. The rest of the varieties were rated either moderately soft or slightly hard grains in aerobic and flooded.

Table 57. Sensory evaluation of rice varieties in Kapangan, Benguet (2010-2011)

SOIL MOISTURE REGIMES	VARIETY	AROMA	TASTE	TEXTURE	GENERAL ACCEPTABILITY
AEROBIC	NSIC Rc9	Moderate	Slightly tasty	Moderately Soft	Like moderately
	PSB Rc14	Moderate	Moderate	Moderately Soft	Like slightly
	PSB Rc68	Moderate	Moderate	Moderately Soft	Like moderately
	NSIC Rc192	Moderate	Moderate	Slightly hard	Like moderately
	Sapaw	Moderate	Moderate	Moderately Soft	Like very much
FLOODED	NSIC Rc9	Bland	Slightly tasty	Slightly hard	Like moderately
	PSB Rc14	Moderate	Moderate	Moderately Soft	Like moderately
	PSB Rc68	Moderate	Moderate	Slightly hard	Like moderately
	NSIC Rc192	Slightly perceptible	Moderate	Slightly hard	Like very much
	Sapaw	Moderate	Moderate	Slightly hard	Like moderately

General Acceptability. *Sapaw* in aerobic plots and NSIC Rc 192 in flooded fields were liked very much by the testers. *Sapaw* grown under aerobic condition had moderate aroma and taste and moderately soft textured grains.

Correlation Among Growth and Yield Parameters on Rice Grain Yield under Aerobic Condition in Lagangilang, Abra during the WS 2010 and DS 2011

Among the various growth parameters used, only total dry matter weight and harvest index had significant correlation with yield (Table 58). Harvest index had a positive significant correlation with yield. This indicates that grain yield in aerobic rice increases as harvest index increases. Thisemphasizes the importance of harvest index enhancement as confirmed by Yang and Zhang (2010), through improved crop management practices like moderate wetting and drying regime (aerobic rice) which reduces redundant vegetative growth, increases harvest index and eventually higher yield.

On the other hand, a negative significant correlation exists between total dry matter weight and yield. This may imply that for every decrease in unit of total dry matter weight there is a corresponding increase in grain yield. Researches on different rice varieties revealed that tall varieties with large canopy and delayed senescence had decreased grain yield since stored carbohydrates are concentrated in the vegetative parts and not on grains (Yang and Zhang, 2010).

Correlation Among Growth and Yield Parameters on Rice Grain Yield under Aerobic Condition in Luna, Apayao during the WS 2010 and DS 2011

The results revealed that panicle length and filled grain number per panicle had significant positive correlation with grain yield (Table 59). Likewise,

Table 58.Correlation among thegrowth and yield parameters on therice grainyield under aerobic condition in Lagangilang, Abra during the WS 2010 and DS 2011

PARAMETERS	COEFFICIENT OF CORRELATION	PROBABILITY
Plant Height at Maturity (cm)	-0.132 ns	0.833
Number of Days from Seeding to Maturity	-0.609 ns	0.275
Leaf Area Index at 75 DAS	0.650 ns	0.936
Tiller Number at Maturity	-0.317 ns	0.604
Panicle Number at Maturity	-0.134 ns	0.830
Panicle Length (cm)	-0.340 ns	0.575
Grain Number per Panicle	-0.192 ns	0.757
Number of Filled Grains per Panicle	-0.189 ns	0.760
Filled Grain Ratio (%)	0.631 ns	0.254
1000-Grain Weight (g)	-0.203 ns	0.743
Total Dry Matter Weight (g)	-0.873*	0.043
Harvest Index	0.850*	0.048

Legend: ns (not significant) * - significant

the total grain number per panicle had significant positive relationship with grain yield. The positive correlationindicates that when the panicle length, grain number and number of filled grains per panicle increasethe grain yieldalso

Table 59. Correlation among thegrowth and yield parameters on the rice grainyield under aerobic condition in Luna, Apayao during the WS 2010 and DS 2011

PARAMETERS	COEFFICIENT OF CORRELATION	PROBABILITY
Plant Height at Maturity (cm)	0.700 ns	0.188
Number of Days from Seeding to Maturity	0.422 ns	0.479
Leaf Area Index at 75 DAS	0.399 ns	0.506
Tiller Number at Maturity	-0.795 ns	0.108
Panicle Number at Maturity	-0.766 ns	0.123
Panicle Length (cm)	0.915*	0.030
Grain Number per Panicle	0.966**	0.008
Number of Filled Grains per Panicle	0.938*	0.018
Filled Grain Ratio (%)	0.349 ns	0.565
1000-Grain Weight (g)	0.285 ns	0.642
Total Dry Matter Weight (g)	0.836 ns	0.078
Harvest Index	0.089 ns	0.886

Legend: ns - not significant
* - significant
** -highly significant

increases. This implies that varieties having long panicle with more filled grains have high grain yield under aerobic condition in Luna, Apayao.

The rest of the parameters did not show significant correlation with grain yield under aerobic condition in Luna, Apayao during the WS 2010 and DS 2011.

Correlation Among Growth and Yield Parameters on Rice Grain Yield under Aerobic Condition in Kapangan, Benguet during the WS 2010 and DS 2011

Plant height at physiological maturity, number of days from seeding to maturity, total and filled grain number per panicle and total dry matter weight had significant positive correlations with grain yield under aerobic condition in Kapangan, Benguet (Table 60). This indicates that for every unit increase in plant height at physiological maturity, maturity days, total and filled grain number per panicle, and total dry matter weight, there is a corresponding increase in grain yield. This suggests that under aerobic condition,varieties that are late maturing, tall, with high dry matter, and have long panicle with more filled grains are adaptable and have high grain yield in Kapangan, Benguet.

The results also reveal that the total tiller number at maturity and panicle number have negative significant correlation with grain yield. Even if there are more tillers at maturity per unit area if most are unproductive, then the grain yield is low. Similarly, even with more panicles at physiological maturity per unit area but if most have unfilled grains, then it would still result to low grain yield.

Table 60. Correlation among thegrowth and yield parameters on rice grain yieldunder aerobic condition in Kapangan, Benguet during the WS 2010 and DS 2011

PARAMETERS	COEFFICIENT OF CORRELATION	PROBABILITY
Plant Height at Maturity (cm)	0.941*	0.017
Number of Days from Seeding to Maturity	0.934*	0.020
Leaf Area Index at 75 DAS	0.059ns	0.925
Tiller Number at Maturity	-0.924*	0.025
Panicle Number at Maturity	-0.911*	0.032
Panicle Length (cm)	0.970**	0.006
Grain Number per Panicle	0.895*	0.040
Number of Filled Grains per Panicle	0.957*	0.011
Filled Grain Ratio (%)	0.852ns	0.067
1000-Grain Weight (g)	0.817ns	0.091
Total Dry Matter Weight (g)	0.937*	0.019
Harvest Index	0.239ns	0.698

Legend: ns - not significant
* - significant
** - highly significant

<u>Correlation Among Growth and Yield Parameters on Rice Grain Yield under Flooded Condition in Lagangilang, Abra during the WS 2010 and DS 2011</u>

The correlations among growth and yield parameters with grain yield are presented in Table 61. No significantcorrelation exist among the growth and

Table 61.Correlation among thegrowth and yield parameters on rice grain yieldunder flooded condition in Lagangilang, Abra during the WS 2010 and DS 2011

PARAMETERS	COEFFICIENT OF CORRELATION	PROBABILITY
Plant Height at Maturity (cm)	-0.602ns	0.283
Number of Days from Seeding to Maturity	-0.738ns	0.155
Leaf Area Index at 75 DAS	-0.235ns	0.704
Tiller Number at Maturity	0.218ns	0.725
Panicle Number at Maturity	0.302ns	0.621
Panicle Length (cm)	-0.049ns	0.937
Grain Number per Panicle	-0.264ns	0.668
Number of Filled Grains per Panicle	-0.483ns	0.410
Filled Grain Ratio (%)	-0.333ns	0.584
1000-Grain Weight (g)	-0.112ns	0.857
Total Dry Matter Weight (g)	-0.663ns	0.222
Harvest Index	0.815ns	0.093

Legend: ns (not significant)

yieldparameters with grain yield under flooded condition in Lagangilang, Abra. This indicates that said parameters did not influence the grain yield. As the result implies, grain yield may be affected by the inherent characteristics of the varieties.

Correlation Among Growth and Yield Parameters on Rice Grain Yield under Flooded Condition in Luna, Apayao during the WS 2010 and DS 2011

Correlation amonggrowth and yield parameters with grain yield of rice grown in aerobic plots in Luna, Apayao is presented in Table 62. The result reveals that both tiller and panicle number at maturity have negative significant correlation with grain yield in flooded fields in Luna, Apayao. This implies that more unproductive tillers, and panicles with more unfilled grains reduce grain yield in flooded plots in Luna, Apayao. Cultural management practices such as proper water and nitrogen fertilizer management maybe adopted to maintain few but productive tillers with more filled grains per panicle.

Correlation Among Growth and Yield Parameters on Rice Grain Yield under Flooded Condition in Kapangan, Benguet during the WS 2010 and DS 2011

Table 63 presents the correlation among the growth and yield parameters with grain yield under flooded condition in Kapangan, Benguet. The result reveals that total dry matter weight and harvest index had significant positive correlations with grain yield. This indicates that for every unit increase in dry matter and harvest index the grain yield also increases. With high dry matter and harvest index, there is also high grain yield.

Table 62. Correlation among the growth and yield parameters on rice grain yieldunder flooded condition in Luna, Apayao during the WS 2010 and DS 2011

PARAMETERS	COEFFICIENT OF CORRELATION	PROBABILITY
Plant Height at Maturity (cm)	0.466ns	0.429
Number of Days from Seeding to Maturity	0.322ns	0.597
Leaf Area Index at 75 DAS	0.134ns	0.830
Tiller Number at Maturity	-0.912*	0.031
Panicle Number at Maturity	-0.896*	0.040
Panicle Length (cm)	0.869ns	0.056
Grain Number per Panicle	0.853ns	0.066
Number of Filled Grains per Panicle	0.777ns	0.122
Filled Grain Ratio (%)	-0.411ns	0.492
1000-Grain Weight (g)	0.384ns	0.524
Total Dry Matter Weight (g)	0.547ns	0.340
Harvest Index	0.094ns	0.881

Legend: ns - not significant
* - significant
** - highly significant

Table 63.Correlation among thegrowth and yield parameters on rice grain yield under flooded condition in Kapangan, Benguet during the August 2010-February 2011 and March-November 2011 cropping periods

PARAMETERS	COEFFICIENT OF CORRELATION	PROBABILITY
Plant Height at Maturity (cm)	0.748ns	0.146
Number of Days from Seeding to Maturity	0.848ns	0.069
Leaf Area Index at 75 DAS	0.813ns	0.095
Tiller Number at Maturity	-0.713ns	0.161
Panicle Number at Maturity	-0.653ns	0.232
Panicle Length (cm)	0.674ns	0.212
Grain Number per Panicle	0.047ns	0.941
Number of Filled Grains per Panicle	0.574ns	0.312
Filled Grain Ratio (%)	0.769ns	0.128
1000-Grain Weight (g)	0.814ns	0.093
Total Dry Matter Weight (g)	0.960**	0.010
Harvest Index	0.966**	0.008

Legend: ns - not significant
* - significant
** - highly significant

Comparison of Plant Height and Maturity of Rice Varieties under Two Moisture Regimes in Different Sites

Characters which significantly differed among the different varieties were considered. In terms of plant height and maturity days under both aerobic and flooded conditions, all varieties were short but late maturing in Kapangan, Benguet; and tall but early maturing in Luna, Apayao. Varieties grown in Lagangilang, Abra were similar with those in Luna, Apayao in terms of plant height and maturity (Table 64).

The variation in plant height and maturity period among varieties maybe influenced by environmental factors like rainfall and relative humidity. In Luna, Apayao, 3,380.60 mm rainfall was recorded during the two cropping seasons which was the highest among the three sites. Further, it is situated at about 5 m asl as compared to 1,000 m asl in Kapangan, Benguet site.

Comparison of Yield and Yield Components of Rice Varieties Across Sites

PSB Rc14 had a mean of 102.50 and 113 panicles in Lagangilang, Abra; 25.13 and 114.88 panicles in Luna, Apayao under aerobic and flooded conditions, respectively (Table 65). In Kapangan, Benguet, NSIC Rc192 had a mean of 44.63 panicles under aerobic and 46.64 panicles from PSC Rc68 under flooded fields.

NSIC Rc9 had 133.46 and 138.33 mean filled grains per panicle in Lagangilang, Abra; 140.88 and 136.14 mean filled grains per panicle in Luna,

Table 64.Comparison of plant height and maturity days of rice varieties grownacross sites during the WS 2010 and DS 2011

PARA-METER	VARIETY	AEROBIC				FLOODED			
		ABRA	APA-YAO	BEN-GUET	MEAN	ABRA	APA-YAO	BEN-GUET	MEAN
Plant Height (cm)	NSIC Rc9	101.41	115.44	80.58	99.14	112.48	127.08	88.94	109.50
	PSB Rc14	75.59	78.69	59.16	71.15	84.26	85.09	68.64	79.33
	PSB Rc68	102.39	113.00	74.55	96.65	113.62	123.41	89.68	108.90
	NSIC Rc192	101.06	107.69	63.88	90.88	106.41	121.15	77.11	101.56
Maturity Days (No.)	NSIC Rc9	116.50	99.00	161.75	125.75	113.50	99.00	155.13	122.54
	PSB Rc14	101.00	94.00	151.50	115.50	101.00	93.00	142.50	112.17
	PSB Rc68	110.00	112.00	174.00	132.00	111.50	110.00	161.50	127.67
	NSIC Rc192	99.50	93.00	148.00	113.50	98.50	92.00	139.50	110.00

Apayao; and 93.38 and 86.75 filled grains per panicle in Kapangan, Benguet, respectively.

As to 1000-grain weight, PSB Rc68 had 28.20 g and 29.59 g in Lagangilang, Abra; 29.98 g and 30.48 g in Luna, Apayao; and 24.04 g and 24.84 g in Kapangan, Benguet under aerobic and flooded condition, respectively.

In terms of grain yield per 5.75 m^2 under aerobic and flooded condition, NSIC Rc192 weighed 3.10 kg and NSIC Rc136H at 4.09 kg in Lagangilang, Abra; NSIC Rc9 weighed 2.92 kg and NSIC Rc136H at 3.33 kg in Luna, Apayao; and NSIC Rc9 with 0.41 kg and PSB Rc68 with 0.94 kg in Kapangan, Benguet, respectively.

Table 65.Comparison of yield and yield components of rice varieties across sites,WS 2010 and DS 2011

PARA-METER	VARIETY	AEROBIC				FLOODED			
		ABRA	APA-YAO	BEN-GUET	MEAN	ABRA	APA-YAO	BEN-GUET	MEAN
Panicle Length (cm)	NSIC Rc9	2.92	22.74	19.73	15.13	24.38	23.23	19.43	22.35
	PSB Rc14	1.55	20.29	17.34	13.06	21.14	20.57	17.97	19.89
	PSB Rc68	2.39	22.61	17.87	14.29	24.42	24.20	18.22	22.28
	NSIC Rc192	1.99	20.55	15.73	12.76	22.56	21.03	17.43	20.34
No. of Filled Grains	NSIC Rc9	133.46	140.88	93.38	122.57	138.33	136.14	86.75	120.41
	PSB Rc14	73.63	74.63	65.38	71.21	79.59	72.86	59.00	70.48
	PSB Rc68	116.28	102.00	70.25	96.18	129.58	120.35	69.25	106.39
	NSIC Rc192	112.24	94.75	59.63	88.87	113.34	111.61	73.75	99.57
1000-Grain Weight (g)	NSIC Rc9	22.48	23.94	20.17	22.20	22.99	23.79	19.51	22.10
	PSB Rc14	22.91	23.29	18.12	21.44	23.23	23.38	19.97	22.19
	PSB Rc68	28.20	29.98	24.04	27.41	29.59	30.48	24.84	28.30
	NSIC Rc192	24.83	24.19	20.23	23.08	26.77	23.95	19.38	23.37
Grain Yield (kg 5.75m^2-^{1})	NSIC Rc9	2.53	2.92	0.41	1.95	3.44	3.21	0.83	2.49
	PSB Rc14	2.50	1.55	0.31	1.45	3.50	2.06	0.59	2.05
	PSB Rc68	2.16	2.39	0.38	1.64	3.20	3.00	0.94	2.38
	NSIC Rc192	3.10	1.99	0.27	1.79	3.62	2.48	0.49	2.20

Comparison of Mean Computed Yield Across Sites

Under aerobic condition the mean computed yield per site from the earlier results are as follows: 5.38 t/ha from NSIC Rc192 in Lagangilang, Abra; 5.07 t/ha from NSIC Rc 9 in Luna, Apayao; and 0.71 t/ha also from NSIC Rc9 in

Kapangan, Benguet. In flooded fields, NSIC Rc136H in Lagangilang, Abra had 7.11 t/ha; NSIC Rc136H in Luna, Apayao produced 5.79 t/ha; and PSB Rc68 in Kapangan, Benguet produced 1.64 t/ha (Table 66).

Comparison of Difference on Computed Yield of Rice Varieties between Aerobic and Flooded Condition

Table 67 shows the varieties which had low mean computed yield difference between aerobic and flooded plots. In Lagangilang, Abra, NSIC Rc192 was 15% (0.92 t/ha) lower on computed yield in aerobic than in flooded fields; 9% (0.51 t/ha) lower on computed yield from NSIC Rc9 in Luna, Apayao; and 46% (0.40 t/ha) lower from NSIC Rc192 in Kapangan, Benguet.

Table 66. Computed yield (t ha^{-1}) of rice in three sites during the WS 2010 and DS 2011

VARIETY	AEROBIC				FLOODED			
	ABRA	APA-YAO	BEN-GUET	MEAN	ABRA	APA-YAO	BEN-GUET	MEAN
NSIC Rc9	4.41	5.07	0.71	3.40	5.98	5.58	1.44	4.33
PSB Rc14	4.34	2.70	0.54	2.52	6.09	3.58	1.03	3.57
NSIC Rc68	3.76	4.16	0.67	2.86	5.56	5.22	1.64	4.14
NSIC Rc192	5.38	3.46	0.46	3.10	6.30	4.31	0.86	3.82

Table 67. Yield difference between aerobic and flooded fields, WS 2010 and DS 2011

PARA-METER	VARIETY	ABRA		APAYAO		BENGUET		MEAN	
		VALUE	%	VALUE	%	VALUE	%	VALUE	%
Compu	NSIC Rc 9	(1.57)	(26)	(0.51)	(36)	(0.73)	(51)	(0.94)	(38)
ted	PSB Rc 14	(1.75)	(29)	(0.89)	(86)	(0.50)	(48)	(1.04)	(54)
Yield	PSB Rc 68	(1.80)	(32)	(1.07)	(65)	(0.97)	(59)	(1.28)	(52)
(t/ha)	NSIC Rc 192	(0.92)	(15)	(0.85)	(99)	(0.40)	(46)	(0.72)	(53)

SUMMARY, CONCLUSIONS AND RECOMMENDATION

Summary

The study was conducted to compare the growth performance and grain yield of different rice varieties under two moisture regimes in different agro-ecological zones; to determine total water use efficiency of different rice varieties under two moisture regimes in different agro-ecological zones; identify the best variety under two moisture regimes in different agro-ecological zones; and evaluate the performance of rice varieties grown organically under two moisture regimes in a mid mountain zone of Benguet.There were sites namely: Lagangilang, Abra; Luna, Apayao; andKapangan, Benguet. The field experiment was conducted in two cropping seasons: July-November 2010 in Lagangilang, Abra and Luna, Apayao; and August 2010-February 2011 in Kapangan, Benguet; and December 2010-April 2011 in Lagangilang, Abra and Luna, Apayao; and March-November 2011 in Kapangan, Benguet.

Moisture Regimes

In all three sites and during both cropping seasons, significant differences were observed between the two moisture regimes on plant height at maturity, total dry matter weight and grain yield. The rest of the parameters showed varied results as influenced by the moisture regimes.

In Lagangilang, Abra, varieties grown under flooded condition were taller, matured earlier, had more panicles and higher grain yieldas well as computed yield per hectare in both seasons. Likewise, longer panicles, more filled and total grains per panicle, dry matter weight, and harvest index during the dry season inthe same moisture regimewere noted. On the other hand, plants in aerobic plots had more grains per panicle during the wet season only.

In Luna, Apayao, plants grown under flooded condition were taller, produced longer panicles, hadhigher filled grain ratio, dry matter weight, grain and computed yield, and higher water use efficiency than the aerobic plots during the wet season. During the dry season, more total and filled grains per panicle, and higher harvest index were observed in flooded than in the aerobic fields. Higher water use efficiency was noted under the aerobic than the flooded condition during the dry season.

In Kapangan, Benguet, the plants in flooded fields were taller, had a higher leaf area index at 75 days after seeding, and higher dry matter weight than in aerobic plots both during the wet and dry seasons. More panicles, higher dry matter weight, and higher grain yield were also noted in plants under flooded than aerobic plots during the wet season cropping. On the other hand, plants under aerobic plots had higher filled grain ratio and higher harvest index than in flooded fields during the dry season.

The water use efficiency between the two moisture regimes in the three sites during the two cropping seasons varied. In Lagangilang, Abra, varieties grown under aerobic condition had lower water use efficiency than in the flooded at 0.4 g/l (6%) and 0.62 g/l (43%) during the wet and dry season, respectively. In Luna, Apayao, water use efficiency in aerobic was 0.06 g/l (26%) lower but was also 0.06 g/l (43%) higher than the flooded during the WS and DS, respectively. In Kapangan, Benguet, water use efficiency was lower by 0.04 g/l (16%) and higher by 0.003 g/l (30%) in aerobic than in flooded fields.

Varieties

Among the rice varieties, highly significant differences were noted in all three sitesand during the wet and dry cropping seasonsin terms of plant height at maturity, panicle length, grain number per panicle, number of filled grains, 1000-grain weight, total dry matter weight, harvest index, and grain yield.

In Lagangilang, Abra during the wet season, NSIC Rc136H had highest grain yield, harvest index and water use efficiency. NSIC Rc192 was comparable with NSIC Rc136H in terms of grain yield and harvest index; both varieties had the highest LAI at 75 days after seeding and filled grain ratio; and matured earliest. On the other hand, PSB Rc14 attained the lowest grain yield, lowest leaf area index at 75 days after seeding, shortest panicle length, least filled and total number grains per panicle, and lowest water use efficiency.

For dry season in Lagangilang, Abra, NSIC Rc136H had the highest grain yield, matured earliest, and had the highest harvest index. NSIC Rc136H and NSIC Rc192were comparable as these varieties produced the highest grain yield, exhibited the highest LAI at 75 DAS, had the most grain number per panicle and highest harvest index. In contrast, PSB Rc14 again produced the lowest grain yield, shortest plants at maturity, lowest leaf area index at 75 days after seeding, shortest panicle with the least filled and total number of grains per panicle.

In Luna, Apayao during the wet season, NSIC Rc9 had attained the highest grain yield with tallest plants, most panicle at maturity, longest panicle, most filled and total number of grains per panicle, highest dry matterand water use efficiency. NSIC Rc192 was comparable with NSIC Rc9 in terms of grain yield. NSIC Rc192 matured the earliest, had the highest leaf area index, filled grain ratio, and harvest index. Further, NSIC Rc136H was comparable with NSIC Rc9 in terms of grain yield. Both varieties are early maturing, had long panicles and had high harvest index and high water use efficiency.

During the dry season, PSB Rc68 produced the highest grain yield; highest and longest panicles, the highest 1000-grain weight, dry matter weight, and water use efficiency. Conversely, PSB Rc14 had the lowest grain yield with the shortest plants at maturity, lowest LAI at 75 DAS, shortest panicle with the least filled grains per panicle, lowest 1000-grain weight, dry matter weight, harvest index and WUE.

In Kapangan, Benguet during the August 2010-February 2011, PSB Rc68 produced the highest grain yield, highest 1000-grain weight, dry matter weight, and harvest index. NSIC Rc9 was comparable with PSB Rc68 in terms of grain yield and harvest index. *Sapaw*was found comparable with PSB Rc68 on grain yield. *Sapaw*had the tallest plants and matured the latest; had the longest with more grains per panicle; produced the highest 1000-grain weight and had the highest harvest index. The lowest yielder for the same growing period was NSIC Rc192.It matured the earliest, had the shortest with the least grains per panicle, and lowest 1000-grain and dry matter weight.

For March-November 2011 cropping season, *Sapaw*produced the highest yield with the longest panicles having the highest grains per panicle; had highest 1000-grain weight, dry matter weight, harvest index and water use efficiency.

Moisture Regime and Variety Interaction

No significant interaction between the moisture regimes and the rice varieties on leaf area index, panicle number at maturity, panicle length, grain number per panicle, and harvest index in all three sites and in both the wet and dry seasons were noted.

In Lagangilang, Abra, plant height at maturity and filled grain ratio both during the dry season had significant interaction effect.

In Luna, Apayao, a significant interaction exist between the moisture regimes and the rice varieties on plant height and filled grain ratio during the wet season. Likewise, a significant interaction effect was observed on water use efficiency during the dry season.

InKapangan, Benguet, a significant interaction was registered between the moisture regimes and the rice varieties in terms of grain yield and number of filled grains per panicle for both cropping seasons; also on dry matter weight during the August 2010-February 2011 cropping season; and on filled grain ratio, 1000-grain weight, and water use efficiency during the March-November 2011 cropping period.

Correlation Between Growth and Yield Parameters

Under aerobic condition, a significant positive correlationon harvest index with grain yield was noted in Lagangilang, Abra. The panicle length, total and filled grain number per panicle with grain yield was likewise notedin Luna, Apayao. The plant height at maturity, number of days from seeding to maturity, panicle length, total and filled grain per panicle, and total dry matter weight were likewise observed to have a significant positive correlation with grain yield in Kapangan, Benguet under the same soil moisture regime. A significant negative correlation existed between total dry matter weight with grain yield in Lagangilang, Abra; and on the total tiller and panicle number at maturity with grain yield in Kapangan, Benguet.

Under flooded condition, a significantpositive correlation occurred between the total dry matter weight and harvest index with grain yield in

Kapangan, Benguet and a significant negative correlation between total tiller and panicle number at maturity with grain yield in Luna, Apayao.

Conclusions

Based on the results of the study, the following conclusions are drawn:

1. NSIC Rc192 and NSIC Rc 136H produces the highest grain yield and water use efficiency in Lagangilang, Abra.under aerobic and flooded conditions, respectively.
2. NSIC Rc9 and NSIC Rc136H have the highest grain yield and water use efficiencyin Luna, Apayaounder aerobic and flooded condition, respectively.
3. *Sapaw*has the highest grain yield and water use efficiency both under aerobic and flooded conditions in Kapangan, Benguet.
4. Water use efficiency is highest in Lagangilang, Abra; Luna, Apayao; and Kapangan, Benguet under aerobic condition with NSIC Rc192, NSIC Rc9, and *Sapaw*; in flooded fields: NSIC Rc136H and *Sapaw*, respectively.
5. *Sapaw*, PSB Rc68 and NSIC Rc9 have high grain yield under organic production in Kapangan, Benguet during the August-February cropping period.
6. Under aerobic condition, significant positive correlation on harvest index with grain yield exist in Lagangilang, Abra; panicle length, total and filled grain number per panicle with grain yield in Luna, Apayao; plant height at

maturity, number of days from seeding to maturity, panicle length, total and filled grain per panicle, and total dry matter weight with grain yield in Kapangan, Benguet.

7. Significant negative correlation exist between total dry matter weight with grain yield in Lagangilang, Abra; and on the total tiller and panicle number at maturity with grain yield in Kapangan, Benguet under aerobic condition.
8. Significant positive correlation happen between the total dry matter weight and harvest index with grain yield in Kapangan, Benguet and a significant negative correlation between total tiller and panicle number at maturity with grain yield in Luna, Apayao under flooded condition.

Recommendations

Considering the findings in the study, the following are recommended:

1. NSIC Rc192 and NSIC Rc9 can be grown under aerobic condition regardless of cropping season in Lagangilang, Abra and Luna, Apayao.
2. NSIC Rc136H can be grown under flooded condition both inLagangilang, Abra and Luna, Apayao.
3. *Sapaw*can alsobe grown under both aerobic and flooded conditions in Kapangan, Benguet.
4. *Sapaw,* PSB Rc68 and NSIC Rc9 can be grown organically in Kapangan, Benguet. Yield levels of these varieties can still be improved with the

application of soil amendments following the organic production approach.

5. Characters significantly correlated with yield can be used as selection indices for rice varieties grown under aerobic and flooded conditions.
6. Further studies for other rice varieties or lines on drought and in other locations in the region experiencing the same water limiting condition during the dry season.

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APPENDICES

APPENDIX TABLE 1. Analysis of variance for plant height at maturity (cm) (Abra, WS 2010)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	65.67	21.89	5.17^{ns}		
Moisture Regimes	1	75.63	75.63	17.87**	10.13	34.14
Error (a)	3	12.68	4.23			
Variety	4	6,932.35	1,733.09	56.25**	2.78	4.22
MR x V	4	82.25	20.56	0.67^{ns}	2.78	4.22
Error (b)	24	739.40	30.81			
TOTAL	39	7,907.97				

ns-not significant CV (a) = 1.76%
**-highly significant CV (b) = 4.76%

APPENDIX TABLE 2. Analysis of variance for plant height at maturity (cm) (Abra, DS 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	9.67	3.22	4.35^{ns}		
Moisture Regimes	1	2,050.62	2,050.62	2,771.11**	10.13	34.14
Error (a)	3	2.22	0.74			
Variety	4	4,155.20	1,038.80	97.90**	2.78	4.22
MR x V	4	135.37	33.84	3.19*	2.78	4.22
Error (b)	24	254.66	10.61			
TOTAL	39	6,607.74				

ns-not significant CV (a) = 1.11%
**-highly significant CV (b) = 4.20%
*- significant

APPENDIX TABLE 3. Analysis of variance for number of days from seeding to maximum tillering (Abra, WS 2010)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	4.08	1.36	8.58^{ns}		
Moisture Regimes	1	0.23	0.23	1.42^{ns}	10.13	34.14
Error (a)	3	0.48	0.16			
Variety	4	42.65	10.66	14.46**	2.78	4.22
MR x V	4	3.65	0.91	1.24^{ns}	2.78	4.22
Error (b)	24	17.70	0.74			
TOTAL	39	68.78				

ns- not significant CV (a) = 1.17%
**- highly significant CV (b) = 2.50%

APPENDIX TABLE 4. Analysis of variance for number of days from seeding to maximum tillering (Abra, DS 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	2.08	0.69	2.36^{ns}		
Moisture Regimes	1	93.03	93.03	318.57**	10.13	34.14
Error (a)	3	0.88	0.29			
Variety	4	15.85	3.96	4.46**	2.78	4.22
MR x V	4	26.85	6.71	7.56**	2.78	4.22
Error (b)	24	21.30	0.89			
TOTAL	39	159.98				

ns- not significant CV (a) = 2.30%
**- highly significant CV (b) = 1.33%

APPENDIX TABLE 5. Analysis of variance for number of days from maximum tillering to booting (Abra, WS 2010)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	5.08	1.69	5.79^{ns}		
Moisture Regimes	1	0.63	0.63	2.14^{ns}	10.13	34.14
Error (a)	3	0.88	0.29			
Variety	4	58.60	14.65	12.21**	2.78	4.22
MR x V	4	13.00	3.25	2.71^{ns}	2.78	4.22
Error (b)	24	28.80	1.20			
TOTAL	39	106.98				

ns- not significant CV (a) = 1.88%
**- highly significant CV (b) = 3.80%

APPENDIX TABLE 6. Analysis of variance for number of days from maximum tillering to booting (Abra, DS 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	0.50	0.17	0.84^{ns}		
Moisture Regimes	1	1.60	1.60	8.00^{ns}	10.13	34.14
Error (a)	3	0.60	0.20			
Variety	4	309.85	77.46	170.56**	2.78	4.22
MR x V	4	3.65	0.91	2.01^{ns}	2.78	4.22
Error (b)	24	10.90	0.45			
TOTAL	39	327.10				

ns- not significant CV (a) = 1.44%
**- highly significant CV (b) = 2.20%

APPENDIX TABLE 7. Analysis of variance for number of days from booting to heading (Abra, WS 2010)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	1.70	0.57	17.18*		
Moisture Regimes	1	0.10	0.10	3.03^{ns}	10.13	34.14
Error (a)	3	0.10	0.03			
Variety	4	112.35	28.09	100.61**	2.78	4.22
MR x V	4	0.15	0.04	0.14^{ns}	2.78	4.22
Error (b)	24	6.70	0.28			
TOTAL	39	121.10				

ns- not significant
**- highly significant
*- significant

CV (a) = 2.10%
CV (b) = 6.10%

APPENDIX TABLE 8. Analysis of variance for number of days from booting to heading (Abra, DS 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	1.48	0.49	1.37^{ns}		
Moisture Regimes	1	0.63	0.63	1.74^{ns}	10.13	34.14
Error (a)	3	1.08	0.36			
Variety	4	106.85	26.71	112.47**	2.78	4.22
MR x V	4	0.25	0.06	0.27^{ns}	2.78	4.22
Error (b)	24	5.70	0.24			
TOTAL	39	115.98				

ns- not significant
**- highly significant

CV (a) = 7.01%
CV (b) = 5.70%

APPENDIX TABLE 9. Analysis of variance for number of days from heading to maturity (Abra, WS 2010)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	2.60	0.87			
Moisture Regimes	1	0.40	0.40	1.20^{ns}	10.13	34.14
Error (a)	3	1.00	0.33	620.03**		
Variety	4	1,281.40	320.35	2.23^{ns}	2.78	4.22
MR x V	4	4.60	1.15		2.78	4.22
Error (b)	24	12.40	0.52			
TOTAL	39	1,302.40				

ns- not significant
**- highly significant

CV (a) = 1.82%
CV (b) = 2.27%

APPENDIX TABLE 10. Analysis of variance for number of days from heading to maturity (Abra, DS 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	8.50	2.83			
Moisture Regimes	1	0.90	0.90	0.39^{ns}	10.13	34.14
Error (a)	3	6.90	2.30	126.00**		
Variety	4	1,629.65	407.41	8.22**	2.78	4.22
MR x V	4	106.35	26.59		2.78	4.22
Error (b)	24	77.60	3.23			
TOTAL	39	1,829.90				

ns- not significant CV (a) = 5.71%
**- highly significant CV (b) = 6.77%

APPENDIX TABLE 11. Analysis of variance for leaf area index at 75 DAS (Abra, WS 2010)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	0.0203	0.0068	0.29^{ns}		
Moisture Regimes	1	0.0006	0.0006	0.03^{ns}	10.13	34.14
Error (a)	3	0.0706	0.0236			
Variety	4	0.3034	0.0758	4.15*	2.78	4.22
MR x V	4	0.0163	0.0041	0.22^{ns}	2.78	4.22
Error (b)	24	0.4390	0.0183			
TOTAL	39	0.8503				

ns- not significant CV (a) = 6.02%
*- significant CV (b) = 5.30%

Appendix Table 12. Analysis of variance for leaf area index at 75 DAS (Abra, DS 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	0.1018	0.0339	0.85^{ns}		
Moisture Regimes	1	1.1170	1.1170	27.92*	10.13	34.14
Error (a)	3	0.1199	0.0400	2.92*		
Variety	4	0.3319	0.0830	2.36^{ns}	2.78	4.22
MR x V	4	0.2681	0.0670		2.78	4.22
Error (b)	24	0.6812	0.0284			
TOTAL	39	2.6198				

ns- not significant CV (a) = 5.85%
*- significant CV (b) = 4.93%

APPENDIX TABLE 13. Analysis of variance for panicle number at maturity (Abra, WS 2010)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	81.0	27.0	0.26ns		
Moisture Regimes	1	4,536.9	4,536.9	43.83**	10.13	34.14
Error (a)	3	310.5	103.5			
Variety	4	9,807.0	2,451.8	13.04**	2.78	4.22
MR x V	4	561.6	140.4	1.38^{ns}	2.78	4.22
Error (b)	24	4,513.0	188.0			
TOTAL	39	19,810.0				

ns- not significant CV (a) = 3.58%
**- highly significant CV (b) = 3.46%

APPENDIX TABLE 14. Analysis of variance for panicle number at maturity (Abra, DS 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	306.9	102.3	0.40^{ns}		
Moisture Regimes	1	1,550.0	1,550.0	6.06^{ns}	10.13	34.14
Error (a)	3	767.7	255.9			
Variety	4	10,508.6	2,627.2	13.14**	2.78	4.22
MR x V	4	433.1	108.3	1.62^{ns}	2.78	4.22
Error (b)	24	4,796.7	199.9			
TOTAL	39	18,363.0				

ns- not significant CV (a) = 4.92%
**- highly significant CV (b) = 3.09%

APPENDIX TABLE 15. Analysis of variance for panicle length (cm) (Abra, WS 2010)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	0.90	0.30	0.24		
Moisture Regimes	1	0.24	0.24	0.19^{ns}	10.13	34.14
Error (a)	3	3.72	1.24			
Variety	4	60.51	15.13	26.03**	2.78	4.22
MR x V	4	5.57	1.39	2.40^{ns}	2.78	4.22
Error (b)	24	13.95	0.58			
TOTAL	39	84.88				

ns- not significant CV (a) = 4.50%
**- highly significant CV (b) = 3.08%

APPENDIX TABLE 16. Analysis of variance for panicle length (cm) (Abra, DS 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	0.97	0.32	0.21		
Moisture Regimes	1	43.83	43.83	28.33*	10.13	34.14
Error (a)	3	4.64	1.55			
Variety	4	53.96	13.49	25.85**	2.78	4.22
MR x V	4	3.95	0.99	1.89^{ns}	2.78	4.22
Error (b)	24	12.52	0.52			
TOTAL	39	119.88				

ns- not significant
**- highly significant
*- significant

CV (a) = 6.00%
CV (b) = 3.49%

APPENDIX TABLE 17. Analysis of variance for total grain number per panicle (Abra, WS 2010)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	590.48	196.83	1.13		
Moisture Regimes	1	540.23	540.23	3.10^{ns}	10.13	34.14
Error (a)	3	523.28	174.43			
Variety	4	32,366.65	8,091.66	54.91**	2.78	4.22
MR x V	4	1,031.65	257.91	1.75^{ns}	2.78	4.22
Error (b)	24	3,536.50	147.35			
TOTAL	39	38,588.78				

ns- not significant
**- highly significant

CV (a) = 9.11%
CV (b) = 8.35%

APPENDIX TABLE 18. Analysis of variance for total grain number per panicle (Abra, DS 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	145.63	48.54	1.07		
Moisture Regimes	1	567.01	567.01	12.47*	10.13	34.14
Error (a)	3	136.45	45.48			
Variety	4	8,550.83	2,137.71	21.33**	2.78	4.22
MR x V	4	237.14	59.28	1.47^{ns}	2.78	4.22
Error (b)	24	2,405.02	100.21			
TOTAL	39	12,042.06				

ns- not significant
**- highly significant
*- significant

CV (a) = 0.00%
CV (b) = 3.65%

APPENDIX TABLE 19. Analysis of variance for number of filled grains per panicle (Abra, WS 2010)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	558.67	186.22	1.04		
Moisture Regimes	1	525.63	525.63	2.94^{ns}	10.13	34.14
Error (a)	3	535.48	178.49			
Variety	4	32,041.15	8,010.29	53.58**	2.78	4.22
MR x V	4	990.75	247.68	1.66^{ns}	2.78	4.22
Error (b)	24	3,588.10	149.50			
TOTAL	39	38,239.78				

ns- not significant CV (a) = 9.18%
**- highly significant CV (b) = 8.42

APPENDIX TABLE 20. Analysis of variance for number of filled grains per panicle (Abra, DS 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	76.69	25.56	1.17		
Moisture Regimes	1	4,698.06	4,698.05	214.83**	10.13	34.14
Error (a)	3	65.61	21.87			
Variety	4	8,550.95	2,137.74	21.22**	2.78	4.22
MR x V	4	655.92	163.98	1.63^{ns}	2.78	4.22
Error (b)	24	2,417.49	100.73			
TOTAL	39	16,464.72				

ns- not significant CV (a) = 4.62%
**- highly significant CV (b) = 3.09%

APPENDIX TABLE 21. Analysis of variance for filled grain ratio (Abra, WS 2010)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	7.88	2.63	0.22		
Moisture Regimes	1	99.23	99.23	8.34^{ns}	10.13	34.14
Error (a)	3	35.68	11.89			
Variety	4	1,492.15	373.04	27.53**	2.78	4.22
MR x V	4	80.65	20.16	1.49^{ns}	2.78	4.22
Error (b)	24	325.20	13.55			
TOTAL	39	2,040.78				

ns- not significant CV (a) = 4.36%
**- highly significant CV (b) = 4.66%

APPENDIX TABLE 22. Analysis of variance for filled grain ratio (Abra,DS 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	19.05	6.35	0.26^{ns}		
Moisture Regimes	1	8.49	8.49	0.35^{ns}	10.13	34.14
Error (a)	3	73.53	24.51			
Variety	4	231.40	57.85	3.53*	2.78	4.22
MR x V	4	200.39	50.10	3.06*	2.78	4.22
Error (b)	24	393.45	16.39			
TOTAL	39	926.31				

ns- not significant CV (a) = 6.44%
*- significant CV (b) = 5.27%

APPENDIX TABLE 23. Analysis of variance for weight of 1000 filled grains (Abra, WS 2010)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	0.34	0.11	0.93^{ns}		
Moisture Regimes	1	0.55	0.55	4.57^{ns}	10.13	34.14
Error (a)	3	0.36	0.12			
Variety	4	210.64	52.66	48.68**	2.78	4.22
MR x V	4	5.24	1.31	1.21^{ns}	2.78	4.22
Error (b)	24	25.96	1.08			
TOTAL	39	243.09				

ns- not significant CV (a) = 1.30%
**- highly significant CV (b) = 3.89%

APPENDIX TABLE 24. Analysis of variance for weight of 1000 filled grains (Abra, DS 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	0.55	0.18	0.09^{ns}		
Moisture Regimes	1	20.15	20.15	9.81^{ns}	10.13	34.14
Error (a)	3	6.16	2.05			
Variety	4	220.43	55.11	93.66**	2.78	4.22
MR x V	4	3.72	0.93	1.58^{ns}	2.78	4.22
Error (b)	24	14.12	0.59			
TOTAL	39	265.13				

ns- not significant CV (a) = 6.07%
**- highly significant CV (b) = 3.25%

APPENDIX TABLE 25. Analysis of variance for total dry matter weight (Abra, WS 2010)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	8,535.92	2,845.31	0.86^{ns}		
Moisture Regimes	1	1.05	1.05	0.0003^{ns}	10.13	34.14
Error (a)	3	9,884.46	3,294.82			
Variety	4	179,913.16	44,978.29	24.04**	2.78	4.22
MR x V	4	3,086.50	771.63	0.41^{ns}	2.78	4.22
Error (b)	24	44,897.88	1,870.75			
TOTAL	39	246,318.97				

ns- not significant CV (a) = 0.13%
**- highly significant CV (b) = 2.83%

APPENDIX TABLE 26. Analysis of variance for total dry matter weight (Abra, DS 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	1,537.37	512.46	1.22^{ns}		
Moisture Regimes	1	50,872.56	50,872.56	121.47**	10.13	34.14
Error (a)	3	1,256.42	418.806			
Variety	4	13,049.81	3,262.45	6.90**	2.78	4.22
MR x V	4	3,962.79	990.70	2.09^{ns}	2.78	4.22
Error (b)	24	11,352.40	473.02			
TOTAL	39	82,031.34				

ns- not significant CV (a) = 1.88%
**- highly significant CV (b) = 4.01%

APPENDIX TABLE 27. Analysis of variance for Analysis of variance for harvest index (Abra, WS 2010)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	79.93	26.65	2.51^{ns}		
Moisture Regimes	1	12.10	12.10	1.14^{ns}	10.13	34.14
Error (a)	3	31.84	10.61			
Variety	4	831.48	207.87	15.17**	2.78	4.22
MR x V	4	20.09	5.02	0.37^{ns}	2.78	4.22
Error (b)	24	328.81	13.70			
TOTAL	39	1,304.26				

ns- not significant CV (a) = 6.38%
**- highly significant CV (b) = 7.25%

APPENDIX TABLE 28. Analysis of variance for harvest index (Abra, DS 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	41.38	13.80	4.25^{ns}		
Moisture Regimes	1	703.08	703.08	216.79**	10.13	34.14
Error (a)	3	9.73	3.24			
Variety	4	2,896.81	724.20	100.15**	2.78	4.22
MR x V	4	33.12	8.28	1.15^{ns}	2.78	4.22
Error (b)	24	173.54	7.23			
TOTAL	39	3,857.67				

ns- not significant CV (a) = 3.99%
**- highly significant CV (b) = 5.95%

APPENDIX TABLE 29. Analysis of variance for grain yield (kg) (Abra, WS 2010)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	144,436.35	48,145.45	1.48^{ns}		
Moisture Regimes	1	565,535.95	565,535.95	17.44*	10.13	34.14
Error (a)	3	97,287.15	32,429.05			
Variety	4	6,568,775.27	1,642,193.82	3.93*	2.78	4.22
MR x V	4	1,236,642.52	309,160.63	0.74^{ns}	2.78	4.22
Error (b)	24	10,028,191.45	417,841.31			
TOTAL	39	18,640,868.68				

ns- not significant CV (a) = 0.89%
*- significant CV (b) = 2.13%

APPENDIX TABLE 30. Analysis of variance for grain yield (kg) (Abra, DS 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	129,453.77	43,151.26	0.99^{ns}		
Moisture Regimes	1	25,392,726.92	25,392,726.92	584.84**	10.13	34.14
Error (a)	3	130,254.35	43,418.12			
Variety	4	3,407,562.00	851,890.70	7.77**	2.78	4.22
MR x V	4	181,731.37	45,432.84	0.41^{ns}	2.78	4.22
Error (b)	24	2,630,630.97	109,609.62			
TOTAL	39	31,872,360.16				

ns- not significant CV (a) = 7.86%
**- highly significant CV (b) = 12.48%

APPENDIX TABLE 31. Analysis of variance for computed yield (t ha^{-1}) (Abra, WS 2010)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	0.51	0.17	1.71		
Moisture Regimes	1	1.71	1.71	17.25**	10.13	34.14
Error (a)	3	0.30	0.10			
Variety	4	19.68	4.92	3.92*	2.78	4.22
MR x V	4	3.84	0.96	0.76	2.78	4.22
Error (b)	24	30.14	1.26			
TOTAL	39	56.17				

ns- not significant CV (a) = 2.88%
**- highly significant CV (b) = 8.58%
*- significant

APPENDIX TABLE 32. Analysis of variance for computed yield (t ha^{-1}) (Abra, DS 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	0.39	0.13	0.99		
Moisture Regimes	1	76.81	76.81	584.70**	10.13	34.14
Error (a)	3	0.39	0.13			
Variety	4	10.33	2.58	7.77**	2.78	4.22
MR x V	4	0.55	0.14	0.41^{ns}	2.78	4.22
Error (b)	24	7.98	0.33			
TOTAL	39	96.45				

ns- not significant CV (a) = 8.36%
**- highly significant CV (b) =
12.50%

APPENDIX TABLE 33. Analysis of variance for water use efficiency (Abra, WS 2010)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	0.0047	0.0016	1.6^{ns}		
Moisture Regimes	1	0.0164	0.0164	16.4*	10.13	34.14
Error (a)	3	0.0029	0.0010			
Variety	4	0.2240	0.0560	3.79*	2.78	4.22
MR x V	4	0.0426	0.0106	0.72^{ns}	2.78	4.22
Error (b)	24	0.3549	0.0148			
TOTAL	39	0.6453				

ns- significant CV (a) = 0.00%
*- significant CV (b) =
2.40%

APPENDIX TABLE 34. Analysis of variance for water use efficiency (Abra, DS 2011)

SOURCE	DEGREES OF	SUM	MEAN	COMPUTED	TABULATED

OF VARIATION	FREEDOM	OF SQUARES	OF SQUARES	F	F 0.05	0.01
Replication	3	0.0252	0.0084	1.06^{ns}		
Moisture Regimes	1	3.8751	3.8751	490.52**	10.13	34.14
Error (a)	3	0.0238	0.0079			
Variety	4	0.6204	0.1551	7.47**	2.78	4.22
MR x V	4	0.0279	0.0070	0.34^{ns}	2.78	4.22
Error (b)	24	0.4986	0.0208			
TOTAL	39	5.0709				

ns- not significant CV (a) = 0.08%
**- highly significant CV (b) = 12.80%

APPENDIX TABLE 35. Analysis of variance for plant height at maturity (cm) (Apayao, WS 2010)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	45.1	15.0	0.84^{ns}		
Moisture Regimes	1	2,544.0	2,544.0	142.92**	10.13	34.14
Error (a)	3	53.5	17.8			
Variety	4	9,361.6	2,340.4	106.04**	2.78	4.22
MR x V	4	265.1	66.3	3.00*	2.78	4.22
Error (b)	24	529.7	22.1			
TOTAL	39	12,799.0				

ns-not significant CV (a) = 3.69%
**-highly significant CV (b) = 4.11%
*- significant

APPENDIX TABLE 36. Analysis of variance for plant height at maturity (cm) (Apayao, DS 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	91.101	30.367	0.609		
Moisture Regimes	1	242.064	242.064	4.856^{ns}	10.13	34.14
Error (a)	3	149.550	49.850			
Variety	4	10,415.903	2,603.976	179.556**	2.78	4.22
MR x V	4	42.489	10.622	0.733^{ns}	2.78	4.22
Error (b)	24	348.055	14.502			
TOTAL	39	11,289.163				

ns-not significant CV (a)= 7.25%
**-highly significant CV (b) = 3.91%

APPENDIX TABLE 37. Analysis of variance for number of days from seeding to maximum tillering (Apayao, WS 2010)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01

Replication	3	1.48	0.49	19.68*		
Moisture Regimes	1	42.03	42.03	1,681.00**	10.13	34.14
Error (a)	3	0.08	0.03			
Variety	4	375.00	93.75	43.95**	2.78	4.22
MR x V	4	34.60	8.65	4.05*	2.78	4.22
Error (b)	24	51.20	2.13			
TOTAL	39	504.38				

*- significant CV (a) = 0.44%
**- highly significant CV (b) = 4.00%

APPENDIX TABLE 38. Analysis of variance for Number of days from seeding to maximum tillering (Apayao, DS 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	16.10	5.37	1.28^{ns}		
Moisture Regimes	1	1.60	1.60	0.38^{ns}	10.13	34.14
Error (a)	3	12.60	4.20			
Variety	4	1,069.15	267.29	74.77**	2.78	4.22
MR x V	4	28.65	7.16	2.00^{ns}	2.78	4.22
Error (b)	24	85.80	3.57			
TOTAL	39	1,213.90				

ns- not significant CV (a) = 4.87%
**- highly significant CV (b) = 4.50%

APPENDIX TABLE 39. Analysis of variance for number of days from maximum tillering to booting (Apayao, WS 2010)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	7.28	2.43	0.97^{ns}		
Moisture Regimes	1	105.63	105.63	42.39**	10.13	34.14
Error (a)	3	7.48	2.49			
Variety	4	220.00	55.00	41.90**	2.78	4.22
MR x V	4	74.50	18.63	14.19**	2.78	4.22
Error (b)	24	31.50	1.31			
TOTAL	39	446.38				

ns- not significant CV (a) = 5.07%
**- highly significant CV (b) = 3.70%

APPENDIX TABLE 40. Analysis of variance for number of days from maximum tillering to booting (Apayao, DS 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	37.48	12.49	5.01^{ns}		
Moisture Regimes	1	9.03	9.03	3.62^{ns}	10.13	34.14

Error (a)	3	7.48	2.49			
Variety	4	451.85	112.96	32.35**	2.78	4.22
MR x V	4	46.35	11.59	3.32*	2.78	4.22
Error (b)	24	83.80	3.49			
TOTAL	39	635.98				

ns- not significant CV (a) = 4.50%
**- highly significant CV (b) = 5.30%
*- significant

APPENDIX TABLE 41. Analysis of variance for number of days from booting to heading (Apayao, WS 2010)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	0.88	0.29	1.30^{ns}		
Moisture Regimes	1	2.03	2.03	9.00^{ns}	10.13	34.14
Error (a)	3	0.68	0.23			
Variety	4	60.25	15.06	50.21**	2.78	4.22
MR x V	4	1.35	0.34	1.12^{ns}	2.78	4.22
Error (b)	24	7.20	0.30			
TOTAL	39	72.38				

ns- not significant CV (a) = 6.65%
**- highly significant CV (b) = 7.70%

APPENDIX TABLE 42.Analysis of variance for number of days from booting to heading (Apayao, DS 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	1.08	0.36	0.84^{ns}		
Moisture Regimes	1	0.03	0.03	0.06^{ns}	10.13	34.14
Error (a)	3	1.28	0.43			
Variety	4	79.15	19.79	96.92**	2.78	4.22
MR x V	4	0.35	0.09	0.43^{ns}	2.78	4.22
Error (b)	24	4.90	0.20			
TOTAL	39	86.78				

ns- not significant CV (a) = 6.31%
**- highly significant CV (b) = 4.40%

APPENDIX TABLE 43. Analysis of variance for number of days from heading to maturity (Apayao, WS 2010)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	6.28	2.09			
Moisture Regimes	1	87.03	87.03	42.97**	10.13	34.14
Error (a)	3	6.08	2.03			
Variety	4	51.40	12.85	9.52**	2.78	4.22
MR x V	4	18.60	4.65	3.44*	2.78	4.22

Error (b)	24	32.40	1.35			
TOTAL	39	201.78				

**- highly significant CV (a) = 6.04%
*- significant CV (b) = 4.93%

APPENDIX TABLE 44. Analysis of variance for number of days from heading to maturity (Apayao, DS 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	16.10	5.37			
Moisture Regimes	1	0.00	0.00	0.00^{ns}	10.13	34.14
Error (a)	3	27.00	9.00			
Variety	4	336.75	84.19	21.40**	2.78	4.22
MR x V	4	59.25	14.81	3.77*	2.78	4.22
Error (b)	24	94.40	3.93			
TOTAL	39	533.50				

ns- not significant CV (a) = 9.30%
**- highly significant CV (b) = 6.15%
*- significant

APPENDIX TABLE 45.Analysis of variance for leaf area index at 75 DAS (Apayao, WS 2010)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	0.1673	0.0558	0.42^{ns}		
Moisture Regimes	1	0.6840	0.6840	5.17^{ns}	10.13	34.14
Error (a)	3	0.3986	0.1323			
Variety	4	1.1992	0.2998	7.00**	2.78	4.22
MR x V	4	0.1163	0.0291	0.68^{ns}	2.78	4.22
Error (b)	24	1.0277	0.0428			
TOTAL	39	3.5912				

ns- not significant CV (a) = 9.07%
**- highly significant CV (b) = 5.16%

APPENDIX TABLE 46. Analysis of variance for leaf area index at 75 DAS (Apayao, DS 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	18.776	6.259	3.08^{ns}		
Moisture Regimes	1	17.490	17.490	8.59^{ns}	10.13	34.14
Error (a)	3	6.104	2.035			
Variety	4	123.100	30.775	4.48**	2.78	4.22
MR x V	4	3.005	0.751	0.11^{ns}	2.78	4.22
Error (b)	24	165.032	6.876			
TOTAL	39	333.507				

ns- not significant CV (a)=5.42%

**- highly significant CV (b) = 10.68%

APPENDIX TABLE 47. Analysis of variance for panicle number at maturity (Apayao, WS 2010)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	TABULATED F 0.01
Replication	3	597.6	199.2	2.03^{ns}		
Moisture Regimes	1	122.5	122.5	1.25^{ns}	10.13	34.14
Error (a)	3	293.9	98.0			
Variety	4	23,871.9	5,968.0	43.08**	2.78	4.22
MR x V	4	830.8	207.7	1.50^{ns}	2.78	4.22
Error (b)	24	3,325.0	138.5			
TOTAL	39	29,041.6				

ns-not significant CV (a)= 8.50%
**-highly significant CV (b) = 10.11%

APPENDIX TABLE 48. Analysis of variance for panicle number at maturity (Apayao, DS 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	TABULATED F 0.01
Replication	3	509.1	169.7	0.71^{ns}		
Moisture Regimes	1	62.5	62.5	0.26^{ns}	10.13	34.14
Error (a)	3	719.5	239.8			
Variety	4	12,232.4	3058.1	14.83**	2.78	4.22
MR x V	4	437.8	109.4	0.92^{ns}	2.78	4.22
Error (b)	24	4,949.9	206.2			
TOTAL	39	18,911.1				

ns-not significant CV (a)= 3.94%
**-highly significant CV (b) = 3.50%

APPENDIX TABLE 49. Analysis of variance for panicle length (cm) (Apayao, WS 2010)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	TABULATED F 0.01
Replication	3	2.39	0.80	1.75		
Moisture Regimes	1	6.40	6.40	14.10*	10.13	34.14
Error (a)	3	1.36	0.45			
Variety	4	83.41	20.85	26.27**	2.78	4.22
MR x V	4	3.73	0.93	1.17^{ns}	2.78	4.22
Error (b)	24	19.05	0.79			
TOTAL	39	116.34				

ns-not significant CV (a) = 2.93%
**-highly significant CV (b) = 3.88%
*- significant

APPENDIX TABLE 50. Analysis of variance for panicle length (cm) (Apayao, DS 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	0.23	0.08	0.12		
Moisture Regimes	1	5.94	5.94	9.07^{ns}	10.13	34.14
Error (a)	3	1.97	0.66			
Variety	4	52.68	13.17	41.82**	2.78	4.22
MR x V	4	2.62	0.65	2.08^{ns}	2.78	4.22
Error (b)	24	7.56	0.32			
TOTAL	39	70.99				

ns-not significant CV (a) = 0.81%
**-highly significant CV (b) =
2.66%

APPENDIX TABLE 51. Analysis of variance for total number of grains per panicle (Apayao, WS 2010)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	622.10	207.37	2.16		
Moisture Regimes	1	115.60	115.60	1.20^{ns}	10.13	34.14
Error (a)	3	288.20	96.07			
Variety	4	24,119.65	6,029.91	43.12**	2.78	4.22
MR x V	4	808.15	202.04	1.44^{ns}	2.78	4.22
Error (b)	24	3,356.20	139.84			
TOTAL	39	29,309.90				

ns- not significant CV (a)= 8.42%
**- highly significant CV (b) =
10.15%

APPENDIX TABLE 52. Analysis of variance for total number of grains per panicle (Apayao, DS 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	753.28	251.09	1.00		
Moisture Regimes	1	2,907.03	2,907.03	11.57*	10.13	34.14
Error (a)	3	753.68	251.23			
Variety	4	19,084.25	4,771.06	15.31**	2.78	4.22
MR x V	4	2,495.35	623.84	2.00^{ns}	2.78	4.22
Error (b)	24	7,476.80	311.53			
TOTAL	39	33,470.38				

ns- not significant CV (a) = 11.82%
**- highly significant CV (b) =
13.16%
*- significant

APPENDIX TABLE 53. Analysis of variance for number of filled grains per panicle (Apayao, WS 2010)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	597.60	199.20	2.03		
Moisture Regimes	1	122.50	122.50	1.25^{ns}	10.13	34.14
Error (a)	3	293.90	97.97			
Variety	4	23,871.85	5,967.96	43.08**	2.78	4.22
MR x V	4	830.75	207.69	0.97^{ns}	2.78	4.22
Error (b)	24	3,325.00	138.54			
TOTAL	39	29,041.60				

ns-not significant CV (a)= 2.29%
**-highly significant CV (b) = 2.86%

APPENDIX TABLE 54. Analysis of variance for number of filled grains per panicle (Apayao, DS 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	394.72	131.57	0.88		
Moisture Regimes	1	1,515.36	1,515.36	10.19*	10.13	34.14
Error (a)	3	446.24	148.75			
Variety	4	18,597.15	4,649.29	22.08**	2.78	4.22
MR x V	4	1,487.02	371.76	1.77^{ns}	2.78	4.22
Error (b)	24	5,054.06	210.59			
TOTAL	39	27,494.54				

ns-not significant CV (a) = 2.81%
**-highly significant CV (b) = 5.24%
*- significant

APPENDIX TABLE 55. Analysis of variance for filled grain ratio (Apayao, WS 2010)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	62.60	20.87	1.92^{ns}		
Moisture Regimes	1	211.60	211.60	19.47*	10.13	34.14
Error (a)	3	32.60	10.87			
Variety	4	1,730.25	432.56	22.60**	2.78	4.22
MR x V	4	287.65	71.91	3.76*	2.78	4.22
Error (b)	24	459.30	19.14			
TOTAL	39	2,784.00				

ns- not significant CV (a)= 4.84%
**-highly significant CV (b) = 6.43%
*- significant

APPENDIX TABLE 56. Analysis of variance for filled grain ratio (Apayao, DS 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	35.59	11.86	0.51^{ns}		

Moisture Regimes	1	35.08	35.08	1.51^{ns}	10.13	34.14
Error (a)	3	69.74	23.25			
Variety	4	2,411.27	602.82	12.60**	2.78	4.22
MR x V	4	180.20	45.05	0.94^{ns}	2.78	4.22
Error (b)	24	1,147.97	47.83			
TOTAL	39	3,879.85				

ns-not significant CV (a)= 8.86%
**-highly significant CV (b) = 9.84%

APPENDIX TABLE 57. Analysis of variance for weight of 1000 filled grains (Apayao, WS 2010)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	0.56	0.19	1.78		
Moisture Regimes	1	0.44	0.44	4.23^{ns}	10.13	34.14
Error (a)	3	0.31	0.10			
Variety	4	217.82	54.46	121.40**	2.78	4.22
MR x V	4	2.22	0.55	1.24^{ns}	2.78	4.22
Error (b)	24	10.77	0.45			
TOTAL	39	232.11				

ns-not significant CV (a)= 1.24%
**-highly significant CV (b) = 2.57%

APPENDIX TABLE 58. Analysis of variance for weight of 1000 filled grains (Apayao, DS 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	3.27	1.09	0.25		
Moisture Regimes	1	0.04	0.04	0.01^{ns}	10.13	34.14
Error (a)	3	13.09	4.36			
Variety	4	209.64	52.41	15.71**	2.78	4.22
MR x V	4	21.52	5.38	1.61^{ns}	2.78	4.22
Error (b)	24	80.05	3.34			
TOTAL	39	327.61				

ns-not significant CV (a)= 8.47%
**-highly significant CV (b) = 7.40%

APPENDIX TABLE 59. Analysis of variance for total dry matter weight (Apayao, WS 2010)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	3,788.03	1,262.68	3.83^{ns}		
Moisture Regimes	1	37,088.10	37,088.10	112.61**	10.13	34.14
Error (a)	3	988.05	329.35			
Variety	4	34,660.71	8,665.18	5.81**	2.78	4.22

MR x V	4	277.71	69.43	0.05^{ns}	2.78	4.22
Error (b)	24	35,796.68	1,491.53			
TOTAL	39	112,599.28				

ns- not significant CV (a) = 6.07%
**- highly significant CV (b) =
12.92%

APPENDIX TABLE 60. Analysis of variance fortTotal dry matter weight (Apayao, DS 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	2,271.03	757.01	0.20^{ns}		
Moisture Regimes	1	93.03	93.03	0.02^{ns}	10.13	34.14
Error (a)	3	11,342.53	3,780.84			
Variety	4	57,711.09	14,427.77	8.77**	2.78	4.22
MR x V	4	2,142.66	535,67	0.33^{ns}	2.78	4.22
Error (b)	24	39,465.95	1,644.42			
TOTAL	39	113,026.28				

ns- not significant CV (a) = 0.00%
**- highly significant CV (a) =
2.19%

APPENDIX TABLE 61. Analysis of variance for harvest index (Apayao, WS 2010)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	28.23	9.41	0.67^{ns}		
Moisture Regimes	1	80.94	80.94	5.72^{ns}	10.13	34.14
Error (a)	3	42.45	14.15			
Variety	4	1,821.29	455.32	62.63**	2.78	4.22
MR x V	4	38.85	9.71	1.34^{ns}	2.78	4.22
Error (b)	24	174.48	7.27			
TOTAL	39	2,186.24				

ns- not significant CV (a) = 10.21%
**- highly significant CV (b) =
7.32%

APPENDIX TABLE 62. Analysis of variance for harvest index (Apayao, DS 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	75.97	25.32	4.60^{ns}		
Moisture Regimes	1	205.03	205.03	37.22**	10.13	34.14
Error (a)	3	16.52	5.51			
Variety	4	983.64	245.91	16.94**	2.78	4.22
MR x V	4	97.92	24.48	1.69^{ns}	2.78	4.22

Error (b)	24	348.37	14.52			
TOTAL	39	1,727.45				

ns- not significant CV (a) = 5.36%
**- highly significant CV (b) = 8.72%

APPENDIX TABLE 63. Analysis of variance for grain yield (kg) (Apayao, WS 2010)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	97,210.98	32,403.66	0.28^{ns}		
Moisture Regimes	1	7,954,945.11	7,954,945.11	63.14**	10.13	34.14
Error (a)	3	345,191.38	115,063.79			
Variety	4	10,123,705.98	2,530,926.50	5.48**	2.78	4.22
MR x V	4	1,082,525.17	270,631.29	0.58^{ns}	2.78	4.22
Error (b)	24	11,092,130.98	462,172.12			
TOTAL	39	30,695,709.59				

ns-not significant CV (a) = 4.44%
**-highly significant CV (b) = 9.27%

APPENDIX TABLE 64. Analysis of variance for grain yield (kg) (Apayao, DS 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	887,726.37	295,908.79	5.98		
Moisture Regimes	1	280,361.58	280,361.58	5.67^{ns}	10.13	34.14
Error (a)	3	148,401.90	49,467.30			
Variety	4	37,985,861.88	9,496,465.47	37.77**	2.78	4.22
MR x V	4	495,737.58	123,934.40	0.94^{ns}	2.78	4.22
Error (b)	24	6,033,703.83	251,404.33			
TOTAL	39	45,831,793.14				

ns- not significant CV (a)= 6.38%
**- highly significant CV (b) = 12.96%

APPENDIX TABLE 65. Analysis of variance for computed yield (t ha^{-1}) (Apayao, WS 2010)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	0.31	0.10	0.29		
Moisture Regimes	1	24.03	24.03	66.92**	10.13	34.14
Error (a)	3	1.08	0.36			
Variety	4	30.15	7.54	5.30**	2.78	4.22
MR x V	4	3.36	0.84	0.59^{ns}	2.78	4.22
Error (b)	24	34.15	1.42			
TOTAL	39	93.08				

ns- not significant CV (a)= 14.36%

**- highly significant CV (b) = 13.90%

APPENDIX TABLE 66. Analysis of variance for computed yield (tha^{-1}) (Apayao, DS 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	TABULATED F 0.01
Replication	3	3.78	1.26	25.07		
Moisture Regimes	1	1.80	1.80	35.83**	10.13	34.14
Error (a)	3	0.15	0.05			
Variety	4	103.56	25.89	48.09**	2.78	4.22
MR x V	4	1.81	0.45	0.84^{ns}	2.78	4.22
Error (b)	24	12.92	0.54			
TOTAL	39	124.02				

ns- not significant CV (a)= 0.00%
**- highly significant CV (b) = 4.26%

APPENDIX TABLE 67. Analysis of variance for water use efficiency (Apayao, WS 2010)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	TABULATED F 0.01
Replication	3	0.00065	0.00022	0.32^{ns}		
Moisture Regimes	1	0.03080	0.03080	44.63**	10.13	34.14
Error (a)	3	0.00207	0.00069			
Variety	4	0.06652	0.01663	6.14**	2.78	4.22
MR x V	4	0.00669	0.00167	0.62^{ns}	2.78	4.22
Error (b)	24	0.06496	0.00271			
TOTAL	39	0.17168				

ns-not significant CV (a) = 3.19%
**-highly significant CV (b) = 3.24%

APPENDIX TABLE 68. Analysis of variance for water use efficiency (Apayao, DS 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	TABULATED F 0.01
Replication	3	0.0047	0.0016	53.33**		
Moisture Regimes	1	0.0325	0.0325	1,083.33**	10.13	34.14
Error (a)	3	0.0001	0.00003			
Variety	4	0.1441	0.360	42.75**	2.78	4.22
MR x V	4	0.0096	0.0024	2.84*	2.78	4.22
Error (b)	24	0.0202	0.0008			
TOTAL	39	0.2112				

*- significant CV (a)= 0.00%
**-highly significant CV (b) = 4.20%

APPENDIX TABLE 69. Analysis of variance for plant height (cm) at maturity (Benguet, Aug 2010-Feb 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	97.64	32.55			
Moisture Regimes	1	825.37	825.37	27.02**	10.13	34.14
Error (a)	3	91.64	30.55			
Variety	4	11,266.14	2,816.54	31.50**	2.78	4.22
MR x V	4	588.43	147.11	1.65^{ns}	2.78	4.22
Error (b)	24	2,146.26	89.43			
TOTAL	39	15,015.48				

ns- not significant CV (a) = 7.08%
**-highly significant CV (b) = 12.12%

APPENDIX TABLE 70. Analysis of variance for plant height (cm) at maturity (Benguet, DS 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	83.31	27.77	0.83^{ns}		
Moisture Regimes	1	2,946.20	2,946.20	88.39**	10.13	34.14
Error (a)	3	100.00	33.33			
Variety	4	39,537.33	9,884.33	1,943.70**	2.78	4.22
MR x V	4	364.95	91.24	17.94*	2.78	4.22
Error (b)	24	122.05	5.09			
TOTAL	39	43,153.83				

ns- not significant CV (a) = 6.14%
**-highly significant CV (b) = 2.40%
*- significant

APPENDIX TABLE 71. Analysis of variance for number of days from seeding to tillering (Benguet, Aug 2010-Feb 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	9.09	3.03	0.00^{ns}		
Moisture Regimes	1	0.00	0.00	0.00^{ns}	10.13	34.14
Error (a)	3	0.00	0.00			
Variety	4	1,573.42	393.36	199.06**	2.78	4.22
MR x V	4	0.00	0.00	0.00^{ns}	2.78	4.22
Error (b)	24	47.43	1.98			
TOTAL	39	1,629.94				

*- significant CV (a) = 0.00%
**- highly significant CV (b) = 2.30%

APPENDIX TABLE 72. Analysis of variance for number of days from seeding to maximum tillering (Benguet, DS 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	8.40	2.80	28.00*		
Moisture Regimes	1	864.90	864.90	8,649.00**	10.13	34.14
Error (a)	3	0.30	0.10			
Variety	4	12,834.40	3,208.60	1,578.00**	2.78	4.22
MR x V	4	425.60	106.40	52.33**	2.78	4.22
Error (b)	24	48.80	2.00			
TOTAL	39	14,182.40				

*- significant CV (a) = 0.39%
**- highly significant CV (b) = 1.80%

APPENDIX TABLE 73. Analysis of variance for number of days from maximum tillering to booting (Benguet, Aug 2010-Feb 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	22.90	7.63	16.34*		
Moisture Regimes	1	0.40	0.40	0.85^{ns}	10.13	34.14
Error (a)	3	1.40	0.47			
Variety	4	868.85	217.21	81.20**	2.78	4.22
MR x V	4	3.35	0.84	0.31^{ns}	2.78	4.22
Error (b)	24	64.20	2.68			
TOTAL	39	961.10				

ns- not significant CV (a) = 2.38%
**- highly significant CV (b) = 5.70%
*- significant

APPENDIX TABLE 74. Analysis of variance for number of days from maximum tillering to booting (Benguet, DS 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	68.00	22.67	1.68^{ns}		
Moisture Regimes	1	176.40	176.40	13.09*	10.13	34.14
Error (a)	3	40.40	13.47			
Variety	4	1,421.35	355.34	53.43**	2.78	4.22
MR x V	4	47.85	11.96	1.80^{ns}	2.78	4.22
Error (b)	24	159.60	6.65			
TOTAL	39	1,913.60				

ns- not significant CV (a) = 11.32%
**- highly significant CV (b) = 8.00%
*- significant

APPENDIX TABLE 75. Analysis of variance for number of days from booting to heading (Benguet, Aug 2010-Feb 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	1.70	0.57	1.21^{ns}		
Moisture Regimes	1	0.40	0.40	0.86^{ns}	10.13	34.14
Error (a)	3	1.40	0.47			
Variety	4	182.65	45.66	130.46**	2.78	4.22
MR x V	4	3.35	0.84	2.39^{ns}	2.78	4.22
Error (b)	24	8.40	0.35			
TOTAL	39	197.90				

ns- not significant CV (a) = 4.10%
**- highly significant CV (b) = 4.70%

APPENDIX TABLE 76. Analysis of variance for number of days from booting to heading (Benguet, DS 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	1.60	0.53	1.33^{ns}		
Moisture Regimes	1	0.40	0.40	0.00^{ns}	10.13	34.14
Error (a)	3	1.20	0.40			
Variety	4	174.35	43.59	145.29**	2.78	4.22
MR x V	4	2.85	0.71	2.38^{ns}	2.78	4.22
Error (b)	24	7.20	0.30			
TOTAL	39	187.60				

ns- not significant CV (a) = 3.81%
**- highly significant CV (b) = 3.30%

APPENDIX TABLE 77. Analysis of variance for number of days from heading to maturity (Benguet, Aug 2010-Feb 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	38.27	12.76			
Moisture Regimes	1	1,729.23	1,729.23	53.88**	10.13	34.14
Error (a)	3	96.28	32.09			
Variety	4	217.90	54.48	2.22^{ns}	2.78	4.22
MR x V	4	125.90	31.48	1.28^{ns}	2.78	4.22
Error (b)	24	588.20	24.51			
TOTAL	39	2,795.78				

**- highly significant CV (a) = 13.12%
*- significant CV (b) = 11.47%

APPENDIX TABLE 78. Number of days from heading to maturity (Benguet, DS 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	32.08	10.69			

Moisture Regimes	1	235.23	235.23	40.38**	10.13	34.14
Error (a)	3	17.48	5.83			
Variety	4	547.85	136.96	36.44**	2.78	4.22
MR x V	4	111.15	27.79	7.39**	2.78	4.22
Error (b)	24	90.20	3.76			
TOTAL	39	1,033.98				

**- highly significant CV (a) = 4.80%
CV (b) = 3.86%

APPENDIX TABLE 79. Analysis of variance for leaf area index at 75 DAS (Benguet, Aug 2010-Feb 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	0.31	0.10			
Moisture Regimes	1	3.80	3.80	87.63**	10.13	34.14
Error (a)	3	0.13	0.04			
Variety	4	0.32	0.08	1.25^{ns}	2.78	4.22
MR x V	4	0.29	0.08	1.13^{ns}	2.78	4.22
Error (b)	24	1.57	0.07			
TOTAL	39	6.44				

ns- not significant CV (a) = 13.95%
**- highly significant CV (b) = 10.81%

APPENDIX TABLE 80. Analysis of variance for leaf area index at 75 DAS (Benguet, DS 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	2.35	0.78			
Moisture Regimes	1	40.40	40.40	40.56**	10.13	34.14
Error (a)	3	2.99	1.00			
Variety	4	8.37	2.09	1.37^{ns}	2.78	4.22
MR x V	4	1.46	0.36	0.23^{ns}	2.78	4.22
Error (b)	24	36.61	1.53			
TOTAL	39	92.17				

ns- not significant CV (a) = 10.18%
**- highly significant CV (b) = 12.77%

APPENDIX TABLE 81. Panicle number at maturity (Benguet, Aug 2010-Feb 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	158.88	52.96			
Moisture Regimes	1	697.23	697.23	34.14**	10.13	34.14

Error (a)	3	61.28	20.43			
Variety	4	459.10	114.78	2.28^{ns}	2.78	4.22
MR x V	4	459.40	114.85	2.28^{ns}	2.78	4.22
Error (b)	24	1,207.10	50.30			
TOTAL	39	3,042.98				

ns- not significant CV (a) = 3.67%
**- highly significant CV (b) = 6.62%

APPENDIX TABLE 82. Analysis of variance for panicle number at maturity (Benguet, DS 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	72.48	24.16			
Moisture Regimes	1	990.03	990.03	8.62^{ns}	10.13	34.14
Error (a)	3	344.48	114.83			
Variety	4	5,577.85	1,349.46	13.08**	2.78	4.22
MR x V	4	675.35	168.84	1.57^{ns}	2.78	4.22
Error (b)	24	2,572.80	107.20			
TOTAL	39	10,232.98				

ns- not significant CV (a) = 6.35%
**- highly significant CV (b) = 6.07%

APPENDIX TABLE 83. Analysis of variance for panicle length (cm) (Benguet, Aug 2010-Feb 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	3.35	1.12	0.30		
Moisture Regimes	1	10.61	10.61	2.89^{ns}	10.13	34.14
Error (a)	3	11.02	3.67			
Variety	4	287.26	71.82	74.16**	2.78	4.22
MR x V	4	12.89	3.22	3.33^{ns}	2.78	4.22
Error (b)	24	23.24	0.97			
TOTAL	39	348.38				

ns- not significant CV (a) = 10.11%
**- highly significant CV (b) = 5.24%

APPENDIX TABLE 84. Analysis of variance for panicle length (cm) (Benguet, DS 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	16.93	5.64			
Moisture Regimes	1	1.52	1.52	0.25^{ns}	10.13	34.14
Error (a)	3	18.27	6.09			
Variety	4	250.45	62.61	15.98**	2.78	4.22
MR x V	4	31.74	7.94	2.02^{ns}	2.78	4.22

Error (b)	24	94.05	3.92			
TOTAL	39	412.96				

ns- not significant CV (a) = 12.64%
**- highly significant CV (b) = 10.14%

APPENDIX TABLE 85. Analysis of variance for total number of grains per panicle (Benguet, Aug 2010-Feb 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	1,821.80	607.27			
Moisture Regimes	1	1,060.90	1,060.90	1.48^{ns}	10.13	34.14
Error (a)	3	2,150.10	716.70			
Variety	4	4,743.65	1,185.91	2.90*	2.78	4.22
MR x V	4	1,771.85	442.96	1.08^{ns}	2.78	4.22
Error (b)	24	9,812.10	408.84			
TOTAL	39	21,360.40				

ns- not significant CV (a) = 4.82%
*- significant CV (b) = 3.42%

APPENDIX TABLE 86. Analysis of variance for total number of grains per panicle (Benguet, DS 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	296.20	98.73			
Moisture Regimes	1	40.00	40.00	0.24^{ns}	10.13	34.14
Error (a)	3	483.40	161.13			
Variety	4	12,613.60	3,153.40	24.55**	2.78	4.22
MR x V	4	12,436.00	3,109.00	24.20**	2.78	4.22
Error (b)	24	3,082.40	128.433			
TOTAL	39	28,951.60				

ns- not significant CV (a) = 6.46%
**- highly significant CV (b) = 11.58%

APPENDIX TABLE 87. Analysis of variance for number of filled grains per panicle (Benguet, Aug 2010-Feb 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	252.28	84.09			
Moisture Regimes	1	319.23	319.23	0.79^{ns}	10.13	34.14
Error (a)	3	1,199.28	399.76			
Variety	4	8,648.60	2,162.15	16.42**	2.78	4.22
MR x V	4	3,052.40	763.10	5.79**	2.78	4.22
Error (b)	24	3,160.20	131.68			
TOTAL	39	16,631.98				

ns- not significant CV (a) = 4.87%

**- highly significant CV (b) = 2.98%

APPENDIX TABLE 88. Analysis of variance for number of filled grains per panicle (Benguet, DS 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	371.08	123.69			
Moisture Regimes	1	1,550.03	1,550.03	9.72^{ns}	10.13	34.14
Error (a)	3	478.08	159.36			
Variety	4	11,362.15	2,840.54	40.89**	2.78	4.22
MR x V	4	11,126.35	2,781.59	40.04**	2.78	4.22
Error (b)	24	1,667.10	69.46			
TOTAL	39	26,554.78				

ns- not significant CV (a) = 4.87%
**- highly significant CV (b) = 2.98%

APPENDIX TABLE 89. Analysis of variance for filled grain ratio (%) (Benguet, Aug 2010-Feb 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	297.55	99.18			
Moisture Regimes	1	649.64	649.64	3.32^{ns}	10.13	34.14
Error (a)	3	587.08	195.69			
Variety	4	1,310.43	327.61	1.38^{ns}	2.78	4.22
MR x V	4	235.01	58.75	0.24^{ns}	2.78	4.22
Error (b)	24	5,678.55	236.61			
TOTAL	39	8,758.55				

ns- not significant CV (a) = 15.99%
CV (b) = 17.10%

APPENDIX TABLE 90. Analysis of variance for filled grain ratio (%) (Benguet, DS 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	46.25	15.42	0.78		
Moisture Regimes	1	796.56	796.56	40.23**	10.13	34.14
Error (a)	3	59.40	19.80			
Variety	4	2,122.62	530.66	18.32**	2.78	4.22
MR x V	4	1,015.18	253.80	8.76**	2.78	4.22
Error (b)	24	695.12	28.96			
TOTAL	39	4,735.13				

**- highly significant CV (a) = 6.76%
CV (b) = 8.18%

APPENDIX TABLE 91. Analysis of variance for 1000 filled grain weight (g) (Benguet, Aug 2010-Feb 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	4.04	1.35	35.09		
Moisture Regimes	1	0.05	0.05	1.28^{ns}	10.13	34.14
Error (a)	3	0.12	0.04			
Variety	4	344.41	86.10	83.36**	2.78	4.22
MR x V	4	5.51	1.38	1.33^{ns}	2.78	4.22
Error (b)	24	24.79	1.03			
TOTAL	39	378.91				

ns- not significant CV (a) = 0.76%
**- highly significant CV (b) =
3.98%

APPENDIX TABLE 92. 1000 filled grain weight (g) (Benguet, DS 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	3.20	1.07	0.18		
Moisture Regimes	1	0.16	0.16	0.03^{ns}	10.13	34.14
Error (a)	3	18.17	6.06			
Variety	4	531.45	132.86	109.17**	2.78	4.22
MR x V	4	46.47	11.62	9.55**	2.78	4.22
Error (b)	24	29.21	1.22			
TOTAL	39	628.65				

ns- not significant CV (a) = 13.30%
**- highly significant CV (b) =
5.96

APPENDIX TABLE 93. Analysis of variance for total dry matter weight (Benguet, Aug 2010-Feb 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	1,017.95	339.32			
Moisture Regimes	1	19,580.63	19,580.63	130.50**	10.13	34.14
Error (a)	3	450.13	150.04			
Variety	4	4,152.48	1,038.12	15.28**	2.78	4.22
MR x V	4	2,789.13	697.28	10.26**	2.78	4.22
Error (b)	24	1,629.80	67.91			
TOTAL	39					

**- highly significant CV (a) =
16.99%

CV (b) =
11.43%

APPENDIX TABLE 94. Analysis of variance for total dry matter weight (Benguet, DS 2011)

SOURCE	DEGREES OF	SUM	MEAN	COMPUTED	TABULATED

OF VARIATION	FREEDOM	OF SQUARES	OF SQUARES	F	F 0.05	F 0.01
Replication	3	5,293.98	1,764.66			
Moisture Regimes	1	37,976.40	37,976.40	39.19**	10.13	34.14
Error (a)	3	2,906.49	968.83			
Variety	4	27,298.89	6,824.72	4.07*	2.78	4.22
MR x V	4	2,814.66	703.66	0.42[ns]	2.78	4.22
Error (b)	24	40,202.10	1,675.09			
TOTAL	39	116,492.51				

ns- not significant CV (a) = 3.93%
**- highly significant CV (a) = 5.46%
*- significant

APPENDIX TABLE 95. Analysis of variance for harvest index (Benguet, Aug 2010-Feb 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	TABULATED F 0.01
Replication	3	144.93	48.31			
Moisture Regimes	1	21.76	21.76	1.35[ns]	10.13	34.14
Error (a)	3	48.28	16.09			
Variety	4	377.34	94.33	6.46**	2.78	4.22
MR x V	4	135.67	33.92	2.32[ns]	2.78	4.22
Error (b)	24	350.45	14.60			
TOTAL	39	1,078.42				

ns- not significant CV (a) = 11.78%
**- highly significant CV (b) = 11.22%

APPENDIX TABLE 96. Analysis of variance for harvest index (Benguet, DS 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	TABULATED F 0.01
Replication	3	11.67	3.89			
Moisture Regimes	1	1,374.76	1,374.76	52.52**	10.13	34.14
Error (a)	3	78.52	26.17			
Variety	4	134.93	33.73	2.85*	2.78	4.22
MR x V	4	54.45	13.61	1.15[ns]	2.78	4.22
Error (b)	24	283.88	11.83			
TOTAL	39	1,938.20				

ns- not significant CV (a) = 5.39%
**- highly significant CV (b) = 5.64%
*- significant

APPENDIX TABLE 97. Analysis of variance for grain yield (kg) (Benguet, Aug 2010-Feb 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	TABULATED F 0.01
Replication	3	547,299.97	182,433.32			

Moisture Regimes	1	6,775,676.92	6,775,676.92	274.60**	10.13	34.14
Error (a)	3	74,022.22	24,674.07			
Variety	4	2,141,506.13	535,376.53	9.23**	2.78	4.22
MR x V	4	825,748.20	206,437.05	3.56*	2.78	4.22
Error (b)	24	1,390,978.84	57,597.45			
TOTAL	39	11,755,232.28				

**- highly significant CV (a) = 2.50%
*- significant CV (b) = 4.14%

APPENDIX TABLE 98. Analysis of variance for grain yield (kg) (Benguet, DS 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	17,045.16	5,681.719			
Moisture Regimes	1	21,413.76	21,413.76	7.47[ns]	10.13	34.14
Error (a)	3	8,597.55	2,865.85			
Variety	4	527,756.78	131,939.19	33.86**	2.78	4.22
MR x V	4	110,784.10	27,696.03	7.11**	2.78	4.22
Error (b)	24	93,503.24	3,895.97			
TOTAL	39	779,100.58				

ns- not significant CV (a) = 7.64%
**- highly significant CV (b) = 8.28%

APPENDIX TABLE 99. Analysis of variance for computed yield (t ha^{-1}) (Benguet, Aug 2010-Feb 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	1.67	0.56			
Moisture Regimes	1	20.45	20.45	228.05**	10.13	34.14
Error (a)	3	0.27	0.09			
Variety	4	6.50	1.63	9.04**	2.78	4.22
MR x V	4	2.60	0.65	3.61*	2.78	4.22
Error (b)	24	4.31	0.18			
TOTAL	39	35.79				

**- highly significant CV (a) = 9.76%
*- significant CV (b) = 9.71%

APPENDIX TABLE 100. Analysis of variance for computed yield (t ha^{-1}) (Benguet, DS 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	0.05	0.02	1.98		
Moisture Regimes	1	0.07	0.07	7.54[ns]	10.13	34.14
Error (a)	3	0.03	0.01			
Variety	4	1.60	0.40	34.20**	2.78	4.22

MR x V	4	0.34	0.08	7.21**	2.78	4.22
Error (b)	24	0.28	0.01			
TOTAL	39	2.36				

ns- not significant CV (a) = 3.84%
**- highly significant CV (b) = 4.27%

APPENDIX TABLE 101.Analysis of variance for water use efficiency (Benguet, Aug 2010-Feb 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	0.31	0.10	1.32		
Moisture Regimes	1	0.02	0.02	0.25^{ns}	10.13	34.14
Error (a)	3	0.24	0.08			
Variety	4	0.45	0.11	1.22^{ns}	2.78	4.22
MR x V	4	0.29	0.07	0.78^{ns}	2.78	4.22
Error (b)	24	2.24	0.09			
TOTAL	39	3.55				

ns- not significant CV (a) = 5.43%
CV (b) = 4.37%

APPENDIX TABLE 102. Analysis of variance for water use efficiency (Benguet, Mar-Nov 2011)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
Replication	3	0.000	0.000	2.08		
Moisture Regimes	1	0.000	0.000	8.53^{ns}	10.13	34.14
Error (a)	3	0.000	0.000			
Variety	4	0.003	0.001	26.86**	2.78	4.22
MR x V	4	0.001	0.000	7.06**	2.78	4.22
Error (b)	24	0.001	0.000			
TOTAL	39	0.005				

ns- not significant CV (a) = 0%
**-highly significant CV (b) =0%

BIOGRAPHICAL SKETCH

The author is the eldest of two children of the late Marcelino B. Atmosfera and Filomena B. Kuezon of Dolores, Abra and Inopacan, Leyte, respectively. She was born on December 31, 1969 in Inopacan, Leyte.

She finished her elementary education in Mudiit Elementary School, Mudiit, Dolores, Abra. She enrolled in Abra State Institute of Sciences and Technology (ASIST), Lagangilang, Abra and graduated in 1985 as Salutatorian. She spent her college days at ASIST and obtained a degree of Bachelor of Science in Agricultural Education major in Agronomy and minor in Animal Husbandry in 1989 where she graduated as Cum Laude. Moreover, she finished Master in Community Development in 2000 at the Benguet State University-Open University. In order to gain more technical knowledge, she pursued another master's degree major in Agronomy and minor in Soil Science.

She has been with the Department of Agriculture-Regional Field Office, Cordillera Administrative Region since 1989 starting as an Agricultural Development Specialist (ADS) to her current position of a Senior Agriculturist and concurrently designated as the Officer-In Charge (OIC) of the Operations Division.

In 1996, she got married to Vincent Emerencio T. Tapat of Lagangilang, Abra. The couple now resides at San Luis Village, Baguio City and has a provincial address of Ducam, Dolores, Abra.

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