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Field Trial of Native Rice (Oryza Sativa lin.) Applied with Urine As a Source of Fertilizer

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Abstract:

The upland rice farmers in the Philippines are searching for cheap fertilizer, organic, and environmentally friendly. Field trials of native rice varieties were studied using human urine as a source of fertilizer for 140 days of the experiment. The four varieties were: Malido, Palawan, Kutsiyam, and Sulig, randomly assigned in a randomized complete block design (RCBD) with five replications. The collected data includes the plant height, number of tillers, weight of 1000-grains, and yield of rice at harvest. Statistical analysis revealed significant differences in the plant height (cm), and weight of 1000-grains (g), however with comparable results in the number of tillers and yield (kg) of rice/ha. Malido native rice variety is significantly taller (150.2 cm) and heavier 1000-grains (29.60 g) compared to other varieties. The result implies that native rice responds significantly in terms of height and weight of grains when applied with human urine as a source of organic fertilizer. The 50,000 liters of urine/ha applied to native rice was sufficient to increase significantly the height and weight of rice grains with comparable yield (2,851 kg/ha to 3,248 kg/ha) in all treatments after the experiments.

Keywords: rice, urine, organic fertilizer

Introduction:

Agriculture in the Philippines is rapidly changing, as new farming techniques and varieties come into use. The deterioration of the environment and natural resources such as deforestation, land degradation, misuse of pesticides and chemicals, and the loss of genetic resources coupled with the fast-growing population in the country gave the Department of Agriculture's (DA) challenge in refocusing strategies in ensuring food security and availability. Upland rice farming is considered an important initiative in attaining the goal of rice sufficiency in the region and the country as well. The upland environment provides an opportunity to solve the household-based food availability, income, and nutrition and in the community in general (Anies, 2014).

According to Philrice's Ruben Miranda, national coordinator for the Upland Rice Development Programs (URDP), the upland ecosystem in the Philippines, which is more than 100.000 hectares has been neglected for a long time. The URDP aims to develop the upland rice areas as food-self-sufficient communities through farm diversification, rice seed assistance, and the formation of the organization. Traditional rice varieties gave low but dependable yields at 1 to 2 tons/hectare once a year, under minimal input and management practices (Philrice, 2015).

Rice is the staple food for over half the world's population. Rice provides up to 50% of the dietary caloric supply for millions living in poverty in Asia and is, therefore, critical for food security. It is becoming an important food staple in both Latin America and Africa. Records in the increase of rice production have been observed since the start of the Green Revolution (Muthayya, 2014). Rice is the second most widely grown cereal crop and the staple food for more than half the world's population. More than 3 billion people consume more than 100 kg of rice per year. Rice is cultivated on 155.5 million ha with an average growth rate of 0.39% a year, in the last 30 years. (Van Nguyen, 2006). Rice production in Asia needs to increase to feed a growing population. Exploring ways to produce more rice with less water is essential for food security and sustaining environmental health in Asia. (Tuong, 2003). Philippine Native rice is considered a drought-resistant strain of rice variety that requires only limited water to grow and produce re-productively during early summertime, particularly in

April to September every year. Traditional lowland rice production in Asia requires much water: it consumes more than 50% of all irrigation water used in the region. Compared with the heavy investments needed to develop new water resources, the adoption of water-saving technologies by farmers is low-cost and has great potential to save water. (Lampayan, 2003). Rice is the most important food crop in tropical and subtropical regions of the world. Yield enhancement to increase rice production is one of the essential strategies to meet the demand for food of the growing population (Giri, 2000).

The field trials of native varieties are a very important endeavor to determine the productivity level of rice under the application of organic urine-based fertilizer purposely for the upland farmers to enhance their household food sufficiency, income, and nutrition. The municipality of Calinog in the central towns of Iloilo province comprises 50% mountainous and upland barangays where most farmers cultivate and grow native rice for their livelihood.

Literature Review:

Crop production in most developing countries is faced with a dearth of resources for optimum production of which fertilizer is one. The use of human urine, as well as its mixture with compost, are potential solutions to this problem. (AdeOluwa, 2012) Human urine, rich in plant nutrients, is a readily available fertilizer but limited information is available about the best use of human urine in crop production. (Shrestha, 2013). Use of urine" is the thematic topic of the third issue of Sustainable Sanitation Practice (SSP). If urine is collected separately, treated, and converted to agricultural usage, the biggest step towards nutrient reuse and highly efficient water protection is taken. (Club, 2010). Interesting prospects of a urine-based product exist as a fertilizer in agricultural applications in developing countries. However, the removal of pharmaceutical residues is essential to prevent long-term environmental hazards. (Pronk, 2009). Urine and feces are complete fertilizers of high quality with low levels of contaminants such as heavy metals. Urine is rich in nitrogen, while feces are rich in phosphorous, potassium, and organic matter. The amount of nutrients excreted depends on the amounts in the food consumed, and equations are presented for the calculation of nitrogen and phosphorus in excreta based on easily-available statistics on the supply of food protein. (Johnson, 2004). Stored human urine had pH values of 8.9 and was composed of eight main ionic species (> 0.1 meg L (-1)), the cations Na, K, NH4, Ca, and the anions, Cl, SO4, PO4, and HCO3. Nitrogen was mainly (> 90%) present as ammoniacal N, with ammonium bicarbonate being the dominant compound. Urea and urate decomposed during storage. Heavy metal concentrations in urine samples were low compared with other organic fertilizers, but copper, mercury, nickel, and zinc were 10-500 times higher in urine than in precipitation and surface waters. In a pot experiment with N-15 labeled human urine, higher gaseous losses and lower crop uptake (barley) of urine N than of labeled ammonium nitrate were found. Phosphorus present in urine was utilized at a higher rate than soluble phosphate, showing that urine P is at least as available to crops as soluble P fertilizers. (Kirch, 1995).

The urine fertilized plants produced equal amounts of tomato fruits as mineral fertilized plants and 4.2 times more fruits than non-fertilized plants. The results suggest that urine with/without wood ash can be used as a substitute for mineral fertilizer to increase the yields of tomatoes without posing any microbial or chemical risks. (Pradhan, 2009). Human excreta contain plant nutrients and have the potential to be used as a fertilizer in agriculture. Urine contributes the major proportion of the nutrients (N, P, and K) in domestic wastewater. Human urine does not generally contain pathogens that can be transmitted through the environment. The risk for viral infection was higher, calculated at 0.56 for accidental ingestion of 1 ml of unstored urine. If the urine mixture was stored at 20°C for six months the risk for viral infection was reduced to 5.4 × 10-4. By following recommendations for storage and reuse, which are dependent on the type of crop to be fertilized, it is possible to significantly decrease the risk for infections. So far, the level of risk that is acceptable is unknown. The acceptable risk will be one of the main factors determining the future utilization of source-separated human urine in agriculture. (Hoglund, 2001). Urine and feces are complete fertilizers of high quality with low levels of contaminants such as heavy metals. Urine is rich in nitrogen, while faces are rich in phosphorus, potassium, and organic matter. The amount of nutrients excreted depends on the amount in the feed consumed, and equations are presented for the calculation of nitrogen and phosphorus in excreta based on easily available statistics on the supply of food protein, (Johnson, 2004).

Human urine was used as a fertilizer in cabbage cultivation and compared with industrial fertilizer and non-fertilizer treatments. Urine achieved equal fertilizer value to industrial fertilizer when both were used at a dose of 180 kg N/ha. Insect damage was lower in urine-fertilized than in industrial-fertilized plots but more extensive than in non-fertilized plots. The microbiological quality of urine-fertilized cabbage and sauerkraut made from the cabbage was similar to that in the other fertilized cabbages. Our results show that human urine could be used as a fertilizer for cabbage and does not pose any significant hygienic threats or leave any distinctive flavor in food products. (Pradhan, 2007).

The specific objectives of the present investigations are a) To find out the yield performance of native rice in off-season time applied with human urine-based organic fertilizer, b) to determine whether human urine is useful and safe for use in the production of native rice through its growth and yield responses. Human urine will be recycled and use in agricultural production to supply valuable plant nutrients, needed by crops, it is expected that urine as a source of Nitrogen, Phosphorous, and Potassium (NPK) will give positive results in terms of the yield of native rice. The output of the study will showcase the possibility of producing native rice in upland areas utilizing human urine only as a source of fertilizer for food production and food security of indigenous people living in uplands.

Conceptual Framework:

The rice plant belongs to the grass family. It has long, narrow leaves and several stems. At the top of each stem, ahead of flower forms. The grains or seeds develop from the flowers. Each head produces 50 to 150 grains of rice. Most rice plants grow 2 to 5 feet (60-150 centimeters) high. Rice is considered to be an annual plant. Most varieties take five or six months to ripen.

Rice strives only where the weather is warm, and the soil is wet in most rice in lowland rice. It is grown on level land and is kept flooded in 4 to 8 inches (10 to 20 cm) of water for part or all the growing season. Upland rice is grown in areas where the land is too rugged for flooding but where the rainfall is heavy enough so that flooding of the fields is not needed. Upland rice yields much

less grain than lowland rice, (Groiler 2002)
In these experiments, Upland native rice varieties were being used (Malido, Palawan, Kutsiyam, and Sulig) in the field trials with the application of urine as a source of organic fertilizers. Below is the diagram showing the conceptual framework of the study.

Independent Variable → Dependent Variable

Native rice varieties fertilized with the same amount of urine (50,000 liter of urine/ha) → Plant height, number of tillers, the weight of grains, and yield of rice/ha at harvest

The field trial study aims to determine the productivity levels of Upland rice varieties fertilized with urine alone under the Calinog- Iloilo soil condition. Specifically, the study sought to answer the following questions:

1. What is the tallest height of the plant (cm) when applied with urine?
2. What is the maximum number of tillers produce when the plant is applied with urine?
3. What varieties will get the heaviest of grains (g) when the rice plant applied with urine fertilizer?
4. What rice varieties will get the highest yield when applied with urine as a source of fertilizer?
5. Are there significant differences in the height, number of tillers, weight of grains, and? the yield of native rice when applied of urine alone as the source of organic fertilizer?

Methodology:

The study was conducted at the experimental area of West Visayas State University, Calinog Campus, Calinog, Iloilo from August 1, 2019, to December 19, 2019. The campus is located in the central towns of Iloilo Province just 58 kilometers away from Iloilo City. It is one of the five satellite campuses of West Visayas State University. The area coordinate is: Latitude = 11.1172376, and Longitude = 122.5370973.

1. Research design:

This research design uses the one-factor variable while all others are kept constant are called single-factor experiments. In such experiments, the treatments consist solely of the different levels of the single variable factor. All other factors are applied uniformly to all plots at a single prescribed level. Most crop variety trials are single-factor experiments in which the single variable factor is variety and the factor levels (i.e. treatments) are the different varieties. The randomized complete block (RCB) design is one of the most widely used experimental designs in agricultural research. The design is especially suited for field experiments where the number of treatments is not large, and the experimental area has a predictable productivity gradient. The primary distinguishing feature of the RCB design is the presence of blocks of equal size, each of which contains all the treatments. Experimental layout and treatments. The four native rice seeds (A-Malido, B-Palawan, C-Kutsiyam, and D-Sulig) were used in the experiment replicated five times with an experimental area of 60 square meters (1x3 meter/plot x 20 plots) laid out in Randomized Complete Block (RCB) design. The experimental layout and treatments are reflected in Figure 1.

Rep 1	**Rep 2**	**Rep 3**	**Rep 4**	**Rep 5**
A	C	B	D	A
B	D	C	B	D
D	A	D	A	C
C	B	A	C	B

Figure 1. Experimental Layout and Treatment In Rcbd
Legend:
A – Malido applied with urine fertilizer
B – Palawan applied with urine fertilizer
C – Kutsiyam applied with urine fertilizer
D – Sulig applied with urine fertilizer

2. Sampling:

In this experimental study, the sampling techniques are not applicable. The subjects of the study are the varieties of native rice and human urine as treatments. The number of rice seeds being used during the experiment is the same, only the varieties differ. Likewise, the amount of urine applied as source organic fertilizer is the same with a rate of 50,000 liters/ha.

Management practices:

Collection of human urine. The source of urine was taken from Bachelor of Science in Agriculture (BSA) male students of West Visayas State University- Calinog Campus, Iloilo, Philippines. The urine was collected and stored for 30 days period in a plastic container before using it as the source of liquid fertilizer.
Frequency of urine application**.** Frequency of urine application was done once a week, every Saturday morning by pouring the diluted (dilution ratio of 1:1 with water) urine in the base of the plant which was started in 10th days after planting. The urine volume was applied in 16 applications (1 application x 16 weeks= 112 days) plus 18 days withdrawal period + 10 days = 140 days period of experiment with 50,000 liters/ha equivalent to 5 liters of human urine/m$^{2.}$ The total amount of human urine plus water in the 60m^2 experimental area was 600 liters (300 liters urine +300 liters water).
Preparation of the experimental area. The area of 60 square meters (excluding canals) was prepared two weeks before the actual date of planting. This area was plowed/ cultivated twice and pulverized before planting. There were 20 experimental plots prepared for the experiments.
Planting of native rice varieties. Planting of native rice was done by drill method with five (5) seeds per hill. There were four native rice varieties planted (Malido, Palawan, Kutsiyam, and Sulig) taken from farmers in the upland area of Calinog. Thinning was done 2 weeks after planting, allowing only 3 rice plants per hill. The planting distance was 25 cm by 25 cm apart in 3 rows with a total of 30 plants per plot.
Control of weeds, pests, and diseases. Hand weeding and spraying of insecticides were done during the experiment. There was a plastic net enclosure in the experimental area as protection against birds, insects, and stray animals.

Harvesting of rice plants. The native rice varieties have different maturity dates. Palawan was harvested ahead at 135 days after planting. This was followed by Sulig at 137 days and the last was Malido at 140 days and Kutsiyam. The rice plant was harvested when the grains were at 85% of maturity. Harvesting was done manually using a scythe or sickle.

3. Data collection:

The data collected came from the 10 plant samples per subplot at harvest with a total of 200 sample plants. All data were taken during the day of harvest. The data collected were the plant height (cm), number of tillers, the weight of 1000- grains (g), and rice yield (ton/ha) at harvest.

Height at harvest. Plant height was measured from the base to the tip of the tallest leaf/leaves of the rice plant. The average was determined by dividing the total height over the 10 sample plants.

The number of tillers. The number of tillers was gathered and counted from ten (10) sample plants at harvest.

The 1000-grains weight. The harvested grains were sun-dried and winnowed. The 1,000 filled grains were collected from each treatment and weighted using a digital weighing scale. The data were obtained from 10 sample plants.

Yield/ha**.** The yield was determined by weighing the cleaned & dried grains (estimated with 14% moisture). Ten sample plants in every plot were used to obtain the average yield, converted to yield per hectare in kilograms.

4. Data Analysis:

Analysis of Variance (ANOVA) in Randomized Completed Block Design was used in evaluating and analyzing the data for all the treatments using the Statistical Tool in Agriculture Research (STAR) software from bbi.irri.org.

Results and discussion:

The results of the experiment are presented in Tables 1, 2, 3, and 4. The plant height, number of tillers, weight of 1000 grains, and yield of rice at harvest respectively.

Plant height (cm) of native rice at harvest:

The plant height of plants is shown in table 1. The Malido rice is the tallest with a mean of 150.2 cm, followed by Sulig (149.8 cm), Palawan (148.4 cm), and the shortest was Kutsiyam with a mean of 137.2 cm. The statistical analysis showed significant differences in the height of native rice. The result implies that human urine at the rate of 5 liters/m2 (50,000 liters/ha) is significantly influenced the plant height of native rice.

Treatments	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Total	Mean*
Malido	154.0	147.0	136.0	158.0	156.0	751.0	150.2^{b}
Palawan	153.0	147.0	150.0	148.0	144.0	742.0	148.4^{a}
Kutsiyam	138.0	138.0	138.0	135.0	137.0	686.0	137.2^{a}
Sulig	146.0	154.0	150.0	146.0	153.0	749.0	149.8^{a}
Grand Total and Mean 2928.0 146.4							

Table 1: Plant Height (Cm) At Harvest
Means with the same letter are not significantly different

* Significant
C.V. = 3.46%

The number tillers of at harvest:

The number of tillers is shown in table 2. The Sulig rice obtained the highest number of tillers with a mean of 21.22 pieces and the smaller number of tillers was Malido. There were differences in the number of tillers however, the statistical analysis did not find any significant differences. The result implies that the number of tillers was comparable among the four native rice varieties after the trials.

Treatments	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Total	Mean^{ns}
Malido	22.0	18.0	18.0	17.0	22.0	97.0	19.40
Palawan	24.0	19.0	21.0	19.0	21.0	104.0	20.80
Kutsiyam	20.0	22.0	19.0	23.0	18.0	102.0	20.40
Sulig	23.0	19.0	22.0	19.0	22.0	105.0	21.00
Grand Total and Mean 408.0 20.40							

Table 2: Number of Tillers (Cm) At Harvest
C.V. = 10.0% ^{ns} - not significant

The weight of 1000-grains (g):

The result of the study in the weight of 1000- grains are shown in table 3. Among the varieties, Malido rice got the heaviest weight with a mean of 39.60 g, followed by Kutsiyam rice (29.46 g), and Sulig (28.60 g). The lightest 1000-grains weight was obtained by Palawan rice (27.40 g) (26.33g). Statistical analysis showed significant differences among varieties. The result implies that human urine affects significantly the weight of grains of native rice at the rate of 5 liters per square meter after the experiment.

Treatments	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Total	Mean*
Malido	29.0	30.0	30.0	29.0	30.0	148.0	29.60^{a}
Palawan	28.0	27.0	27.0	28.0	27.0	137.0	27.40^{a}
Kutsiyam	29.0	29.0	30.0	29.0	30.0	147.0	29.40^{c}
Sulig	28.0	29.0	29.0	28.0	29.0	143.0	28.60^{b}
Grand Total and Mean 575.0 28.75							

Table 3: Weight Of 1000-Grains (G) At Harvest
Means with the same letter are not significantly different *

Significant
C.V. = 1.96%

The yield (kg/ha) of native rice at harvest:

The result of the study in the yield of rice is reflected in table 4. Among the varieties, Kutsiyam rice got the highest yield of 3,248 kilograms, followed by Sulig (2,893 kg) and the least yield was Malido rice (2,8511 kg). Statistical analysis showed no significant differences among varieties. The result implies that human urine was able to supply needed nutrients for plant growth and development of plant until harvesting of grains at the rate of 5 liters per square meter after the experimental trials.

Treatments	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Total	Mean^{ns}
Malido	2096.0	2520.0	3225.0	32.48.0	3166.0	14255.0	2851.0
Palawan	2760.0	2691.0	3060.0	2858.0	3024.0	14393.0	2878.6
Kutsiyam	3280.0	3110.0	3180.0	3330.0	3340.0	16240.0	3248.0
Sulig	2320.0	2598.0	3248.0	3863.0	2436.0	14465.0	2893.0
Grand Total and Mean 59353.0 2967.65							

Table 4: Yield of Native Rice (Kg/Ha) At Harvest
C.V. = 11.89
^{ns} - not significant

Conclusions:

The result of the experiment showed that the four native rice varieties planted in 60 square meters of area fertilized with human urine were able to grow productively. The application of 5 liters of urine per square meter (50,000 liters/ha) was sufficient enough to increase the plant height and produce the weight of grains significantly during the trials for almost 140 days. The yields of native rice were all comparable in all treatments applied with human urine as a source of fertilizer. The following conclusions were drawn from the experiment:

1. The Malido rice with an average height of 150.2 cm was the tallest among the four native rice varieties with significant differences among the treatments.
2. The Sulig rice with 21.0 pieces of tillers got the maximum average number of tillers but no significant differences among treatments.
3. The Malido rice got the heaviest 1000-grain weight with an average of 29.60 g with significant differences among the treatments.
4. The Kutsiyam rice got the highest yield with an average of 3,248 kg/ha but no significant differences among the treatments.
5. There were significant differences in the plant height and 1000-grains weight among the treatments and the rest were comparable in terms of the number of tillers produced and yield of rice express in kg/ha.
6. Human urine as a source of plant nutrition in the form of liquid fertilizer can be utilized by rice farmers in upland rice production.
7. The utilization of human urine as a source of fertilizer in upland rice production enhance household food sufficiency, income, and nutrition of rice farmers in the mountainous area of the municipality of Calinog, Iloilo in Panay Island, Philippines.

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