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Integrated nutrient management of upland rice

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Key words: Concoction, Nutrient management, Variation, Yield component.

Abstract

The study aimed to develop site-specific nutrient management for upland rice (Aringay)and to determine the profitability of the different fertilizer treatments and the best nutrient treatment in terms of the agronomic characteristic, yield, yield component parameters of Aringay. RCBD with 3 replications was used with10 treatments. Results revealed that regardless of fertilizer treatments used, plants had mean height ranged from 125-137.27cm. Average productive and unproductive tillersplant^{-1}ranged from 9-11 and 0.13-0.6, respectively. Moreover, length of panicles ranged19.8-20.8cm. No significant difference was noted between treatments on all the above parameters. T_3 statistically outranked all other treatments in terms of the number of spikelets per plant with a mean of 139.96, other treatments ranged from 91.13-109.26 with no significant difference between them. Likewise, fertilizer dressings posed no significant effect on seed density which ranged from 18.5-22.77g/1000 seeds. Higher net incomes and ROIs were obtained from T3 (Recommended Inorganic Fertilizer + 6 bags organic fertilizer (recommended rate), followed by T9 (Recommended rate Inorganic Fertilizer + concoctions (FPJ & KAA) with corresponding incomes P29,999.2 (93.63) and P25,513.8 (81.65), respectively. All other treatments gave an income ranges from P9,738.37 to P18,642.4. Researchers recommend the use of 40-60kg N/ha and 14kg of P and K for lesser cost in upland rice production.

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Introduction

Rainfed agricultural ecosystem (lowland and upland areas) plays a vital role in the food production and sufficiency of the country. These areas are usually planted to corn, upland rice and other early maturing commodities. However, the production capacity of these production environments areconstrained with insufficient water or soil moisture, severe pest and disease infestations, poor soil fertility status, degradation, weak access to technology, insufficient quality seeds, including the adverse impact of climate change resulting to poor socio-economic condition of families of rainfed farmers.

Cagayan province alone have vast marginal rainfed areas which can be potentially developed into a more productive source of food to alleviatepoverty, malnutrition and socio-economic problems in these rainfed communities**.** Cagayan province had a total of 37,650 and 1,864 hectares of rainfed lowland and upland areas planted to rice (BAS & DA-RFU II BAPS, 2007). Greater portion of these rainfed lowland rice fields are usually planted once a year i.e. during rainy season where there is an abundant rain water to support the growth and development of rice, leaving the field idle during the dry season period due to lack of water and moisture.

Kaingin (slash-and-burn) farms keep on expanding to keep pace with the food demand of the continuously increasing populations. Kaingin destroys the diverse flora and fauna and other soil resources, make soil more prone to water erosion due to denudation of forest and other natural vegetation. Research authorities must therefore find ways and means to increase productivity of the upland areas without necessarily compromising the sustainability and quality of the ecosystems.

Development and adoption of improved upland rice farming systems to maximize production and utilization of the upland areas can ultimately increase the income of the upland rice farmers. One strategy to increase farmers' production and income apart from the use of adaptable improved upland rice varieties, improved post- harvest facilities and value-adding activities, is the use of right kind, right amount, and site-specific fertilizer dressings. Comparing farmers practice to recommended fertilizer rate to know the advantage and disadvantage of the technologyis worthwhile to farmers who wants to minimize fertilizer costs.

In addition, organic and inorganic fertilizer needs to be compared to document the advantage of organic over inorganic. Hence, this study was focused on determining the right amount of organic (liquid and solid) and inorganic fertilizers for Aringayupland rice.

Generally, it aimed to develop a site-specific integrated nutrient management for upland rice. Specifically, the study aimed to: (1) Determine which of the different fertilizer treatments is the best in terms of the agronomic characteristic, yield and yield component parameters of upland rice; and (b) Compare the economics and profitability of the different fertilizer treatments.

Materials and methods

The study was established in a well-drained, rolling area at the upland experimental farm of Cagayan State University, Piat, Cagayan with a GPS reading of 17°48'4.1" North, and 121°30'31.3" East. The field has been planted previously with aerobic rice.

Experimental Procedures

Soil sampling

Composite soil samples were collected from the experimental area before land preparation to determine the kind and amount of inorganic fertilizer to be applied based on Bureau of Soils chart and standards. It came out that recommended rates of fertilizers are the following: 50-40-60kg NPK/ha which was one of the treatments used.

Land preparation

The area was thoroughly prepared by plowing and harrowing using a four wheel tractor. After the second and final harrowing, furrows were made at a distance of 40cm with depths of 10cm.

Experimental layout

Randomized Complete Block Design (RCBD) was used in the study with three replications. The treatments used were: T_1 (Farmer's practice with 2 Bags 14-14-14 and 2 bags Urea); T_2 (Pure Inorganic Fertilizer (recommended rate 50-40-60kg NPK/ha); T_3 (RR- Recommended Inorganic Fertilizer + 6 bags organic fertilizer); T_4 (Pure recommended rate using Organic Fertilizer based on the nutrient analysis at Bureau of Soils); T_5 (RR rate using Organic Fertilizer + concoctions i.e., FPJ and KAA); and T_6 (75% Inorganic Fertilizer (RR) + 25% recommended Organic Fertilizer (RR) based on nutrient analysis; T_7 (50% Inorganic Fertilizer (RR) + 50% recommended rate using Organic Fertilizer based on nutrient analysis; T_8 (25% Inorganic Fertilizer (RR) + 75% Organic Fertilizer based on nutrient analysis); T_9 (RR- Inorganic Fertilizer + concoctions (FPJ & KAA); and T_{10} (Farmers' practice + concoctions (FPJ & KAA).

Seed sowing and thinning

Seeds were drilled along the furrows at the rate 8-10 seeds per hill to ensure complete crop stand. Thinning was done one week after emergence leaving only five (5) vigorous plants per hill. The distance between hills is 35cm.

Fertilization

For T1 and T10, two bags of triple 14 were applied at basal and two bags of urea were applied 30 days after emergence (DAE). For T2,T3, T6 and T8, 2/3 of the recommended rate of N and the whole of P and K fertilizers requirement were basally applied, while the remaining 1/3 was applied at 30 DAE. For T7 and T8, the whole of NPK is applied basally. All solid organic fertilizers (Greenfriend) were applied basally. Organic concoctions were applied twice a week starting at tillering to panicle initiation.

Weeding and cultivation

Cultivation was done using an animal-drawn plow. Inter-row cultivation was done every after side dressing to cover the N fertilizer to minimize loss of fertilizer through volatilization. However, all plots (even those without side dressing) were cultivated to minimize bias results.

Irrigation

Supplementary irrigation was done when the soil is too dry i.e. in cases where there is no rain within two weeks to avoid prolonged water-stress among test plants.

Pest and disease management

Stem borers, rice bugs, rodents (field rats)were controlled using integrated pest management (IPM) strategies. Scare crow and old VHS tapes films were installed in the experimental area to minimize bird infestation.

Harvesting, threshing and drying

Harvesting was done when 80% of the grains were matured. Crops contained in harvest area (Fig.1) were harvested first and threshed separately for the determination yield component parameters and computed yield.

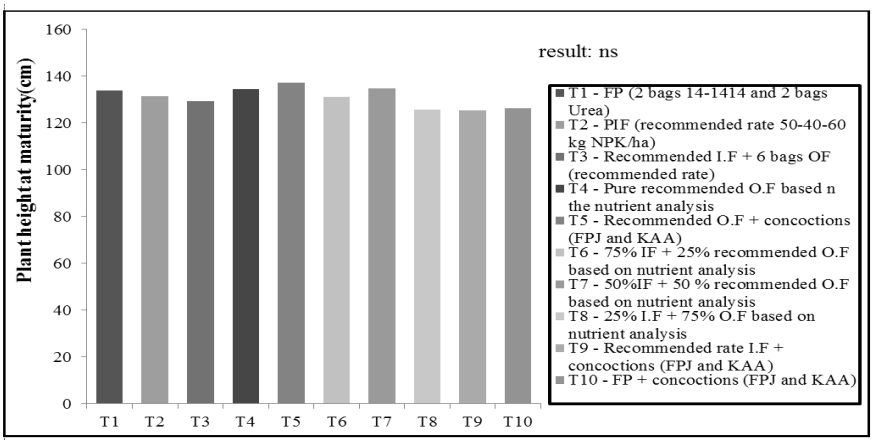

Fig. 1. Average height at maturity (cm) of upland rice (Aringay) using different nutrient management. CSU-Piat, Cagayan. November 2014.

Data Gathered

A. Agronomic Characteristics

1. Days to emergence – the number of days from sowing to 90 % of the seedling emergence.
2. Days to Flowering and Maturity – the days number of days from seed emergence to 80% of the experimental plants have flowered and matured were noted.
3. Height at Maturity – the same RS plants are measured from the base up to the tallest plant part.

B. Yield and Yield Component Parameters

1. Number of productive tillers – the total number of tillers of the 10 RS plants is counted at maturity; the total is divided by 10 to get the average.
2. Length of Panicles –the mother panicles of the 10 RS plants per treatment are measured, the total length is divided by 10 to get the average.
3. Number of Spikelet /panicle – the mother panicle of the 10 RS plants will be used in the determination of this data. The total number of spikelets will be divided into 10 to get the average.
4. Weights of 1000 seeds (g) – dried seeds taken from the pool of harvests per treatment are weighed. Four weighing trials were done and the average was recorded.
5. Computed yield (ton/ha) – the formula below is used in the determination and projection of yield per hectare:

Computed Yield (tons/ha) = E!

Other Supporting Data

Cost and Return Analysis – all expenses is recorded from and preparation to drying and the total cost is deducted from the sales to get the net income. Each treatment is treated separately.

Results and discussion

Theoretical NPK levels of treatments

The basis of applying different NPK levels of the different treatments are presented in Table 1.

Computations were made using the percentage basis or grade analysis of NPK of organic and inorganic fertilizer. Number of times spraying throughout the study period (frequency) was considered for those treatment with concoction. Output capacity of the knapsack sprayer was calibrated to compute the amount of NPK.

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

Treatments/Treatments Description	Amount of NPK kg/ha		
	N	P	K
T1=Farmers' practice	60.0	14.0	14.0
T2	50.0	40.0	60.0
T3	60.5	49.2	60.0
T4	50.0	40	60.0
T5	50.0	41.3	72.61
T6	48.2	40.0	60.0
T7	50.0	40.0	60.0
T8	50.0	40.0	60.0
T9	50.1	41.3	72.6
T10	60.1	15.3	26.6

Results revealed that Nitrogen/ha ranges from 48 to 60kg/ha. T2, T4, T5, T6, T7, T8 and T9 had almost the same N level (50kg/ha) while the other treatments T1, T3 and T10 have 60kg N/ha. For P_2O_5, T2, T3, T4, T5, T6, T7, T8 and T9 had 40-41kg/ha while T1 and T10 had 14kg to 15kg P_2O_5/ha. For K_2O level, it came out that T2, T3, T4, T5, T6, T7, T8 and T9 have a K2O level of 60-72kg/ha while T1 and T10 have the least K2O amount of 14-26kg/ha. Generally as to balance ratio of NPK T1 and T10 were the inferior treatments. However, these treatments have comparable N amount with the other treatments, and that their P and K was much lower (35%).

Average height of plants at maturity (cm).

Fig. 2 shows the average height of plants at maturity. This is done by measuring the base of the plants up to the tip most part of the plant.

As reflected in the table 1a, Treatment 5 attained the highest height with a mean of 137.27 followed by Treatment 7, Treatment 4, Treatment 1, Treatment 2, Treatment 6, Treatment 3, Treatment 10, and Treatment 8 and 9 with a height range of 125-135cm.

Differences are only numerical because analysis of variance reveals no significant difference among treatment means. The very reason for this is that, the N level variation of the treatments was only

minimal among treatments (48 to 60kg/ha). The minimal level of P and K in T1and T10 lower the height of plants as they are still statistically comparable to the other treatments.

Table 1b. Cost of fertilizers per treatment/ha.

Treatments	14-14-14	46-0-0	16-20-0	0-0-60	Organic fertilizer	Concoction	Total
I	1960	2040					4000
II		300.28	3800	1120			5220.28
III		300.28	3800	1120	1800		7020.28
IV					5485.68		5485.68
V					5485.68	189	5674.68
VI		300.28	2850	840	1371		5361.28
VII			1900	560	2742		5202
VIII		300.28	950	280	4113		5643.28
IX			3800	1120		189	5109
X	1960	2040				189	4189

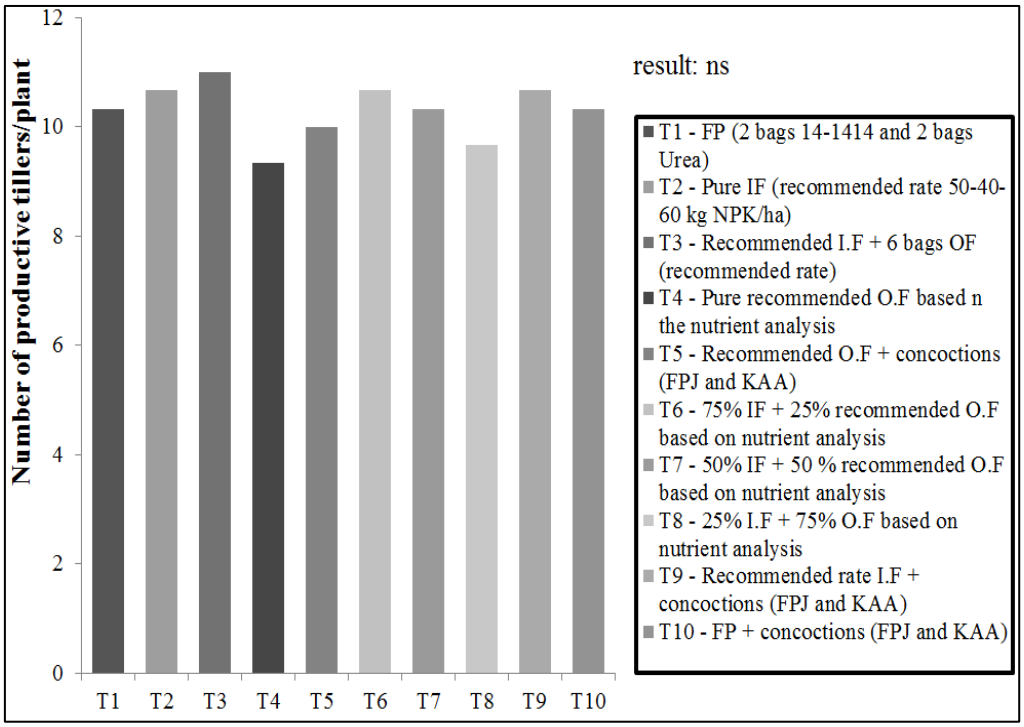

Fig. 2. Average number of productive tillers of upland rice (Aringay) using different nutrient management. CSU-Piat, Cagayan. November 2014.

Average number of productive tillers per hill

Fig. 3 shows the average number of productive tillers per plant. Table 2. Shows the average number of number of productive tillers per plant. No significant differences existed between treatments. Productive tillers/plant ranges from 9.33 to 11 tillers/plant.

This means that the actual NPK level amount of the different fertilizer treatments are within the biological requirement of the aringay upland rice and that nutrient stress was never experienced by the plants.

Average number of unproductive tillers

Fig. 4 shows the average unproductive tillers of rice. T4 obtained the highest number of unproductive tillers followed by T5 and T8, T1, T10, T2, T7, T6 and T9. T3 has the lowest mean of unproductive tillers. Likewise, the result revealed no significant differences existed between treatments. Values ranges from 0.13 to 0.6 number of tillers/hill which is very minimal. This means that the range of the NPK level of treatments is just enough to sustain the range of nutrient requirement of the upland rice crop (Aringay).

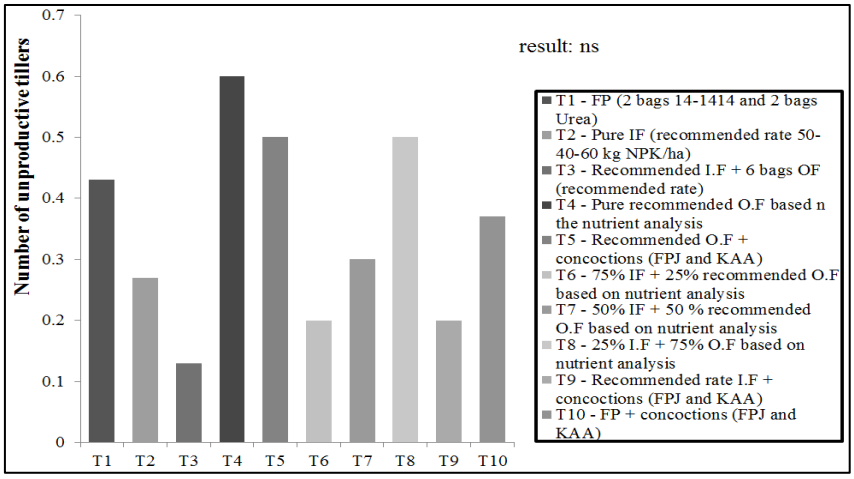

Fig. 3. Average number of unproductive tillers of upland rice (Aringay) using different nutrient management. CSU-Piat, Cagayan. November 2014.

Table 2. Cost and Return Analysis of 1 hectare Upland Rice (Aringay) at Different Nutrient Management.

Particulars	Treatments									
	I	II	III	IV	V	VI	VII	VIII	IX	X
A. Materials										
1. Seeds (Aringay)	2400	2400	2400	2400	2400	2400	2400	2400	2400	2400
2. Fertilizer (refer to table 2a)	4000	5220.28	7020.28	5485.68	5674.68	5361.28	5202	5643.28	5109	4189
B. Labor Cost										
Land Preparation										
Plowing	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500
Harrowing	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500
Furrowing	1114.84	1114.84	1114.84	1114.84	1114.84	1114.84	1114.84	1114.84	1114.84	1114.84
Fertilizer application (basal)	446.42	446.42	446.42	446.42	446.42	446.42	446.42	446.42	446.42	446.42
Fertilizer application (side dress)		446.42	446.42			446.42		446.42		
Planting	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
Irrigation	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500
Weeding	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500
Hilling up	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
Spraying decoction					1635.41				1635.41	1635.41
Harvesting and Thresher	3200	3200	3200	3200	3200	3200	3200	3200	3200	3200
Drying	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500
Sub Total	25661.3	27328	29128	27146.9	28971.4	27469	26863.3	27751	28405.7	27485.7
C. Contingency cost	2566.13	2732.8	2912.8	2714.69	2897.14	2746.9	2686.33	2775.1	2840.57	2748.57
D. Total cost of production	28227.4	30060.8	32040.8	29861.6	31868.5	30215.9	29549.6	30526.1	31246.2	30234.2
E. Gross sale	43560	47520	62040	39600	43560	48840	44880	43560	56760	46200
F. Net Income	15332.6	17459.2	29999.2	9738.37	11691.5	18624.1	15330.4	13033.9	25513.8	15965.8
G. ROI	54.32	58.08	93.63	32.61	36.69	61.64	51.88	42.70	81.65	52.81

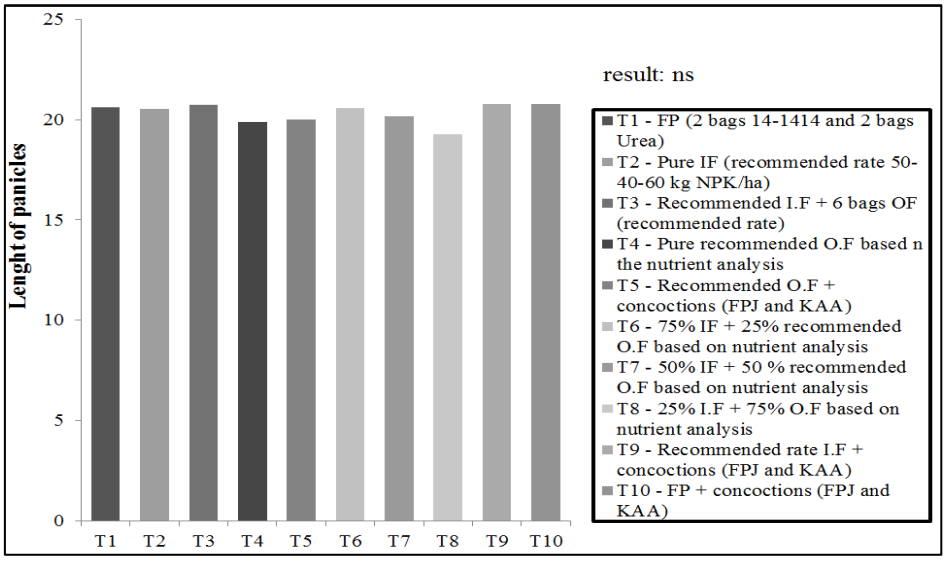

Fig. 4. Average length of panicles of upland rice (Aringay) using different nutrient management. CSU-Piat, Cagayan. November 2014.

Average length of panicles per plant

Fig. 5 shows the average length of panicles. This is done by measuring the above flag leaf at the lowest attachment of spikelet up to the tip most spikelet. Length of panicles ranges from 19.8 to 20.8cm. Likewise, the result analysis of variance reveals no significant difference among treatment means.

Average number of spikelets per panicle

Fig. 6 shows the average number of spikelet/plant. This is done by counting the mother panicle of the 10 RS plants. This was divided to 10 to get the average. Treatment 3 ranked first followed by Treatment 9, Treatment 6, Treatment 2, Treatment 7, Treatment 10, Treatment 1, Treatment 5, Treatment 8 and Treatment 4 with a mean of 139.96, 109.26, 107.33, 105.16, 102.6, 102, 101.26, 100.76, 99, and 91.13 respectively.

Analysis of variance reveals significant difference between treatment means. It was known that the relatively higher P and K amount of T_3 affected positively this parameter.

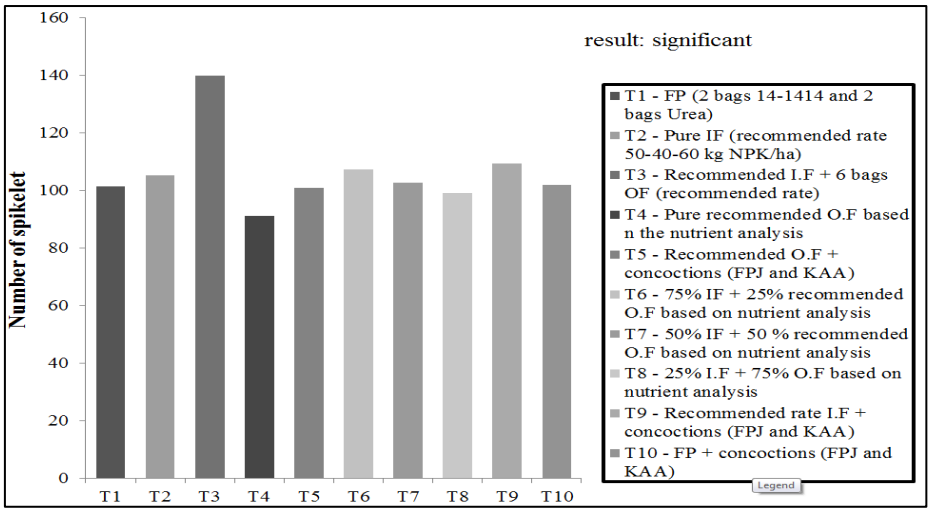

Fig. 5. Average number of spikelet of upland rice (Aringay) using different nutrient management. CSU-Piat, Cagayan. November 2014.

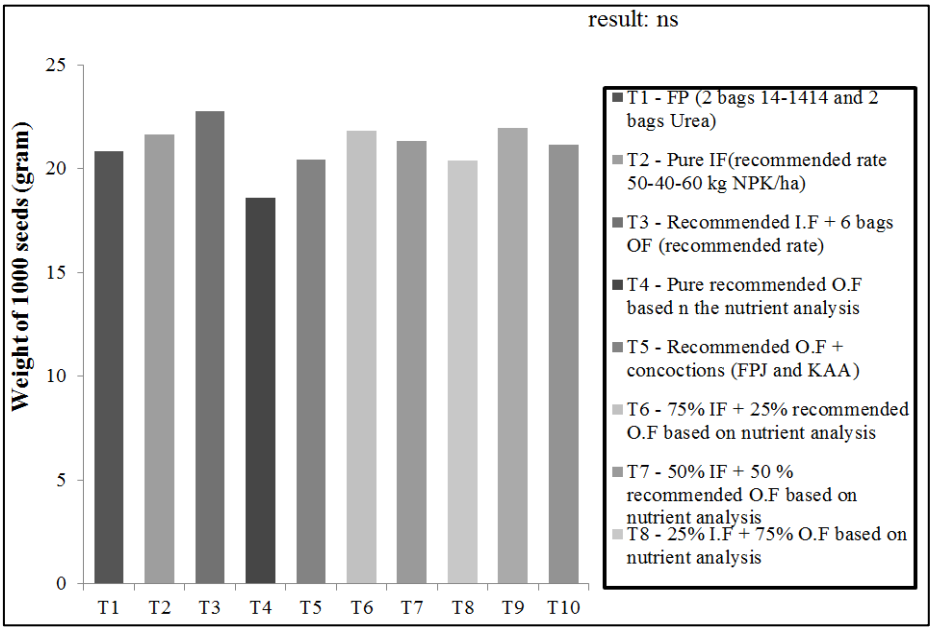

Fig. 6. Weight of 1000 seeds of upland rice (Aringay) using different nutrient management. CSU-Piat, Cagayan. November 2014.

Weight of 1000 seeds (gram)

Fig. 7 shows the weight of 1000 seeds. This is the parameter that described the seed size o weight per seed. Treatment 3 obtained the heaviest with a mean of 22.77 g as followed by T9, T6, T2, T7, T10, T1, T5, T8, and T4. The weight/1000 seeds range from 18.5 grams to 22.77 grams. Again, analysis of variance reveals no significant differences among and treatment means. This means that differences are only numerical and not statistically different.

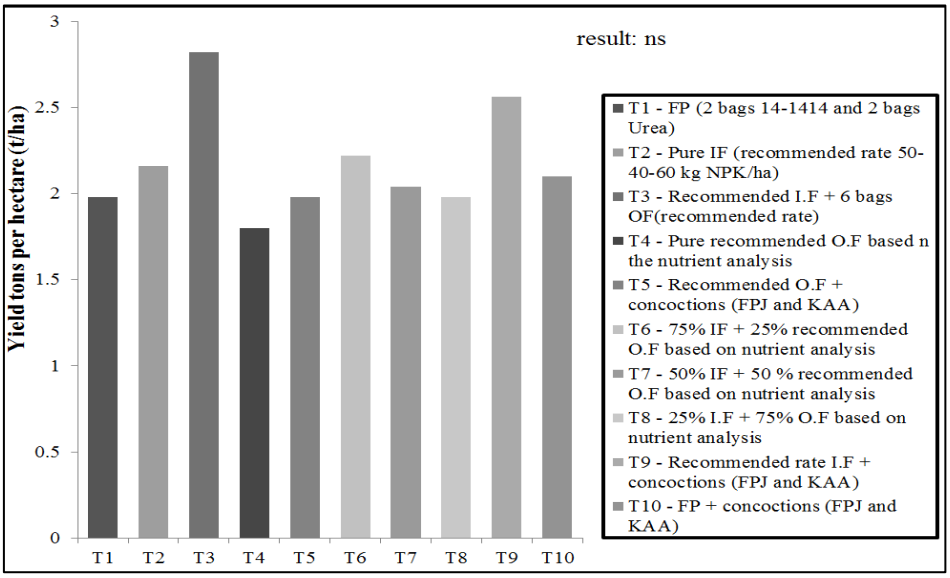

Fig. 7. Yield(t/ha) of upland rice (Aringay) using different nutrient management. CSU- Piat, Cagayan. November 2014.

Yield (t/ha)

Fig. 8 shows the yield in tons/hectare. The insignificant differences on the yield component parameters of the different treatments as presented in the preceding section made the yield to have no significant differences between treatments. Yield/ha ranges from 1.8 tons/ha to 2.82 tons/ha. Numerical differences of yield in all treatments are only by chance and not statistically significant.

The significantly higher number of spiklets/panicle in T3 did not affect increases in yield because all other yield component parameters are not significantly different. The joint effect of no significant result had pulled down the effect of the number of spiklets to increase significantly the yield. It could be inferred from the result that the NPK level requirement of aringay upland rice fall within the range of NPK levels of the fertilizer treatments.

Yield was not lowered if N level/ha is reduced from 60kg to 50kg/ha. Similarly, same conclusion could be derived on the P and K requirement of upland rice. The yield could not be positively affected if P and K level will be increased from 14kg to 49kg P/ha and 14kg to 72kg K/ha. Moreover, the minimal differences of the level of N among the treatments could be deduced to be the reason why the yield performances of treatments were statistically similar.

It could be safe to conclude that the Farmers practice (T_1 - 2 bags of 14-14-14 and 2 bags urea/ha) could be at par with the other treatments. Likewise, it could be inferred also from this study that Bureau of Soils recommendation of organic fertilizer and addition of concoction spray to rice has no positive effect to increase the yield of upland rice under CSU Piat condition.

Moreover, if farmers practice is sprayed with concoction, the yield was not also increased. Likewise, combination levels between inorganic and organic fertilizer did not also affect the increase in yield of upland rice. Yield on plants applied with pure recommended organic fertilizer (powder form) was found to be not significantly different with that of

farmers practice and the Bureau of Soils recommended rate using inorganic fertilizer. It should be stated that the effect of these nutrient management on long term basis with regards to soil chemical and textural characteristics could not be evaluated in this one cropping study. Long term studies along this line are recommended.

Cost and Return Analysis

The costs of the different materials used and the cost of their preparation were compared per hectare basis. The highest net income was obtained from T3 (Recommended Inorganic Fertilizer + 6 bags organic fertilizer (recommended rate), followed by T9 (Recommended rate Inorganic Fertilizer + concoctions (FPJ & KAA) with corresponding incomes P29,999.2 and P25,513.8, respectively. T6 (75% Inorganic Fertilizer +25% recommended Organic Fertilizer based on nutrient analysis), T2 (NPK recommended rate using inorganic fertilizer), T10 (Farmers' practice + concoctions (FPJ & KAA), T1(Farmers Practice), T7 (50% Inorganic Fertilizer + 50% recommended Organic Fertilizer based on nutrient analysis), T8 (25% inorganic + 75% concoction spray), T5 (recommended NPK using organic + spraying of concoction), and the lowest was obtained from T4 (recommended NPK using organic fertilizer) with corresponding incomes of P18,624.1, P17,459.2, P15,965.8, P15,332.6, P15,330.4, P15,330.4, P13,033.9 and P11,691.5. The highest ROI was obtained from T3 and T8 with 93.6 and 81.65. All other treatments gave an ROI ranges from 36.69 to 61.64. The lowest was obtained from T4 with 32.61. The results indicates that the farmers practice (T1) could be at more or less same level with the recommended rate of NPK using inorganic source as far as cost of fertilizer is concern.

Conclusion

In spite of the high variation of P and K, the yield result of upland rice did not affect significant differences among treatments. This means that the nitrogen level which is almost similar to all treatments (50-60kg N/ha) was the reason of the non-significant differences of yield. Yield is dependent on the added N element in the soil and not so much on P and K. Additional spray of concoction to recommended rate of any source (organic and inorganic) and to farmers practice did not increase yield of upland rice. The Bureau of Soil's recommendation was found tobe the highest yielder but farmer's practice is also accep table under CSU Piat condition since it is at par to the other fertilizer treatments. The higher cost of fertilizerin T3 has been compensated by a higher yield which resulted to higher net income.

Based from the result of the study, it could be concluded that the farmers practice (2 bags 14-14-14 + 2 bags urea) could be at par with the Bureau of Soils fertilizer recommendation of 50-60-60 kg NPK/ha. It could also be concluded that nitrogen level is important to be at the level of 50-60kg/ha in CSU Piat regardless of any source (organic or inorganic). P and K levels in CSU Piat could be as low as 14kg/ha without any decrease in yield from those fertilized with 60kg PK/ha. Concoction spray is only an additional cost to upland rice cost of production and not found to increase yield if compared to farmers practice.

Recommendation

It is recommended that the use of 40-60kg N/ha and 14kg of P and K for lesser cost upland rice production in CSU-Piat. In terms of ecological balance and environment sustainability, the use of organic-based fertilizer source is recommended. Though there was an insignificant difference in yield of upland rice applied with inorganic and organic fertilizer at the level of NPK mentioned above, the use of organic fertilizer is highly recommend as this conserve the physical and chemical characteristics.

References

Ahmad I. 1999. The Effect of Phosphorus Application in Different Proportions with Nitrogen on theGrowth and Yield of Maize. M.Sc. (Hons.) Agri. Thesis, Dep. of Agron. Univ of Agric. Faisalabad, Pakistan.

Celik H, Asik BB, Gurel S, Katkat AV. 2010. Potassium as an Intensifying Factor forIron Chlorosis.Int. J. Agric. Biol **12,** 359-364.

Devasenapathy P. 1997. Split Application of Potassium in Rice. Madras. Agric. J **84(5),** 265-266.

Squire GR, Ong CK, Monteith JL. 1997. Crop Growth in Semi-arid Environment. Proceedings of Seventh International Workshop, Held During 7-11 April 1997 at International Crops Research Institute for Semi-arid Tropics, Patancheru, Hyderabad.

Stefano P, Dris R, Rapparini F. 2004. Influence of Growing Conditions and Yield and Quality of Cherry. II. Fruit. J. Agric. And Env **2,** 307-309. Proceedings of the Annual Conference of Horticulture Society of Nigeria (HORTON), pp. 123-127.