Results of Upland Rice and Nutrient Uptake in Rainfed Lowland Due to Giving Potassium, Straw Compost and Cow Manure

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Abstract: The purpose of this study was to determine the effect of package Potassium fertilization, straw compost and cow manure on upland rice yield with planting time intervals follow the planting calendar in rainfed lowland at the third planting season. The research design is split plot design with three factors and two replications. The main plot is planting time with three levels, T1: September day 10th, T2: September day 20th, T3: September day 30th. Sub-plots were fertilization package treatment with six levels: K1: without Potassium and compost, K2: 50 kg ha^{-1} KCl, K3: 5 t ha^{-1} straw compost, K4: 2.5 t ha^{-1} straw compost + 2.5 t ha^{-1} cow manure compost, K5: 50 kg ha^{-1} KCl + 5 t ha^{-1} straw compost, K6: 50 kg ha^{-1} KCl + 2.5 t ha straw compost + 2.5 t ha^{-1} cow manure compost. Sub-sub-plots were eight rice varieties, V1: Situbagendit, V2: Towuti, V3: Batutegi, V4: Inpago 8, V5: Inpago 9, V6: Inpago 10, V7: Ciherang, V8: Inpari 10. The results showed that interaction of the three treatment factors had a significant effect on grain yield and Phosphorus uptake. The highest grain yield was obtained at planting time in September day 10th, fertilizing packages straw compost 5 t ha^{-1}, Inpago 9 variety (9.24 t ha^{-1}) and planting time in September day 10th , fertilizing packages KCl 50 kg ha^{-1} + straw compost 2.5 t ha^{-1} + cow manure 2.5 t ha^{-1}, Inpago 9 variety (9.01 t ha^{-1}).

1 INTRODUCTION

Rice is a national staple crop and mostly consumed by Indonesians people. Generally, efforts to increase rice production in various regions are focused on irrigated land, namely paddy fields, where water is always available throughout the season. However, the production rate still does not meet national needs and even shortages occur due to pests and diseases, droughts, and natural disasters such as floods. Upland rice is a dry land type that is tolerant to drought or without flooding such as wetland rice. Growth of upland rice is very dependent on climate factors, especially rainfall. Generally, upland rice is planted in dry land where the intensity and distribution of rainfall are erratic. One criterion of rice varieties that can grow well in limited rainfall environments is drought tolerant and is able to maintain greenness during drought. The average productivity of upland rice on dry land is 2.56 tons ha^{-1}, while the average productivity of rice in irrigated fields is 4.57 tons ha^{-1}.

Rainfed lowland has the potential to develop and increase rice production. Upland rice cultivation in rainfed lowland is expected to contribute to national rice production. Some obstacles in rainfed lowland are having irrigation which is very dependent on rainfall. In general, rainfed lowland has a low K content (Saha *et al*., 2009 and Subandi, 2013), due to absence of K supply from irrigation water and outside transport of plant residues to the field. Potassium supply in the soil can be reduced due to three things, namely Potassium uptake by plants, Potassium leaching by water, and soil erosion. In the dry season or inundated conditions in reinfed area, Potassium in soil solutions is in balance with K adsorbed by clay. During the rainy season, flooding can increase the availability of K and produce Fe^{2+} and Mn^{2+} which in large quantities can replace K adsorbed by clay so that K is released into the solution and available to plants. (Prasetyo *et al*., 2004). Input K is absolutely needed in crop farming systems, especially in soils with low Potassium availability. The main function of Potassium is to help the development of roots, process

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of protein formation, increases plant resistance to disease and stimulates grain filling. Potassium has important role in metabolic processes, from photosynthesis; assimilate translocation to formation of starch, proteins, and enzyme activators (Prajapati and Modi, 2012; Ashley *et al*., 2006)

Generally, Potassium contained in inorganic fertilizers is quickly available to plants, if managed appropriately (Subandi, 2013). However, with the increasing cost of inorganic fertilizers, especially KCl, straw compost can be used as substitute. In reinfed lowland rice, nutrient sources of Potassium come from fertilizer inputs or returning straw to the field (Wihardjaka *et al*., 2002). Potassium management can be performed with Potassium fertilizer input along with organic matter such as straw compost and manure. The use of organic matter can reduce NPK inorganic fertilizers (Magdalena *et al*, 2013; Sarno, 2009; Sarkar *et al*., 2017). Rice straw is a Potassium source which is easily obtained and available relatively in large number. Each rice harvesting time, straw will be produced with a grain weight-straw ratio is 2/3 (Cosico, 1985).

Appropriate planting time is one of the determinants of crop success and increased productivity of crops. Local wisdom and conventional methods used to apply cropping patterns have been biased due to a shift in the beginning of the planting season. The Agricultural Research and Development Agency has been developed an Integrated Cropping Calendar System to answer fundamental problems related to security and increase national rice production to face variability and climate change (Runtunuwu *et al*., 2012). To anticipate the above conditions, the development of upland rice production on reinfed land needs attention. Therefor this research was conducted to determine the productivity of upland rice with Potassium and compost inputs, as well as planting time in rainfed lowland.

2 MATERIALS AND METHODS

The research was conducted in rainfed lowland at the third planting season in Serdang Village, Beringin Sub-district, Deli Serdang Regency, Sumatera Utara Province. The research design is split split plot design with three factors and two replications. The main plot is planting time with three levels, T1: September day 10th, T2: September day 20th, T3: September day 30th. Sub-plots were fertilization package treatment consisted of 6 levels: K1 : without Potassium and compost, K2 : 50 kg ha^{-1} KCl, K3 : 5 t ha^{-1} straw compost, K4 : 2.5 t ha^{-1} straw compost + 2.5 t ha^{-1} cow manure compost, K5 : 50 kg ha^{-1} KCl + 5 t ha^{-1} straw compost, K6 : 50 kg ha^{-1} KCl + 2.5 t ha straw compost + 2.5 t ha^{-1} cow manure compost. Sub-sub-plots were rice varieties, V1: Situbagendit, V2: Towuti, V3: Batutegi, V4: Inpago 8, V5: Inpago 9, V6: Inpago 10, V7: Ciherang, V8: Inpari 10. Totally, there are 144 different treatments. Plant nutrient uptake was observed at 55 days after planting.

Application of straw compost and cow manure is one week before planting with a fertilizer package according to treatment. Size of the experimental plot is 4 x 5 meters, with *jajar legowo planting system* 2: 1 (20 cm - 40 cm) x 15 cm (20 cm inter row *legowo* spacing, 40 cm spacing between 2 *legowo*, 15 cm in row *legowo* spacing). Seedling age is 10 days with 3 seedlings per planting hole. Urea fertilizer (45% N) is 250 kg ha^{-1}, SP 36 (30% P_2O_5) 75 kg ha^{-1} and KCl (60% K_2O) according to treatment. Fertilization I (7 days after planting) is 1/3 part of Urea + SP 36 + 1/2 part of KCl, fertilizing II (30 days after planting) is 1/3 part of Urea, and fertilizing III (40 days after planting) is the rest of Urea and KCl. Control of pests and diseases as well as weeds is following the concept of integrated pest, disease and weed control. Weather data at the research site was obtained using the automatic weather station device - Davis Vantage Pro 2 made in US - which is a weather station for recording climate data with a radius of 200 m. The number of rainy days and rainfall during planting are displayed on a weekly basis per month.

The variables observed included: (1) K nutrient using the Atomic Absorption Spectrophotometer; P nutrient using Spectrophotometry. Nutrient uptake = nutrient content (%) x canopy dry weight (g), then converted into kilograms per hectare. (2) The grain yield is taken from a sample plot size of 2 m x 2 m. Rice grain weight is converted to tonnes per hectare using the formula: grain weight (kg ha^{-1}) = [grain weight of sample plot size (kg)/sample plot size x 10.000]/1.000. The rice grain weight is then calculated by adjusted with water content of 14% using formula as stated by Gomez (1972) : adjusted grain weight = A x W; where A = adjustment coefficient (A = [(100-M) / 86]); M = grain water content (%) measured by moisture meter (TS - D1 model, Tokyo Rika Kogyosho Co, Ltd, Japan), and W = harvested grain weight.

Data were analyzed statistically using F test and continued with the Duncan Multiple Range Test (DMRT) at the level of significance 5%. Correlation and regression test were conducted to find out the relationship between variables.

3 RESULTS AND DISCUSSION

3.1 Experimental Site Conditions

Serdang Village, Beringin Sub-district, Deli Serdang Regency, Sumatera Utara Province is located at coordinates 3°38'32 and 98°49'43", and ± 5 meters above sea level. Average annual rainfall is 1900 mm, number of wet months is > 200 mm for 5 months and dry month is < 100 mm for 4 months. The average temperature is 26-28 °C with maximum air temperature 30-34 °C and minimum 23-26 ° C. Soil types is *Typic Endoaquepts*, which clay texture and medium water holding capacity. pH (H_2O) 5.4 (slightly acid), cation exchange capacity 26.85 me 100 g^{-1} (high). Fertility rate is N total 0.10% (low), P-available 19.26 ppm (moderate), K exchangeable bases 0.26 me 100 g^{-1} (low), Na 0.36 me 100 g^{-1} (medium), Ca 9.98 me 100 g^{-1} (high), Mg 3.81 me 100 g^{-1} (high), Zn 6.8 ppm (very low), and Al is not detected. Straw compost contains N 1.30%, P 1.02%, K 3.02%, and C organic 14.90%. Cow manure contains N 1.02%, P 1.09%, K 2.91%, and C organics 12.53%.

Weekly rainfall and rainy days data are presented from September 2016 to January 2017 during research. The third planting season showed the amount of rainfall is 80 times with a total rainfall of 1273.73 mm, with the highest rainfall from September to October. The maximum tiller phase in all planting time treatments is in from September to October. This relatively high of rainfall distribution is very beneficial for vegetative growth of clump formation until panicle initiation, because water is available during its growth period.

3.2 Nutrient Uptake and Grain Yield

Planting time, fertilization, and varieties had significant effect on Potassium uptake ($p < 0.01$), Phosphorus uptake ($p < 0.01$), and grain yield ($p < 0.01$). Interaction of planting time and fertilizing, as well as fertilization and varieties had significant effect on Phosphorus uptake ($p < 0.01$) and grain yield ($p < 0.01$). Interaction of planting time and varieties had a significant effect on Potassium uptake ($p < 0.05$), Phosphorus uptake ($p < 0.01$) and grain yield ($p < 0.01$). Interaction of planting time, fertilizing, and varieties did not show significant effect on Potassium uptake, but has significant effect on Phosphorus uptake ($p < 0.01$) and grain yield ($p < 0.01$).

The effect of planting time shows that the highest Potassium uptake is at September day 10th, which is 243.28 kg ha^{-1} and significantly different from other planting times. The highest Phosphorus uptake was obtained at September day 10th and September day 20th (56.81 and 55.94 kg ha^{-1}) that is significantly different to September day 30th (51.75 kg ha^{-1}). The highest grain yield was obtained at planting on September 10th day (8.30t ha^{-1}), and significantly different to September day 20th and September day 30th (8.14 and 7.31t ha^{-1}).

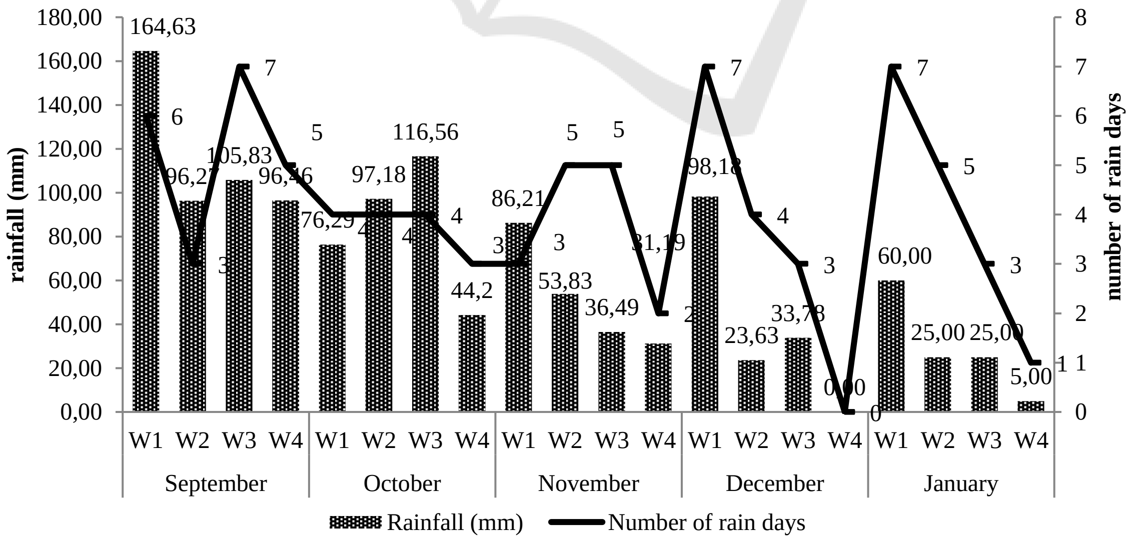

Figure 1: Graph of rainfall and rainy days in Serdang Village, Regency of Deli Serdang, North Sumatra from September 2016 - January 2017.

Table 1: The effect of planting time and varieties on Potassium and Phosphorus uptake, and grain yield.

Planting time	Potassium uptake (kg ha^{-1})	Phosphorus uptake (kg ha^{-1})	Grain yield (t ha^{-1})	Varieties	Potassium uptake (kg ha^{-1})	Phosphorus uptake (kg ha^{-1})	Grain yield (t ha^{-1})
September day 10th	243.28 a	56.81 a	8.30 a	Situbagendit	210.88 cd	56.22 b	8.02 ab
September day 20th	202.95 b	55.94 a	8.14 b	Towuti	199.46 d	51.55 c	7.86 c
September day 30th	194.73 b	51.75 b	7.31 c	Batutegi	259.66 a	59.80 b	7.99 b
				Inpago 8	200.72 d	46.70 d	8.03 ab
				Inpago 9	240.53 b	66.07 a	8.09 a
				Inpago 10	210.63 cd	58.78 b	7.97 b
				Ciherang	165.60 e	42.92 d	7.59 e
				Inpari 10	221.74 c	56.63 b	7.78 d

Note: The numbers followed by the same letters in the same group show no significant difference according to the DMRT Test at the level of α 0.05.

Table 2: The effect of fertilization on Potassium and Phosphorus nutrient uptake, and grain yield.

Fertlilizer	Potassium uptake (kg ha^{-1})	Phosphorus uptake (kg ha^{-1})	Grain yield (t ha^{-1})
0 kg ha^{-1} KCl + 0 t ha^{-1} compost	107.94 f	31.03 e	7.15 e
50 kg ha^{-1} KCl + 0 t ha^{-1} compost	154.56 e	34.01 d	7.56 d
0 kg ha^{-1} KCl + 5 t ha^{-1} straw compost	217.67 d	59.58 c	8.07 c
0 kg ha^{-1} KCl + 2.5 t ha^{-1} straw compost + 2.5 t ha^{-1} cow manure	250.30 c	63.86 b	8.03 c
50 kg ha^{-1} KCl + 5 t ha^{-1} straw compost	266.47 b	69.10 a	8.39 a
50 kg ha^{-1} KCl + 2.5 t ha^{-1} straw compost + 2.5 t ha^{-1} cow manure	284.98 a	71.41 a	8.31 b

Note: The numbers followed by the same letters in the same group show no significant difference according to the DMRT Test at the level of α 0.05.

Varieties treatment show that Batutegi variety had the highest Potassium uptake (259.66 kg ha^{-1}), significantly different from other varieties. Ciherang, a rice variety that is usually planted by farmers in the experimental sites, show the lowest uptake of Potassium and Phosphorus (165.60 kg ha^{-1} and 42.92 kg ha^{-1}), and produce the lowest grain of 7.59 t ha^{-1}. The highest Phosphorus uptake was obtained in varieties Inpago 9 (66.07 kg ha^{-1}), which is significantly different from other varieties. The highest grain yield was obtained in varieties Inpago 9 (8.09 t ha^{-1}), which is not significantly different from Situbagendit and Inpago 8 (8.02 t ha^{-1} and 8.03 t ha^{-1}) (Table 1).

Fertilization treatment show that the highest Potassium uptake (284.98 kg ha^{-1}) is fertilizing packages KCl 50 kg ha^{-1} + straw compost 2.5 t ha^{-1} + cow manure 2.5 t ha^{-1} that is significantly different from other fertilizers. The highest Phosphorus uptake was obtained at KCl 50 kg ha^{-1} + straw compost 5 t ha^{-1} and KCl 50 kg ha^{-1} + straw compost 2.5 t ha^{-1} + cow manure 2.5 t ha^{-1} (69.10 and 71.41 kg ha^{-1}), that is significantly different from other fertilizers. The highest grain yield (8.39 t ha^{-1}) was obtained at KCl 50 kg ha^{-1} + straw compost 5 t ha^{-1}, that is significantly different from other treatments (Table 2).Interaction of planting and fertilizing time showed the highest Potassium uptake (340.84 kg ha^{-1}) was planting time at September day 10th, fertilization package straw compost 2.5t ha^{-1} + cow manure 2.5t ha^{-1} and September 10th day, fertilizer package KCl 50 kg ha^{-1} + straw compost 2.5 t ha^{-1} + cow manure 2.5 t ha^{-1} (328.37 kg ha^{-1}), which is significantly different from other treatments. The highest Phosphorus uptake (74.63 kg ha^{-1}) is planting time at September 20th day , fertilizing package KCl 50 kg ha^{-1} + straw compost 2.5 t ha^{-1} + cow manure 2.5 t ha^{-1}, which is not significantly different from September day 20th, fertilizing package KCl 50 kg ha^{-1} + straw compost 5 t ha^{-1} (72.21 kg ha^{-1}), and September day 10th with fertilizing packages KCl 50 kg ha^{-1} + straw compost 2.5 t ha^{-1} + cow manure 2.5 t ha^{-1} (70.89 kg ha^{-1}) and fertilizing package straw compost 2.5 t ha^{-1} + cow manure 2.5 t ha^{-1} (69.34 kg ha^{-1}). The highest grain yield was obtained at planting time in September day10th with a package of fertilizing KCl 50 kg ha^{-1} + straw compost 5 t ha^{-1} (8.79 t ha^{-1}), which is not significantly different to September day 10th with fertilization package straw compost 5 t ha^{-1}, KCl 50 kg ha^{-1} + straw compost 2.5 t ha^{-1} + cow manure 2.5 t ha^{-1}, and straw compost 2.5 t ha^{-1} + cow manure 2.5 t ha^{-1}, respectively (8.76; 8.75; 8.68 t ha^{-1}) (Table 3).

Table 3: The interaction of planting time and fertilizer on Potassium and Phosphorus uptake, and grain yield.

Fertilizer	Planting time								
	Sept day 10th	Sept day 20th	Sept day 30th	Sept day 10th	Sept day 20th	Sept day 30th	Sept day 10th	Sept day 20th	Sept day 30th
	Potassium uptake (kg ha^{-1})			Phosphorus uptake (kg ha^{-1})			Grain yield (t ha^{-1})		
K1	104.64 e	112.77 e	106.41 e	33.20 gh	29.8 o-h	30.07 h	7.27 h	7.39 g	6.78 j
K2	163.54 d	153.06 d	147.07 d	38.73 g	31.15 h	32.15 gh	7.53 f	7.84 de	7.31 gh
K3	257.29 b	204.01 c	191.71 c	62.52 cde	66.06 b-e	50.17 f	8.68 a	8.41 bc	7.12 i
K4	340.84 a	208.16 c	201.92 c	69.34 abc	61.78 de	60.48 e	8.76 a	8.31 c	7.01 i
K5	265.01 b	272.03 b	262.37 b	66.15 b-e	72.21 ab	68.92 a-d	8.79 a	8.49 b	7.89 d
K6	328.37 a	267.66 b	258.90 b	70.89 ab	74.63 a	68.71 a-d	8.75 a	8.43 b	7.76 e

Note: K1 = without Potassium and compost, K2 = 50 kg ha^{-1} KCl, K3 = 5 t ha^{-1} straw compost, K4 = 2.5 t ha^{-1} straw compost + 2.5 t ha^{-1} cow manure compost, K5 = 50 kg ha^{-1} KCl + 5 t ha^{-1} straw compost, K6 = 50 kg ha^{-1} KCl + 2.5 t ha straw compost + 2.5 t ha^{-1} cow manure compost. The numbers followed by the same letters in the same group show no significant difference according to the DMRT Test at the level of α 0.05.

Table 4: The interaction of planting time and varieties on Potassium and Phosphorus uptake, and grain yield.

Varieties	Planting time								
	Sept day 10th	Sept day 20th	Sept day 30th	Sept day 10th	Sept day 20th	Sept day 30th	Sept day 10th	Sept day 20th	Sept day 30th
	Potassium uptake (kg ha^{-1})			Phosphorus uptake (kg ha^{-1})			Grain yield (t ha^{-1})		
Situbagendit	247.18 cd	198.05 fgh	187.42 ghi	64.62 bc	55.51 d-h	48.53 g-j	8.55 a	8.21 cd	7.30 j
Towuti	229.44 cde	187.81 ghi	181.13 hi	47.56 hij	53.30 d-h	53.78 d-h	8.07 ef	8.17 de	7.35 ij
Batutegi	278.01 b	252.93 bc	248.03 cd	66.36 b	59.46 b-e	53.57 d-h	8.24 cd	8.20 cde	7.55 h
Inpago 8	229.32 cde	191.11 fgh	181.74 ehi	40.74 jk	52.46 e-h	46.89 hij	8.41 b	8.21 cd	7.46 hi
Inpago 9	303.66 a	213.96 efg	203.98 e-h	78.11 a	61.20 b-e	58.90 b-f	8.55 a	8.34 bc	7.40 ij
Inpago 10	220.26 def	209.29 e-h	202.33 e-h	62.30bcd	60.54 b-e	53.49 d-h	8.35 bc	8.19 de	7.38 ij
Ciherang	182.65 hi	161.11 ij	153.05 j	36.47 k	50.14 ghi	42.14 ijk	7.92 g	7.87 g	6.98 k
Inpari 10	255.73 bc	209.33 e-h	200.15 e-h	58.27 b-f	54.90 d-h	56.71 c-g	8.30 bcd	7.96 fg	7.10 k

Note: The numbers followed by the same letters in the same group show no significant difference according to the DMRT Test at the level of α 0.05.

Interaction of planting time and variety, showed the highest Potassium uptake at planting time on September day 10th and Inpago 9 variety (303.66 kg ha^{-1}), which is significantly different from other treatments. The highest Phosphorus uptake at planting time on September day 10th and Inpago 9 variety (78.11 kg ha^{-1}), which is significantly different from the other treatments. The highest grain yield was also at planting time of September day 10th, Inpago 9 and Situbagendit varieties, each 8.55 t ha^{-1} and significantly different from other treatments (Table 4).

Interaction of fertilization and varieties showed that the highest Potassium uptake (334.49 kg ha^{-1}) is fertilizing package of KCl 50 kg ha^{-1} + straw compost 5 t ha^{-1} and Inpago 9 variety, which is not significantly different from Situbagendit and Batutegi varieties, as well as fertilizing packages KCl 50 kg ha^{-1} + straw compost 2.5 t ha^{-1} + cow manure 2.5 t ha^{-1} in varieties of Situbagendit, Towuti, Batutegi, and Inpago 9 (296.36; 318.38; 318.42; and 299.42 kg ha^{-1}), then fertilizing packages straw compost 2.5 t ha^{-1} + cow manure 2.5 t ha^{-1} in Batutegi variety (308.75 kg ha^{-1}). The highest Phosphorus uptake was fertilizing packages of KCl 50 kg ha^{-1} + straw compost 2.5 t ha^{-1} + cow manure 2.5 t ha^{-1} in Inpago 10 variety (90.44 kg ha^{-1}), which is not significantly different from KCl 50 kg ha^{-1} + straw compost 5 t ha^{-1} in Inpago 8, Inpago 9, and Inpago 10 varieties (82.03; 85.77; 81.13 kg ha^{-1}), and straw compost 5 t ha^{-1} in Inpago 8.

The highest grain yield was obtained on KCl 50 kg ha^{-1} + straw compost 2.5 t ha^{-1} + cow manure 2.5 t ha^{-1} on Inpago 9 (8.56 t ha^{-1}), which is not significantly different from Situbagendit, Towuti, Batutegi, Inpago 8, and Inpago 10 varieties (8.44; 8.38; 8.48; 8.55; 8.40 t ha^{-1}), as well as fertilizing packages KCl 50 kg ha^{-1} + straw compost 5 t ha^{-1} in Situbagendit, Towuti, Batutegi, Inpago 8, and Inpago 10 varieties (8.51; 8.41; 8.52; 8.46; 8.50 t ha^{-1}) (Table 5).

Table 5: The interaction of fertilizer and varieties to Potassium and Phosphorus uptake, and grain yield.

Fertlilizer	Varieties							
	Situbagendit	Towuti	Batutegi	Inpago 8	Inpago 9	Inpago 10	Ciherang	Inpari 10
Potassium uptake (kg ha^{-1})								
K1	93.06 wx	104.12 vwx	144.84 s-v	92.42 wx	129.21 t-w	115.49 u-x	85.45 x	98.94 wx
K2	130.23 t-w	145.35 s-v	194.70 n-q	129.08 t-w	190.37 o-r	161.41 q-t	123.69 t-x	161.63 q-t
K3	209.27 m-p	179.10 p-s	280.67 b-h	210.19 l-p	237.71 i-m	212.74 k-p	153.36 r-u	258.33 d-j
K4	236.40 i-n	221.93 j-o	308.75 abc	243.33 h-m	252.00 g-l	254.96 f-k	223.07 j-o	261.99 d-j
K5	299.97 a-d	227.87 i-o	310.57 abc	259.34 d-j	334.49 a	269.07 c-i	172.93 p-s	257.50 e-j
K6	296.36 a-f	318.38 ab	318.42 ab	269.98 c-i	299.42 a-e	250.09 g-m	235.13 i-n	292.04 b-g
Phosphorus uptake (kg ha^{-1})								
K1	29.97 p	34.37 op	60.09 h-k	68.82 e-i	73.98 b-g	70.09 d-h	29.97 p	34.37 op
K2	31.05 p	31.98 p	47.45 lmn	52.60 jkl	76.50 b-f	69.71 d-h	31.05 p	31.98 p
K3	31.41 p	36.42 nop	68.88 e-i	79.99 a-f	68.25 f-i	73.82 b-g	31.41 p	36.42 nop
K4	30.05 p	31.20 p	57.09 i-l	54.20 jkl	54.93 jkl	52.71 jkl	30.05 p	31.20 p
K5	33.30 op	39.63 m-p	74.54 b-g	82.03 a-d	85.77 ab	81.13 a-e	33.30 op	39.63 m-p
K6	31.08 p	31.70 p	68.84 e-i	62.53 g-j	68.09 f-i	90.44 a	31.08 p	31.70 p
Grain Yield (t ha^{-1})								
K1	7.10 o	6.91 p	7.18 no	7.21 no	7.25 m	7.16 no	7.20 no	7.16 no
K2	8.03 f-k	7.12 no	7.68 m	7.75 lm	7.88 kl	7.66 m	7.05 op	7.32 n
K3	8.05 e-k	8.25 b-e	8.18 d-h	8.20 d-g	8.22 c-f	8.03 f-k	7.64 m	7.98 h-k
K4	8.00 g-k	8.11 e-j	7.93 i-l	7.99 g-k	8.10 e-k	8.10 e-k	7.89 jkl	8.09 e-k
K5	8.51 a	8.41 abc	8.52 a	8.46 a	8.56 a	8.50 a	8.13 e-i	8.06 e-k
K6	8.44 ab	8.38 a-d	8.48 a	8.55 a	8.56 a	8.40 abc	7.62 m	8.09 e-k

Note: K1 = without Potassium and compost, K2 = 50 kg ha^{-1} KCl, K3 = 5 t ha^{-1} straw compost, K4 = 2.5 t ha^{-1} straw compost + 2.5 t ha^{-1} cow manure compost, K5 = 50 kg ha^{-1} KCl + 5 t ha^{-1} straw compost, K6 = 50 kg ha^{-1} KCl + 2.5 t ha straw compost + 2.5 t ha^{-1} cow manure compost. The numbers followed by the same letters in the same group show no significant difference according to the DMRT Test at the level of α 0.05.

Interaction of three factors of planting time, fertilization, and varieties show that the highest Phosphorus uptake is at planting time on September day 10th, fertilizing package straw compost 2.5 t ha^{-1} + cow manure 2.5 t ha^{-1}, Inpago 9 variety (115.29 kg ha^{-1}), which is not significantly different from Batutegi varieties (107.18 kg ha^{-1}), and planting time on September day 10th, package of fertilizing compost straw 5 t ha^{-1}, Inpago 9 variety (112.81 kg ha^{-1}), and September day 10th, fertilizing package KCl 50 kg ha^{-1} + straw compost 5 t ha^{-1}, Inpago 9 variety (101.81 kg ha^{-1}) (Table 6). Interaction of three factors of planting time, fertilization, and varieties showed the highest grain yield (9.24 kg ha^{-1}) is obtained during planting on September day 10th, straw compost 5 t ha^{-1}, Inpago 9 variety, which is not significantly different from planting time September day 10th, KCl 50 kg ha^{-1} + straw compost 2.5 t ha^{-1} + cow manure 2.5 t ha^{-1}, Inpago 9 variety (9.01 kg ha^{-1}) (Table 7).

Planting time has greatly effect on Potassium and Phosphorus uptake, and grain yield. Based on planting time, September day 10th and September day 20th showed higher grain yields compared to day September 30th. Increasing the rate of nutrient uptake of Potassium and Phosphorus, caused by the high distribution of rainfall at the beginning of the planting season in September to October. Plants get enough water for vegetative and generative growth, namely the formation of maximum tillers and initiation of panicles until flowering. As a result of the water supply during the rainy season, there is an increase in soil water content and an increase in the concentration of Potassium and Phosphorus is available.

As a result of flooding, K adsorbed by clay will be released into the soil solution. Inundation produces large amounts of Fe^{2+} and Mn^{2+} which can replace K adsorbed by clay so that K is released into the solution and available to plants. The statement of Shrestha *et al*. (2011) that the determination of the beginning of the right planting time can overcome the loss of plant nutrients, especially during the transition from the dry season to the rainy season. Therefore, planting time on September day 10th and September day 20th guarantees the availability of water until generative phase which is a critical phase of water availability.

Increased uptake of Potassium and Phosphorus occurs due to increased plant biomass (Bustami *et al*., 2012). Rice biomass production rate is proportional to mineral content on each part of the plant as a result of changes in plant physiology status following growth phases and environmental conditions such as nutrient availability in the soil during. Low dry weight is caused by inhibited vegetative growth due to low nutrients uptake which effects the plant growth.

Table 6: The interaction of three factors of planting time, fertilizer, and varieties on Phosphorus uptake.

Fertlilizer	Phosphorus uptake (kg ha^{-1})							
	Varieties							
	Situbagendit	Towuti	Batutegi	Inpago 8	Inpago 9	Inpago 10	Ciherang	Inpari 10
September day 10th								
K1	31.11 qrs	32.03 qrs	36.30 o-s	31.68 qrs	37.74 n-s	33.07 qrs	30.48 rs	33.19 qrs
K2	41.18 i-s	35.53 p-t	42.30 l-t	31.14 qrs	48.91 j-s	35.78 o-s	31.78 qrs	43.21 k-s
K3	71.42 d-j	31.89 qrs	78.51 c-h	49.11 j-s	112.81 ab	66.72 e-k	29.55 rs	60.15 g-n
K4	80.23 b-h	38.68 m-s	107.18 ab	43.02 k-s	115.29 a	78.54 c-h	32.90 qrs	58.87 g-o
K5	88.03 b-e	82.34 b-g	59.41 g-o	39.80 m-s	101.81 ab	52.65 i-r	42.95 k-s	62.26 f-m
K6	75.75 c-i	64.88 e-l	74.48 d-j	49.69 j-s	100.13 bc	107.04abc	51.18 j-s	91.98 bcd
September day 20th								
K1	28.94 s	30.51 rs	29.12 s	28.32 s	29.34 s	30.42 rs	30.68 qrs	31.10 qrs
K2	32.43 qrs	28.79 s	33.10 qrs	31.13 qrs	33.49 qrs	28.96 s	29.48 rs	31.79 qrs
K3	61.21 g-m	60.46 g-n	78.21 c-h	67.96 e-k	57.77 h-p	85.78 b-f	58.98 g-o	58.10 h-p
K4	65.15 e-l	59.28 g-o	64.14 f-l	60.30 g-n	58.78 h-p	63.26 f-m	62.52 f-m	60.79 g-n
K5	71.42 d-j	68.75 d-k	68.50 d-k	63.91 f-l	87.69 b-e	88.88 b-e	60.52 g-n	68.03 e-k
K6	73.94 d-j	72.02 d-j	83.66 b-g	63.11 f-m	91.17 bcd	65.95 e-k	58.68 h-p	79.58 c-h
September day 30th								
K1	29.87 rs	30.63 qrs	28.82 s	30.15 rs	32.82 qrs	29.73 rs	29.34 s	29.24 s
K2	29.51 rs	31.61 qrs	33.86 qrs	31.34 qrs	36.51 n-s	30.35 rst	30.81 qrs	33.18 qrs
K3	47.63 k-s	50.02 j-s	49.92 j-s	54.18 i-q	53.04 i-r	54.02 i-q	45.47 k-s	47.04 k-s
K4	61.07 g-n	59.83 g-n	68.64 d-k	59.26 g-o	72.03 d-j	45.78 k-s	49.38 j-s	67.82 d-k
K5	62.50 f-m	78.40 c-h	76.84 c-i	61.07 g-n	67.81 e-k	62.75 f-m	56.49 h-p	85.53 c-f
K6	60.59 g-n	72.21 d-j	63.32 f-l	45.32 k-s	52.10 j-s	98.32 bc	41.34 l-s	77.44 c-i

Table 7: The interaction three factors of planting time, fertilizer, and varieties on grain yield.

Fertlilizer	Grain yield (t ha^{-1})							
	Varieties							
	Situbagendit	Towuti	Batutegi	Inpago 8	Inpago 9	Inpago 10	Ciherang	Inpari 10
September day 10th								
K1	7.41 r-v	6.62 z	6.88 w-z	7.58 rst	7.54 r-u	7.52 r-u	7.16 u-x	7.42 r-v
K2	8.53 b-j	6.70 yz	7.51 r-u	7.88 n-r	7.63 q-t	7.53 r-u	6.75 yz	7.74 o-r
K3	8.80 a-e	8.83 a-d	8.52 b-j	8.70 a-g	9.24 a	8.71 a-g	8.18 j-n	8.46 d-k
K4	8.74 a-f	8.65 a-h	8.75 a-f	8.66 a-h	8.92 ab	8.84 a-d	8.65 a-h	8.88 abc
K5	8.92 ab	8.72 a-f	8.86 abc	8.82 a-d	8.95 ab	8.76 a-e	8.77 a-e	8.54 b-j
K6	8.88 abc	8.88 abc	8.91 ab	8.80 a-e	9.01 a	8.72 a-f	8.02 m-p	8.75 a-f
September day 20th								
K1	7.25 t-w	7.35 r-v	7.64 p-t	7.32 s-v	7.40 r-u	7.28 t-w	7.52 r-u	7.33 s-v
K2	8.09 k-o	7.63 q-t	8.06 l-o	7.99 m-q	8.31 g-n	8.02 m-p	7.59 q-t	7.03 v-y
K3	8.51 c-k	8.60 b-l	8.32 g-n	8.58 b-i	8.68 a-h	8.32 g-n	7.99 m-q	8.26 h-n
K4	8.22 u-n	8.40 e-m	8.15 j-n	8.32 g-n	8.42 e-j	8.57 b-j	8.01 m-q	8.35 f-m
K5	8.65 a-h	8.53 b-j	8.58 b-i	8.51 c-k	8.56 b-j	8.54 b-j	8.12 k-o	8.46 d-k
K6	8.56 b-j	8.53 b-i	8.45 d-k	8.56 b-j	8.67 a-h	8.43 d-l	7.96 n-q	8.30 h-n
September day 30th								
K1	6.65 yz	6.75 yz	7.04 u-y	6.72 yz	6.80 xyz	6.68 yz	6.90 w-z	6.73 yz
K2	7.49 r-u	7.03 v-y	7.46 r-u	7.39 r-v	7.71 o-s	7.42 r-u	6.82 xyz	7.18 u-x
K3	6.83 xyz	7.32 s-v	7.71 o-s	7.32 s-v	6.74 yz	7.06 u-y	6.74 yz	7.22 t-w
K4	7.03 v-y	7.28 t-w	6.88 w-z	7.00 yz	6.97 v-z	6.89 w-z	7.02 v-y	7.05 u-y
K5	7.96 m-q	7.98 m-q	8.12 k-o	8.05 l-o	8.16 j-n	8.19 i-n	7.52 r-u	7.18 u-x
K6	7.88 n-r	7.72 o-s	8.07 l-o	8.30 h-n	8.00 m-q	8.06 l-o	6.89 w-z	7.21 t-x

Note: K1 = without Potassium and compost, K2 = 50 kg ha^{-1} KCl, K3 = 5 t ha^{-1} straw compost, K4 = 2.5 t ha^{-1} straw compost + 2.5 t ha^{-1} cow manure compost, K5 = 50 kg ha^{-1} KCl + 5 t ha^{-1} straw compost, K6 = 50 kg ha^{-1} KCl + 2.5 t ha straw compost + 2.5 t ha^{-1} cow manure compost. The numbers followed by the same letters in the same group show no significant difference according to the DMRT Test at the level of α 0.05

Nutrient uptake of Potassium and Phosphorus greatly influences the increase in grain yield. This is showed by uptake of Potassium and Phosphorus by plants has positive correlation ($p < 0.01$) with grain yields with correlation values of 0.75 and 0.68. Potassium is needed to transport photosynthetic products in plants, strengthen cell walls, and increase the amount of grain per panicle and percentage of grain content (Fairhurst *et al*. 2007). Increased Potassium uptake also increases Phosphorus uptake, as evidenced by a positive correlation ($p < 0.01$) with a correlation value of 0.73. The application of straw compost and NPK fertilizer significantly improved grain yield (Barus, 2011) and increased N uptake (Kaya, 2013). Some interactions of fertilization and varieties showed high Potassium uptake, but also fewer grain yields, thus Potassium did not have significant efect to the increase in grain consumption (*luxury consumption*) (Yoshida, 1981). Such condition is related to the function and physiological role of Potassium which is very important in relation to water in plants. The results of research by Mashaee and Bahmanyar (2010) also prove that Potassium has a significant effect on plant height, number of tillers, panicle length, number of seeds per panicle, percentage of empty grain, and grain yield. Potassium acts to regulate osmotic pressure, maintaining plant turgor pressure, photosynthesis, photosynthate translocation, and as an enzyme activator in the process of starch and protein formation (Thomas and Thomas, 2009). Potassium effects the growth, production, and quality of plants (Pettigrew, 2008 and Quampah, 2012). In rice, Potassium serves to improve the quality of grain, stimulates root growth, plants do not fall easily and are more resistant to pests (Sarwar, 2012 and Salim, M., 2002) and diseases (Syarif *et al*., 2017).

Interaction of three factors of planting time, fertilization, varieties showed the planting time of September 10th day, application of straw compost 5 tons per hectare, produced grain yield 9.24 t ha^{-1} on varieties Inpago 9 is not significantly different from application of Potassium fertilizer 50 kg per hectare and straw compost 2.5 tons per hectare and cow manure 2.5 tons per hectare on produce grain yield 9.01 t ha^{-1} on varieties Inpago 9. This shows that without the addition of Potassium with organic matter is not significantly different from addition of Potassium with organic matter to the grain yield, thus it can be used as fertilization recommendation for the third planting season.

Other studies also show that, application of straw compost 2.5 tons per hectare can reduce the need for KCl from 100 kg ha^{-1} to 75 kg h^{-1} and effectively increase grain yield. Application of straw compost 10 tons is able to eliminate application of Potassium and the results are not significantly different from application of 100 kg KCl/ha (Ismon and Yufdy, 2011). Karimuna and Asmin (2014) show that application of straw compost 2.5 tons per hectare can reduce the need for KCl from 100 kg ha^{-1} to 75 kg ha^{-1} and effectively increase grain yield. Potassium fertilization combined with straw compost and cow manure resulted in higher average of Potassium and Phosphorus uptake, and grain yields than without a combination of straw compost and cow manure. Straw compost and cow manure is nutrient source and increasing nutrient availability as well as maintain soil moisture at low rainfall. Beside as source of Potassium, returning straw to paddy fields, will also increase fertilizer efficiency, because around 80% of the Potassium is contained in paddy straw (Dobermann and Fairhurst, 2002). Almost all K and a third of N, P and S are contained in straw. Every 5 tons of straw has 2 tons of C organic. Nutrient levels of P, K, Na, Ca, Mg, Mn, and Cu in composted straw are higher than raw straw (Gunarto *et al*., 2002). Addition of straw compost and cow manure can increase nutrient uptake and nutrient availability, especially Potassium and Phosphorus (Tekwa *et al*., 2010 and Wiharjaka, 2015).

4 CONCLUSIONS

Potassium fertilization, straw compost and cow manure on upland rice yield with planting time intervals follow the planting calendar in rainfed lowland at the third planting season show that, especially for planting time, the best time for planting schedule is September day 10^{th}, which is give the highest Potassium uptake, Phosphorus uptake and grain yield by 243.28 kg ha^{-1}, 56.81 kg ha^{-1} and 8.30 t ha^{-1}, respectively. Furthermore, for the fertilization 50 kg ha^{-1} KCl + 2.5 t ha straw compost + 2.5 t ha^{-1} cow manure compost would give the highest output for Potassium and Phosphorus uptake by 284.98 kg ha^{-1} dan 71.41 kg ha^{-1}, respectively. Meanwhile, the fertilization 50 kg ha^{-1} KCl + 5 t ha^{-1} straw compost showed the higest grain yield by 8.39 t ha^{-1}. The variety treatment, Batutegi would give the highest result for Potassium uptake by 259.66 kg ha^{-1}, and Inpago 9 would give the highest result for the Phosphorus uptake and grain yield by 66.07 kg ha^{-1} and 8.09 t ha^{-1}, respectively. Especially for the interaction on three factors of planting time, fertilization, and varieties show that planting time at September day 10^{th}, aplication 2.5 t ha^{-1} straw compost + 2.5 t ha^{-1} cow manure compost with Inpago 9 would give the highest Posporus uptake at 115.29, meanwhile planting time at September day 10^{th}, application 5 t ha^{-1} straw compost with Inpago 9 variety would give the highest grain yield of rice at 9.24 t/ha.

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REFERENCES

Ashley, M.K., Grant, M., Grabov, A. 2006. Plant responses to Potassium deficiencies: a role for potassium transport proteins. *Journal of Experimental Botany*, 57(2), 425–436.

Dobermann, A., Fairhurst, T. H. 2002. Rice straw management. *Better Crops International*, 16, 7-11.

Barus, J. 2011. Effectiveness test of rice straw compost and NPK fertilizer on rice yields. *J. Agrivigor*, 10(3), 247-252.

Bustami, Sufardi, Bakhtiar. 2012. Nutrient uptake and efficiency fertilizing to growth varieties local of rice. *Jurnal Manajemen Sumberdaya Lahan*, 1(2), 159-170.

Cosico, W.C. 1985. Organic Fertilizer. Their Natur, Persepective and Used. Farming System and Soil Resource Institute. UPLB Laguna. Philippines. 136 p.

Fairhurst, T., Witt, C., Buresh, R., Dobermann, A. 2007. *Rice : A Practical Guide to Nutrient Management*. International Rice Research Institute, International Plant Nutrition Institute, and International Potash Institute. 2nd Edition. 96 p.

Gomez, K. A. 1972. Techniques for field experiment with rice. IRRI. Los Baños, Philippines. 46 p.

Gunarto, L., Lestari, P., Supadmo, H., Marzuki, A. R. 2002. Decomposition of rice straw with Azospirillum inoculation and its effect on the efficiency of the use of N fertilizer in lowland rice. *Agricultural Research, Center of Research and Development, Bogor*, 21(2), 1-9.

Ismon, L., Yufdy, M. P. 2011. Application of rice straw with potassium fertilizer in lowland rice plantations on dystropepts land. *Journal of Assessment and Development of Agricultural Technology*, 14(3), 217-230.

Kaya, E. 2013. The effect of rice straw compost and NPK fertilizer to available N, N-absorption, growth and yields of lowland rice (*Oryza Sativa L*). *Jurnal Ilmu Budaya Tanaman. Agrologia*, 2(1), 43-50.

Karimuna, L., Asmin. 2014. Assessment of potasium fertilizer with application of rice straw on rice growth and production at newly cultivated area in Buton Regency, Southeast Sulawesi. *Jurnal Agroteknos*, 4(3): 180-188.

Magdalena, F., Sudiarso, T., Sumarni. 2013. The use of manure and green manure *Crotalaria juncea* L. to reduce the use of inorganic fertilizers on corn (*Zea mays* L.). *Journal of Plant Production*, 1(2), 61-71.

Mashaee, S. S., Bramanyar, M. A. 2010. Influences of nitrogen and potassium top dressing on yield and yield components as well as their accumulation in rice (*Oryza sativa*). *African Journal of Biotechnology*, 9(18), 2648-2653.

Prasetyo, H. P., Adiningsih, J. S., Subagyono, K., Simanungkalit, R. D. M. 2004. Mineralogy, chemistry, physics, and biology of paddy fields lands and itsmanagement technology. *Center for Land Research and Development and Agro-climate, Agricultural Research Agency.*

Pettigrew, W. T. 2008. Potassium influences on yield and quality production for maize, wheat, soybean and cotton. *Physiologia Plantarum* 133(4), 670-681.

Prajapati, K., Modi, H. A. 2012. The importance of potassium in plant growth- A Review. *Indian Journal of Plant Sciences*. 1(2-3), 177-186.

Quampah A, Wang R. M., Shamsi I. H., Jilani, G., Zhang, Q., Hua, S., Xu, H. 2011. Improving water productivity by potassium application in various rice genotypes. *International Journal of Agriculture and Biology*., 13, 9-17.

Runtunuwu, E., Syahbuddin, H., Ramadhani, F., Pramudia, A., Setyorini, D., Sari, K., Apriyana, Y., Susanti, E., Haryono., Setyanto, P., Las, I., Sarwani, M. 2012. Integrated Planting Calendar Information System: Current Status and Future Challenges. *Journal of Land Resources*, 6 (2). 67-78.

Saha, P. K., Miah, M. A. M., Hossain, A. T. M. S., Rahman, F., Saleque, M. A. 2009. Contribution of rice straw to potassium supply in rice-fallow-rice cropping pattern. *Bangladesh. J. Agril Res.*, 34(4), 633-643.

Salim, M., 2002. Effects of potassium nutrition on growth, biomass and chemical composition of rice plants and on host-insect interaction. *Pakistan J. Agric. Res*., 17(1): 14-21.

Sarkar, M. I. U., Islam, M. N., Jahan, A., Islam, A., Biswas, J. C. 2017. Rice straw as a source of potassium for wetland rice cultivation. *Geology, Ecology, and Landscapes*, pp.1-6.

Sarno. 2009. Effect of NPK and manure combination on soil properties and growth and production of caisim plants. *J. Tropical Land*. 14 (3): 211-219.

Sarwar, M. 2012. Effects of Potassium fertilization on population build up of rice stem borers (lepidopteron pests) and rice (*Oryza sativa* L.) yield. *Journal of Cereals and Oil seeds*, 3(1): 6-9.

Shrestha, S., Asch, F., Dingkuhn, M., Becker, M. 2011. Cropping calendar options for rice-wheat production systems at high-altitudes. *Field Crops Research*, 121(1): 158-167.

Subandi. 2013. Role and management of potassium nutrient for food production in Indonesia. *Pengembangan Inovasi Pertanian*, 6(1): 1-10.

Syarif, S.A., Suryono, W., Bonny, P.W.S., Bambang, S., Purwoko. 2017. Role of rice straw compost and potassium in controlling blast disease of paddy rice in South Sulawesi, Indonesia. *International Journal of Sciences: Basic and Applied Research (IJSBAR)*, 36(4): 244-254.

Tekwa, I.J., Olawoye, H.U., Yakubu. 2010. Comparative effect of separate incorporation of cowdung and rice-husk materials on nutrient status of some lithosols. *J. Agric. Biol*., 12(6): 857-860.

Thomas, T. C., Thomas, A. C. 2009. Vital role of potassium in the osmotic mechanism of stomata aperture modulation and its link with potassium deficiency. *Plant Signal Behaviour*, 4(3): 240–243.

Wihardjaka, A. 2015. The role of rice straw in improving grain yield and potassium uptake in rainfed rice fields in Pati Regency, Central Java. *Journal of Agricultural Sciences* 27(1-2): 15–22.

Wihardjaka, A., Idris, K., Rachim, A., and Partohardjono, S. 2002. Straw management and potassium fertilizers to rice in the rainfed areas of deficiency K. Research *Journal of Agriculture* 21(1): 26-32.

Yoshida, S. 1981. Fundamentals of rice crop science. *The International Rice Research Institute. Los Banos, Phillipiness.*