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Phosphorus and Potassium Balances of Cabagge at Different Soil Conservation Techniques in Talun Berasap, Indonesia

Sukristiyonubowo, Umi Haryati, Ai Dariah, Wiwik Hartatik
Indonesian Agency for Agricultural Research and Development,
Indonesian Soil Research Institute
Jalan Tentara Pelajar 12, Bogor, Telp. +62 81226277259
Email: sukristiyonuboworicky@yahoo.com

***Abstract* – Study on phosphorus and potassium balances of cabbage at different soil conservation techniques was conducted in Talun Berasap, a vegetables growing area in Kerinci District, Indonesia in 2011. Four treatments were tested including control, a farmers practices with the direction of planting in line with slop (KTA-1), modification of farmer practice by adding ridge terrace every 5 m of slope length (KTA-2), modification of farmer practice by adding ridge terrace and hill side ditch every 5 m of slope length (KTA-3), and (4) planting in line with contour (KTA-4). Phosphorus and potassium balances were calculated according to the differences between phosphorus and potassium gains and losses. To quantify total phosphorus and potassium inputs, P and K contents in SP-36 and KCl, rate of compost, P and K concentrations in compost, as well as P and K concentrations in rainfall were collected. Output parameters were cabbage yield, crop residues production, P and K concentrations in cabbage and crop residues as well as erosion. The results indicated that positive balances of phosphorus and potassium were taken place in all treatments. Concerning the environmental, agronomical and economic point of views as well as to get higher cabbage yield and stabile, recommended SP-36 application rate should be 100 kg SP-36 and 50 kg KCl ha^{-1} season^{-1} with adding more compost up to 20 - 30 tons ha^{-1} season^{-1}.**

***Keywords* – Phosphorus and Potassium Balances, Plot Scale, Phosphorus and Potassium Input, Phosphorus and Potassium Losses, Cabbage, Soil Conservation Techniques.**

I. INTRODUCTION

Cabbage can be used as a food and a medicine. It has round shape and composed of superimposed leaf layers. Study on N balance indicated that negative nitrogen balances are taken place in planting in line with slop and planting in line with contour treatments. Concerning the environmental, agronomical and economic point of views as well as to get higher cabbage yield and stabile, recommended urea application rate should be from 400 to 500 kg ha^{-1} season^{-1} with adding more compost to 20 - 30 tons ha^{-1} season^{-1}(Sukristiyonubowo *et al.* 2013). Phosphorus and potassium are the essentials plant nutrient required by plant to optimal growth and yields. The functions of phosphorus in plant are as nucleic acids and ATP, while potassium as catalyst and ion transport or enzyme activator as well as to improve disease resistance.

Usually, farmers do not apply or very seldom to apply phosphorus and potassium fertilisers and they like to add nitrogen fertiliser. In Indonesia, vegetables are mainly grown in highland, from 750 m to 2800 m above sea level under big different management systems. They vary between traditional low input and excessive input, especially for nitrogen fertiliser. Besides these conditions, crop rotations are also imbalanced. Inorganic fertilisers application rate are based on their experiences, usually too high and has no relationship with inherent soil fertility, like done in many growing areas. In addition, selecting crops to be planted is mostly deal with market demands in spite of climate and pest and diseases problems.

By definition nutrient balance is the difference between nutrient gains and losses. The nutrient gains include nutrients coming from fertilisers, returned crop residues, irrigation, rainfall, and biological nitrogen fixation (Sukristiyonubowo *et al.* 2010; Sukristiyonubowo. 2007; Wijnhoud *et al.* 2003; Lefroy and Konboon. 1999; Miller and Smith, 1976). According to Sukristiyonubowo *et al.,* (2010), Sukristiyonubowo (2007) and Uexkull (1989), the nutrient losses include removal through harvested biomass (all nutrients), erosion (all nutrients), leaching (mainly nitrate, potassium, calcium and magnesium), fixation (mainly phosphate), and volatilisation (mainly nitrogen and sulphur). When the nutrient removals are not replaced by sufficient application of fertilisers or returning of biomass, soil mining takes place and finally crop production do not reach its potential yield and reduces.

Nutrient balances can be developed at different scales, including (a) plot, (b) field, farm or catchment, (c) district, province, and (d) country scale, and for different purposes (Sukristiyonubowo *et al.* 2010; Sukristiyonubowo. 2007; Leroy and Konboon. 1999; Bationo *et al.* 1998; Hashim *et al.* 1998; Van den Bosch *et al.* 1998a and 1998b; Syers. 1996; Smaling *et al.* 1993; and Stoorvogel *et al.* 1993). Many studies indicate that at plot, farm, district, province, and national levels, agricultural production is characterised by a negative nutrient balance (Sukristiyonubowo *et al.*, 2011; Sukristiyonubowo *et al*., 2010; Sukristiyonubowo. 2007; Nkonya *et al.* 2005; Sheldrick *et al.,* 2003; Harris. 1998; Van den Bosch *et al.* 1998b). A long-term nitrogen experiment at plot scale in the dry land sloping area of Kuamang Kuning, Jambi Province, Indonesia provided confirmation that the balance in the plots without input was - 4 kg N ha^{-1} yr^{-1}. However, this do not happen in the plots treated with a combination of high fertiliser application rates and *Flemingia congesta* leaves planted in a hedge row system (Santoso *et al.,* 1995). Study on plot scale nitrogen balance of newly opened wetland rice indicates that positive nitrogen balances are taken place in all treatments and the best is NPK with recommendation rate + Compost + Dolomite (N and K were split 3x). Concerning the environmental, agronomical and economic point of views, recommended urea application rate should be 200 kg ha^{-1} $season^{-1}$ with adding more compost to 3000 kg ha^{-1} $season^{-1}$ (Sukristiyonubowo *et al.,* 2011)

Principally, a complete study of nutrient balances is very complicated. In a simple way, nutrient loss is mainly calculated based on removal by harvested products and unreturned crop residues, while the main inputs are organic and mineral fertilisers. So far, it is reported that most assessment is partial analysis of these in- and output data (Wijnhoud *et al.,* 2003; Drechsel *et al.,* 2001; Lefroy and Konboon. 1998).

This paper discussed the phosphorus and potassium balances of cabbage at different soil conservation techniques at Talun Berasap in Kerinci District. It was hypothesized that by determining the proper phosphorus and potassium fertilisers application rate, the phosphorus and potassium requirement at district level and optimal cabbage production can be reached as well as phosphorus and potassium fertilisers stock at the Kerinci District were met every planting season. In addition, the farmers like to give phosphorus and potassium fertilisers.

II. Materials and Methods

Field experiment on phosphorus and potassium balances of cabbage was conducted on farmer field in Talun Berasap, Kerinci District, Jambi Province. The position of location was at the coordination S: 01° 41‘. 58.3” E: 101° 20’ 50.3”. The area was sloping with altitude 1500 m above sea level. The treatments were control, a farmers practices with the direction of planting in line with slop (KTA-1), modification of farmer practice by adding ridge terrace every 5 m of slope length (KTA-2), modification of farmer practice by adding ridge terrace and hill side ditch every 5 m of slope length (KTA-3), and (4) planting in line with contour (KTA-4). They were arranged into Randomized Complete Block Design (RCBD) and replicated three times. The plot size was 20 m in length x 5 m in width. The distance among plot was 50 cm and between replication was 100 cm. The application rate of fertiisers was 180 kg N ha^{-1}, 54 kg P_2O_5 ha^{-1} dan 60 kg K_2O ha^{-1} or equivalent with 400 kg urea ha^{-1}, 150 kg SP-36 ha^{-1} dan 100 kg KCl ha^{-1}. In this experiment fertilisers were not as treatments. Nitrogen and potassium were split two times, 50 % at a week after transplanting and 50 % at 35 DAT (days after Planting), while for P was given one time at a week after transplanting time

Compost of about 10 tons ha^{-1} were broadcasted a week before planting. Before broadcasting the compost, one kg composite compost were taken and brought to Bogor for nutrient analysing.

The phosphorus and potassium inputs were the sum of phosphorus and potassium coming from mineral fertiliser (IN-1), compost (IN-2), irrigation (IN-3), and precipitation (IN-4). Phosphorus and potassium outputs were sum of nutrients removed by cabbage production (OUT-1) crop residues (OUT-2), erosion (OUT-3) and surface runoff (OUT-4). Because the area was sloping and mainly planting with vegetables, during the wet season there was no irrigation supply. Therefore, the formula became

P and K Inputs (IN) = IN-1 + IN-2 + IN-4 (1)

P and K Outputs (OUT) =
OUT-1 + OUT-2 + OUT-3 + OUT-4 (2)

P and K Balances = IN – OUT (3)

To quantify gain data included phosphorus and potassium content in SP-36 and KCl, rate of SP-36 and KCl application, amount of organic fertiliser, and in rainfall were collected. The output parameters were cabbage (marketable leaves) yield, crop residue production, erosion, phosphorus and potassium concentrations in cabbage and crops residue as well as phosphorus and potassium concentration in erosion.

IN-1 and IN-2 was calculated based on the amount of mineral and organic fertilisers added multiplied by the concentration of phosphorus and potassium in SP-36 and KCl as well as compost, respectively. IN-4 was estimated by multiplying rainfall volume with nutrient concentrations in the rain water. In a hectare basis, it was calculated as follow (Sukristiyonubowo. 2007; Sukristiyonubowo *et al.* 2011):

$$\text{IN-4} = \frac{A \times 10.000 \times 0.80 \times B \times 1000}{1000 \times 10^6}$$

Where:

- IN-4 is phosphorus or potassium contribution of rainfall water in kg P ha^{-1} $season^{-1}$ or kg K ha^{-1} $season^{-1}$
- A is rainfall in mm
- 10000 is conversion of ha to m^2
- 0.80 is factor correction, as not all rain water goes in the soil
- B is phosphorus or potassium concentration in rainfall water in mg l^{-1}
- 1000 is conversion from m^3 to l
- 1000 is conversion from mm to m
- 10^6 is conversion from mg to kg

To monitor rainfall events, data from rain gauge and climatology station of Kerinci were considered. Rain waters were sampled once a month from a rain gauge in 600 ml plastic bottles and was also analysed according to the procedures of the Laboratory of the Soil Research Institute, Bogor.

Theoretically, the phosphorus or potassium loss can be through harvested product (cabbage and crop residues yields), leaching (potassium) and fixation (phosphorus). Due to leaching and fixation as well as surface runoff were not yet measured, thus the phosphorus and potassium loss was calculated only from harvested products and erosion. Consequently, the total phosphorus and potassium output was bit underestimated. As all cabbages are consumed, OUT-1 was estimated based on cabbage yield multiplied with nutrient concentration in the cabbage. OUT-2 was calculated according to the total crop residue production multiplied with nutrient concentration in the crop residue. It was considered as output because all crop residues was taken out from the field for making compost and the compost will be applied for coming planting season. Out-3 was calculated based on the total erosion multiplied with nutrients concentration in eroded soil or samples.

Cabbage were sampled at harvest and were collected from every plot, one plant per plot. After pulling out, the plant roots were washed with water. For the laboratory analyses, the samples were treated according to procedures of the Analytical Laboratory of the Soil Research Institute, Bogor. Samples were washed with deionised water to avoid any contamination and dried at 70^0 C. The dried samples were ground and stored in plastic bottles. P and K were measured after wet ashing using $HClO_4$ and HNO_3 (Soil Research Institute, 2009)

III. Results and Discussion

Phosphorus and Potassium Balances

The phosphorus and potassium balances at plot scale were constructed according to the different between phosphorus and potassium inputs and losses.

Phosphorus and Potassium Inputs

The phosphorus and potassium input originated from application rate of SP-36 and KCl (IN-1), compost (IN-2) and rainfall water (IN-3) and their nutrient contribution were presented in Table 3 and Table 4. The IN-1 (contribution of inorganic fertiliser) were + 23.11 kg P and + 49.79 kg K ha^{-1} season^{-1}. We can say that the higher the rate of SP-36 and KCl, the higher the P and K contributions to the inputs (Table 1).

The IN-2 (contribution of compost) was about + 16 kg P ha^{-1} season^{-1} from the average of P contents in compost of 0.09 %, 0.11 % and 0.27 % P, while for K were about + 290 kg K ha^{-1} season^{-1} from the average of K contents in compost of 2.90 %, 2.92 % and 2.87 % K. Hence, besides the application rate of organic fertiliser or compost, the P and K concentrations in compost will also influence their contributions.

Table 1: The contribution of inorganic fertiliser (IN-1) and compost (IN-2) to nutrient input at Talun Berasap village, a vegetables growing area in Kerinci District

Treatment	Rate and contribution of SP-36 and KCl (kg ha^{-1} season^{-1})				Rate and contribution of compost (kg ha^{-1} season^{-1})		
	SP-36	KCl	IN-1 (P)	IN-1 (K)	Rate	IN-2 (P)	IN-2 (K)
KTA 1	150	100	23.11	49.79	10 000	16	290
KTA 2	150	100	23.11	49.79	10 000	16	290
KTA 3	150	100	23.11	49.79	10 000	16	290
KTA 4	150	100	23.11	49.79	10 000	16	290

Note: KTA 1: Control, a farmers practices with the direction of planting in line with slope
KTA 2: Modification of farmer practice by adding ridge terrace every 5 m of slope length
KTA 3: Modification of farmer practice by adding ridge terrace and hill side ditch every 5 m of slope length
KTA 4: Planting in line with contour

So far, the phosphorus and potassium inputs from rainfall water were about 0.28 kg P, equal to 1.56 kg SP-36 and for K was 7.90 kg K equal to 13.17 kg KCl (Table 2). Theses contributione were classified low, about 1 % from total phosphorus and 3 % of total potassium inputs (Table 6 and 7).

Table 2: The contribution of rainfall water (IN-4) to nutrient input at Talun Berasap village, a vegetables growing area in Kerinci District.

Treatment	Rainfall (mm yr^{-1}) and Contribution to input (kg P ha^{-1} season^{-1} and kg K ha^{-1} season^{-1})				
	Rainfall (mm yr^{-1})	Consentration P (mg l^{-1})	Consentration K (mg l^{-1})	IN-4 (kg P ha^{-1})	IN-4 (kg Kha^{-1})
KTA 1	1 039	0.08	0.95	0.28	7.90
KTA 2	1 039	0.08	0.95	0.28	7.90
KTA 3	1 039	0.08	0.95	0.28	7.90
KTA 4	1 039	0.08	0.95	0.28	7.90

Note: KTA 1: Control, a farmers practices with the direction of planting in line with slope
KTA 2: Modification of farmer practice by adding ridge terrace every 5 m of slope length
KTA 3: Modification of farmer practice by adding ridge terrace and hill side ditch every 5 m of slope length
KTA 4: Planting in line with contour

Phosphorus and Potassium loss

To compute the phosphorus and potassium loss, data of cabbage production namely cabbage (marketable leaves) yield, crop residues (roots, steam, and 'unqualified leaves' or non marketable leaves) production, erosion, phosphorus and potassium concentrations in cabbage (marketable leaves) and crop residues (roots, steam, and unqualified leaves) and erosion were collected. The phosphorus and potassium loss were estimated from phosphorus and potassium taken away from cabbage or marketable leaves (OUT-1) as all cabbage was consumed and taken out by crop residues (OUT-2). The phosphorus and potassium loss are presented in Table 3 and Table 4.

The nutrient loss due to erosion (OUT-3) is presented Table 5. Because the run off was not sampled and not measured, therefore nutrient loss due to surface run off was neglected and phosphorus and potassium balances were little bit underestimated.

Table 3: The phosphorus lost through cabbage (OUT-1) and crop residues production (OUT-2) at different soil conservation techniques at Talun Berasap village, a vegetables growing area in Kerinci District.

Treatment	Cabbage production (t ha^{-1} $season^{-1}$), P concentration and P loss (kg P ha^{-1} $season^{-1}$)			Crop residues production (t ha^{-1} $season^{-1}$), P concentration and P loss (kg ha^{-1} $season^{-1}$)		
	Marketable yield (t $ha^{-1}$$Season^{-1}$)	Concentration P (%)	OUT-1	Crop Residues (t $ha^{-1}$$Season^{-1}$)	Concentration P (%)	OUT-2
KTA 1	9.43	0.59	56.23	1.23	0.27	3.32
KTA 2	7.33	0.57	41.78	0.81	0.27	2.19
KTA 3	6.67	0.49	32.68	0.80	0.30	2.40
KTA 4	10.56	0.53	55.97	1.48	0.35	5.18

Note: KTA 1: Control, a farmers practices with the direction of planting in line with slope
KTA 2: Modification of farmer practice by adding ridge terrace every 5 m of slope length
KTA 3: Modification of farmer practice by adding ridge terrace and hill side ditch every 5 m of slope length
KTA 4: Planting in line with contour

Table 4: The potassium lost through cabbage (OUT-1) and crop residues production (OUT-2) at different soil conservation techniques at Talun Berasap village, a vegetables growing area in Kerinci District.

Treatment	Cabbage production (t ha^{-1} $season^{-1}$), K concentration and K loss (kg K ha^{-1} $season^{-1}$)			Crop residues production (t ha^{-1}), K concentration and N loss (kg K $ha^{-1}$$season^{-1}$)		
	Marketable yield (t $ha^{-1}$$season^{-1}$)	Con K (%)	OUT-1	Crop Residues (t $ha^{-1}$$season^{-1}$)	Concentration K (%)	OUT-2
KTA 1	9.43	1.43	134.85	1.23	1.40	17.22
KTA 2	7.33	1.42	104.09	0.81	1.42	11.52
KTA 3	6.67	1.66	110.72	0.80	1.32	10.56
KTA 4	10.56	1.61	170.02	1.48	1.54	22.79

Note: KTA 1: Control, a farmers practices with the direction of planting in line with slope
KTA 2: Modification of farmer practice by adding ridge terrace every 5 m of slope length
KTA 3: Modification of farmer practice by adding ridge terrace and hill side ditch every 5 m of slope length
KTA 4: Planting in line with contour

Table 5: The phosphorus and potassium lost through erosion (OUT-3) at different soil conservation techniques at Talun Berasap village, in Kerinci District.

Treatment	Erosion and phosphorus and potassium loss (OUT-3)				
	Erosian (t ha^{-1})	P Consentration (mg P_20_5 kg^{-1})	K Consentration (mg K_20 100 gr^{-1})	OUT-3 (kg P ha^{-1} $season^{-1}$)	OUT-3 (kg K ha^{-1} $season^{-1}$)
KTA 1	14.70 a	30.14	10.93	0.20	1.28
KTA 2	11.30 c	40.00	14.09	0.20	1.34
KTA 3	10.90 c	25.30	11.74	0,13	1.02
KTA 4	12.70 b	28.30	12.83	0.16	1.30

Note: KTA 1: Control, a farmers practices with the direction of planting in line with slope
KTA 2: Modification of farmer practice by adding ridge terrace every 5 m of slope length
KTA 3: Modification of farmer practice by adding ridge terrace and hill side ditch every 5 m of slope length
KTA 4: Planting in line with contour

Output-Input Assessment

The P and K balances of cabbage at different soil conservation techniques at Talun Berasap village, vegetables growing area in Kerinci District is presented in Table 6 and Table 7. In general, the results indicated that inorganic fertiliser (IN-1) contributes considerably to total phosphorous input as well as in potassium input in all soil conservation techniques. Because this experiment was the soil conservation techniques, the amounts of inorganic fertiliser were the similar namely 150 kg SP-36 dan 100 kg KCl ha^{-1} ha^{-1} $season^{-1}$. It can be said that inorganic fertiliser is the most important phosphorous and potassium sources to enhance yield and manage the soil fertility in field. This means that the needs for mineral fertilisers may be greater when we grow leafy vegetables or tuber crop.

Like P as well as K fertiliser rate, the rate of compost was also similar in all treatments, namely 10t ha^{-1} $season^{-1}$. The contribution of compost (IN-2) was also very important nutrient source, covering about 16 kg P ha^{-1} $season^{-1}$ as well as 290 kg K ha^{-1} $season^{-1}$. The IN-2 inputs are getting more important, when less or no inorganic fertilisers are applied and more organic fertiliser is added, like in the organic agriculture (rice and vegetables) farming system. The P and K supplied by compost was equivalent to 310 kg of SP-36 ha^{-1} and 580 kg KCl and will be more when the rate of compost application increases.

IN-4 (contribution of rainfall water) was about 0.28 kg P ha^{-1} and 7.90 kg K ha^{-1} also an important nutrient source, particularly for K during the wet season, covering 3 % of the total K input (Table 7).

With respect to the output, depending on the treatment, around 91 % - 94 % of total P was taken up by marketable leaves or cabbage yield, about 5 – 8 % by crop residues and the rest by erosion. Meanwhile, around 87 % - 90 % of total K was taken up by marketable leaves or cabbage yield, about 9 – 12 % by crop residues and the rest by erosion. This means that P and K were greater removed by marketable leaves or cabbage yield followed by crop residues.

Table 6: Output-input analysis for phosphorus of cabbage at different soil conservation techniques at Talun Berasap village, a vegetables growing area in Kerinci District (kg P ha^{-1} season^{-1})

Parameter	Soil Conservation techniques			
	KTA-1	KTA-2	KTA-3	KTA-4
P INPUT (kg P ha^{-1} season^{-1}) **:**				
IN-1	+ 23.11	+ 23.11	+ 23.11	+ 23.11
	31 %	31 %	31 %	31 %
IN-2	+ 49.79	+ 49.79	+ 49.79	+ 49.79
	68 %	68 %	68 %	68 %
IN-4	+ 0.28	+ 0.28	+ 0.28	+ 0.28
	1 %	1 %	1 %	1 %
Total P Input	+ 73.18	. + 73.18	+ 73.18	+ 73.18
	100 %	100 %	100%	100 %
P OUPUT (kg P ha^{-1} season^{-1})**:**				
OUT-1	- 56.23	- 41.78	- 32.68	- 55.97
	94 %	94 %	93 %	91 %
OUT-2	- 3.32	- 2.15	- 2.40	- 5.18
	5 %	5 %	6 %	8 %
OUT-3	- 0.20	- 0.20	- 0.13	- 0.16
	1 %	1 %	1 %	1 %
OUT-4	-	-	-	-
Total P Output	-59.75	- 44.13	- 35.21	- 61.31
	100 %	100 %	100 %	100 %
P Balance	+ 3.43	+ 19.05	+ 27.97	+ 1.87

Note: KTA 1: Control, a farmers practices with the direction of planting in line with slope
KTA 2: Modification of farmer practice by adding ridge terrace every 5 m of slope length
KTA 3: Modification of farmer practice by adding ridge terrace and hill side ditch every 5 m of slope length
KTA 4: Planting in line with contour

Assessment of phosphorus and potassium input and output shows positive balances for all soil conservation techniques (KTA-1, KTA-2, KTA-3 and KTA-4) treatments (Table 6 and Table 7). The surplus ranged between + 3.43 and +27.97 kg P ha^{-1} season^{-1}. This were happened because their marketable yields were considered low, 7.33 for KTA-2 and 6.67 t ha^{-1} season^{-1} for KTA-3. In contrast, the surplus P balances in the KTA-1 and KTA-4 were less or small (+3.43 kg P ha $^{-1}$ season^{-1} for KTA-1 and + 1.87 kg P ha $^{-1}$ season^{-1} for KTA-4. This may be explained by increasing of cabbage yields due to soil conservation technique. It should also be noted that the P output will even be higher, when P fixation, surface runoff and leaching are taken into account.

Table 7: Output-input analysis for potassium of cabbage at different soil conservation techniques at Talun Berasap village, a vegetables growing area in Kerinci District (kg K ha^{-1} season^{-1})

Parameter	Soil Conservation techniques			
	KTA-1	KTA-2	KTA-3	KTA-4
K INPUT (kg K ha^{-1} season^{-1}) **:**				
IN-1	+ 49.79	+ 49.79	+ 49.79	+ 49.79
	14 %	14 %	14 %	14%
IN-2	+ 290.00	+ 290.00	+ 290.00	290.00
	83 %	83 %	83%	83%
IN-4	+ 7.90	+ 7.90	+ 7.90	+ 7.90
	3 %	3 %	3%	3%
Total K Input	+ 347.69	+ 347.69	+ 347.69	+ 347.69
	100 %	100 %	100%	100%
K OUPUT (kg K ha^{-1} season^{-1})**:**				
OUT-1	- 134.85	- 104.09	- 110.72	- 170.02
	88 %	89 %	90 %	87 %
OUT-2	-17.22	- 11.52	- 10.56	- 22.79
	11%	10 %	9 %	12 %
OUT-3	-1.28	- 1.34	- 1.02	- 1.30
	1 %	1 %	1 %	1 %
OUT-4	-	-	-	-
Total K Output	-153.35	- 116.95	- 122.30	- 194.11
	100 %	100 %	100 %	100 %
K Balance	+ 194.34	+ 230.74	+ 225.39	+ 153.58

Note: KTA 1: Control, a farmers practices with the direction of planting in line with slope
KTA 2: Modification of farmer practice by adding ridge terrace every 5 m of slope length
KTA 3: Modification of farmer practice by adding ridge terrace and hill side ditch every 5 m of slope length
KTA 4: Planting in line with contour

The positive P and K balances in all treatments also demonstrated that the application rates of inorganic were sufficient to substitute P and K removed by marketable (cabbage) yield and crop residues as well as erosion. However, we do believe that when the fertilisers application rates (organic/compost and inorganic), cabbage yield increase and P fixation, surface run off and leaching are taken into account, the balance will move. Therefore, phosphorus and potassium fertilisers' application rate could be between 100 kg of SP-36 and 100 kg KCl ha^{-1} $season^{-1}$, when compost rate was not increased. To protect environment as well as to reduce the production cost, compost should be increased from 10 to tons ha^{-1} $season^{-1}$ to 20 to 30 tons ha^{-1} $season^{-1}$ of compost and SP-36 and KCL can be reduced to 100 kg SP-36 and 50 kg KCl ha^{-1} $season^{-1}$ to increase and sustain a higher cabbage yield, at least it is higher than normal yield (25 t ha^{-1} $season^{-1}$)

As sometime it was not easy to get SP-36 and KCl during planting time and the price were considered higher than normal price, providing SP-36 and KCl based on total planted areas or existing and SP-36 and KCl application rates are very important. According to anonymous (2010) the total cabbage areas in Kerinci District is about 619 ha, therefore, total SP-36 should be available are about 62 tons $district^{-1}$ $season^{-1}$ (100 kg x 619 ha) and KCl about 31tons $district^{-1}$ $season^{-1}$ (50 kg x 619 ha) .

IV. Conclusion

Evaluation of SP-36 and KCl inputs and outputs of cabbage at different soil conservation techniques in Talun Berasap, Kerinci District indicated the surplus balances of P and K. Surplus phosphorus varied from +3 to + 27 kg P ha^{-1} $season^{-1}$ and positive potassium balances between 153 and 230 kg K ha^{-1} $season^{-1}$. These mean cabbage yield were not stabile and considered lower than normal yields. To enhance the cabbage yield and to consider the environmental, agronomical and economic aspects, the rate of SP-36 application can be decreased around 100 kg SP-36 and 50 kg KCl ha^{-1} $season^{-1}$with adding more compost from 20 to 30 tons ha^{-1} $season^{-1}$.

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