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Phosphor Rate for Vegetable Grown in the Ultisol-Nanggung, Bogor, Indonesia

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Phosphor Rate for Vegetable Grown in the Ultisol - Nanggung, Bogor, Indonesia

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ABSTRACT

Amaranth (*Amaranthus sp*), Kangkung (*Ipomoea aquatica* L), Egplant (*Solanum melongena* L*)*, Chili (C*apsicum annuum* L), Tomato (*Lycopersicon esculentum* Mill), Green Bean (*Pahaseolus vulgaris* L), and Yard Long Bean (*Vigna unguilata L*) were grown on *Ultisol Nanggung* soil with low pH (5.2), low C-Organic (1.70%), very low N-total (0.21 %), low K content (0.33 me/100 g), but high soil P_2O_5 concentration (10.8 ppm) to optimize P rate application. Treatments were P rate : 0, 45, 90, 135 dan 180 kg $P_2O_5ha^{-1}$ or equal to 0, 125, 250, 375 dan 500 kg SP36 (36% P_2O_5) ha^{-1}. Treatments were arranged in Randomized Completely Block design with three replications. In the level of soil P concentration of 10.8 ppm (Bray-1) of Ultisol, application of P fertilizer up 180 kg P_2O_5 ha^{-1} increased linearly plant height of kangkung, eggplant, chili, tomato, yard long bean and green bean and increased linearly yield of amaranth, kangkung, egplant, chili, tomato and green bean. To achieve optimum P fertilizer rate, the range of P rate application need to be increased.

INTRODUCTION

Vegetable is the main source of vitamin and mineral for human diet. Vegetable consumption per capita per year recommended by Food and Agriculture Organization (FAO) is approximately 75 kg. However, Indonesian vegetable consumption per capita per year is 35.30 kg still far bellow FAO recommendation. That evident showed that vegetable production in Indonesia is still very open to be improved. Increasing in cropping area and building best management practices for vegetable become more important issue to accomplished.

Proper fertilization of acrop on knowing the crop nutrient requirement for production of maximum yield and the potential level of nutrient availability from the soil. In addition to yield obtained, quality of the commodity is an important factor of profit and shelf-life for high-value crops (Hochmuth et al., 1993).

Nitrogent, phosphor, and potasium availability is the most limiting factors for maximim groet and yield l (Tisdale, Nelson dan Beaton, 1990). In the mineral soil Phospor concentration and availabilty is low, therefore application of P fertilizer is needed. In the acis soil, most of the P was not available for the plant due to fixed by Al and Fe, Therefore, P availablitity normally become the most was critical nutient. Phospohor is needed is the cell formation of apical root an soot, flower and reproductive process, flower and initiation and fruit development (Thompson dan Troeh, 1978, Nyakpa, *et al.,* 1988; Rosmarkam dan Yuwono, 2002). Phospor deficiency will reduce plant growth, stunted, root formation, fruit initiation and development was delayed (Embleton *et al.*, 1973; Marschner 1995).

Soil testing has been employed for identifying the level of plant available nutrients provided by the soil and predicting needed fertilizer. For predictive soil testing to be succesfull, the nutrient tested for must be immoblie (Kidder, 1993; Melsted and Peck, 1977), and nutrrient extracted must be related to crop response (Danke, 1993; Nelson and Anderson. 1977). For practical desirable to use an aextraction reagent thai is effective for manny nutrients in one sxtraction procrdure (Jones, 1990). However, In indonesia, fertilizer recommendation base on soil analyses for vegetable crop have not been developed.

Aplication of Phospor on tomatoes var. Intan was reported increasing in plant height, biomass dry weight, root and stem dry weight, also influenced on days to flowering adn maturity, number of flower per plant (Musa, 1991). Phospohor application up to 11.5 ppm in the nutrient solution increase biomass dry weight of corn (Syafruddin, 2002). Syarif (2005) reported that P application on rice influence root/stem ratio, root length, and P efficiency

This experiment was established as a preliminary data base collection to bulid soil P status and quick references to obtain P optimum rate in the acid soil (Ultisol-Nanggung) for seven vegetable crops. This experiment will be followed by correlation and callibration study to buld P fertilization recommendation base on soil analyses .

MATERIALS AND METHODS

Research was carried out at the SANREM Base camp at Hambaro Villlage, Nanggung Sub-District, Bogor, West Java, Indonesia Demo Farm, Tenjo area, Bogor Regency from December 2006 to April 2007. The soil type in the location is *Ultisol*, which typically have low pH and high P-fixation by Aluminum. Pre fertilizer soil samples were taken with a soil probe from the top 15 cm. Fertilizer was applied at 200-90 kg N-K2O.ha^{-1} from Urea (45% N) and potassium sulfate (60% K2O). Phosphor rate were applied base on the treatments. All the P and 50 % of N and K applied preplant, and 50 % of N and K were side dressed two times each of 25% at 3 and 6 weeks after transplanting.

Treatments were P rate : 0, 45, 90, 135 dan 180 kg P_2O_5ha^{-1} or equal to 0, 125, 250, 375 dan 500 kg SP36 (36% P_2O_5) ha^{-1}. Treatments were arranged in Randomized Completely Block design with three replications.

Preplant applications were applied of fertilizer broadcast and rototilled into raised bed approximately 0.9 m wide and 20 cm high. The plot size were 1.5 x 4 m, with 0.9 m for raise bed and 0.6 m as a ditch. Seven vegetables used in this experiment were Tomato (*Lycopersicon esculentum* L) var Ratna Chili (*Capsicum anuum* L) var. Prabu, Eggplant (*Solanum melongena*) var. Ungu, Kangkung (*Ipomoea reptans* L) var Sutera, and Yard Long Bean (*Vigna unguilata* L) var. hijau panjang , Amaranth (*Amaranthus* sp) var. local, Green Bean (*Phaselous Vulgaris* L) var low land. Chili, Tomato, and Eggplants were spaced 0.4 m within row and 0.6 between rows (double rows). Yard long bean and Pole bean were spaced 0.25 m within row and 0.6 between rows (double rows). Kangkung and Amaranth were spaced 0.1 m within row and 0.25 between rows (four rows).

Measurement on plant height were conducten for Chili, Tomatoes, Eggplant on 2,3,4,5,6, and 7 weeks after transplanting, whereas for Kakngkung, Amaranth, Yard long bean and greeenbeen were conducter on 2,3,4 weeks after transplanting. Fruit weight per plant and per plot were measured for marketable and un-marketable fruit. Analysis of variance of data was calculated using SAS 6.12 (SAS Institute, N.C). Polynomial regression was used to analyzed P-rate effect (linear or quadratic) and to find out the optimum rate for maximum yield..

RESULTS AND DISCUSSION

Soil Analysis.

Pre plant soil analysis showed that soil pH (water) at the experimental area was very low (5.20). It was common situation for Ultiisol/Podzoliz soil type. C-Organic content was 1.70 % (low), N total 0.21 % (very low), and C/N ratio of 6 (consider very low). Soil P_2O_5 concentration (Bray 1) was 10.8 ppm (high), but the P availability for the plant was low and K (NH4 Acetat 1N, pH 7) was 0.33 cmol/kg. Soil Analysis is presented at Table 1

Table 1. Pre plant Soil Analyses for Ultisol at the Experimental Site.

Soil Character	Soil Index	Methods
pH H2O	5.20	pH meter
pH KCl	4.10	pH meter
C-org (%)	1.70	Walkley and Black
N-org (%)	0.21	Kjeldahl
P Bray-1 (ppm)	10.8	Bray-1
K_2O Morgan (ppm)	167	Morgan
Ca (cmol/kg)	18.45	1 N NH_4Oac pH 7.0
Mg (cmol/kg)	4.63	1 N NH_4Oac pH 7.0
K (cmol/kg)	0.33	1 N NH_4Oac pH 7.0
Na (cmol/kg)	0.07	1 N NH_4Oac pH 7.0
KTK	27.98	1 N NH_4Oac pH 7.0
Al (me/100 g)	1.14	1 N KCl
H (me/100 g)	0.40	1 N KCl

Tekstur :		
Pasir (%)	10	Pipet
Debu (%)	30	Pipet
Liat (%)	60	Pipet

Amaranth (*Amaranthus sp*)

The total plant weight, shoot, and root weihghts of amaranth increased linearly with an increase in P rate from 0 to 180 kg P_2O_5 ha^{-1} . With no P aplication the total plant weight, shoot weight, and root weight per plot are 247.00 g, 209.0 g and 38.0 g ,repectively. Whereas with 180 kg P_2O_5 ha^{-1} are 2804.31 g, 2587. 33 g, and 384 g, respectively (Table 2) This data indicated that soil P concentration of 10.8 ppm (Bray-1) is still not enough contribute available P for amaranth yield with application of P fertilizer up to 180 kg P_2O_5 ha^{-1}. To achieve maximum yield, P rate still can be incraesed. However, in variable shoot/root ratio, increase P application from 135 to 180 kg P_2O_5 ha^{-1} tend to reduce tne number

Table 2. The Effect of P Rate on Total Plant, Leaf, Root Weight per Plot , and Leaf/Root Ratio of Amaranth (*Amaranthus sp*)

P Rate (kg P_2O_5 ha^{-1})	Total Plant weight	Shoot weight	Root weight	Shoot/Root Ratio
	-----gram-----			
0	247.00	209.00	38.00	3.37
45	1304.83	1143.83	201.00	5.54
90	1999.33	1944.67	291.33	6.68
135	2179.67	2080.33	332.67	7.31
180	2804.31	2587.33	384.00	6.60
Regression	L*	L*	L*	

ns,*, ** Non significant or significant at P =0.05 and 0.01, respectively, P rate effects were L= Linear, Q = Quadratic

Kangkung (*Ipomoea aquatica* L.*)*

The plant height of Kangkung at 2,3,4 Weeks After Treansplanting (WAT) increased linearly (Table 3). However, the total plant weight, shoot, and root weihghts per plot of kangkung not influenced by P rate from 0 to 180 kg P_2O_5 ha^{-1} $^{(}$(Table 4.) Leaves weight per plant increased linearly with P application. With no P aplication leaves weight per plant was 3.69 g. Whereas, with 180 kg P_2O_5 ha^{-1} was 7.99 g (Table 5) This data indicated that soil P concentration of 10.8 ppm (Bray-1) is still not enough contribute available P for amaranth yield with application of P fertilizer up to 180 kg P_2O_5 ha^{-1}. To achieve maximum yield, P rate still can be incraesed. However, application of 180 kg P_2O_5 ha^{-1} is enough to increase plant height.

Table 3. The effect of P Rate on Plant Height of Kangkung (*Ipomoea aquatica L)*

P Rate (kg P_2O_5 ha^{-1})	Plant Height (cm)		
	2 WAT	3 WAT	4 WAT
0	12.13	16.62	23.19
45	11.53	13.97	19.19
90	12.33	18.08	25.69
135	12.91	17.79	27.70
180	13.92	19.42	28.61
Regression	L*	L**	L**

ns,*, ** Non significant or significant at P =0.05 and 0.01, respectively, P rate effects were L= Linear, Q = Quadratic

Tablel 4. The Effect of P Rate on Total Plant weight, Leaf, Root Weight per Plot , and Leaf/Root Ratio of Kangkung (*Ipomoea aquatica L*)

P Rate (kg P_2O_5 ha^{-1})	Total P\plant weight	Shoot weight	Root weight	Shoot/Root Ratio
	---------------------------gram-------------------------			
0	490.60	403.93	86.67	4.63
45	562.73	458.70	104.03	4.53
90	437.63	361.77	75.83	4.58
135	667.03	559.40	107.63	5.09
180	642.28	520.63	121.63	4.61
Regression	tn	tn	tn	

ns,*, ** Non significant or significant at P =0.05 and 0.01, respectively, P rate effects were L= Linear, Q = Quadratic

Table 5. The Effect of P Rate on Leaves Weight per Plant Amaranth (*Ipomoea aquatica sp*)

P Rate (kg P_2O_5 ha^{-1})	Shoot weight per plant (g)
0	3.69
45	2.60
90	5.14
135	6.67
180	7.99
Regression	L*

ns,*, ** Non significant or significant at P =0.05 and 0.01, respectively, P rate effects were L= Linear, Q = Quadratic

Egplant (*Solanum melongena* L.

The effect of P application was not significant for plant height of egplant at 2,3 Weeks After Treansplanting (WAT), however increased linearly plat height at 4,5,6, and 7 WAT (Table 6). Fruit weight per plot was not influenced by P application, but fruit weight per plant was increase linearly with P aplication to 180 kg P_2O_5 ha^{-1} (Table 7)

Table 6. The Effect of P Rate on Plant Height of Eggplant (*Solanum melongena*)

P Rate	Plant height (cm)					
(kg P_2O_5 ha^{-1})	2 WAT	3 WAT	4 WAT	5 WAT	6 WAT	7 WAT
0	3.43	4.57	5.30	6.60	9.40	10.01
45	4.14	5.77	7.67	12.27	17.90	19.04
90	3.66	4.90	7.40	12.66	20.63	27.03
135	2.85	4.40	6.07	9.90	10.80	13.70
180	3.11	5.33	7.98	13.23	19.93	30.73
Regression	ns	ns	L*	L**	L**	L**

ns,*, ** Non significant or significant at P =0.05 and 0.01, respectively, P rate effects were L= Linear, Q = Quadratic

Table 7. The Effect of P Rate on Fruit Weight per Plots and Fruit Weight per Plant of Eggplant (*Solanum melongena*)

P Rate	Fruit Weight per Plot	Fruit Weight per Plant
(kg P_2O_5 ha^{-1})	----------------------------gram----------------------------	
0	419.32	80.54
45	285.89	75.56
90	786.02	167.79
135	252.71	44.68
180	633.53	176.47
Pola respon	ns	L*

ns,*, ** Non significant or significant at P =0.05 and 0.01, respectively, P rate effects were L= Linear, Q = Quadratic

Chili (C*apsicum annuum* L.)

The trend of Chili plant height at 2,3 Weeks After Treansplanting (WAT) was quadratic with application of P rate from 0 to 180 kg P_2O_5 ha^{-1} . However application of P to 180 kg P_2O_5 ha^{-1} increased linearly plant height at 4,5,6, and 7 WAT (Table 8). Total fruit yield and total marketable yield also increased linearly wit P application to 180 kg P_2O_5 ha^{-1} (Table 9.) Similar with eggplant, application of P fertilizer up to 180 kg P_2O_5 ha^{-1} is stil increased linearly fruti yield of Chili grown in the ultisol with soil P concentration of 10.8 ppm (Bray-1). However, P application was not influence un marketable chili fuit.

Table 8. The Effect of P Rate on Plant Height of Chili (*Capsicum annuum*)

P Rate (kg P_2O_5 ha^{-1})	Plant Height(cm)					
	2 WAT	3 WAT	4 WAT	5 WAT	6 WAT	7 WAT
0	15.40	19.87	23.31	27.40	32.30	33.90
45	17.27	19.90	24.77	29.93	35.43	36.63
90	18.24	23.43	26.27	33.23	36.93	39.60
135	15.49	220.83	26.03	31.93	38.53	41.27
180	15.53	21.13	28.47	34.47	41.40	41.97
Regression	Q**	Q*	L*	L**	L*	L*

ns,*, ** Non significant or significant at P =0.05 and 0.01, respectively, P rate effects were L= Linear, Q = Quadratic

Tabel 9. The Effect of P Rate on Total, Marketable, and Un-marketable Fruit Weight per Plant of Chili (*Capsicum annuum*)

P Rate (kg P_2O_5 ha^{-1})	Total Fruit Weight	Marketable Frut Weight	Un-marketable Fruit Weight
	gram		
0	66.64	61.56	5.08
45	102.70	101.31	1.40
90	86.58	84.30	2.28
135	144.17	141.83	2.33
180	140.49	138.50	1.99
Regression	L**	L**	ns

ns,*, ** Non significant or significant at P =0.05 and 0.01, respectively, P rate effects were L= Linear, Q = Quadratic

Tomato (*Lycopersicon esculentum* L)

Phospor application from 0 to 180 kg P_2O_5 ha^{-1} incrased linearly plant height of tomato from 1 to 7 WAT (Tabel 10). The lineary trend also occured on total fruit weight and marketable fruit weight, but not significant on unmarketable fruit weight (Table 11). With no P aplication the total fruit weight and marketable fruit weight were 96.67 g and 87.79 g , repectively. Whereas with 180 kg P_2O_5 ha^{-1} were 315.76 g and 304.45 g, respectively. Similar with eggplant and and chili, application of P fertilizer up to 180 kg P_2O_5 ha^{-1} is still increased linearly fruit yield of tomato grown in the ultisol with soil P concentration of 10.8 ppm (Bray-1). However, P application was not influence un marketable tomato fuit.

Tabel 10. The Effect of P Rate on Plant Height of Tomato (*Lycopersicon esculentum*)

P Rate (kg P_2O_5 ha^{-1})	Plant Height (cm)					
	2 WAT	3 WAT	4 WAT	5 WATT	6 WAT	7 WAT
0	19.87	21.57	28.50	32.00	35.40	36.50
45	17.27	24.15	31.03	36.20	40.73	43.77
90	20.07	28.60	37.33	49.90	54.40	53.57
135	17.47	26.47	31.00	38.17	44.77	42.4
180	20.40	30.10	38.23	50.53	59.80	61.03
Regression	L*	L**	L*	L**	L**	L**

ns,*, ** Non significant or significant at P =0.05 and 0.01, respectively, P rate effects were L= Linear, Q = Quadratic

Tabel 11. The Effect of P Rate on Total, Marketable, and Un-marketable Fruit Weight per Plant of Tomato (*Lycopersicon esculentum*)

P Rate (kg P_2O_5 ha^{-1})	Total Fruit Weight	Marketable Frut Weight	Un-marketable Fruit Weight
	---------------------------gram-----------------------------		
0	95.67	87.79	7.88
45	150.39	138.26	12.13
90	204.97	192.87	12.18
135	176.29	168.90	7.39
180	315.76	304.45	11.31
Regression	L**	L**	ns

ns,*, ** Non significant or significant at P =0.05 and 0.01, respectively, P rate effects were L= Linear, Q = Quadratic

Green Bean (*Pahaseolus vulgaris* L*)*

The effect of P application was not significant for plant height of green beans except at 2 WAT (Table 12). Fruit weight per plot was not influenced by P application, but fruit weight per plant was increase linearly with P aplication to 180 kg P_2O_5 ha^{-1} (Table 13).

Tabel 12. The Effect of P Rate on Plant Height of Pole Bean (*Phaseolus vulgaris*)

P Rate (kg P_2O_5 ha^{-1})	Plant Height (cm)		
	2 WAT	3 WAT	4 WAT
0	24.03	39.90	55.03
45	17.43	37.83	71.23
90	24.67	41.23	72.97
135	43.43	43.43	80.23
180	30.57	40.10	112.50
Regression	L**	ns	ns

ns,*, ** Non significant or significant at P =0.05 and 0.01, respectively, P rate effects were L= Linear, Q = Quadratic

Tabel 13. The Effect of P Rate on Fruit Weight per Plot and Fruit Weight per Plant of Pole Bean (*Phaseolus vulgaris*)

P Rate ($kg\ P_2O_5\ ha^{-1}$)	Fruit Weight per Plot	Fruit Weight per Plant
	---------------------------gram---------------------------	
0	355.67	27.33
45	889.00	86.44
90	616.00	36.21
135	924.00	96.48
180	944.67	102.96
Regression	ns	L*

ns,*, ** Non significant or significant at P =0.05 and 0.01, respectively, P rate effects were L= Linear, Q = Quadratic

Yard Long Bean (*Vigna unguilata*)

The effect of P application was not significant for plant height of yard long beans except at 25WAT (Table 14). Fruit weight per plot was not influenced by P application, but fruit weight per plant was increase linearly with P aplication to 180 kg P_2O_5 ha^{-1} (Table 13).

Tabel 14. The Effect of P Rate on Plant Height of Yard Long Bean (*Vigna Ungulilata*)

P Rate	Plant Height (cm)			
($kg\ P_2O_5\ ha^{-1}$)	2 WAT	3 WAT	4 WAT	5 WAT
0	13.23	16.57	40.73	84.16
45	12.70	20.43	36.83	62.83
90	12.13	19.20	51.13	89.43
135	12.90	23.76	52.30	81.57
180	11.83	18.92	42.87	97.87
Regression	ns	ns	ns	L*

ns,*, ** Non significant or significant at P =0.05 and 0.01, respectively, P rate effects were L= Linear, Q = Quadratic

Tabel 15. The Effect of P Rate on Fruit Weight per Plot and Fruit Weight per Plant of ard Long Bean (*Vigna Ungulilata*)

P Rate ($kg\ P_2O_5\ ha^{-1}$)	Fruit Weight per Plot	Fruit Weight per Plant
	---------------------------gram---------------------------	
0	192.89	62.51
45	233.11	101.96
90	144.50	85.96
135	100.33	39.63
180	31.67	84.91
Regression	ns	ns

ns,*, ** Non significant or significant at P =0.05 and 0.01, respectively, P rate effects were L= Linear, Q = Quadratic

Tabel 15. Analyses of Varian for all Measured Variable of the P application on Vegetable Grown on Ultisol Nanggung, Bogor, Indonesia

	Phosphor Rate			
	F Hit	p		
Amaranth (*Amaranthus sp*)				
Leaf weight per plots (4x1.5 m)	6.32	0.0135tn	402,6420	
Total biomass weight per plots	4.55	0.0328*	46.37291	L*
Root weight per plot	5.82	0.0170*	39.10681	L*
Root/leaf ratio	1.28	0.3550tn	64.94166	
Kangkung (*Ipomoea aquatica*)				
Plant height				
1 WAT	2.77	0.0341*	16.7414	L*
2 WAT	6.52	0.0002**	18.1197	L**
3 WAT	6.99	0.0001**	22.3743	L**
Leaf weight per plots (4x1.5 m)	0.59	0.6769tn	39.5639	
Total biomass weight per plots	0.61	0.6652tn	38.5088	
Root weight per plot	0.73	0.5951tn	36.8056	
Root/Leaf ratio Bobot	0.29	0.8787tn	15.6481	
Leaf weight per plant	4.09	0.0429*	35.7447	L*
Eggplant (*Solanum melongena)*				
Plant height				
1 WAT	1.83	0.1340tn	41.6674	
2 WAT	1.69	0.1615tn	33.4012	
3 WAT	2.79	0.0330*	38.6123	L*
4 WAT	6.34	0.0002**	44.5600	L**
5 WAT	5.59	0.0006**	54.7793	L**
6 WAT	12.99	0.0001**	46.6756	L**
Fruit weight per plot	1.26	0.3593tn	74.2585	
Fruit weight per plant	3.99	0.0057*	105.4840	L*
Chili *(Capsicum annuum)*				
Plant Height				
1 WAT	5.15	0.0011**	13.4900	Q**
2 WAT	2.94	0.0267*	15.6200	Q*
3 WAT	3.02	0.0235*	16.5200	L*
4 WAT	3.95	0.0061**	17.9900	L**
5 WAT	3.26	0.0165*	19.6600	L*
6 WAT	2.45	0.0540*	21.5300	L*
Total fruit weight per plot	0.74	0.5887tn	45.7100	
Marketable fruit weight per plot	0.75	0.58298tn	46.5000	
Unmarketable fruit weight per plot	0.60	0.6746tn	113.4980	
Total fruit weight per plant	4.94	0.0015**	54.4200	L**
Marketable fruit weight per plant	5.26	0.0009**	55.4800	L**
Unmarketable fruit weight per plant	0.74	0.5703tn	246.1820	
Tomato (*Lycopersicon esculentum*)				
Plant height				
1 WAT	2.45	0.0540*	21.5305	L*
2 WAT	4.42	0.0031**	24.0482	L**

3 WAT	3.06	0.0221*	28.6531	L*
4 WAT	5.63	0.0006**	30.2450	L**
5 WAT	7.79	0.0001**	29.4160	L**
6 WAt	6.51	0.0002**	29.3266	L**
Total fruit weight per plot	5.39	0.0211*	32.3809	L*
Marketable fruit weight per plot	5.86	0.0167*	32.1767	L*
Unmarketable fruit weight per plot	0.17	0.9454tn	81.0680	
Total fruit weight per plant	5.47	0.0007**	71.7349	L**
Marketable fruit weight per plant	5.8	0.0004**	72.6542	L**
Unmarketable fruit weight per plant	0.22	0.9278tn	190.8840	
Pole Bean (*Pahaseolus vulgaris*)				
Plant height				
1 WAT	11.57	0.0001**	42.4100	L**
2 WAT	0.45	0.7722tn	29.3200	
3 WAT	1.97	0.1082tn	35.8300	
4 WAt	6.49	0.0002**	35.5900	L**
Fruit weight per plot	1.33	0.3382tn	51.5000	
Fruit weight per plant	2.98	0.0251*	84.9200	L*
Yard Long Bean (*Vigna unguilata*)				
Plant height				
1 WAT	1.06	0.3845tn	17.0880	
2 WAT	1.1	0.3642tn	49.1750	
3 WAT	1.47	0.2210tn	47.8700	
4 WAT	2.79	0.0329*	36.1305	L*
Fruit weight per plot	1.93	0.1267tn	121.2260	
Fruit weight per plant	2.39	0.0594tn	80.8920	

CONCLUSSION

From the experiment can be clonculed

1. In the level of soil P concentration of 10.8 ppm (Bray-1) of Ultisol, application of P fertilizer up 180 kg P_2O_5 ha^{-1} increased linearly plant height of kangkung, eggplant, chili, tomato, yard long bean and green bean.
2. The same (point 1) application increased linearly yield of amaranth, kangkung, egplant, chili, tomato and green bean.
3. To achieve optimum P fertilizer rate, the range of P rate application has tobe increased.
4. To accomplish correlation study in this ultisol wider range of soil P status more than 180 kg P_2O_5 ha^{-1} should be applied.

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