Peanut (*Arachis hypogaea* L.) yield and its components as affected by lime and rice husk ash in An Phu soils, An Giang, Viet Nam

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Abstract

The study of the effects of lime and rice husk ash in peanuts was carried out in winter-spring 2017 inside the dyke at An Phu district, An Giang province, consisted of following experiments: (i) Effects of lime, rice husk ash to Characters in soil. (ii) Effects of lime, rice husk ash on Arsenic and Cadmium uptake of peanuts, (iii) Effects of lime, rice husk ash to Yield and yield components of peanuts. The experiment was carried out with 4 treatments, 4 replications. The results showed that the treatment with lime and rice husk ash combination increased pH and EC in soil; the arsenic and cadminm contents in stems and seeds were lowest (81.0; 27.0 µg/kg and 1.7; 0.18 mg/kg, respectively) and produced the highest average total yield per hectare (7.59 tons) which significantly differed from all other treatments, the lowest yield (4.63 tons) was in the control treatment

Keywords: *Arsenic, cadmium, lime, Peanut (Arachis hypogaea L.), rice husk ash*

1. Introduction

Peanut is one of the world's most popular crops cultivated in tropical and sub-tropical regions. Because of its high protein, oil, fatty acid, carbohydrates, vitamins and minerals contents, peanut has high commercial and nutritional value. It contains 45-55% oil, 20-25% protein, 16-18% carbohydrate and 5% minerals (Gulluoglu, 2011; Gulluoglu, Bakal, Onat, Sabagh, & Arioglu, 2016). Effects on soil physical, chemical and Soil organic matter and lime play a key role in maintainability of soil fertility and productivity. The effects of the organic mater and lime may be either direct or indirect. Organic matter combined liming acts directly as a source of plant nutrients and indirectly influences the physical and chemical properties. Farming practices, which involve heavy application of chemical fertilizers, may cause depletion of certain nutrients in soils and certain others. It would generally accumulate in excess resulting in nutrient imbalance and affects soil productivity. Among available means to achieve sustainability in agricultural production, organic mater play an important and key role because they possesses many desirable soil properties and exerts beneficial biological characteristics (Tran Thi Ngoc Son, Vu Van Thu, Luu Hong Man, Kobayashi, & Yamada, 2004).

Due to the intensive farming, Viet Nam is known as a heavy consumer of chemical fertilizer. Additionally, arsenic (As) and cadmium (Cd) pollution in soils has been warned in An Phu district. The resuls of on-farm research conducted on Cd contaminated fields showed that Cd levels in grain of maize, rice and mung bean were higher at 46.3% deep-well water treatments compared with river water use treatments. The results showed that, when applied lime at 5 tons/ha had a significant effect on amount of Cd in the grains of rice, corn and green beans decreased 48.4; 43.6; 40.6%, respectively, compared without liming (Nguyen Van Chuong & Ngo Ngoc Hung, 2015). Previous studies have reported that the use of well water contaminated with arsenic caused serious contamination of soil and crops. The application of lime combined with rice husk ash, which reduces the absorption of arsenic and increase the yield of soybean (Nguyen Van Chuong & Nguyen Trung Chinh, 2018), may be the only renewable soil fertility input that the farmer can acquire without significant investment. By additing lime combined with rice coconut fiber, a farmer can raise his yield and income. The aim of this study was to investigate the effects of lime and coconut fiber fertilization on yield, yield components and some chemical trails of peanut cultivated in newly reclaimed land in Quoc Thai, An Giang province, Viet Nam.

2. Materials and Methods

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The study is experimented at field in Quoc Thai, An Phu district, An Giang province. The experiment was carried out in the field at areas inside the dyke with 4 treatments: control (0 tons liming and coconut fiber/ha), liming (5 tons CaO/ha), coconut fiber (5 tons/ha) and liming (5 tons CaO/ha) combined coconut fiber(5 tons/ha) and 4 replications. The kind of irrigation water (deep well water) x 2 doses of lime and coconut filber (5 tons/ha), with area of each replicate of being equivalent to 24 m^2 (6m x 4m), planted in a single row with distance of 50 cm x 30 cm (three seeds/hole), the distance between plants is 30 cm and row is 50 cm.

Each of the pots was fertilized with a basal dose of N, P and K at 40, 60 and 50 kg/ha, respectively. Peanuts (LD14) were sown in each pot, and the germinated plants were later thinned to keep three plants per pot. After 10 weeks of growth, the aboveground biomass of the peanut plants was harvested. The dry matter yield was recorded and the dried samples were digested in a mixture of nitric and percholoric acids. The digests were analysed for As with a Varian Vista AX CCD inductively coupled plasma atomic emission spectrometer. After the harvest of plants, soil was air dried, well mixed and passed through a 2-mm sieve. Soil pH and electrical conductivity (EC) were measured. All data were analyzed by the generalized linear model analysis of variance using Genstat v10 (VSN International Ltd, UK, 2007).

3. Results and Discussion

Total Arsenic (As): The result from Table 1, which shows average As concentration of soils is 41.2; 38.1 mg/kg in deep soil from 0-20 cm to 20-40 cm taken in surveyed areas. Arsenic concentrations of soils is very high, which exceeds As concentration in agricultural of 12 mg/kg according to Vietnamese allowed standard. Farmers in Quoc Thai have been using As contaminated drilled well water to irrigate plants, which causes As poluted soils

Total Cadmium (Cd): Cadmium concentration in soil with average concentration from 178-239 µg/kg for twee kinds of soil used to plant peanuts from 0-20 cm to 20-40 cm of soil deep (Table 1). The key cause of high Cd concentration in soil is that farmers used As contaminated drilled well water to irrigate plants and applied the Cd content of low quality of inorganic fertilizers.

Table 1 Soil particle size distribution and chemical characteristics at the first of the experiment

Soil Analysis		**Soil depth (cm)**		**Soil analysis**		**Soil depth (cm)**	
		0 -20	**20-40**			**0-20**	**20-40**
Mechanical analysis	Sand (%)	6.20	3.10	Available nutrients	Total N(%)	0.134	0.130
	Clay (%)	64.0	65.0		Available P (ppm)	55.1	52.3
	Silt (%)	29.8	31.9		Available K(ppm)	634	612
	C (%)	1.23	1.13		Total Ca (%)	22	21
	OM (%)	2.46	2.26		As (mg/kg)	41.2	38.1
	C/N	11.0	8.70		Cd (µg/kg)	239	178

Soil pH: the results at the end of the experiment did not show any significant difference among all treatments, for soil pH (Table 2). This could be due to the fact that the soil of the experimental site had a relatively high buffering capacity based on its high carbonate content its high calcium content (22.3-28.2 %) as found in Table 2 and can fix any change in its pH during organic matter decomposition.

Total Soluble Salts (EC): There were no significant differences among treatments used (Table 2), eventhough the highest EC (230 µS/cm) was obtained by the coconut fiber and liming treatment due to the use of Coconut fiber and liming fertilizers, which accumulated and raised the soil EC, while the lowest EC (210 µS/cm) was obtained by the control treatment, since no organic or liming fertilizers were used. The highest EC that obtained by the coconut fiber combined lime treatments could be attributed to the addition of organic fertilizers that supplied soil with soluble compounds. In addition the highest EC that was obtained from the organic and lime treatment could be due to the high use of carbonate content.

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Table 2 Results of Soil chemical analysis at the end of the experiment*

Treatments	Characters						
	pH	EC (µS/cm)	Total N (%)	Available P (ppm)	Available K (ppm)	Total O.M. (%)	Total Ca (%)
-Control (Non liming and coconut fiber)	7.26	210	0.133^{b}	45.2^{d}	610^{c}	1.18^{d}	22.3^{d}
-Liming (5tons/ha)	7.44	213	0.155^{c}	60.2^{c}	625^{c}	1.23^{c}	26.8^{b}
-Coconut fiber (5tons/ha)	7.40	220	0.166^{b}	78.2^{b}	657^{b}	1.45^{b}	24.5^{c}
-Coconut fiber and liming (5tons/ha + 5tons/ha)	7.53	230	0.423^{a}	90.3^{a}	780^{a}	1.57^{a}	28.2^{a}
F	*ns*	*ns*	**	**	*	*	*
CV(%)	5.8	7.8	12.8	13.4	12.3	13.5	12.4

** Values are the mean of four replicates. Means within each column having different letters, are significantly different according to LSD at ns: no significant differences, 5 % (*) and 1% (**) level.*

Total Nitrogen (N): Table 2 indicates that total nitrogen percent in the Coconut fiber and liming treatment were significantly higher than all other treatments (0.423%), whereas no significant effects of control treatments on the lowest soil total nitrogen was noticed, when compared to Coconut fiber and liming treatment (0.133%). This difference can be attributed to the slow release of nutrients from the organic matter (Brown, Christy, & Smith, 1993).

Available Phosphorous (P): Highly significant available phosphorus was obtained by using lime, coconut fiber, lime combined coconut fiber treatments (Table 2), compared to control treatment. These results proved that the use of mixture fertilizers could supply the plants with good amounts of available phosphorous. On the other hand, higher amounts of available phosphorous (90.3 ppm) were obtained by the mixture treatment when compared with the conventional and the control treatment, but without significant differences.

Available Potassium (K): Coconut fiber and liming treatment had the highest available potassium (780 ppm), which was significantly higher than all other treatments (Table 2). On the other hand, higher amounts were recorded by using mixture lime and coconut fiber treatments with a highly significant difference when compared to other treatments (control, lime and coconut fiber). the available potassium of all treaments was significantly different according to LSD at 1%.

Total Organic Matter (O.M.): The highest soil organic matter content (1.57 %) was obtained by the liming combined coconut fiber treatment, a significant difference with all other treatments, while the lowest content (1.188 %) was obtained by the control treatment (Table 2).

Total Calcium (Ca): Soil Calcium showed significant differences among the different treatments as shown in Table 2; which could be due to the high content of soil calcium and the amounts of applied organic matter or inorganic fertilizers were relatively to affect the soil calcium content.

Nodulation status: Results in Table 3, non-liming and coconut fiber treatment secured 37 nodules/ plant and 0.231 dry weight (g/ plant). This indicates that innative lime and coconut fiber in soil. On the other hand, irrespective of lime, coconut fiber treatments revealed significant differences among them where lime combined coconut fiber are 109 nodules of 0.822 dry weight (g/ plant). In control treatments, average nodules of dry weight is the lowest meaning difference with liming combined coconut fiber treatments of 5 tons/ha with respectively 37 nodules of 0.231 dry weight; 109 nodules of 0.822 dry weight (g/ plant). On liming or coconut fiber treatments (5 tons/ha), nodules of dry weight (g/ plant) is higher compared to control treatments (reduce about 0.5 times). The analytical result also shows that there is difference from lime combined coconut fiber treatments secured significant increases in shoot fresh and total plant fresh weights (485 and 470 gm/ plant) respectively. The interaction between lime and coconut fiber application on the

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highest number of Character, Significant increases were obtained (9.92; 0.822; 485; 470 gm.plant^{-1}) for nodule fresh and dry weights as well as shoot fresh and total plant fresh weights respectively. Dual no liming and coconut fiber gained significant numbers of 55 and 60 nodules with 5 coconut fiber tons/ha, 5 lime tons/ha, respectively. Chemical Properties of the Coconut fiber and liming treatments were significantly higher than all other treatments. whereas control treatments were the lowest soil value of chemical Properties when compared to other treatment. This difference can be attributed to the slow release of nutrients from the organic matter and lime (Brown, Christy, & Smith, 1993).

Table 3 Effects of liming and coconut fiber application on nodulation status and total fresh weight of peanut in Quoc Thai region, 7/2017

Treatment	Characters				
	Nodules No.	Nodules F.W. (gm.plant^{-1})	Nodules D. W. (gm. plant^{-1})	Shoot F. W. (gm)	Total plant F. W. (gm)
-Control (Non liming and coconut fiber)	37.0^{d}	0.630^{d}	0.231^{d}	210^{d}	256^{d}
-Liming (5tons/ha)	60.0^{b}	1.05^{c}	0.451^{c}	430^{b}	398^{b}
-Coconut fiber (5tons/ha)	55.0^{c}	1.78^{b}	0.541^{b}	340^{c}	370^{c}
-Coconut fiber and liming (5tons/ha + 5tons/ha)	109^{a}	9.92a	0.822^{a}	485^{a}	470^{a}
F	**	**	**	**	**
CV(%)	14.2	11.1	7.98	13.9	13.2

** Values are the mean of four replicates. Means within each column having different letters, are significantly different according to LSD at ns: no significant differences, 5 % (*) and 1% (**) level.*

Chemical traits of peanut: Results in Table 4 revealed that there were significant effect by lime and coconut fiber treatments on all studied traits of yield and yield components. All studied yield characters increased gradually by control, lime, coconut fiber, lime combined coconut fiber levels from 0 to 5tons/ha and the differences between levels were significance for all traits at most differences between levels in the whole study. Lime combined coconut fiber at (5 CaO + 5 coconut fiber) tons /ha produced the maximum values of number of pods/plant (42.8), weight of stems and seeds/ 10 plants (7.6 and 0.802 kg), weight of 100 and 1,000 seeds/plant (57.5 and 558 gm), weight of pods/ha (7.59 tons) in 2017 growing seasons, respectively. Organic fertilizer is an important factor in achieving better growth and development of plant and reproductive organs of groundnut and with increases of photosynthesis rate and photosynthetic matter production and sequently the yield components and seed yield of peanut. Lime and coconut fiber treatments significantly affected all studied characters in this study (Table 4). Using Lime and coconut fiber treatments gave significant increase in all studied traits. Lime + coconut fiber produced the highest values of number of pods/plant (42,8), fresh weight of pods/plant (80.2 gm), weight of 100 and 1,000 seeds/plant (57.5 & 558 gm), weight of pods/ha (Table 4).

The Coconut fiber and liming treatment (Table 4) produced the highest average total yield per hectare (7.59 tons/ha) which significantly differed from all other treatments, while the lowest yield (4.63 tons/ha) was obtained from the control treatment. Yield per hectare in the present study was relatively high and varied from 4.63-7.59 tons/ ha depending on the production system. The yield increase per hectare percentage was calculated in compare to other treatment results, the percentage of increase in yield per hectare was ranged from 6.8 to 39%, the highest increase was obtained by the lime combined coconut treatment while the lowest yield was obtained by the control treatment

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Table 4 Effect of liming and coconut fiber application on yield and yield components of peanut in Quoc Thai region, 7/2017

Treatment	Characters						
	Wt.stems/10 Pl. (kg)	Wt.pods/ 10Pl.(kg)	No.pods/Pl.	Wt.pods/ Pl.(g)	Wt.seeds/ plant(g)		Wt.pods/ha. (ton)
					100	1,000	
-Control (Non liming and coconut fiber)	5.85^{d}	0.561^{d}	30.1^{d}	56.1^{d}	40.0^{d}	435^{d}	4.63^{d}
-Liming (5tons/ha)	6.20^{b}	0.562^{c}	36.1^{c}	64.9c	49.0^{c}	485^{c}	5.25^{c}
-Coconut fiber (5tons/ha)	5.95^{c}	0.744^{b}	40.3^{b}	74.4^{b}	52.0^{b}	513^{b}	6.19^{b}
-Coconut fiber and liming (5tons/ha + 5tons/ha)	7.60^{a}	0.802^{a}	42.8^{a}	80.2^{a}	57.5^{a}	558^{a}	7.59^{a}
F	*	*	*	*	*	*	**
CV(%)	12.7	12.6	14.9	12.1	10.4	10.7	12.5

** Values are the mean of four replicates. Means within each column having different letters, are significantly different according to LSD at ns: no significant differences, 5 % (*) and 1% (**) level.*

Chemical traits: Data presented in Table 5 showed that oil % in seeds, seed protein% content in seeds significantly affected by lime and coconut fiber levels. The oil and protein content in seeds significantly affected by lime and coconut fiber treatments. The highest values of oil and protein (46.7 and 26.8%) were obtained by lime combined coconut fiber, while seed oil and protein of seeds (44.3 and 20.1%) respectively in control treatmens received no lime and coconut fiber fertilizer. Other levels of Lime or coconut fiber fertility affected seed quality by increasing protein and oil concentrations. The oil content appears to be less negatively impacted by Lime or coconut fiber. Lime or coconut fiber application significantly affected oil %, seed protein%. These results are in harmony with those obtained by (Bogino, Bancho, Rinaudi, Cerioni, Bonfiglio, & Giordano, 2006; Nasr-Alla, Osman, & Soliman, 1998).

The result in Table 5 indicates that, As concentration in stems and seeds of peanuts that is (1.70 and 0.18 mg/kg) in lime and coconut treaments, is lower than compared to control treatments (3.12 and 0.38 mg/kg), respectively. In lime treatments (5 tons/ha), As accumulation in peanut stems and seeds is (2.46 and 0.26 mg/kg) lower than 0,5 times non-liming treatments. Arsenic concentration of lime or coconut fiber treatments is averagely decreased from 0.5 to 1.5 times compared to control treatments. The lowest values of As concentration in stems and seeds of peanuts that is (1.70 and 0.18 mg/kg) were obtained by lime combined coconut fiber, while the highest As concentration in stems and seeds (3.12 and 0.38 mg/kg) in control treatmens. Other levels of Lime or coconut fiber fertility affected seed quality by decreasing As concentrations in stems and seeds.

Similarly, the result in Table 5 also shows that Cd concentration in stems and seeds of peanuts respectively is 81 µg/kg and 27 µg/kg in lime combined coconut fiber treatments lower non- lime and coconut fiber treatments **(**100 and 35 µg/kg**)**. Among which, in liming (5 tons/ha) and coconut fiber (5 tons/ha) treatments, Cd accumulation in stems, seeds of peanuts is entirly lower than control treatments.

Table 5 Effect of liming and coconut fiber application on some chemical traits of peanut in Quoc Thai region, 7/2017

Treatment	Characters			
			Cadmium	Arsenic

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	Seed Oil (%)	Seed protein (%)	(µg/kg)		(mg/kg)	
			Stems	Seeds	Stems	Seeds
-Control (Non liming and coconut fiber)	44.3^{c}	20.1^{d}	100^{a}	35.0^{a}	3.12^{a}	0.38^{a}
-Liming (5tons/ha)	45.1^{b}	23.5^{c}	84.0^{c}	29.0^{c}	2.46^{b}	0.26^{b}
-Coconut fiber (5tons/ha)	45.7^{bc}	24.1^{b}	90.0^{b}	33.0^{b}	2.51^{b}	0.36^{a}
-Coconut fiber and liming (5tons/ha + 5tons/ha)	46.7^{a}	26.8^{a}	81.0^{d}	27.0^{d}	1.70^{c}	0.18^{c}
F	**	**	**	**	**	**
CV(%)	11.3	12.6	9.4	11.8	14.2	15.3

** Values are the mean of four replicates. Means within each column having different letters, are significantly different according to LSD at ns: no significant differences, 5 % (*) and 1% (**) level.*

Cadmium and As concentration in seeds, stems of peanuts in non-liming and coconut fiber experiments is always higher than other treatments of 5 CaO tons/ha and 5 coconut fiber tons/ha. Through which, we can see the effects of lime and coconut fiber application to uptake of Cd and As contaminated from soil into stem and seed of peanuts. Lime combined coconut fiber reduced the ability of As and Cd absorption of peanuts in stems and seeds is very different and has statistical meaning compared to control treatments.
All growth parameters were improved when peanut plants received advantage effects of lime and coconut fiber. Moreover, a great potential of peanut growth was resulted by co-lime with coconut fiber. Continued application of other levels of lime and organic enhanced nodule formation and reduced the need to chemical fertilizer, pesticide ultimate, and As and Cd absorption of peanuts in stems and seeds, conserved environment and braving sustainability.

4. Conclusions

Treatment kind had no significant effect on the soil pH, EC and calcium, the arsenic and cadmium contents in stems and seeds were lower than that of the control. The application of lime combined with coconut fiber reduced the absorption of arsenic, cadmium and increase the yield and yield components of peanuts. On the other hand, the highest soil total nitrogen percent and available potassium, available phosphorous, organic matter content were were obtained by the lime combined with coconut fiber, while the soil available characters were obtained for all treatments other than control treatments. In addition, significant differences were observed between lime and coconut fiber source treatments.

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