Journal of Positive School Psychology
2022, Vol. 6, No. 5, 6015 – 6019 http://journalppw.com

Quality And Yield Amelioration of Edamame By Integration Application Of Lime, Vermicompost And Rhizobium

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ABSTRACT

The posititve benifite of lime and vermicompost complement, which associated with *Rhizobium* inoculum on Arsenic (As) absorption and yield production of Vegetable Soybean cultivated on the As pollution soil and water was obtained the great results. The field study that was perfectly arranged in the urban commune of An Phu town from Jun to September of 2022 included five treatments and four replications. Treatment 1 (NPK:40-60-60 kg/ha, respectively); 2 (NPK + *Rhizobium*); 3 (NPK + 10t vermicompost/ha + *Rhizobium*); AD4 (NPK + 1.5t $CaCO_3$/ha + Rhizobium) and 5 (NPK + 1.5t $CaCO_3$/ha+10t vermicompost/ha + Rhizobium). The maximum productivity and productivity components of Vegetable Soybean was at additional treatments of the vermicompost and lime during the crop season. positive results of vermicompost alone or combined with lime and *Rhizobium* inoculum raised the Vegetable Soybean productivity from 9.50% (NPK+ 10 t vermicompost /ha), 11.3% (NPK+ 1.5 t $CaCO_3$/ha) to 21.8% (NPK+ 10 t earthworm manure/ha+1.5 t $CaCO_3$/ha cum *Rhizobium*) comparison with control (NPK only) and 2 (NPK and *Rhizobium*). The highest reduction percentage of soil As concentration was 35.4% in treatment 5 and lowest rate of 14.5% in treatment 1 comparision with before and after experiment. Further, the As concontration of vegetable soybean in bodies and in grains of treatment 3 got lower than 44.8 % in body and 33.3% in grains comparison with no lime or vermicompost application. the As absorption of Vegetable Soybean body and grain noticeably reduced in the additional treatments of lime, vermicompost to As polution soils.

Keywords: Arsenic, Vegetable soybean, lime, *Rhizobium*, vermicompost

Introduction

Vegetable soybean (Edamame) [*Glycine max* (L.) Merr.] is a low expenditure, high nutritiousness, short cultivation time and soil fertility increase. It brings a high profit and good food for health to the consumers. The vegetable soybean need has gradually increased in the recent years thank to be aware of nutrition lack and the demand increase of the life standard towards safer and healthier foodstuff [1]. The vegetable soybean consumption could significantly bring to reduce nutrition lacks of children and adults, through its high nutrition concentration and healthy interest [2]. Legumes have perfectly contributed to sustainable intensive farming of agricultural production in Asian countries and the ecosystem promotion in the agricultural production [3].

Arsenic, However, which is a pollutant for crop soil and irrigation water causes to reduce crop productivity and raise As uptake of bodies and grains of crops. The high pH of crop soils, which may increase the immobility of iron and aluminum ions could reduce the As uptake of plants in order to improve the growth, productivity and quality of crops [4]. Animal manures and positive microbes have improved the quality and productivity of groundnut [5]. Almost all crop soils have been a nitrogen inadequacy for plants [6]. The key method that overcomes these disadvantages is the co-application of lime, vermicompost and *Rhizobia* inoculation [7]. *Rhizobia* inoculation has perfectly brought the positive effects thank to support a nitrogen from the atmosphere for legume [8]. The addition of vermicompost could help to increase the productivity and quality of legume and the nutrition of the crop soil in the degraded soil [9]. The lime, organic fertilizer and *Rhizobia* inoculation has been using in the agricultural cultivation [10]. the lime application for As pollution soils, which could lessen As uptake of plants due to increase pH and As immobility of soils is the best way. The combination of lime, organic manure with *Rhizobia* reduced the As absorption and raised productivity of plants [11]. The study aims discover positive influences of lime, vermicompost and *Rhizobium* adaptability on the As accumulation soil (i); leesening As uptake and raising productivity of Vegetable soybean. This study result could recommend farmers, who can apply for their cultivation from these research results.

Materials and methods

The field experiment was designed by Five treatments with 20 blocks in the suburban commune of An Phu town from March to Jun of 2022. Five treatments, which were five blocks included 20 experimental plots. The whole Area of one plot with size 0.5×20 m^2, distance between two plants 20 cm, so that obtained 10 plants. crops were

applied by lime (1.5t $CaCO_3$/ha), vermicompost (10 t/ha) and *Rhizobium inocolum* (10^8CFU/g) (Table 1). Edamame grains were seeded two grains per hole. Fifteen days before the grain sowing, 100% of lime and vermicompost levels were applied to each experimental plot. One day Before seed germination, edamame grains were carefully mixed by *Rhizobium* (10^8CFU/g). This local farm was experimented by one season and deep well water. Plants were watered by deep well water for two times per day. Pests were manually controled by handing and killing them and then destroying. The weed was regularly cleaned after fifteen days sowing. About two months, edamame pods gave that the grains in the pods were perfectly ripe fruits. The productivity component and yield were determinated by observing in ten plants. fresh pods were counted for ten plants for each plot.

Table 1 Levels of organic and inorganic fertilizer

Treatment	*Rhizobia* (10^8CFU/g)	$CaCO_3$ (t/ha)	Vermicompost (t/ha)	Chemical fertilizer (kg/ha)
1: NPK (control)	No	0.000	0.000	
2: NPK + Rhizobia	Yes	0.000	0.000	
3: NPK + $CaCO_3$ + *Rhizobia*	Yes	0.000	10.00	40N-60P-40K
4: NPK + Vermicompost + *Rhizobia*	Yes	1.500	0.000	
5:NPK + $CaCO_3$ + Vermicompost + *Rhizobia*	Yes	1.500	10.00	

The data analysis was determinated by using statgraphics centurion xv at LSD < 0.05.

Results and discussion

a. Soil pH

Before the experiment, Soil pH ranged from 5.06 to 5.10 and remarkably diferrence at 5%. There was significantly diferrent at the 1% level of soil pH after the experiment of treatments. Soil pH at the end of experiment, which remarkably decreased (LSD ≤ 0.05) in treatment 1 & 2 except the treatment 3, 4 and 5 during the study time valued from 4.91 to 6.17. The maximum pH of treatment 5 was 6.17 and the minimum pH (4.92) of treatment 1 and 2. The pH of soil at treatments of lime, vermicompost amendment and *Rhizobium* inoculation (3, 4 and 5) raised remarkably higher than without lime and vermicompost at harvest (treatment 1 & 2). The pH of soil of treatment 1 & 2 at first of experiment which was higher than soil pH at harvest. On contrary, pH values of treatment 3, 4 and 5 at harvest that increased remarkably from 5.1, 5.09 and 5.06 to 5.45, 5.9 and 6.17, respectively, comparison with the first time of the experiment.

The first time of experimentation amended the lime and vermicompost remarkably differences at LSD < 1% at harvest. The prior research showed that lime application for the agricutural soil contributed number of calcium ions and soil pH increase raised the soil fertility and crop productivity [12]. Furthermore, the amendment of lime associated vermicompost raised soil pH and increased the soil fertility [13]. Many studies presented that the supplementation of lime associated with animal and chemical fertilizers raised soil nutrients, yield and quality of crops comparison with the control [14], [15].

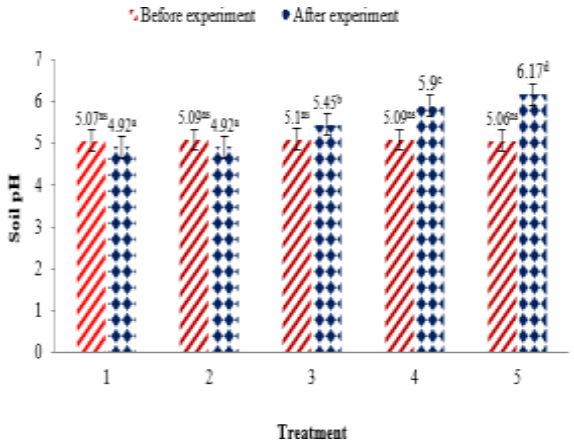

Fig. 1 Soil pH

b. Yield component differences of Vegetable soybean

Table. 2 differences of the height and shoot of vegetable soybean during the growth

Treatment	height (cm) per plant				Branches per plant			
	DAS				DAS			
	20	45	65	Harvest	20	45	65	Harvest
1	25.2[b]	33.2	34.6	34.7	1.25[b]	5.25[b]	6.00[b]	6.00[b]
2	27.2[b]	33.6	35.9	36.1	1.75[ab]	6.00[b]	6.00[b]	6.00[b]
3	25.8ab[b]	33.0	34.3	34.4	2.00[b]	6.00[b]	6.00[b]	6.00[b]
4	24.6[b]	31.6	34.1	34.2	1.50[ab]	5.75[ab]	6.75[b]	6.75[b]
5	24.1[b]	31.1	34.9	35.0	1.50[ab]	5.75[ab]	7.25[b]	7.25[b]
F_{test}	*	ns	ns	ns	*	*	**	**
CV(%)	5.66	5.73	5.09	5.01	21.4	7.70	9.34	9.34

DAS: Day after sowing; ns: insignificantly different; (;**): significantly different at 5% and 1% level*

The result of Table 2 was showed that amendment of lime, vermicompost combined with *Rhizobia* inoculum on the edamame height, all treatments were insignificant variousness at 5%, the only exception being twenty Days after sowing). The maximum branch (7.25) and minimum value (6.0) were in treatment 5 (NPK + 1.5 t $CaCO_3$ + 10 t vermicompost per ha and *Rhizobia* inoculum) and other treatments at the end of crop season. Further, branches of *Vegetable soybean* remarkably

increased 45 DAS to the end of crop season (Table 3). The useful influences of animal manures, limes, *Rhizobia* help to develop the matureness of *productivity* components like heights and effective branches of Vegetable soybean [16], [17].

Table 3 The yield component and yield of Vegetable soybean in the different treatments

Treatment	Biomass (g)	No. of pods		Wt. of pods (g)		Wt. of 1,000 grains (g)
		Full	Empty	Full	Empty	
1	125^{b}	47.2^{d}	10.5^{e}	120^{d}	14.0^{d}	600^{a}
2	105^{a}	40.4^{a}	5.13^{b}	$90,1^{a}$	5.38^{a}	700^{b}
3	125^{b}	44.5^{b}	5.68^{d}	100^{b}	6.25^{b}	700^{b}
4	125^{b}	45.5^{c}	5.48^{c}	105^{c}	6.25^{b}	700^{b}
5	130^{c}	48.1^{e}	5.00^{a}	105^{c}	8.00^{c}	750^{c}
F_{test}	**	**	**	**	**	**
CV(%)	7.91	6.13	23.7	9.85	7.31	7.52

(**) *ns: insignificantly different; (*;**): significantly different at 5% and 1% level*

There were sufficiently affected by the additon of lime, vermicompost combined with Rhizobia on The vegetable soybean biomass (Table 3). The vegetable soybean biomass of treatment 5 (130 g plant^{-1}) that was added by the lime, vermicompost combined with Rhizobia had the maximum biomass comparison with other treatments. The biomass of vegetable soybean valued from 105g plant-1 to 130 g plant-1. The treatment 2 had the minimum biomass (105g plant^{-1}), which only fertilized by NPK associated with Rhizobia and variousness at 1% (Table 3).

This results in Table 3 caused the significant relations between vermicompost and lime with the soil nutritive [18]. The maturity and yield production of vegetable soybean increased remarkably when applying vermicompost associated with lime [19].

The highest number and weight of full pods obtained 48.1 pods and 105 g plant^{-1}, respectively in treatment 5 (lime, vermicompost, *cum Rhizobia* and chemical fertilizer). However, the lowest number and weight of full pods in treatment 2 were 40.4 pods and 90.1 g plant^{-1}, respectively (only NPK application + cum *Rhizobia*) and significantly various at 1% level (Table 3). Opposite results showed that the number and weight of empty pods had the highest number (10.5 pods) and weight (14.0 g plant^{-1} in treatment 1. The lowest value of empty pod number (5.0) and empty pod weight (8.0 g plant^{-1}) (Table 3). There are significant differences of 1,000 grains weight among treatments at 1%. The above results in Table 3 showed that maximum weight of 1,000 grains obtained 750 g plant^{-1} in treatment 5, followingin 2, 3, 4 (700g plant^{-1}) and the minimum weight (600 g plant^{-1}) of treatment 1 (control treatment). The amendment of animal manure only or associated with lime had higher 1,000 grains weight of groundnuts than other treatments [20].

c. Yield and As uptake of Vegetable soybean

There were sufficiently influenced by the additon of lime, vermicompost combined with *Rhizobia on* the theoretical yield and fresh pod yield of the vegetable soybean (Table 4).

There are remarkably various at the 1% level in both of yield kinds, which valued from 3.40 to 4.33 t/ha for the theoretical yield. The maximum yield (4.33 t/ha) and the minimum yield of theoretical yield (340 t/ha) for treatment 1 & 2 (Table 4). Similarly, the fresh pod yield of vegetable soybean had by the relation between vermicompost, lime with *Rhizobia*. The pod yield of vermicompost regularly raised in the mixture treament of organic and Chemical fertilizer. The vegetable soybean productivity obtained higher than treatments of animal organic, lime and *Rhizobia* combined NPK or NPK only. Results in Table 4 presented that the highest fresh pod yield of vegetable soybean (3.90 t/ha achieved in treatment 5. There are clearl opposite of the lowest pod yield of vegetable soybean (3.05 t ha^{-1}) proved at treatment 1 (NPK only) and 2 (NPK + *Rhizobia*). The results of fresh pod yield of vegetable soybean were followed by treatment 3 (3.37 t/ ha) and 4 (3.44 t/ha) and clear variousness at 1% . Results of this research was shown that positive influences of vermicompost only or lime mixture and *Rhizobia* reached the vegetable soybean productivity from 9.50% (NPK+ 10 t vermicompost per ha), 11.3% (NPK+ 1.5 t $CaCO_3$ per ha) to 21.8% (NPK+ 10 t vermicompost ha^{-1}+1.5 t CaCO3 ha^{-1} and *Rhizobia*) comparison with treatment 1 (NPK only)treatment 2 (NPK + *Rhizobia).* Addition of lime and vermicompost reached the highest groundnut yield comparison with no vermicompost amendment [21], [22].

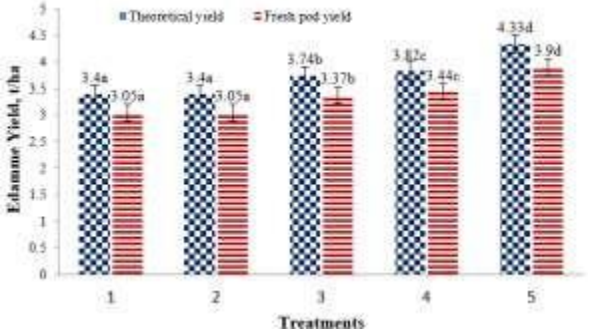

Fig. 2 Vegetable soybean productivity

Table 4 Yield and as uptake of vegetable soybean

Treatments	As contents			
	experimental	Soil	plant	
	before	after	bodies (mg kg^{-1})	grains (µg kg^{-1})
1	86.1	73.6^{a}	1.83^{a}	50.0^{b}
2	85.7	59.0^{c}	1.58^{b}	60.0^{a}
3	86.2	68.1^{b}	1.01^{d}	40.0^{d}
4	86.0	54.6^{d}	1.94^{a}	40.0^{d}
5	86.2	43.8^{e}	1.36^{b}	50.0^{b}
F_{test}	ns	**	**	**
CV(%)	0.49	17.9	22.2	16.2

(**) correlation is significant differences at level of 1%

The As contents of crop soil ranged from 85.7 to 86.2 mg kg^{-1} before the experiment and insignificantly differences at 5%. However, the As values of crop soil ranged from 43.8 to 73.6 mg kg^{-1} at harvest was lower than those of all treatments before the experimentl and significantly differeces of 1%. The reducible rate of soil As content in treatment 5 was 14.1% comparison with treatment 1 (control). Especially, soil As reduction in all mixture treatments of lime, vermicompost and *Rhizobia* remarkably obtained higher percentage of soil As concentration than control treament (**Table 4).** The highest reduction percentage of soil As concentration was treatment 5 (35.4%) andlowest rate of 14.5% in treatment 1 comparision with before and after experiment.

The everage As level of bodies and grains of vegetable soybean contained from 1.01 to 1.94 mg kg^{-1}40.0 to 60.0 mg kg^{-1}, respectively. The maximum As content of vegetable soybean body (1.83 mg kg^{-1}) in treatment 1 and grain (60 µg kg^{-1}) in treatment 2. Further, the minimum As value of vegetable soybean body (1.01 mg kg^{-1}) in treatment 3 and graind (40 mg kg^{-1}) of 3 and 4 (Table 4). The everage As level of bodies and grains of vegetable soybean of treatment 3 (NPK+ 10 t vermicompost ha^{-1}) reached lower than 44.8 % in bodies and 33.3% in grains comparison with non lime or vermicompost application. In general, the As store of vegetable soybean body and grains drastically decreased in treatments in which amended lime, organic manures to crop soils. The negtive relationship between the pH and As store of plants by applicatin of lime and vermicompost [23]. The prior study proved that lime and vermicompost may lessen the As store and raise yield production of agriculture [24].

Conclusion

The water irrigation and agricultural soil were polluted by the high As level which affected on the nitrogen fixation of *Rhizobia.* There was not any node on roots of vegetable soybean. The yield components of vegetable soybean obtained maximum values of NPK + lime + vermicompost and *Rhizobia* inoculation. The maximum productivity and minimum As store of vegetable soybean obtained in treatments of mixture application. The As store of vegetable soybean significantly lessened in treatments of lime and vermicompost amendment. It could conclude from this study results in order to increase yield production, quality and lessen As store of vegetable soybean by the co-application of lime and vermicompost.

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