Output and Nutrition of the Peanut as Affected by Lime, Vermicompost Addition with *Enterobacter Asburiae* Strain Cjy141 Inoculation in The Low Nutrient Soil

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Abstract

Background: Improving soil fertility and peanut yield is the primary objective of this study. Therefore, the use of symbiotic nitrogen-fixing bacteria combined with lime and vermicompost is being implemented. **Aim:** The study Purpose was to evaluate effects of lime, vermicompost (VT) addition combined with Enterobacter asburiae strain cjy141 (EA cjy141) inoculation on the yield and quality of Peanut in the AGU, Giang province during both crops of 2023. **Research design**: The field experiment laid out in Randomized Complete Block Design, four treatments and four replications. Treatments of crop 1: The control treatment (NT1) only applied NPK (20 kgUrea + 60 kgP_2O_5 + 60kg KCl per ha); (NT2): Co-application of N, P, K + 500 kg $CaCO_3$ ha^{-1} and EA cjy141 inoculation (10^8CFU g^{-1}); (NT3): NPK + CM (10 t ha^{-1}) and EA cjy141 inoculation; (NT4): Incorporation of NPK + VT (10 t ha^{-1}) + 500 kg $CaCO_3$ ha^{-1} and EA cjy141 inoculation. Treatments of crop 2 were carried on the prior experiment (crop 1). However, this treatments did not apply to VT, lime and no EA cjy141 inoculation (only applying NPK). **Results:** The EA cjy141 inoculation significantly enhanced the growth and yield parameters of peanut cultivars. However, the maximum plant Biomass (168 g $plant^{-1}$), number of nodule (92.1 $plant^{-1}$), fresh and dry weight of fill pods (61.4 and 37.6 g $plant^{-1}$, respectively), fresh and dry weight of empty pods (2.07 and 1.19 g $plant^{-1}$), weight of dry nodules (0.83 g $plant^{-1}$), yield (6.12 t ha^{-1}), protein and oil in seeds (26.1 and 50.1 %, respectively) was observed in cow manure and lime applied with rhizobium inoculated treatments. **Conclusion:** All the parameters of growth and yield showing best result for application of lime and cow manure with synthetic EA cjy141 inoculation of seeds. Vermicompost has significantly increased the yield of peanut in the next crops.

Key words: Peanut, vermicompost, lime, *Enterobacter asburiae* strain cjy141.

INTRODUCTION

Peanut, which is one of the world's most popular crops cultivated in tropical and sub-tropical regions, has the high economic value. It contents high protein, oil, fatty acid, carbohydrates, vitamins and minerals. Peanut, which contains 45-55% oil, 20-25% protein, 16-18% carbohydrates and 5% minerals, is one of the most popular crops in the world (Gulluoglu, 2011; Gulluoglu *et al.*, 2016a). The urbanization has narrowed the agricultural soil, reducing food production. The government developed an intensive system to overcome the food shortage that has resulted in the deterioration of the quality of agricultural soil. Therefore, the agricultural production may be faced with environmental changes that make the soil increasingly apparent depression (Barrow, 2012). The grey degraded soils have good drainage and aeration due to the high rate of sand in the soil structure, but low organic matter content due to easy leaching (Yunilasari et al., 2020). Increasing crop yields, farmers use more and more chemical fertilizers and pesticides. This is the cause of environmental pollution due to the accumulation of nutrients derived from fertilizers and pesticides. Land will be damaged slowly and the productivity of crops will continue to decrease. The application of organic fertilizers (biochar and cow manure) that replaces for inorganic fertilizers can improve the soil fertility (Yunilasari *et al.,* 2020).

Peanuts, which like many other plants, the same peanut family, are the symbiosis of rhizobium roots and *Rhizobium*. *Rhizobium* is a type of bacteria, the ability to fix nitrogen. Plants provide photosynthesis products for the life and activity of *Rhizobium*. on the other hand, *Rhizobium* are responsible for fixing free nitrogen from the air for plants. (Krishnan *et al.*, 2018). The amount of nitrogen that was fixed by *Rhizobium* was achieved an average of 94 kg N/ ha / crop (about 200 kg urea/ha/crop) (Krishnan *et al.,* 2018). In the good condition, it can reach 168 kg N / ha / crop. The amount of nitrogen that fixed by *Rhizobium,* can support to 74% of N the peanut trees. Environmental conditions have a great influence on the activity and ability of nitrogen fixation of *Rhizobium*. If application of N is too high, it can inhibit the nitrogen fixation of bacteria. Phosphorus has a positive effect on the formation and nitrogen fixation of nodules. Especially, the soil is sufficiently applied the calcium or lime (Krishnan *et al.,* 2018; Mbah and Dakora,2018). Nitrogen is an important element for effective production of peanut, adequate supply of nitrogen fertilizer is essential for growth and yield due to the intensive farming. Therefore, farmers have used a large amount of chemical fertilizer. The application of biofertilizeris frequently recommended to get high and clean agricultural product (Awadalla and Mohammed, 2017). The recent challenge faced by advanced farming is to achieve higher yields in an environment-friendly manner. Thus, there is an immediate need to find eco-friendly solutions. Among various types of species being used as biocontrol agents (Muhammad et al., 2018). Inoculation of rhizobia helps to add nitrogen to peanuts because native rhizobia species cannot provide enough nitrogen for it (Doloum et al.,2017). The nitrogen of Rhizobium-legume symbiosis is one of the nutrients that increase the soil fertility. This nutrition makes it help the farmers reduce N application. Farmers can increase their productivity and income by maximizing bio-nitrogen fixation through the *Rhizobium* strain. Helping peanuts grow and raise the population of *Rhizobium* strain to improve nitrogen supply, so yield of peanuts will be increased, (Korir *et al.*, 2017). *Trichoderma* is widely used as biocontrol agent against different kinds of plant pathogens. Trichoderma spp. are asexual fungi that are present in all types of agricultural soils and also in decaying wood. The hostile activity of Trichoderma species showed that it is parasitic on many soil-borne and foliar plant pathogens (Karthikeyan et al., 2015). Trichoderma are highly interactive fungi that live in soil, root, and foliar environments. In addition to assisting plants to resist various diseases and drought stress, Trichoderma has been reported to have positive effects on the growth of many crops. While Trichoderma inoculants have been developed for use with numerous crops, explorations of the use of Trichoderma inoculants in rice farming systems are still in a nascent stage (F*ebri et al.,* 2017). The aim of this study find out effects of *Rhizobium* and vermicompost on yield and quality of the Peanut in the low nutrient soil outside AGU net house.

MATERIALS AND METHODS

Description of the study sites

Two field experiments were carried out in the low nutrient soil outside the AGU net house, An Giang province, Vietnam during the two crop of 2023 under drip irrigation system. The study soil is the low nutrient soil zones that obtain 400–600 mm of annual rainfall. The rainfall of the rains season occurs 50-60%, between April and October. The mean maximum and minimum temperatures are 21 and 31^{0}C, respectively. Soil samples were collected from 0 to 20 cm depth and analyzed for some physical, and chemical properties.

Microorganism isolation

Enterobacter asburiae strain cjy141, which was isolated from of peanuts nodules on peanut fields in An Phu town, An Giang province, Vietnam, was a bacterial endophyte, and isolated from small nodules (<1.5 mm). Twenty small nodules from peanut roots were collected and cleaned with water to remove any dirt or foreign particles attached to the nodules. Cleaned nodules were then surface sterilized using 70% ethanol for 1.5 min, washed with sterile water (H_2O) three times, and then soaked in 10% commercial bleach for 5 min. After this, nodules were washed at least 5–6 times with sterile H_2O to rinse off any trace element of bleach. Then, washed nodules were crushed in 1 mL of 1 x sterilized phosphate-buffered saline, and the resulting suspension was streaked on yeast extract mannitol agar (YMA) plates with multiple dilution series. We also streaked 100 µL of the final washed solution from the above to check if any contamination occurred during the sterilization process. The streaked YMA agar plates were incubated at 28 °C for 3 to 5 days, and the selected isolates (pure colonies) were grown in liquid YMA and later archived in glycerol stock. The genomic DNA was extracted from all the selected isolates using the Promega genomic isolation kit. The 16S rRNA gene was amplified from these isolates using 27F and 1492R primer sets under the following PCR conditions: 1 cycle of 95 °C for 5 min (preheating), 25 cycles of 95 °C for 30 s, 55 °C for 30 s, 72 °C for 1 min, and a final extension period at 72 °C for 5 min. The amplified PCR products (5 µL) were loaded into 2% agarose gel to check the fragment size and then purified from the PCR products using the Promega PCR cleanup kit. The resulting purified PCR products were Sanger sequenced by Eton Bioscience Inc. (https://etonbio.com (accessed on 11 August 2022).

Inoculation

Enterobacter asburiae strain cjy141 was mixed well with seeds of peanut. Seeds of peanut were soaked in liquid inoculum after diluted 1:1 with well water for 30 min. before sowing. *Trichoderma* spp. that was collected from Loc Troi group, was mixed well with cow manure (10 tons. ha^{-1}) and applied to the soil 15 days before sowing for treatments of *Trichoderma* spp.

Treatments and crop management

The field experiment included four treatments and four replications. Each treatment has an area of 80 m^2 (1 m x 20 m x 4 replications). Treatments of crop 1: The control treatment (NT1) only applied N, P, K per ha (20 kg Urea + 60 kgP_2O_5 + 60kg KCl); (NT2): Co-application of N, P, K + 500 kg $CaCO_3$/ha and EA cjy141 inoculation (10^8CFU/g); (NT3): N, P, K + VT (10 t/ha) and EA cjy141 inoculation (NT4): Incorporation of N, P, K + VT (10 t/ha) + 500 kg $CaCO_3$/ha and EA cjy141 inoculation. Treatments of crop 2 were carried on the prior experiment (crop 1). However, the treatments did not apply to VT, lime and EA cjy141 inoculation (only applied NPK). Seeds of peanut (L14) were obtained from local farmers in An Giang, Vietnam.

Data Recorded

four samples were taken at 4, 6 and 8 weeks after sowing and four plants were taken from each plot randomly. Nodule numbers were counted also the fresh weight of shoot total plant fresh weight and nodules dry weight were measured after 100 days after sowing (DAS). At harvest, on May, 30th, 2023, and November, 15th, 2023 seasons, random samples of ten plants were taken from each plot to determine number of pods/plant, weight of pods/ plant (g), weight of seeds/ plant (g), and seed index. Plants on the middle two rows in each plot were harvested separately and dried in order to estimate weight of pods yield/ha and weight of seeds/ ha/50g. Seed samples were grinded into fine powder and stored in brown glass bottles for chemical analysis.

Analysis methods

After the harvest of plants, soil was air dried, well mixed and passed through a 2-mm sieve. Soil pH was measured. All data were analyzed by the generalized linear model analysis of variance using Genstat v10 (VSN International Ltd, UK, 2007). Oil% and NPK in seeds were determined according to methods described by A.O.A.C. and the seed protein content was calculated by multiplying total nitrogen concentration by 6.25.

Statistical analysis

Data were statistically analyzed and means were compared by least significant differences (LSD) at 5% level of probability test according to procedures outlined by Steel and Torrie using MSTAT-C computer program.

Table 1: The physic-chemical properties of the soils (0–20 cm) performed before sowing

Characters	**Value**	
Soil deep (0-20 cm)	**Crop 1**	**Crop 2**
CEC $Cmol^{+}/kg$	2.52	2.54
pH	5.02	4.82
Soil moisture (%)	10.3	11.1
Organic matter (%)	0.91	0.82
Available potassium ($mg.kg^{-1}$)	Undetected	Undetected
Total Nitrogen (%)	0.25	0.80
Available Phosphorus (mg/100g)	11.1	12.0
silt (%)	15.3	15.4
clay (%)	1.89	2.20
sand (%)	82.8	82.4
Texture	Sandy loam	Sandy loam

RESULTS

Plant height and branches per plant: The effect of VT, lime, NPK and EA cjy141 inoculation (Table 3) showed that plant height between treatments in the Winter-Spring crop had a significant difference ($P \leq 0.05$ and ≤ 0.01) during the growth time of peanuts. Maximum plant height of the co-application treatments was always higher than control treatment. The highest height of peanut was observed in NT4 (10 tons VT /ha + 500 kg $CaCO_3$/ ha + NPK and EA cjy141 inoculation (10^8CFU/g), while the lowest plant height was recorded in the control treatment (NT1: Without application of VT, lime and no EA cjy141 inoculation). The crop 2, The highest plant height was observed a statistically significant value in the F_{test} ($p \leq 0.05$ and $p \leq 0.01$) significant difference at 1% and 5% (except 80 DAS).

Table 3. the peanut height affected by combined application of VT, lime, NPK and EA cjy141 inoculation both crops of 2023

Treatments	Plant height (cm)			
	20 DAS	40 DAS	60 DAS	80 DAS
Crop 1 (A)				
NPK	19.5[a]	37.8[a]	50.3[a]	62.1[a]
NT2	21.3[b]	38.4[a]	51.6[ab]	66.7[b]
NT3	21.8[bc]	41.4[b]	54.2[bc]	65.5[ab]
NT4	22.7[c]	44.4[c]	56.7[c]	68.2[b]
Crop 2 (B)				
NT1	2.40[a]	41.7[a]	58.8[a]	70.8
NT2	22.0[ab]	42.5[a]	59.7[ab]	72.0
NT3	22.5[b]	42.6[a]	60.1[b]	70.9
NT4	22.9[b]	44.4[b]	61.8[c]	71.5
F_{test}(A)	**	**	**	*
F_{test} (B)	*	**	**	ns
CV_A(%)	15.5	11.7	14.1	14.8
CV_B(%)	10.5	6.90	4.47	5.41

DAS: Days after seeding; (NT1):20 kg Urea + 60 kgP_2O_5 + 60kg KCl; (NT2): Co-application of N, P, K + 500 kg $CaCO_3$/ha and EA cjy141 inoculation (10^8CFU/g); (NT3): N, P, K + VT (10 t/ha) and EA cjy141 inoculation; (NT4): Incorporation of N, P, K + VT (10 t/ha) + 500 kg $CaCO^3$/ha and EA cjy141 inoculation. Treatments of crop 2 were carried on the prior experiment (crop 1). However, the treatments did not apply to VT, lime and EA cjy141 inoculation (only applied NPK). ns: no significant; *: Significant at P≤0.05; **: Significant at P≤0.01

Table 4. Peanut branches as affected by VT, lime application and EA cjy141 inoculation in both crops of 2023

Treatments	Branch number per Plant			
	20 DAS	40 DAS	60 DAS	80 DAS
Crop 1 (A)				
NT1	2.13[a]	3.93	4.48	4.80
NT2	2.25[ab]	3.88	4.38	4.80
NT3	2.55[b]	3.83	4.45	4.80
NT4	2.05[a]	3.88	4.55	4.95

Crop 2 (B)				
NT1	2.85	4.50	4.75	4.75
NT2	3.08	4.48	4,65	4.65
NT3	3.10	4.53	4.68	4.68
NT4	3.15	4.55	4.73	4.73
F_{test} *(A)*	**	ns	ns	ns
F_{test} *(B)*	ns	ns	ns	ns
CV_A(%)	31.9	15.8	11.8	11.8
CV_B(%)	25.6	15.3	12.8	12.8

DAS: Days after seeding; (NT1):20 kgUrea + 60 kgP2O5 + 60kg KCl; (NT2): Co-application of N, P, K + 500 kg $CaCO_3$/ha and EA cjy141 inoculation (108CFU/g); (NT3): N, P, K + VT (10 t/ha) and EA cjy141 inoculation; (NT4): Incorporation of N, P, K + VT (10 t/ha) + 500 kg $CaCO_3$/ha and EA cjy141 inoculation. Treatments of crop 2 were carried on the prior experiment (crop 1). However, the treatments did not apply to VT, lime and EA cjy141 inoculation (only applied NPK). ns: no significant; *: Significant at P≤0.05; **: Significant at P≤0.01. The branch number per plant was insignificantly affected by various treatments in the growing stages from 20 to 80 DAS between crop 1 and 2 (Except 20 DAS in the crop 1) (Table 4).

Biomass per plant**:** VT and lime treatments were significantly affected by the biomass of peanut in crop 2 (Table 5). The biomass of peanut of all studied treatments in the crop 2 was higher than that in crop 1. The biomass value ranged from 125 to 168 g/plant in both crops. The NT3 and NT4 treatment gave the highest values of biomass (168 g. $plant^{-1}$), which was not co-application of VT, lime and EA cjy141 inoculation but based on the VT and lime treatments of crop 1. While lowest value of biomass (125 g. $plant^{-1}$) was given by application of NPK, lime and EA cjy141 inoculation (the NT2 treatment of crop 1).

Number of nodules per plant**:** The nodulation of peanut had significantly affected by lime, VT and inorganic fertilizer (NPK) integrated with EA cjy141 inoculation (Tables 5). Maximum nodules per plant (92.1) were produced in the inoculated plants, while less nodules per plant (58.0) had at the control treatment (no EA cjy141 inoculation and no VT application). Table 5 showed that interaction between VT, lime and EA cjy141 inoculation on maximum nodules per the plant in the crop 1. On the contrary, Number of nodules per plant were insignificant effected by all treatments in the crop 2 (without lime, VT application and no EA cjy141 inoculation). At the crop 2, results, which ranged from 26.8 to 31.3, was found to be decreased by 53.8, 67.8, 66.2 and 64.8% due to the inorganic fertilize in all treatments, respectively, compared to the crop 1 (Table 5). Number of nodules of peanut in the crop 1 were higher than that in the crop 2 in all treatments (Table 5). The reason might be explained the synthetic inoculation of EA cjy141 inoculation, which increased number of maximum nodules per the plant in the crop 1 (co-application of VT, lime and EA cjy141 inoculation) and decreased number of nodules in the crop 1 (no VT, lime application and no EA cjy141 inoculation.

Dry nodules weight per plant: Inoculating Rhizobium integrated with cow manure found out the higher weight of dry nodule than those of NPK fertilizers without EA cjy141 inoculation in the crop 2. Values of weight of dry nodule were from 0.178 to 0.830 g. $plant^{-1}$. The highest value recorded at VT, lime integrated with EA cjy141 inoculation (NT4:0.83g $plant^{-1}$), and the lowest weight of dry nodule was 0.178 g. plant^{-1}(NT1- only NPK). Similar to the nodulation of peanut, Weight of dry nodule were from 0.178 to 0.830 g. plant^{-1} in both crops. At the crop 2, all treatments, which applied 20 kg Urea + 60 kgP_2O_5 + 60 kg KCl, was found to be decreased by 58.6, 75.3, 73.2 and 75.7%, respectively, compared to the in crop 1 (Table 5). Weight of dry nodules in the crop 1 were higher than those of treatments in the crop 2 (Table 5). The current study agreed with the result of Michael Asante *et al.,* (2020) that inoculating peanut with Rhizobium combined with 30 kg. P ha^{-1} increased the mean nodule dry weight per plant compared to the no inoculated treatment

Table 5. Peanut yield traits affected by VT, lime and EA cjy141 inoculation between both crops of 2023

Treatments	**Peanut yield traits**						
	Biomass (g)	**No. of Nodule**	**Wt. of dry Nodule (g)**	**Wt. of fill pods (g)**		**Wt. of empty Pods(g)**	
				fresh	**dry**	**fresh**	**Dry**
Crop 1 (A)							
NT1	145^{bc}	58.0^{b}	0.430^{b}	54,8^{a}	31.5^{a}	2.07^{e}	1.19^{d}
NT2	125^{a}	85.8^{c}	0.748^{c}	56,7^{abc}	31.6^{a}	1.92^{cd}	1.09^{abc}
NT3	133^{ab}	92.1^{c}	0.765^{c}	58,9^{abc}	35.5^{b}	1,88^{bc}	1.14^{bcd}
NT4	138^{ab}	88.9^{c}	0.830^{c}	60.8^{bc}	36.9^{b}	1.78^{ab}	1.08^{ab}
Crop 2 (B)							
NT1	160^{cd}	26.8^{a}	0.178^{a}	55.3^{ab}	31.7^{a}	2.04^{de}	1.17^{cd}
NT2	165^{d}	27.6^{a}	0.185^{a}	56.5^{abc}	31.6^{a}	1.85^{bc}	1.05^{ab}
NT3	168^{d}	31.1^{a}	0.205^{a}	60.2^{abc}	36.3^{b}	1.83^{bc}	1.10^{abc}
NT4	168^{d}	31.3^{a}	0.210^{a}	61.4^{c}	37.6^{b}	1.69^{a}	1.01^{a}
F_{test} *(A)*	ns	**	**	ns	*	**	*
F_{test} *(B)*	ns	ns	ns	*	**	**	*
CV_A(%)	10.8	22.4	28.1	7.29	9.80	6.53	6.08
CV_B(%)	4.43	22.5	22.6	7.49	9.89	8,64	7.92

Note: (NT1):20 kg Urea + 60 kgP2O5 + 60kg KCl; (NT2): Co-application of N, P, K + 500 kg CaCO3/ha and EA cjy141 inoculation (108CFU/g); (NT3): N, P, K + VT (10 t/ha) and EA cjy141 inoculation; (NT4): Incorporation of N, P, K + VT (10 t/ha) + 500 kg CaCO3/ha and EA cjy141 inoculation. Treatments of crop 2 were carried on the prior experiment (crop 1). However, the treatments did not apply to VT, lime and EA cjy141 inoculation (only applied NPK). ns: no significant; *: Significant at P≤0.05; **: Significant at P≤0.01

Fresh and dry weight of filled pods per plant: The weight of fresh and dry fill pods plant^{-1} was affected only by co-application of lime, VT with EA cjy141 inoculation (Table 5). Application of VT, lime was significantly affected weight of fill pods per plant on peanuts and statistically significant ($P \leq 0.01$) (Table 5). Effect of lime and EA cjy141 inoculation was not on the dry and fresh weight of peanut filled pods. While VT significantly affected ($P \leq 0.01$) the dry and fresh weight of peanut fill pods. The result from Table 5 showed that VT application treatments (NT3 and NT4) had significantly higher than the dry and fresh weight of peanut filled pods compared to the other treatments. In the crop 2, the experimental sites were arranged on the experimental base of the crop 1 (NPK only), but the dry and fresh weight of peanut filled pods of NT3 and NT4 treatment were still higher than NT1 and NT2.

***Fresh and dry weight of empty pods per plant*:** The opposite of fill pods, the dry and fresh weight of peanut empty pods per plant was significantly affected by all treatments (Table 5). In the crop 2, the minimum value of dry and fresh weight of peanut empty pods (1.69 and 1.01g plant^{-1}, respectively) was given by NT3 and NT4 treatment, which did not apply the VT, lime and no inoculation with EA cjy141 inoculation, while the control treatment (crop 1) had the fresh and dry weight of maximum empty pods (2.07 and 1.19 g plant^{-1}, respectively).

Fresh yield (t ha^{-1}): Table 6 showed that combined application of lime, VT with EA cjy141 inoculation had a significant increase effect on seeds yield of peanut compared to control treatments (Only application of NPK) in both crops. The value of yield per ha ranged from 5.44 to 6.12 t/ ha in both seasons. Maximum yield (6.12 t ha^{-1}) was given by the NT4 treatment of crop 2, which was combined application of lime, VT with EA cjy141 inoculation in the prior season (crop 1). while less yield of crop 1 and 2 (5.44 and 5.49 t ha^{-1}, respectively) was given by the control treatments.

Table 6. Effects of VT, lime and EA cjy141 inoculation on the quality and yield of peanut in both crops

Treatments	Peanut nutrient composition and yield		
	Seed protein (%)	Seed Oil (%)	Fresh yield (t/ha)
Crop 1 (A)			
NT1	23.9^{b}	48.8^{b}	5.44^{a}
NT2	23.0^{b}	50.1^{c}	5.62^{b}
NT3	23.9^{b}	48.8^{b}	5.83^{c}
NT4	26.1^{c}	47.6^{a}	6.00^{d}
Crop 2 (B)			
NT1	21.0^{a}	48.9^{b}	5.49^{a}
NT2	21.5^{a}	48.8^{b}	5.60^{b}
NT3	21.5^{a}	48.3^{ab}	5.96^{d}
NT4	21.9^{a}	49.0^{b}	6.12^{e}
F_{test} (A)	**	**	**
F_{test} (B)	ns	ns	**
F_{test}(A*B)	**	**	**
CV_A(%)	5.45	1.89	3.85
CV_B(%)	3.00	1.15	4.64
CV_{A*B}(%)	7.58	1.67	4.24

Note: DAS: Days after seeding; (NT1):20 kg Urea + 60 kgP2O5 + 60kg KCl; (NT2): Co-application of N, P, K + 500 kg CaCO3/ha and EA cjy141 inoculation (108CFU/g); (NT3): N, P, K + VT (10 t/ha) and EA cjy141 inoculation; (NT4): Incorporation of N, P, K + VT (10 t/ha) + 500 kg CaCO3/ha and EA cjy141 inoculation. Treatments of crop 2 were carried on the prior experiment (crop 1). However, the treatments did not apply to VT, lime and EA cjy141 inoculation (only applied NPK). ns: no significant; *: Significant at $P \leq 0.05$; **: Significant at $P \leq 0.01$

Lipid and protein content

Table 6 s' presentation showed that percent of oil and protein content in seeds significantly affected ($P \leq 0.01$) by lime, VT addition with EA cjy141 inoculation in crop 1. While all treatments were insignificantly affected on oil and protein content in seeds of peanuts in crop 2. The maximum values of oil and protein (50.1 and 23.9%, respectively) were obtained by lime, VT with EA cjy141 inoculation treatments, while the lowest oil content of 47.6% was given by the lime, VT with EA cjy141 inoculation and 21.0 % of protein in all treatments of in the crop 2 (Table 6). Results (Table 6) were shown that oil and protein content were significantly increased by the studied treatments of VT, lime application with EA cjy141 inoculation.

DISCUSSION

According to Hillary et al., (2018), the co-application of NPK + lime and cow manure helped soybeans had higher plant height and higher ground biomass than the treatments using only NPK. The Prior studies further showed that Rhizobium inoculation treatments also gave different results to the un-inoculated ones in plant height; stem dry weight, number of nodules/plant and nodule dry weight (Sajid et al.,2011; Ahmad et al., 2009). The average number of shoots recorded at the low leaf stage (5 < shoots / plant) during the growth of peanut plants. The number of shoots per a peanut plant is less likely to be changed by the fertilizer, because this characteristic is determined by genetics (Shiyam, 2010). The result may be the cause of the relationship of VT, lime and EA cjy141 inoculation with roots of prior peanut crop (Awadalla and Mohammed, 2017). when applying organic fertilizers, which improved Biomass yield, growth and highest weight, were in the following crops (Anas et al., 2019). According to Anteneh Argaw (2017), the nodulation of peanut showed a significant response to organic (compost and manure) integrated with *Bradyrhizobium* inoculation. Five Rhizobium strains increased nodule number of peanut plant^{-1}, and was a significant effect of synthetic inoculation of Rhizobium on nodules per the plant of groundnut (Sajid *et al.*, 2011). Previous work of Kimiti and Odee, (2010), co-application of lime, organic manure increased the population of Rhizobium in soil by 23% compared to application of inorganic fertilizer only. Furthermore, result showed that positive influence increased the root growth and the uptake of nutrients (Ibrahim *et al.* 2011) and improved the nodulation (Basu *et al.* 2007). The nodule dry weight of soybean at the combined application of the Rhizobium strains and the inorganic fertilizer increased about 145% over no inoculated treatments (Tarekegn and Kibret, 2017). The prior research of Anteneh Argaw (2017) reported that *Bradyrhizobium* integrated with manure and compost were found to record the highest total biomass and total pods weight at both crops. Application of organic and inorganic fertilizer could significantly increase growth and yield of peanut in the next crop (after 4 months) (Han *et al.*, 2016). Application of 10 t ha^{-1} of chicken manure was significantly increased on weight of fill pods and decreased weight of empty pods *of* peanuts (Hardjoloekito, 2020). Sajid et al., (2011) showed that inoculation of Rhizobium to groundnut has significantly increased plant height, yield and yielding components. Co-Application of organic and inorganic fertilizer increased yield of peanut in both seasons (Awadalla and Mohammed, 2016). Application of Rhizobia inoculation combined with organic (compost and manure) and inorganic fertilizer significantly increased the yield of peanut at both experimental sites (Desta et al.,2015). Co-application of organic, lime and inorganic with Rhizobium inoculation to sandy soil increased oil, protein and yield of peanut (Emam, 2018; Anas et al., 2019; Anteneh Argaw, 2017; Awadalla & Mohammed, 2017; Nguyen Van Chuong and Nguyen Trung Chinh, 2018).

CONCLUSION

Application of VT, lime and inorganic associated with EA cjy141 inoculation on the low nutrient soil significantly increased yield component, yield and quality of peanut outside the net house of AGU experiment center. This study found out positive effects of EA cjy141 species on nodulation and yield of peanut in the crop 1. In the crop 2, all treatments only applied to inorganic fertilizer (NPK), it has been concluded that the VT application significantly increased peanut plant height, yield and yield components. On the other hand, lime and VT application associated with EA cjy141 inoculation significantly increased in plant height, weight and number of filled pods, nodulation, yield and quality of peanuts as comparing with control treatments.

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