



Effects of Lime, Cow Manure Application with *Rhizobium* Inoculation on Yield and Quality of the Peanut in the Grey Degraded Soil of Tri Ton town

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This work was carried out in collaboration among all authors. Author NVC designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors PVL and HTT managed the analyses of the study. Author HTT managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The field study was carried out in the grey degraded soil of Tri Ton town during Winter-Spring and Summer-Autumn crop of 2019- 2020. The field experiment was carried out by four treatments and four replications. Four treatments of Winter-Spring crop: The control treatment applied NPK (100 kg Urea + 556 kg P₂O₅ + 100kg KCl); (NT2): application of NPK, lime with *Rhizobium* inoculation; (NT3): NPK, cow manure and *Rhizobium* inoculation; (NT4):NPK, cow manure and lime with *Rhizobium*. Four treatments of Summer-Autumn crop were carried on the prior experiment (Winter-Spring crop). However, treatments did not apply to cow manure, lime and *Rhizobium* (only NPK). The maximum plant biomass (168 g), number of nodule (92.1), fresh and dry weight of fill pods (61.4 and 37.6 g, respectively), fresh and dry weight of empty pods (2.07 and 1.19 g), weight of dry nodules (0.83 g) per plant, yield (6.12 ton ha⁻¹), protein and oil in seeds (26.1 and 50.1%, respectively) were observed in cow manure and lime applied with *Rhizobium* inoculated treatments. All the parameters of growth and yield showed best result for application of lime and cow manure with synthetic *Rhizobium* inoculation of seeds. Cow manure has significantly increased

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the yield of peanut in the next crops. The results from our two crops of study showed that co-application of NPK, cow manure, lime and *Rhizobium* inoculation always increased field capacity in both crops.

Keywords: Peanut; yield; cow manure; lime; *Rhizobium*.

1. INTRODUCTION

Peanut (*Arachis hypogaea* L.), which is one of the world's most popular crops cultivated in tropical and sub-tropical regions, has the high economic value. It contains high protein, oil, fatty acid, carbohydrates, vitamins and minerals [1]. Peanut contains 45-55% oil, 20-25% protein, 16-18% carbohydrates and 5% minerals [2]. 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 [3]. 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 [4]. 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 [4].

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. *Rhizobium* are responsible for fixing free nitrogen from the air for plants [5]. The amount of nitrogen that was fixed by *Rhizobium* was achieved an average of 94 kg N/ ha / crop (about 200 kg ureas/ha/crop) [5]. In the good condition, it can reach 168 kgN / ha / crop [5]. 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 [5,6]. 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, which has been the cause of soil degradation. The application of biofertilizer is frequently recommended to get high and clean agricultural product [7]. 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 [4]. Inoculation of rhizobia helps to add nitrogen to peanuts because native rhizobia species cannot provide enough nitrogen for it [8]. The nitrogen of *Rhizobium*-legume symbiosis is one of the nutrients that increase the soil fertility. This nutrition makes it help the farmers reduce application of many nitrogens. 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, [9]. The aim of this study find out effects of *Rhizobium* and cow manure on yield and quality of the Peanut in the grey degraded soil of Tri Ton town.

2. MATERIALS AND METHODS

2.1 Description of the Study Sites

Two field experiments were carried out in the grey degraded soil of Tri Ton district, An Giang province, Vietnam during the Winter-Spring and Summer-Autumn crop of 2019 and 2020 under drip irrigation system. The study soil is the grey degraded soil zones that obtain 400–600 mm of annual rainfall. Tri Ton is a rural district of An Giang Province in the Mekong Delta region of Vietnam. The district covers an area of 598 square kilometres (231 square miles). The district capital lies at Tri Ton and is 44 kilometres (27 miles) away from Chau Doc city. The rainfall of the rains season occurs 50-60%, between April and October. Temperature varies from 25-35°C in the summer and from 20- 30°C in the winter [10].

2.2 Microorganisms

Rhizobium spp. was isolated from Nodules of peanuts on fields of farmers in Tri Ton district, An Giang province, Vietnam. *Rhizobium* spp. was mixed well with seeds of peanut. Seeds of peanut were soaked in liquid inocula after diluted 1:1 with well water for 30 min. before sowing.

2.3 Treatments and Crop Management

The field experiment included four treatments and four replications. Each treatment has an area of 80 m² (1.0 m x 20 m x 4 replications). Treatments of crop 1 (Winter-Spring): The control treatment only applied N, P, K per ha (100 kgUrea + 556 kgP₂O₅ + 100kg KCl); (NT2): Co-application of N, P, K (100 kgUrea + 556 kgP₂O₅ + 100kg KCl)+ 500 kg CaO/ha and *Rhizobium* inoculation (10⁸CFU/g); (NT3): N, P, K(100 kgUrea + 556 kgP₂O₅ + 100kg KCl) + cow manure (10 tons/ha) and *Rhizobium* inoculation; (NT4): Incorporation of N, P, K (100 kgUrea + 556 kgP₂O₅ + 100kg KCl)+ cow manure (10 tons/ha) + 500 kg CaO/ha and *Rhizobium* inoculation. Treatments of crop 2 (Summer-Autumn) were carried on the prior experiment (crop 1). However, the treatments did not apply to cow manure, lime and *Rhizobium* inoculation (only applied NPK), which evaluate the effects of cow manure, lime and *Rhizobium* inoculation on the next crop. Seeds of peanut were obtained from Dinh Thanh Agricultural Research Center, An Giang, Vietnam.

2.4 Data Recorded

Four samples, which were taken at 20, 40 and 60 and 80 days after sowing after sowing and ten plants were taken from each plot randomly, estimated the average height and number of Shootsper plant. At harvest, on December 30, 2019, and May 15, 2020 seasons, random samples of ten plants were taken from each plot to determine number of biomass, number of nodule per plant, dry weight of Nodule, fresh and dry weight of fill and empty pods per plant (g). Plants on the middle two rows in each plot were harvested separately and dried in order to estimate weight of pods yield per ha, % protein and % oil in seed.

2.5 Methods of Analysis

At harvest, on December 30, 2019 and May 15, 2020. Plants on the middle two rows in each plot were harvested separately and dried in order to

estimate weight of pods yield per ha and weight of seeds per ha. Seed samples were grinded into fine powder and stored in brown glass bottles for chemical analysis. All data were analysed 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 AOAC. And the seed protein content was calculated by multiplying total nitrogen concentration by 6.25.

2.6 Statistical Analysis

For statistical analysis, F-test was use by using LSD test [11]. Data was analyzed by using STATISTIX programme and the means were separated by LSD test at P= .05 probability level. Soil, plant analysis and *Rhizobium* spp. was isolated in laboratory of An Giang University . This study was carried out for six months and materials used were cow manure, lime, peanut seeds and *Rhizobium* and also urea, KCl and P₂O₅ fertilizers. Soil and cow manure samples were taken for first and analysis before application. Lime and cow manure were applied on soil several days before planting. Soil samples were taken before and after planting of peanut. Observed parameters were soil chemical properties such as soil pH, CEC, Soil moisture (%), Organic matter (%), Ca (µg.g⁻¹), Mg (µg.g⁻¹), Total N(%), available P (mg 100g⁻¹) and available K (mg kg⁻¹) and silt (%),clay (%),sand (%) . Plant growth parameters were also observed as yield components, yield, seed protein and oil of peanut.

3. RESULTS AND DISCUSSION

3.1 Plant Height

Results in Table 3 showed that plant height between treatments in the Winter-Spring crop had a significant difference (P = .05 and .01) during the growth time of peanuts. Maximum plant height of the co-application treatments was always higher than control treatment (Table 3). The highest height of peanut plant was founded in NT4 (10 tons cow manure ha⁻¹ + 0.5 ton CaO ha⁻¹ + NPK and *Rhizobium* inoculation 10⁸ CFU g⁻¹), while the lowest plant height was recorded in the control treatment (NT1:Without application of cow manure, lime and *Rhizobium* uninoculation). The Summer-Autumn crop, the highest plant height was observed a statistically significant value in the F_{test} (p=.05 and p=.01) significant difference at 1% and 5% (except 80 DAS). According toHillary et al. the co-

application of NPK (100 kgUrea + 556 kgP₂O₅ + 100kg KCl) + lime and cow manure helped soybeans had higher plant height and higher ground biomass than the treatments using only NPK. 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 per plant and nodule dry weight [13,14].

3.2 Number of Shoots Per Plant

The number of shoots per plant was insignificantly affected by various treatments in the growing stages from 20 to 80 DAS between Winter-Spring and Summer-Autumn crop (Except 20 DAS in the Winter-Spring crop) (Table 4). The average number of shoots recorded at the low leaf stage (5 < shoots / plant) during the

Table 1. The chemical properties of cow manure (n=10)

Cow manure	Character (dry weight of cow manure)					
	dry weight	%N	%P ₂ O ₅	%C	%K ₂ O	C/N
	49.29+3.13	0.95+0.33	0.24+0.10	0.35+0.03	0.89+0.11	25.30+0.27

Table 2. The physico-chemical properties of the soils (0–20 cm) performed before sowing [12]

Characters	Value	
	Winter-Spring	Summer-Autumn
Soil deep (0-20 cm)		
CEC Cmol ⁺ /kg	2.52	2.54
pH	5.02	4.82
Soil moisture (%)	10.3	11.1
Organic matter (%)	0.91	0.82
Ca ²⁺ (µg.g ⁻¹)	504	496
Mg ²⁺ (µg.g ⁻¹)	386	369
Available K (mg.kg ⁻¹)	120	160
Total N (%)	0.25	0.80
Available Phosphorus (mg/100g)	11.1	12.0
silt (%)	15.33	15.4
clay (%)	1.89	2.19
sand (%)	82.78	82.41
Texture	Sandy loam	Sandy loam

Table 3. The height of peanut as affected by combined application of cow manure, lime, NPK and *Rhizobium* inoculation in Winter-Spring and Summer-Autumn crop of 2019- 2020

Treatments	Plant height (cm)			
	20 DAS	40 DAS	60 DAS	80 DAS
Winter-Spring (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
Summer-Autumn (B)				
NT1	21.4 ^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; Means with different letters, in the same column differ significantly (p= .05, according to LSD Fisher's multiple range test)

Table 4. Shoots of peanut as affected by combined application of cow manure, lime, NPK and *Rhizobium* inoculation in Winter-Spring and Summer-Autumn crop of 2019- 2020

Treatments	Number of Shoots Plant ⁻¹			
	20 DAS	40 DAS	60 DAS	80 DAS
Winter-Spring (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
Summer-Autumn (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; Means with different letters, in the same column differ significantly ($p = .05$, according to LSD Fisher's multiple range test)

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 [15].

3.3 Biomass Per Plant

Cow manure and lime treatments were significantly affected by the biomass of peanut in Summer-Autumn crop (Table 5). The biomass of peanut of all studied treatments in the Summer-Autumn crop was higher than that in Winter-Spring crop. The biomass value ranged from 125 to 168 g.plant⁻¹ in both crops. The NT3 and NT4 treatment gave the highest values of biomass (168 g. plant⁻¹), which was not co-application of cow manure, lime and *Rhizobium* inoculation but based on the cow manure and lime treatments of Winter-Spring crop. While lowest value of biomass (125 g. plant⁻¹) was given by application of NPK, lime and *Rhizobium* inoculation (the NT2 treatment of Winter-Spring crop). The result may be the cause of the relationship of cow manure, lime and *Rhizobium* inoculation with roots of prior peanut crop [7]. when applying organic fertilizers, which improved Biomass yield, growth and highest weight, were in the following crops [14].

3.4 Number of Nodules Per Plant

The nodulation of peanut had significantly effected by lime, cow manure and inorganic fertilizer (NPK) integrated with *Rhizobium* inoculation (Tables 5). Maximum nodules per plant (92.1) were produced in the inoculated

plants, while fewer nodules per plant (58.0) had at the control treatment (Without *Rhizobium* and cow manure). Table 5 shows that interaction between cow manure, lime and *Rhizobium* co-application on maximum nodules per the plant in the Winter-Spring crop. On the contrary, Number of Nodules per plant were insignificant effected by all treatments in the Summer-Autumn crop (without lime, cow manure and *Rhizobium* uninoculation). At the Summer-Autumn crop, 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 in Winter-Spring crop (Table 5). Number of nodules of peanut in the Winter-Spring crop were higher than that in Summer-Autumn crop in all treatments (Table 5). The reason might be explained the synthetic inoculation of *Rhizobia*, which increased number of maximum nodules per the plant in the Winter-Spring crop (co-application of cow manure, lime and *Rhizobium* inoculation) and decreased number of nodules in the Summer-Autumn crop (without cow manure, lime and *Rhizobium* uninoculation). The nodulation of peanut showed a significant response to organic (compost and manure) integrated with *Bradyrhizobium* inoculation [16]. 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 [17,18]. The co-application of lime, organic manure increased the population of *Rhizobium* in soil by 23% compared to application of inorganic fertilizer

only [19]. Furthermore, result showed that positive influence increased the root growth and the uptake of nutrients and improved the nodulation [20,17].

3.5 Weight of Dry Nodules Plant⁻¹

Inoculating *Rhizobium* integrated with cow manure found out the higher Weight of dry nodule than those of NPK fertilizers without inoculation at the Summer-Autumn crop. Values of Weight of dry nodule were from 0.178 to 0.830 g. plant⁻¹. The highest value recorded at cow manure, lime integrated with *Rhizobium* treatment (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 Summer-Autumn crop, all treatments, which applied 100 kgUrea + 556 kgP₂O₅ + 100kg KCl, was found to be decreased by 58.6, 75.3, 73.2 and 75.7%, respectively, compared to the in Winter-Spring crop (Table 5). Weight of dry nodules in the Winter-Spring crop were higher than those of treatments in Summer-Autumn crop (Table 5). The current study coincide with the result in [21] that inoculating peanut with *Rhizobium* combined with 30 kg. P ha⁻¹ increased the mean nodule dry weight per plant compared to the uninoculated treatment. The nodule dry weight of soybean at the combined application of the *Rhizobium* strains and the inorganic fertilizer increased about 145% over the uninoculated treatment [22,23,18].

3.6 Fresh and Dry Weight of Fill Pods Plant⁻¹

The weight of fresh and dry fill pods plant⁻¹ was affected only by co-application of lime, cow manure with *Rhizobium* inoculation (Table 5). Application of cow manure, lime was significantly affected weight of fill pods per plant on peanuts and statistically significant (P = .01) (Table 5). Effect of lime and *Rhizobium* inoculation didn't affect the dry and fresh weight of peanut fill pods. While cow manure significantly affected (P = .01) the dry and fresh weight of peanut fill pods. The results from Table 5 showed that cow manure treatments (NT3 and NT4) had significantly higher than the dry and fresh weight of peanut fill pods compared to the other treatments. In the Summer-Autumn crop, the experimental sites were arranged on the experimental base of the winter-spring crop (NPK only), but the dry and

fresh weight of peanut fill pods of NT3 and NT4 treatment were still higher than NT1 and NT2. The prior research reported that Brady *Rhizobium* integrated with manure and compost were found to record the highest total biomass and total pods weight at both crops [16]. Application of organic and inorganic fertilizer could significantly increase growth and yield of peanut in the next crop (after 4 months) [24,25].

3.7 Fresh and Dry Weight of Empty PodsPlant⁻¹

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 Summer-Autumn crop (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 cow manure, lime and uninoculated with *Rhizobia*, while the control treatment (Winter-Spring crops) had the fresh and dry weight of maximum empty pods (2.07 and 1.19 g plant⁻¹, respectively). Application of 10 tons ha⁻¹ of chicken manure was significantly increased on weight of fill pods and decreased weight of empty pods of peanuts [26,27].

3.8 Yield (ton ha⁻¹)

Table 6 showed that combined application of lime, cow manure with *Rhizobium* 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 ha⁻¹ ranged from 5.44 to 6.12 ton ha⁻¹ in both Winter-Spring and Summer-Autumn seasons. Maximum yield (6.12 ton ha⁻¹) was given by the NT4 treatment of Summer-Autumn crop, which was combined application of lime, cow manure with *Rhizobium* inoculation in the prior season (Winter-Spring). while less yield of Winter-Spring and Summer-Autumn crop (5.44 and 5.49 ton ha⁻¹, respectively) was given by the control treatment. The result in [13,25] 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 [7,25,28]. Application of *Rhizobia* inoculation combined with organic (compost and manure) and inorganic fertilizer significantly increased the yield of peanut at both experimental sites [29,30].

Table 5. Yield components of peanut as effected by cow manure, lime and *Rhizobium* inoculation between Winter-Spring and Summer-Autumn crop of 2019-2020

Treatments	Parameters.plant ⁻¹						
	Biomass (g)	No. of Nodule	Wt. of dry Nodule (g)	Wt. of fill pods (g)		Wt. of empty Pods(g)	
				fresh	dry	fresh	dry
Winter-Spring (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}
Summer-Autumn (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
<i>F</i> _{test} (A)	ns	**	**	ns	*	**	*
<i>F</i> _{test} (B)	ns	ns	ns	*	**	**	*
<i>F</i> _{test} (A*B)	**	**	**	**	**	**	**
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
CV _{A*B} (%)	12.7	23.7	23.7	7.37	9.71	7.68	7.18

Means with different letters, in the same column differ significantly ($p = .05$, according to LSD Fisher's multiple range test)

Table 6. Effects of cow manure, lime and *Rhizobium* on the quality and yield of peanut in Winter-Spring and Summer-Autumn crop of 2019-2020

Treatments	Parameters		
	Seed protein (%)	Seed Oil (%)	Yield (ton ha ⁻¹)
Winter-Spring (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
Summer-Autumn (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
<i>F</i> _{test} (A)	**	**	**
<i>F</i> _{test} (B)	ns	ns	**
<i>F</i> _{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

DAS: Days after seeding; Means with different letters, in the same column differ significantly ($p = .05$, according to LSD Fisher's multiple range test)

3.9 Lipid and Protein Content

Table 6 showed that percent of oil and protein content in seeds significantly affected ($P = .01$) by lime, cow manure levels with *Rhizobium* inoculation in Winter-Spring crop. While all treatments were insignificantly effected on oil and protein content in seeds of peanuts in Summer-Autumn crop. The maximum values of oil and protein (50.1 and 23.9%, respectively) were obtained by lime, cow manure with *Rhizobium* inoculation treatments, while the lowest oil content of 47.6% was given by the lime, cow manure with *Rhizobium* inoculation treatment and 21.0% of protein in all treatments of in the Summer-Autumn crop (Table 6). Results (Table 6) were shown that oil and protein content were significantly increased by the studied treatments of cow manure, lime application with *Rhizobium* inoculation. Co-application of organic, lime and inorganic with *Rhizobium* inoculation to sandy soil increased oil, protein and yield of peanut [31,32,16,7,24].

4. CONCLUSION

Incorporation of N, P, K (100 kgUrea + 556 kgP₂O₅ + 100kg KCl) + cow manure (10 tons/ha) + 500 kg CaO/ha and *Rhizobium* inoculation to the grey degraded soil increased yield component, yield and quality of peanut in Tri Ton town. This study found out positive effects of *Rhizobium* on nodulation and yield of peanut.

This study concluded that application of cow manure to groundnut was significantly increased yield and yield components in the next crop. Co-application of lime, cow manure with *Rhizobium* inoculation, which increased significantly in and yield of peanut as compared to control treatments.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of us.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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