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Effects of rhizobia inoculation and molybdenum application on nodulation, N uptake and yield of peanut (*Arachis hypogaea* L.)

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Key words: *Arachis hypogaea*, *Rhizobium*, Molybdenum, Nodulation, Yield and N uptake.

Abstract

A field experiment was conducted in two sites of the humid forest zone of the Centre Region of Cameroon (Yaounde and Bokito), to study the interactive effect of rhizobia inoculation and Molybdenum (Mo) application on nodulation and yield of peanut (*Arachis hypogaea* L.). The experiment was laid out in a randomized complete block design with four replications. The treatments consisted of control (C), Rhizobium inoculation (R), Mo application (Mo) and a combination R+Mo. The results showed that Molybdenum and rhizobia inoculation had a significant effect on the yield of peanut at both sites. The inoculation with rhizobia showed a remarkable effect on the nodulation of the fallow of Yaounde (67. 73%) and not on the mixed- farm in Bokito (55. 43%) at P = 0.05. Nodulation was also stimulated through the combination of rhizobia inoculation with molybdenum application with increment of 111.26% and 50.44% nodule dry weight respectively for Yaounde and Bokito sites. The application of molybdenum alone improved significantly (P = 0.05) seed yield of peanut in both sites. However the increment was high in Yaoundé site (174%) as compared to Bokito site (10%). It stands out clearly that rhizobia inoculation combined with molybdenum application greatly enhanced biological N-fixation of peanut. The effect of these treatments on yield and the nitrogen uptake of peanut were much more remarkable on the fallow of Yaounde than the mixed-farm of bokito. It is therefore possible to greatly stimulate the biological N-fixation and the nitrogen uptake of peanut through symbiosis with the native rhizobia of the soil alone or after inoculation.

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Introduction

Peanut (*Arachis hypogaea* L.) is one of the principal economic crops of the world and ranks 13th among the food crops (Kabir *et al.*, 2013). In Cameroon it is the main cultivated grain legume in all the agro - ecological zones. 250,000 ha are under its cultivation with half of the area concentrated in the northern part of the country (Ntoukam *et al.*, 1996). Peanut is an important source of protein for human nutrition and income for the farmers. However its average yield in Cameroon is still low with 1.40 t ha^{-1} (FAOSTAT, 2014). The poor yields are partly due to poor soil fertility of acidic soils with low nutrient content including nitrogen (Zahran, 1999) and molybdenum (Liebenberg, 2002).

Nitrogen is a critical limiting element for the growth and development of most plants (Bambara and Ndakidemi, 2010). It is the most affected due to its high uptake, vulnerability to leaching, losses in gaseous form and through crop harvest (Stoorvogel *et al.*, 1993) and has been previously identified as the main soil fertility constraint for crop yields (Bationo and Mokyunwe (1991). Then supply to plants is mostly done through the application of mineral fertilizers which are costly and not available to poor resource farmers such as those found in Africa (Bado, 2002). Also, its production requires high amounts of non-renewable fossil energy resulting to the release of greenhouse gases (Jensen *et al.*, 2012). However, biological N-fixation (BNF), a key resource of N may represent one of the possible solutions and a great possibility for sustainable production of grain legumes (Mfilinge *et al.*, 2014).

The BNF is an alternative to the use of expensive inorganic fertilizers. This process can reduce the need for N fertilizers, resulting in an economy estimated to 3billion US dollars per cropping season (Nicolas *et al.*, 2006). Peanut, as leguminous plant, in symbiotic relationship with *Rhizobium*, has the ability to convert nitrogen from the air into the soil and transform it into ammonium (NH_4). According to Giller (2001), the quantities of nitrogen fixed by peanut vary from 21 to 206 kg Nha^{-1}.

However, soil nutrient deficiencies can limit the BNF in several agricultural soils and subsequently reduce the yield potential (Bordeleau and Prévost, 1994; Zahran, 1999; Hussein, 2000; Paudyal *et al.*, 2007). In addition, nutrient limitations in the production of grain legume results not only from the deficiency of macroelements such as nitrogen, phosphorus, potassium and sulfur (Jamal, 2010), but also from the deficiency of microelements such as molybdenum (Mo), boron and iron (Rahman, 2008).

Molybdenum is one of the micronutrients required for plant growth and development. It constitutes part of the enzyme nitrogenase which is essential for the conversion of atmospheric N_2 to ammonia NH_3. Mo deficiencies are therefore much more pronounced in legumes (Bailey and Laidlaw, 1999) as compared to non-leguminous plants. Symbiotic bacteria require more Mo than host plant for N_2 fixation (O'hara *et al.*, 1988) and thus, the supply of this element to bacteroids is an important process in the maintenance of BNF in legumes. In Cameroon 80 % of the arable lands are acidic with low Mo content (Thé, 2000). Since peanut is a legume, it is highly susceptible to Mo deficiency when grown in acidic soils and subsequently affects its ability to nodulate and to biologically fix N. Although yield increase is observed following inoculation with selected strains of rhizobia, there is little or no data on yield response of peanut in legumes mix-cropping. In addition, the application of molybdenum in these conditions has been seldom reported in Cameroon. This study therefore aimed at investigating the effects of seed rhizobia inoculation and/or molybdenum application on peanut nodulation, yields and N-uptake in two contrasting soils in the humid forest zone of Cameroon.

Materials and methods

Experiments were carried out in two location sites of the humid forest zone in the Centre Region of Cameroon: Yaounde with a red clayey soil and Bokito with a gray sandy soil. The site of Yaounde (3°50'N, 11°30'E) was a three years fallow dominated by *Chromolaena odorata* and *Pennisetum purpeureum* whereas that of Bokito (4°34'N, 11°6'E) was a mixed farm with a long history of legume cropping such as peanut and cowpea. Soil chemical characteristics of both sites are presented on the table 1.

Experimental design and treatments

The experiment followed a complete randomized bloc design with four treatments: C (Control: no inoculation and no Mo application), R (inoculation with rhizobium), Mo (Mo application) and R+Mo (the combination of rhizobia inoculation and Mo application). Each treatment was replicated four times. The basic plot size was 8 m2 and plots were separated by 0.5 m to prevent contamination. The peanut seeds of the A26 variety obtained from the Institute of Agricultural Research and Development (IRAD) were used in this experiment.

Planting was done during the rainy season in the month of April. For Mo and Mo+R treatments, seeds were soaked overnight in the solution of ammonium molybdate (53% of Mo) at the rate of 1kg of Moha^{-1}. The C and R treatment seeds were soaked overnight in distilled water. The rhizobium inoculant used was "Cynthia T" and consisted of a charcoal carrier *Bradyrhizobium* spp (10^8 cells/g of inoculant) isolated from Cameroonian soils. It was provided by the Laboratory of Microbiology, Biotechnology Centre, University of Yaounde I. The inoculant was coated to R and R+Mo treatment seeds (1kg inoculant per hectare) using powder milk as a sticking agent and the inoculated seeds were air-dried 1 hour before sowing. To avoid contamination, all *Rhizobium* uninoculated treatments were sown first. Sowing was carried out manually at 25 cm between rows, 20cm between plants (240000 plants per hectare) and at depth 2–4 cm. One seed was introduced in each planting hole and no nitrogen fertilizer was applied throughout the study period.

Data collection

Estimation of viable rhizobia in soils

An experiment was set up in a growth chamber (Laboratory of Soil Microbiology, Biotechnology Centre, University of Yaounde I) to estimate the total viable rhizobia in the experimental soils using plant infection method (Most Probable Number [MPN] technique). Soil samples collected from Bokito and Yaounde sites (0-20 cm) were stored at 4°C overnight. Serial dilutions (ten-fold dilution) were prepared as described by Somasegaran and Hoben (1994) with 100g of soil for the first dilution step. The dilution was up to 10^{-6} level. A diluent solution was prepared by dissolving 0.125 g KH_2PO_4 and 0.05 g $MgSO_4.7H_2O$ in 1000 ml of distilled water. The host plants, *Macroptilium atropurpureum,* were cultured in tubes containing a sterilized mixture of sand and vermiculite (1:3 (v/v)). Seeds were scarified and surface sterilized in concentrated sulfuric acid (H_2SO_4) for 4 minutes, rinsed several times with sterile distilled water and pre-germinated in petri dishes filled with agarose solution (2%). Upon emergence of the radicle, one pre-germinated seed was transferred aseptically to each tube. A week later, 1 ml of each level of dilution in four replicates was inoculated onto the root zone of cultured plants. Plants were watered with sterile nitrogen free-nutrient solution (Vincent, 1970). They were then scored for nodulation 28 days after inoculation and the indigenous rhizobia was determined using the Fisher and Yate table (Vincent, 1970).

Nodulation and biomass assessment

Ten plants from the inner rows were harvested randomly in each plot (total of 40 plants per treatment) at 55days after sowing to record the nodulation status and biomass of *A. hypogaea*. The plants were carefully dug out with their entire root system, washed with tap water and their nodules picked and counted. Nodules were then excised and the number with pink pigmentation were recorded. The nodules with pink color were considered efficient. The efficiency of nodulation was calculated per plant using the formula:

Number of pinked nodules/total number of nodules x 100.

The nodules were oven dried at 70° C for 72 hours. The dry nodules were then weighed and nodule dry weight recorded. The aboveground or the aerial plant part was oven dried at 70°C and weighed using a top scale balance to determine the shoot dry weight.

Yield attributes

At maturity (120 days after sowing), 10 plants from the inner rows of each plot were harvested to evaluate the yield components. The number of pods were counted for each plant and the average number for each plot was determined. Pods were oven dried and weighed to determine the dry weight. The kernels were removed from the pods and their weight determined per plant. Grain yield was recorded from each plot (2 x 4 m) and expressed in kgha^{-1}. The shelling percentage was calculated according to the equation:

$$\text{Shelling \%} = \frac{\text{Seed weight plant}^{-1}}{\text{Pod weight plant}^{-1}} \times 100$$

Plant N content

Plant samples of *A. hypogaea* coolected at 55 days after sowing, were analysed for N. The above plant parts were oven-dried at 60°C for 48 h and ground into a fine powder for the analysis of N. At harvest, N content of the seeds was determined using the Kjeldahl method (A.OA.C., 1984).

Statistical analysis

Statistical analysis was performed with the statistical software program STATISTICA. Data was analyzed by ANOVA and mean separation test was done using Student-Newman-Keuls test at P = 0.05.

Results and discussion

Rhizobia population density in soil

The population size of the indigenous rhizobia as evaluated with *Macroptilium atropupurpureum* plants was higher in Bokito than in Yaounde (Table 1).

Table 1. Soil chemical properties of the studied sites.

Site	pH (H_2O)	%			C/N		CEC	(mg kg^{-1})			
		OM	C	N		Rhizobia g^{-1} soil	(meq100 g^{-1})	P ext	Mg	K	Ca
Yaounde	4.6	0.98	0.57	0.06	16	1.7 x 10^2	4.14	2.0	0.20	0.11	1.31
Bokito	6.1	1.72	1.0	0.08	12.5	1.7 x 10^4	5.11	10	0.32	2.0	5.01

The acidity of the soil of Yaounde site (pH: 4, 6) likely influenced the bacteria population. This result confirms works of Ngo-Nkot (2009) who discovered a higher number of rhizobia in the soils of Bokito than in Yaounde. A similar relationship between soil pH and the number of rhizobia in the soil has been noticed with *Calliandra*, *Gliricidia* and *Leucaena* (Bala *et al.*, 2003). These authors showed that soil pH clearly influences soil rhizobia, with the lowest numbers obtained in zones where the average pH is 4. This offer the possibility of selecting the rhizobia that are less sensitive to acidic conditions and effectively fix nitrogen in this condition. In addition Yaounde site was a fallow with no history of legume cropping.

Table 2. Effect of *rhizobium* inoculation and Mo application on nodulation status of peanut after 60 days from sowing.

Treatments	Root nodules					
	Site Yaounde			Bokito		
	Number/ plant	Dry weight (mg plant^{-1})	Efficiency (%)	Number/ plant	Dry weight (mg plant^{-1})	Efficiency (%)
C	40.63 d	46.23 c	45.46 c	72.25 b	43.54 b	55.22 a
R	98.00 a	101.57 a	67.73 b	93.36 a	55.55 ab	55.43 a
Mo	56.88 c	61.45 b	67.09 b	86.25 a	48.54 b	57.54 a
R+Mo	77.25 b	97.67 a	87.96 a	96.00 a	65.50 a	64.62 a

Mean in the same column followed by different letters are significantly different at P = 0.05 according to Newmann Keuls Test. C: control; R: rhizobia inoculation; Mo: molybdenum application; R + Mo: combination of rhizobia and molybdenum.

The continuous cropping of legumes in Bokito resulted in higher rhizobia population in the soil (Table 1). Legumes serve to maintain rhizobia in the soils through rhizosphere effect and senescence of the nodules. These results are similar to that obtained by Thies *et al.* (1995) and Abera *et al.* (2015).

Studies by Atemkeng and Begoude (2014) in the south of Cameroon highlighted the effects of legumes on rhizobia populations. However, host species and physicochemical of the soil have to be taken in consideration.

Table 3. Effect of *rhizobium* inoculation and Mo application on nodulation status of peanut after 60 days from sowing.

	Shoot dry weight (g plant^{-1})		Shoot N content (mg plant^{-1})	
Treatments / Sites	Yaounde	Bokito	Yaounde	Bokito
C	5.12 c	7.95 b	136.25 c	160.00 b
R	11.52 a	7.48 b	330.50 a	181.50 b
Mo	9.69 b	8.68 a	275.32 b	202.25 a
R+Mo	11.33 a	8.56 a	319.50 a	234.00 a

Mean in the same column followed by different letters are significantly different at P = 0.05 according to Newmann Keuls Test. C: control; R: rhizobia inoculation; Mo: molybdenum application; R+Mo: combination of rhizobia and molybdenum.

Response of peanut plants to the interactive effect of rhizobium inoculation and Mo application Root nodulation status

The nodulation features of the peanut plants as affected by inoculation with *Bradyrizobium* spp and Mo application 60 days after sowing (DAS) are presented in Table 2. Nodule occurrence on the controlled plants at both sites suggested that natural rhizobia were able to infect peanut roots.

Peanut has long been considered as a highly "promiscuous" species because it was nodulated by rhizobia able to nodulate a diverse group of legumes (Alwi *et al.* (1989); Bogino *et al.* (2006)). However the proportion of nodules formed was different from one site to another.

Table 4. Effect of *rhizobium* inoculation and Mo application on peanut yield and its components.

	Seed yield (Ton ha^{-1})	Number of pods/plant	Pod weight (g plant^{-1})	Seed weight (g plant^{-1})	Shelling %	Yield increase (%)
Treatments	Yaounde					
C	0.60	6.25 c	4.84 c	2.50 c	51.65 b	-
R	1.57	10.25 b	9.74 b	6.55 b	67.24 a	161
Mo	1.62	9.50 b	9.56 b	6.73 b	70.39 a	174
R+Mo	2.33	13.25 a	13.24 a	9.72 a	73.41 a	288
	Bokito					
C	1.26	7.00 a	7.10 b	5.24 b	73.80 a	-
R	1.32	8.50 a	7.46 b	5.53 b	71.23 a	5
Mo	1.45	7.75 a	8.03 ab	6.04 a	75.21 a	10
R+Mo	1.52	9.25 a	8.56 a	6.32 a	73.83 a	21

Mean in the same column followed by different letters are significantly different at P = 0.05 according to Newmann Keuls Test. C: control; R: rhizobia inoculation; Mo: molybdenum application; R+Mo: combination of rhizobia and molybdenum.

The data revealed that the control peanut plants had the least number of nodules (40.63), nodule dry weight (46.23 mg plant^{-1}) and nodule efficiency (45.46 %) in the Yaounde site. These results suggest that the presence of native rhizobia of peanut in this experimental soil is inadequate (1.7x10^{1}), resulting to a low efficiency in nodule formation. Inoculation of peanut with *Bradyrhizobium* at the Yaounde site exerted a significant improvement in nodulation status, which led to significant (P = 0.05) increases in number (98.00), dry weight (101.57 mg) and efficiency (67.73%) of nodules per plant compared to the control treatment (Table 2). This observation corroborates the findings of Thies *et al.* (1991) and Lanier *et al.* (2005).

Table 5. Effect of *rhizobium* inoculation and Mo application on seed N content of peanut.

	Seed N content (mg plant^{-1})	
Treatments Site	Yaounde	Bokito
C	369.33 c	371.32 b
R	466.60 b	335.00 b
Mo	485.00 b	381.52 b
R+Mo	592.40 a	415.40a

Mean in the same column followed by different letters are significantly different at P = 0.05 according to Newmann Keuls Test C: control; R: rhizobia inoculation; Mo: molybdenum application; R+Mo: combination of rhizobia and molybdenum.

Contrarily, significant improvement of nodulation was observed only for the nodule number in Bokito. The bacterization of seeds in Bokito had no effect on nodule dry weight and efficiency. Nodule dry weight is very important in strain evaluation as it serves as an indicator for symbiotic efficiency (Graham *et al.*, 2004).

Results obtained in this site revealed that the population density of indigenous rhizobia in the soil was sufficient for efficient nodulation. Thies *et al.* (1991) indicated that response to inoculation is likely to occur when the indigenous rhizobia population is less than 1x10^{3} rhizobia cells g^{-1} soil. In the case of Bokito, 1.7x10^{4} rhizobia g-1 were estimated. These results are in conformity with those of Sanginga *et al.* (1996), Baraibar *et al.* (1999), Castro *et al.* (1999) and Houngnandan *et al.* (2000) who showed that soils with a high population of rhizobia, did not respond to inoculation. The presence of competitive bacteria in the soil can compromise the inoculation of a leguminous plant by a powerful inoculum but which is less competitive. Inoculation with rhizobia does not always elicit significant response and its effect is site specific (Date, 2000).

The application of Mo followed a similar pattern to that of *Bradyrhizobium* inoculation. The nodulation was significantly improved after application of Mo in Yaounde. The percentage increases were 40, 32.92 and 47.58% for number, dry weight and efficiency of nodule respectively (Table 2). These results can be explained by the fact that Yaounde soil, being acidic (pH: 4.6), had low Mo content. According to Bambara and Ndakidemi (2010), acidic soil usually has low phosphorus, calcium and molybdenum content. In acidic soils (pH <5·5) molybdenum availability decreases as anion adsorption to soil oxides increase (Reddy *et al.* 1997).The application of molybdenum in deficient soil encouraged nodule formation and N-fixation (Rahman *et al.*, 2008).

In Bokito no significant effect was observed in nodule dry weight and efficiency due to Mo application compared to the control treatment (Table 2). The soil of this site had a neutral pH (7.1) and seemed to have no need for Mo amendment. Plants in general require minute quantities of micronutrients, and higher quantities may hamper plant growth (Jabbar and Saud, 2012).

The combination of Mo and rhizobium inoculation tended to remarkably improve nodule number, dry weight and efficiency in both sites. However, nodulation was much higher in Yaoundé as compared to Bokito (Table 2). The percentage increases were 90.13, 111.26 and 93.49% for number, dry weight and efficiency of nodules, respectively over the control treatment in Yaounde. The corresponding values in Bokito were 32.87, 50.44 and 17%, respectively, for the same order mentioned above. These results are in the same line with those obtained by Bhuiyan *et al.* (2008), Bambara and Ndakidemi (2010).

Plant dry matter and N content

Plant dry matter and N content as affected by *Bradyhizobium* inoculation and the application of Molybdenum 60 DAS are given in Table 3. Data revealed that R, Mo and R+Mo treatments significantly (P = 0.05) increased shoot dry matter as compared to the control in Yaounde. Increases in shoot dry weights were 125, 89.25 and 121 %, respectively, for R, Mo and R+Mo above the control plants in Yaounde. In Bokito all the Mo treatments resulted in shoot dry weight improvement. However the percentage increases were low as compared to that of Yaounde (9 and 7% respectively for Mo and R+Mo over the control). Sable *et al.* (1998) reported significant influence of seed inoculation with *Bradyhizobium* and molybdenum on soybean dry matter accumulation. However the low response in Bokito may be probably due to its soil Mo and rhizobia ($1.7x10^4$ rhizobia g^{-1} of soil) status.

Efficiency of N-fixation performance is expressed by nitrogen accumulation in the plant tissues. Data in Table 3 showed that the percentage increases in total N-content of peanut shoots reached to 142.56, 102 and 134.5 % due to R, Mo and R+Mo treatments in Yaounde, respectively, whereas in Bokito these values were 13.44, 26.41 and 46.25 % due to the same order mentioned above. There was a significant (P = 0.05) increase in shoot N content after R, Mo and R+Mo treatments in the Yaounde Site. Nodule mass in the R inoculated treatments influenced the amount of fixed N.

Contrarily, only Mo and R+Mo treatments improved significantly (P = 0.05) shoot N content in Bokito. No significant effect was observed due to inoculation with *Bradyrhizobium* in this site. According to Dakora (1985), the native strains were more adapted to their environment while those brought by inoculation can have difficulties to express their ability in N fixation.

The Application of Mo alone or in combination with rhizobium inoculation led to significant increase of shoot matter and N accumulation. Mo application can play a vital role in increasing the N-fixation process by *Bradyrhizobium* and is responsible for the formation of nodule tissue and consequently the accumulation of shoot mass (Sharma *et al.*, 1988). Similar results were obtained by Shil *et al.* (2007), Bambara and Ndakidemi (2010) and Alam *et al.* (2015).

Peanut yield and some yield attributes

Pod number plant^{-1}, pod and seed weight plant^{-1} as well as yield (ton seed ha^{-1}) and the shelling percentage of peanut crop in studied sites, as affected by rhizobia and Mo application alone or in combination are given in Table 4. Results elicited that the inoculation with *Bradyrhizobium* alone resulted in significant increases in pod number, pod and seed weight and shelling percentage (64, 101.24, 162 and 30 %) in Yaounde, above the control treatment. The works of Lanier *et al.*, (2005) showed the important increase of the peanut yield after inoculation with *Bradyrhizobium* sp. obtained especially in the places where peanut is being cultivated for the first time. This increase seemed to indicate that the inoculated strains were more efficient for the N-fixation than native strains. Similar results were reported by. El-Azouni *et al.* (2008) and Ulzen *et al.* (2016). Increases in the yield of leguminous grains from 74% to 556% according to legume species and site were obtained on the ferralitic soil in Cameroun after *Bradyrhizobium* inoculation (Nwaga *et al.*, 2010). The shelling percentage values ranged from 65 to 73% except in the untreated plant in Yaounde. These results can be considered as the beginning of the solution to the phenomenon of "empty pods" in peanut, significant in humid forest zone of Cameroun.

The Mo application followed the same trend as the rhizobium inoculation. The percentage increases due to Mo application were 52, 97.52, 169.2 and 36.22%, respectively for pod number, pod and seed weight and shelling percentage, above the control (Table 4). These results are in harmony with those obtained by Vieira *et al.* (1995), Bhuiyan *et al.* (2008) and Alam *et al.* (2015).

In Bokito, the figure was different. No significant increases of number of pod and shelling percentage were observed due to R, Mo, and R+Mo treatments as compared to the control treatment. Some previous reports suggested that cowpea yields are not improved by rhizobia inoculation (Mathu *et al.*, 2012) because either their study sites had large numbers of indigenous rhizobia or the strains used were not effective enough to elicit a significant response. All Mo treatments led to significant improvement of pod and seed weight compared to the control. The combination treatment (R+Mo) significantly magnified all the peanut yield components compared to the control treatment. This trend was true at both sites. This combination attained increases of 288 and 20 % above the control in Yaounde and Bokito, respectively. In the two sites, molybdenum was beneficial for yield increase and hence the interest to carry out multi-local tests to determine optimal concentration for molybdenum to be applied according to the nature of the soil.

The efficiency of N-fixation performance is expressed by nitrogen accumulation in the plant tissues. Data in Table 5 showed the effect of *Bradyrhizobium* inoculation and Mo application on seed N content of peanut. Result elicited that the significant highest seed N content was obtained by combining rhizobium inoculation with Mo application at both sites. The improvement of 60.40 and 11.89%, respectively in Yaounde and Bokito was observed above the control treatment. We noticed that the effect of rhizobia inoculation on the seed N content is more important when inoculum was combined with molybdenum. This effect has been made evident in bean in Brazil by Vieira *et al.* (1995) and Quaggio *et al.* (2004).

Molybdenum is an essential trace element and is vital for synthesis and activity of molybdoenzymes such as nitrate reductase and nitrogenase, the key regulatory component for nodule initiation and maintenance of N-fixation in legumes (Franco and Munns, 1981). In the case of this study, molybdate ammonium was used as source of Mo. Then Mo was applied with small part N which helped to boost growth, and N uptake before the establishment of the symbiosis.

Conclusion

Nutrient uptake and yield of peanut (*Arachis hypogaea* L.) is greatly influenced by rhizobia inoculation and Molybdenum application in the humid forest zone of the Centre Region of Cameroon. However, previous cropping history of the farmland has role to play on the effect of rhizobia inoculation and Molybdenum application on N-nodulation, yield and N uptake as was the case of this study.

Rhizobia inoculation and Molybdenum application showed significant effect on nodulation, yield and N uptake on the three years fallow at the Yaounde site compared to the mixed farm with a long history of legume cropping at the Bokito site. Thus previous cropping system on a farmland influences the microbial population, soil fertility status, nutrient availability and consequently the nutrient uptake and yield of the next cropping season.

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