Identification of the Morphological Characters of some Nodules Belonging to the Fabaceae Family

Yee Yee Than

Abstract

Many leguminous plants are being grown in Hinthada environs, Ayeyarwady Region. Among these plants, the total numbers of 4 species namely, ***Vigna mungo*** L. (Mat Pe), ***Vigna radiata*** L. (Pe Di Sein), ***Vigna catjang*** Walp. (Bo Cate Pe) and ***Glycine max*** L.(Pe Bok) belonging to family Leguminosae were studied for nodules characters in this research. The experiment was laid out in Randomized Complete Block Design with four replications and conducted during from March to Jun 2018 at Hinthada University. It was found that the highest mean value of nodule number (46) and nodule size (5.5 mm) was found in Cowpea whereas the smallest mean value of nodule number (9) and nodule size (2.0 mm) was found in Green gram. Nodules colour of four cultivars was Cream and brown. Spherical and oval shape of nodules was found in Black gram and Green gram. In Cowpea and Soy bean, the shape of nodules was Spherical, oval, oblong and amorphous. Number of nodule clusters was not significantly different among cultivars. Among four cultivars, the highest mean values of shoot length, root length, nodule number and nodule size were found in Cowpea.

Keywords: leguminous plants, nodules characters, Randomized Complete Block Design, cultivars

Introduction

In the present work, morphological features of four species belonging to family Leguminosae are studied on the base of nodules. Nodules are very important to fill the needed nitrogen for soil fertility and cultivation. Therefore, some nodules present species ***Vigna mungo*** L. (Mat Pe), ***Vigna radiata*** Walp. (Pe Di Sein), ***Vigna catjang*** Walp. (Bo Cate Pe) and ***Glycine max*** L. (Pe Bok) are investigated in this work.

Other grain legumes such as peanuts, cowpeas and soybeans are good nitrogen fixers, and will fix all of their nitrogen needs other than that absorbed from the soil. These legumes may fix up to 250 lbs of nitrogen per acre and are not usually fertilized. In fact, they usually don't respond to nitrogen fertilizer as long as they are capable of fixing nitrogen. Nitrogen fertilizer is applied at planting to these legumes when grown on sandy or low organic matter soils to supply nitrogen to the plant before nitrogen fixation starts (Website 5).

The amount of nitrogen returned to the soil during or after a legume crop can be misleading. Almost all of the nitrogen fixed goes directly into the plant. However, nitrogen eventually returns to the soil for a neighbouring plant when vegetation (roots, leaves, fruits) of the legume die and decompose (Website 5).

Fabaceae or Leguminosae is a large and economically important family of flowering plants which is commonly known as the legume family, pea family, bean family or pulse family. Leguminosae is an older name still considered valid, and refers to the typical fruit of these plants, which are called legumes Fabaceae is the third largest family of flowering plants with 730 genera and over 19,400 species. ***Vigna*** genus also comes under Leguminosae family and has got many traditional usages. These genus plants are mainly cultivated in India, Thailand, Philippines, Indonesia, Burma, Bangladesh and China, but also in hot and dry regions of South Europe and Southern USA (Website 2).

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Legumes are the second most important group of food plants belonging to the family Leguminosae. They form an important and indispensable part of our daily diet and are commonly known as pulses. Leguminous plants are cultivated all over the world, but India has the distinction of being the world's single largest producer of pulses (Pandey and Chadha, 1999).

Pulses are valued for their highly nutritious contents. The seeds are rich in proteins, carbohydrates, fats, vitamins and minerals and are an important source of dietary proteins for the predominantly vegetarian population of India. The protein rich plants provide excellent green fodder and feed for livestock (Pandey and Chadha, 1999).

Black gram (***Vigna mungo***) is a widely grown grain legume and belongs to the family **Fabaceae** and assumes considerable importance from the point of food and nutritional security in the world. Black gram is favorable short duration pulse crop as it thrives better in all seasons either as sole or as intercrop or fallow crop. India is the world's largest producer as well as consumer of black gram (MoA, 2012).

Nodules are found on tropical legume such as those of the genera *Glycine* (soybean), *Phaseolus* (common bean), and *Vigna* and on some temperate legumes such as Lotus. These determinate nodules lose meristematic activity shortly after initiation, thus growth is due to cell expansion resulting in mature nodules which are spherical in shape (Postgate, 1998).

Cowpea is an introduced species in the United States. It is native to tropical and subtropical regions. It can grow both wild and cultivated. Cowpea is commonly cultivated as a nutritious and highly palatable food source in the southern United States. The seed is reported to contain 24% crude protein, 53% carbohydrates, and 2% fat (FAO, 2012). The leaves and flowers can also be consumed (Website 6).

The main aim is to study the morphological characters of nodules in some species of **Fabaceae** family. The objectives of this research are

- to know the different lengths of shoot and root between four cultivars
- to evaluate the number, size, shape and color of nodules on tested cultivars
- to investigate the response of soil on tested variety and
- to find out the appropriate cultivar which is reliable for the tested soil.

Materials and Methods

Materials

Samples of four testing varieties, *Phaseolus mungo* L. (Mat Pe), *Vigna radiata* L. (Pe Di Sein), *Vigna catjang* Walp. (Bo Cate Pe) and *Glycine max* L. (Pe Bok) were recorded from March to Jun 2018 for morphological characters of nodules (Fig. 1). The pea cultivars were obtained from the Department of Agriculture (DOA), Seed Division, Tagonding Seed Farm, Hinthada, Ayeyarwady Region.

Methods

Soil samples collection and analysis

Soil samples were taken from Khaung Say Kyun at depth of 15 cm for soil analysis. The collected soil samples were analyzed at the Soil Analysis Laboratory, Land use Division, Department of Agriculture, Yangon Region.

Soil preparation

Soil samples from Khaung Say Kyun were thoroughly mixed with humus.

Number and size of plastic bags

A total number of 32 plastic bags were used in this experiment. The size of bags was 15 inches in height and 10 inches in diameter.

Data collection and analysis

Plant materials were photographically recorded about their habits, flowers, fruits, root length and nodules. The specimens were identified with the help of standard literatures such as Hooker (1875-1897), Baker and Brink (1934-1965), Dassanayake (1980-1999), John Kress (2003) and Hong Koung (2007-2009). The measurements of shoot length and root length were recorded and analysis on the color, number, size and cluster of nodules was done. Effects on growth were recorded in every two weeks after seedling and nodules were recorded after harvesting.

Experimental design

The experiment was laid out in a randomized complete block design (RCBD) with four replications (Gomez, 1984) (Fig. 2).

A. *Vigna mungo* L.

B. *Vigna radiata* L.

C. *Vigna catjang* Walp.

D. *Glycine max* L.

Figure (1) Phtograph of four testing varieties samples.

Figure (2) Experimental design of four testing varieties.

Results

The four testing varieties, ***Vigna mungo*** L. (Mat Pe), ***Vigna radiata*** L. (Pe Di Sein), ***Vigna catjang*** Walp. (Bo Cate Pe) and ***Glycine max*** L. (Pe Bok) were used to study the shoot length, root length and nodules analysis such as colour, shape, number, size and cluster of nodules under Botany Department of Hinthada University, Hinthada Township.

Morphological characters

The morphological characters were described in brief for correct specimens.

Vigna mungo L.

Herbaceous annual herbs with spreading, procumbent branches. Stems or young twigs sparsely to densely brown hairy. Leaves alternate, trifoliolate pinnately compound, odd pinnate. Inflorescence axillary racemes. Flowers small, petal yellow. Pods long, cylindrical, seeds black (Fig. 3).

Vigna radiata L.

An annual, erect or semi-erect with many-branched. The leaves are alternate, trifoliolate with broad leaflets. The flowers pale yellow in colour. The pods are long, cylindrical, hairy, seeds green (Fig. 4).

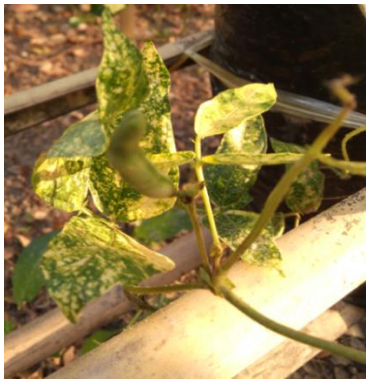
Vigna catjang Walp.

Annual herbs with erect or sub erect, trilling, climbing branches. Leaves large, alternate, trifoliolate pinnately compound, odd pinnate. Flowers in raceme inflorescence at the distal ends of long peduncles, only two to a few flowers, purple in colour. Pods long, cylindrical, seeds black (Fig. 5).

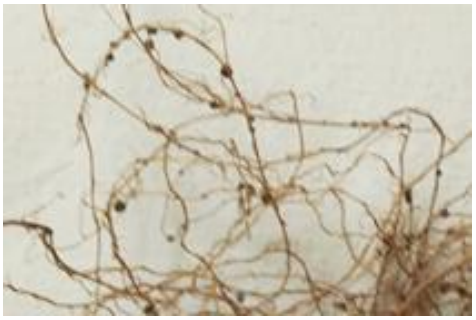
Glycine max L.

Small, sub-erect annuals showing prostrate habit. Stem bears large trifoliate leaves. Inflorescence axillary racemes. Flower small, white. Pods hairy, dark brown in color, seeds cream (Fig. 6).





Habit Flowers Fruit


Root Nodules

Figure (3) The morphological characters of *Vigna mungo* L.



Habit Flowers Fruit



Root Nodules

Figure (4) The morphological characters of *Vigna radiata* L.



Habit Flowers Fruit



Root Nodules

Figure (5) The morphological characters of *Vigna catjang* Walp.



Habit Flowers Fruit



Root Nodules

Figure (6) The morphological characters of *Glycine max* L.

Table (1) Maximum, minimum and mean values of growth parameter in four cultivars.

Cultivars	Shoot length	Root length	Nodule colour	Nodule Shape	Nodule number	Nodule size	Nodule clusters
Black gram	18.0 in - 20.0 in (**19.5 in**)	7.0 in - 10.5 in (**9.0 in**)	Cream - brown	Spherical/ oval	15 - 71 (**30**)	0.5 mm- 3.5 mm (**2.25 mm**)	2 - 4 (**3**)
Green gram	13.0 in - 14.5 in (**13.5 in**)	4.0 in – 8.0 in (**6.0 in**)	Cream	Spherical/ oval	3 - 13 (**9**)	0.5 mm - 2.5 mm (**2.0 mm**)	2 - 4 (**3**)
Cowpea	51.5 in - 87.0 in (**62.0 in**)	10.0 in - 12.0 in (**11.0 in**)	Cream - brown	Spherical/ oval/oblong/ amorphous	43 - 50 (**46**)	1.0 mm - 6.5 mm (**5.5 mm**)	2 - 5 (**4**)
Soy bean	39.5 in - 43.0 in (**40.0 in**)	7.0 in - 18.0 in (**10.0 in**)	Cream	Spherical/ oval/oblong/ amorphous	15 - 35 (**22**)	0.5 mm - 5.0 mm (**4 mm**)	2 - 6 (**4**)

Table (1) showed that the maximum, minimum and mean values of growth parameter in four cultivars. The shoot length of Black gram was 18.0 in - 20.0 in (**19.5 in**) and the root length was 4.0 in - 10.5 in (**9.0 in**). The 13.0 in - 14.5 in (**13.5 in**) of shoot length and 4.0 in - 8.0 in (**6.0 in**) of root length were found in Green gram. In Cowpea, shoot length was 51.5 in - 87.0 in (62.0 in) and the root length was 10.0 in - 12.0 in (**11.0 in**). The shoot and root length of Soy bean were 39.5 in – 43.0 in (**40.0 in**) and 7.0 in – 18.0 in (**10.0 in**) respectively. The highest mean values of shoot length and root length were found in Cowpea (62.0 in) and (11.0 in) receptively. Similarly, the smallest mean values of shoot length (13.5 in), root length (6.0 in) were found in Green gram (Fig. 7).

In nodules analysis, nodules number of 15 - 71 **(30)**, 3 - 13 (**9**), 43 - 50 (**46**), 15 - 35 (22) and size of 0.5 mm - 3.5 mm (**2.25 mm**), 0.5 mm -2.5 mm (**2 mm**), 1.0 mm - 6.5 mm (**5.5 mm**) and 0.5 mm - 5.0 mm (**4mm**) were found in Black gram, Green gram, Cowpea and Soy bean respectively. The highest mean value of nodule number (46) and nodule size (5.5 mm) was found in Cowpea whereas the smallest mean value of nodule number (9) and nodule size (2.0 mm) was found in Green gram. Nodules colour of four cultivars was Cream and brown. Spherical and oval shape of nodules was found in Black gram and Green gram. In Cowpea and Soy bean, the shape of nodules was Spherical, Oval, oblong and amorphous. Number of nodule clusters was not significantly different among cultivars. Among four cultivars, the highest mean values of shoot length, root length, nodule number and nodule size were found in Cowpea (Fig. 8, 9 and 10).

Soil analysis

Soil texture was sandy loam (sand – 63.40%, silt – 20.00%, clay – 16.60%) and pH value was slightly acid (6.49) (Appendix 1).

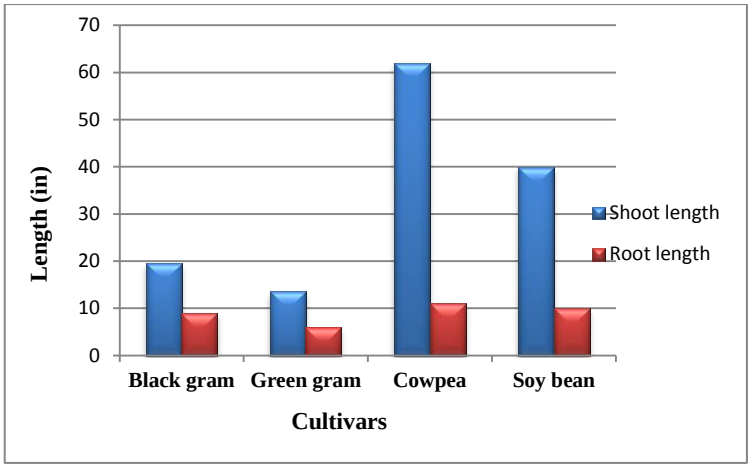


Figure (7) Comparison of shoot length and root length in four cultivars.

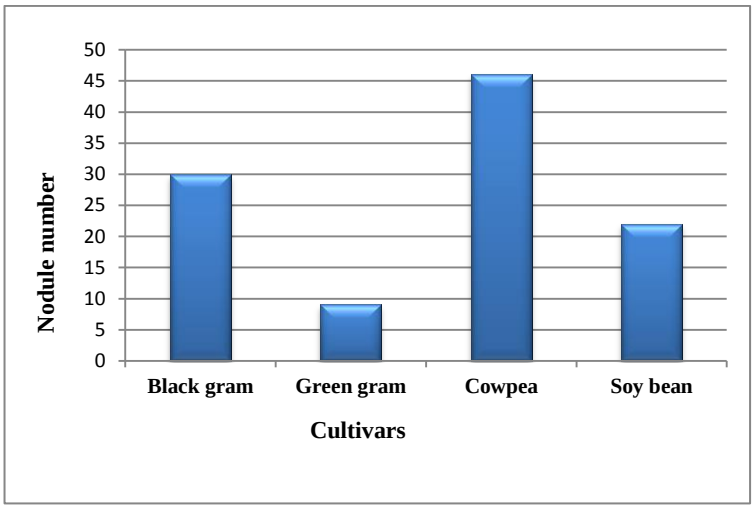


Figure (8) Comparison of nodule number in four cultivars.

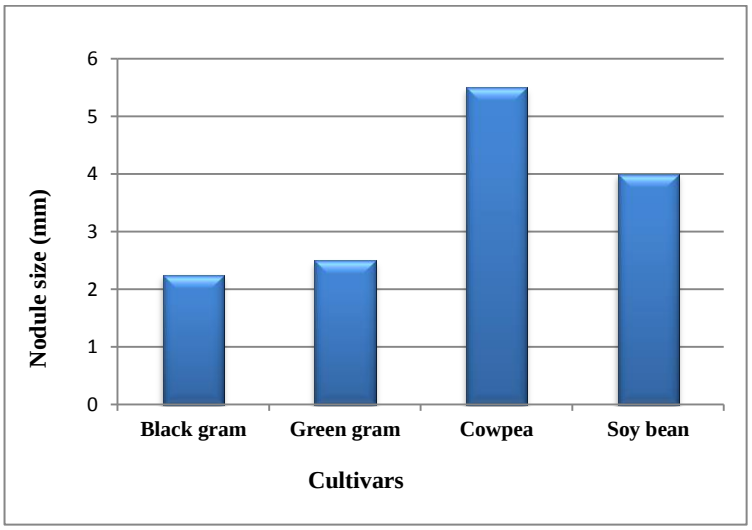


Figure (9) Comparison of nodule size in four cultivars.

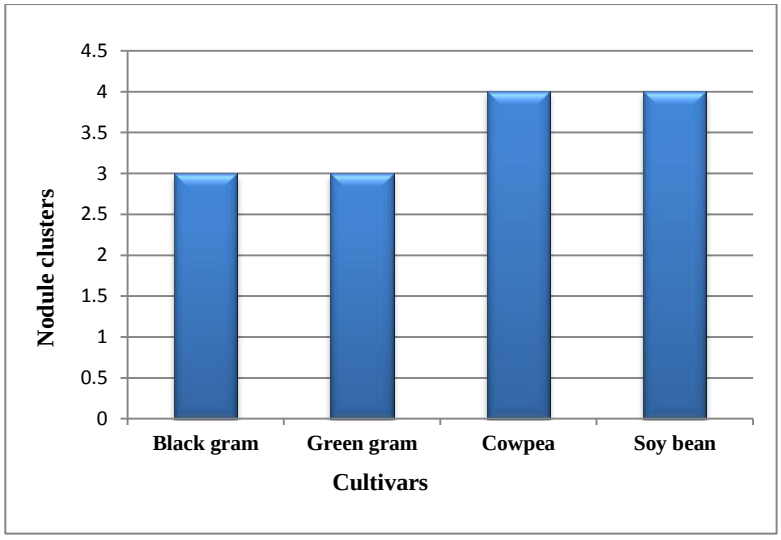


Figure (10) Comparison of nodule clusters in four cultivars.

Discussion and Conclusion

The four cultivars (Mat Pe, Pe Di Sein, Bo Cate Pe and Pe Bok) belonging to family **Fabaceae** were studied for their morphological characters of nodules. Some physiological characters such as shoot length and root length were measured for range between different varieties.

Legumes have long been known to be good for cultivation by fixing nitrogen and improving soil fertility. These legumes come in the form of common peas and beans, as well as cover crops that act as green manure in the off season. They are cultivated as tropical or sub-tropical crops, and require warm temperatures (optimally round 30- 35°C). Well drained **loamy soil** is best for the cultivation of ***Vigna*** genus plants (Website 2).

Although, this crop is capable of fixing atmospheric nitrogen through Rhizobium species living in root nodules, however, under agro-ecological conditions, the nodulation of mung bean is poor and is a major cause of its lower yield. It was observed that inoculation of mung bean with ***Rhizobium*** spp. increased plant height, leaf area, photosynthetic rate and dry matter production (Thakur & Panwar, 1995).

Black gram complements the essential amino acids provided in most cereals and plays an important role in the diets of the people. Green gram (***Vigna radiata***) and black gram (***Vigna mungo***) are two of the most imperative food legumes grown and consumed (Kakati *et al.,* 2010).

The cowpea is used both as a vegetable and grain. The semi- spreading types are suitable for use as a vegetable. The use of cowpea seeds as a seed vegetable provides an inexpensive source of protein in the diet (Website 3).

The present studies were conducted to evaluate effect of soil and time duration from March to Jun 2018 on the growth parameter of four tested cultivars. The climate of Ayeyarwady Region is hot and humid condition. In the present study, the soil type was sandy loam and pH was slightly acid (6.49 %) (Appendix - 1) .

Black gram prefers warm, sunny climate with moderate rainfall and it is well adapted to grow on heavy, loamy soils having water retention properties. Green gram prefers favouring warm weather but requires a well distributed rainfall and it is well suited to grow

on deep, well drained, loamy soil (Pandey and Chadha, 1999). Maesen and Sommatmadja (1992) revealed that Black gram is basically a warm-season crop but is grown in both summer and winter.

Cowpea grows best during summer. The optimum sowing times are December to January. The presence of nodular bacteria specific to cowpea (***Bradyrhizobium*** spp.), make it suitable for cultivation. However, cowpea is much less tolerant to cold soils. Cowpea is a more drought-tolerant crop than many other crops. Cowpea also has a great tolerance to water logging (Website 3).

Cowpea grows on a wide range of soils but shows a preference for sandy soils, which tend to be less restrictive to root growth. It is more tolerant to infertile and acids soils than many other crops. Cowpea thrives in well-drained soil and less on heavy soils. It also requires a soil pH of between 5.6 and 6.0 (Website 3).

Soybean is well adapted to grow in varying climatic conditions. Temperate climate and moderate rainfall produces the best results. Though, the plant may be grown on all types of soil, a fertile sandy loamy soil is preferred (Pandey and Chadha, 1999).

Among these cultivars, Pe di sein plants, Cow pea plants and Soybean plants were well grown on the selected soil (sandy loam and slightly acid -6.49 %) and time duration. Mat pe plants were not preferred on selected soil and time duration because physiological characters were not good conditions but nodules characters were well observed in present work.

These conditions were agreements with the reveals of Pandey and Chadha (1999), Maesen and Sommatmadja (1992) and (Website 3).

In nodules analysis, the spherical, oval, oblong and amorphous of nodules shape and 0.5 mm - 5.0 mm of nodules size were found in Soybean. Black gram has 71 nodules per plant and Soy bean has 35 nodules per plant in present work (Table 1).

Nodules on annual legumes such as beans and soybeans are round and can reach the size of a large pea. Beans will generally have less than 100 nodules per plant and soybeans will have several hundred per plant (Website 5).

Nodule size, shape and number vary with the host plant and ***Rhizobium*** strain. Cowpea and soybean nodules are spherical (Website 4). According to (Tanabata *et al*., 2014) and (Website 1), young soybean nodules are globular or oval in shape and the nodule size of soybean is smaller than 1 mm.

In these experiment, the observations of nodule size, shape and number in Cowpea and soybean were agreements with the reveals of (Tanabata *et al*., 2014), (website 1), (Website 4) and (Website 5).

Leguminous plants are excellent for crop rotation since they have a high nitrogenous content, which on their death and decay are released into the soil, there by adding to the soil fertility. A remarkable feature about legumes is the association of nitrogen fixing bacteria with their roots in the form of root nodules. These bacteria (***Rhizobia***) on their death release the nitrogenous compounds into the soil, adding to the nitrogen content of the soil (Pandey and Chadha, 1999).

Ineffective nodules are usually small and scattered over the entire root system. The exact lifespan of a given nodule is not known. Nodules on older roots may naturally senesce with time. The pattern of nodule growth, decay and shedding is not the same in all legumes.

Following forage harvest, nodules of most legumes are usually shed, and new nodules form when root growth is renewed (Website 4).

Many leguminous plants are grown in the study areas. Among these plants, four leguminous plants are studied in this project paper. These plants are important to use as sole or intercrop or fallow crop for rice cultivation and to produce the protein rich seeds, foods, fodder and medicines for local people as well as other foreign people.

The different chemical fertilizers and manure applications on leguminous plants should be tested for different growth rate and structure of nodules in future works. It is hoped that the results of the present study would contribute knowledge to the interested researchers.

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Appendix - 1

DEPARTMENT OF AGRICULTURE (LAND USE)
SOIL ANALYTICAL DATA

Division - ဧရာဝတီ
Township - ဟသ်ာတ

Dr. Yee Yee Than (25.9.2018)

Sheet No. 1
Sr No. S-1/18-19

Sr No.	Sample plot	pH Soil : Water 1 : 2.5	Texture				SOIL INTERPRETATION OF RESULTS	
			Sand %	Silt %	Clay %	Total %	pH	Texture
1	မြေနမူနာ	6.49	63.40	20.00	16.60	100.00	Slightly acid	Sandy Loam

ခင်ဝင်းမာ
ဒု-ညွှန်ကြားရေးမှူး
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