CHAPTER 3

MATERIALS AND METHODS

This study consists of two parts: first is field survey which objective aims to gain knowledge about farming systems and the current farmers' practices in peanut production. The survey also accesses to the variation of peanut yield and limiting factors in peanut production in the hilly zone. Second is field experiment which sets up and focuses on identifying the response of peanut to various rates of lime and phosphorous fertilizer. The details of both parts are described as follows:

3.1. Field survey

The formal survey was conducted from March to May 1999 in the research area. Three villages representing for sub-ecological zones were selected for the survey study. Two villages were in the West and the Southwest of the province (Thuychau and Binhdien) and one village in the Northwest of the province (Phongson). Twenty households in each village where peanut is grown were randomly chosen as targets for the formal survey with questionnaires.

Data related to the research sites was collected during the survey from the farmers as well as other related authorities including information on agriculture land use, cropping pattern, crops yield, the inputs and output status for production of major crops and gross margin for some cropping patterns under farm conditions. Secondary data on climatic conditions (rainfall, temperature, air humidity and evaporation) and soil properties were collected from reliable authorities. Survey data

have been analyzed by descriptive statistical methods. Results from the survey were utilized to plan and execute the field experiment.

3.2. Field experiment

3.2.1. Experimental site

The field experiment was conducted in the field at Thuychau village of Thua Thien Hue province located in 16°15' N latitude and 101°15' E longitude during the Spring - Summer season of 1999. The soil type at the experimental site is classified as Yellow – Red Ferralitic soil. In general, the soil is acidic and is very low fertility particularly available phosphorous.

3.2.2. Treatments and design

The experiment consisted of 2 factors (phosphorous and lime application) arranged in a split - plot design with three replications. Main plot was assigned to four rates of lime (0, 500, 700, 900 kg of lime ha^{-1}) and the sub plot was assigned to four rates of phosphorous (0, 60, 90, 120 kg of P_2O_5 ha^{-1}). The size of each experiment unit was 2.6 x 5.0 m. Peanut seeds were sown in row with spacing of 30 cm and a distance of 10 cm between plants within a row. The plant density was 33 plants per m^2. The variety of peanut used in the field experiment was Giay- BTT (local variety).

3.2.3. Field management

The determination of phosphorous and lime levels was based on the field survey and previous research results. Results of field survey showed that most farmers applied approximately 60 kg of P_2O_5 ha^{-1} and 400 - 500 kg of lime ha^{-1} in their fields. And some past research results also suggested that the application of 90 - 150 kg of P_2O_5 ha^{-1} and 500 - 900 kg of lime ha^{-1} for peanut and other crops achieved higher economic efficiency (Phuong, 1994; Cong and Ha, 1996; Tinh, 1996; An, 1996). Thus phosphorous and lime application rates at treatments and treatment combinations in this study were as follows:

P_2O_5 (kg ha^{-1}) Lime (kg ha^{-1})	0 (P_1)	60 (P_2)	90 (P_3)	120 (P_4)
0 (L_1)	P_1L_1	P_2L_1	P_3L_1	P_4L_1
500 (L_2)	P_1L_2	P_2L_2	P_3L_2	P_4L_2
700 (L_3)	P_1L_3	P_2L_3	P_3L_3	P_4L_3
900 (L_4)	P_1L_4	P_2L_4	P_3L_4	P_4L_4

Phosphorous fertilizer and lime used in this experiment were in the form of super-phosphate (16.5% P_2O_5) and burned limestone (CaO), respectively. Placement method for lime was a broadcast application prior to sowing two weeks and incorporated to the soil depth of 20 cm. Phosphorous fertilizer was applied as a banded application (5 cm to the side and 5 cm below the seed) at sowing. Different lime and phosphorous fertilizer rates were applied in each plot selected randomly of each replication.

Nitrogen fertilizer (Urea, 46%N) at the rate of 40 kg of N ha^{-1}, potassium fertilizer (KCl, 50%K_2O) at the rate of 50 kg of K_2O ha^{-1} and 8 ton of manure ha^{-1}

were applied as dressed and basal fertilizer, respectively. Both nitrogen and potassium fertilizer were applied as row applications at two stages of the plant growth (1) one third of the amount at the stage of full expansion of the third leaf and (2) just prior to flowering the remaining two thirds of the amount.

3.2.4. Sampling procedures

3.2.4.1. Plant sample

Observations were made at four different growth stages of peanut namely R_2, R_4, R_6 and R_8 (Boote and Jones, 1982) where:

- R_2 is the stage at which 50% of plants is beginning peg and 50% of plants have 1 elongated peg (gynophore).
- R_4 is the stage of full pod and 50 % of plants have 1 fully – expanded pod to dimensions characteristic of the cultivar.
- R_6 is the stage of full seed and 50% of plant with 1 pod with seeds filling cavity of pod when fresh.
- R_8 is the stage of harvest maturity and 50% of plants with 2/3 to 3/4 of all developed pods having testa or pericarp coloration.

Data of peanut crop including the number of nodules, dry weight of nodules, leaf areas and dry matter were collected at four stages as mentioned above. Beside this, yield and yield components of peanut were also collected at harvest stage.

Nodule

Ten plants are chosen randomly from each plot for measuring the number of nodules. These plants were carefully dug out and cleaned with water in a water tank. The number of nodules was counted for each plant at four stages namely R_2, R_4, R_6 and R_8.

Nodule dry weight

Nodule dry weight per plant was determined on 10 plants selected randomly from each plot at R_2, R_4, R_6 and R_8 stages. These plants were dug out carefully and cleaned in a water tank. Dry weight of nodules was determined after drying at 70°C until weight stabilized.

Leaf areas

In each plot at R_2, R_4, R_6 and R_8 stages, 10 plants were chosen randomly. All leaves were cut and weighed. An area of 1 dm^2 of leaf was cut by putting leaves in a cardboard container with area of 1 dm^2 and then cutting. The 1 dm^2 of leaf was weighed. Leaf area was then estimated by comparing the total leaf weight and the known areas (1 dm^2) weight . Leaf area was converted to 1 m^2.

Dry matter

An area of 1 m^2 was sampled from each plot of the experiment at R_2, R_4, R_6 and R_8 stages and dried at 70°C until the weight stabilized in order to determine the dry matter.

Pod yield and yield components

At harvest time, seed yield was determined on a sample area of $1m^2$ from each plot. Yield components (number of pod, unfilled pod and filled pod per plant and weight of 100 - seed and also weight of 100 - pod) was measured on a randomly selected subsample of ten plants. Filled pods were separated and dried. Filled pod yield with 12% of moisture was determined.

Concentration of N, P, K in the plant

At R_2 stage, 30 youngest fully expanded leaves were samples from each plot and analyzed for N, P, K concentrations (Ulrich and Hills, 1967; Bell *et al.*, 1986 cited by Crashwell *et al.*, 1987). The concentration of N, P and K in leaf of peanut were analyzed using the following chemical methods: Total nitrogen content (%) was determined by Kjeldahl method (Bremmer, 1968). Total phosphorous content (%) was determined by colourimetric method based on ascorbic acid reduction of ammonium phosphomolybdate complex (Olsen and Dean, 1982). Total potassium content (%) was determined by flame photometry (Knudsen, 1980).

3.2.4.2. Soil sample

A composite soil sample (0-20 cm depth) from each replication was collected before and after the experiment to analyze the chemical properties of the soil which are organic matter, pH_{KCl}, total N, P_2O_5 and K_2O concentration and available phosphorous. These data were used to characterize the properties of the experimental soil and evaluate soil response to different phosphorous and lime levels. The soil chemical properties were analyzed by the following methods:

Measurement	Unit	Method	References
pH_{KCl}		pH meter	Buurman et al., 1996
Organic matter	%	Walkley-Black	Alison, 1960
Available phosphorous	mg/100g soil	Bray II's	Bray and Kurzt, 1945
Total phosphorous	%	Colourimetric	Olsen and Dean, 1982
Total potassium	%	Flame photometry	Knudsen, 1980
Total nitrogen	%	Kjeldahl	Bremmer, 1968

3.2.5. Data analysis

Descriptive method with tables, figures and charts is used to meet the stipulated objectives. The data was analyzed and briefly discussed as follows:

To achieve the first objective, to review the situation of peanut production system in hilly zone of Thua Thien Hue province, the results from formal survey and interview were analyzed by using descriptive statistics. Percentage, mean and standard error of the mean were used for the analysis information regarding land use, technologies which are related to peanut production in farming systems, production constraints and supporting factors.

To achieve the second objective, to examine the responses of peanut to lime and phosphorous fertilizer application, the results from field experiment were analyzed by using two statistic programs including Statistix version 4.1 and Statistica vesion 5.0. Descriptive statistics, analysis of variance (general AOV/AOVC), coefficient of variation, least significant difference (LSD) and comparisons of means were used for the analysis information about peanut growth, development and yield

indicators as well as soil properties and plant nutrient concentration indicators in field experiment.

To achieve the third objective aims to evaluate the effectiveness of lime and phosphorous in improving yield of peanut and to understand the profitability of peanut production, all variable costs of labors, seeds and fertilizers employed during peanut production and gross margin are estimated for each treatment. The variable costs for calculation was based on the average data from three surveyed villages and estimation in field experiment. Comparisons between treatments in the field experiment were also undertaken. Gross margin calculation based on equations as follows:

1. Total revenue = Total production in kg multiplied by price per kg
2. Total variable cost = Labor cost + Land preparation (Plough machine) + Fertilizer cost + Seed cost + Pesticide cost
3. Gross margin = Total revenue – total variable cost.

The currency used in calculating cost, revenue and gross margin is Vietnamese currency (VND). One $US was approximately equal to 14,000 VND during the survey.