SUITABILITY AND FERTILIZATION ASSESSMENT OF SOME FRUIT CROPS IN BALIDONG RESEARCH AND DEVELOPMENT, EXTENSION (R & D/E) LABORATORY[1]

by

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KEY WORDS: soil, fruit crops, crop environmental adaptation, annual rainfall, elevation, fertilizer recommendation, actual plant food requirement, lime requirement, climate, pH preference

ABSTRACT

The study showed that both pineapple and citrus are suitable for extensive crop production in the Balidong R & D/E field laboratory. Mango, however, was eventually ruled out from being suitable in the area after careful matching of its land and climatic preferences though it was initially found to have potential for extensive production in the same area. Pineapple was found to have a recommended rate of 50-25-186 kg NPK/ha during the second fruit harvest and 16-5-80 kg NPK/ha during the first harvest. Citrus, on the other hand was found to have a recommended rate of 257-48-254 kg NPK/ha. Recommended rates were computed based on nutrient removals of the particular fruit crop and the soil test result. Liming was not found to be necessary for both crops, although maintenance liming may be advisable in the case of citrus.

INTRODUCTION

Land may be classified into different suitability classes depending on slope, soil properties and characteristics, and water supply. With respect to lands suitable for agriculture and forestry where production and nature conservation are the primary goals, soil properties and characteristics must be considered.

Matching the existing environmental conditions of a place with the preferences of crops as to soil properties and climate gives one a useful tool for determining the suitability of an area to crop production or whether a crop can be grown productively in an area. Soil fertility evaluation, on the other hand, will be a useful tool in assessing the fertilization requirement and or scheme of a crop. Albeit, soil fertility does not guarantee crop productivity, when treated as part of crop management, it can certainly augment crop productivity and increases soil productivity.

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In crop production, many economic losses are incurred in various ways either controlled (e.g., losses due to pests and diseases) or uncontrolled (e.g., losses due to typhoons). Farmers, knowingly or unknowingly, also incur losses from over-fertilization or under-fertilization. Over-fertilization results from applying too much fertilizer than is necessary or needed by crops while under-fertilization may result from applying insufficient fertilizers than is required by crops or through losses of nutrients from fertilizers due to leaching, volatilization, mechanical/physical fixation by the soil, and chemical fixation or reaction with the elements present in the soil.

Problems on over-fertilization though are more likely to occur than under-fertilization. This can be addressed by predicting the actual food requirement of the crop and applying the right amount of fertilizer (or nutrients) to supply only this needed quantity. Sometimes, liming can also make some of the previously unavailable nutrients in the soil available to crops in a particular growing or cropping season indirectly by increasing the pH of the soil. Furthermore, it supplies calcium and or magnesium or both, depending on the liming material used, to crops. Liming makes the soil more suitable to crops that prefer near neutral (pH=6.0-7.0) to more than neutral soil pH (pH=7.0-8).

The study site—Balidong R & D/E laboratory—is located in Tadian, Mountain Province along the tri-boundary of barangays Kayan, Bunga, and Lubon having an elevation of 1,030 m above sea level (ASL). It is approximately 2 km away by foot WSW from the Mountain Province State Polytechnic College, College of Engineering and Technology by way of the pine forest below or South of the arena field. The field laboratory has geographical coordinates of 17 º 00' N Lat. and 120 º 48' E Long.

METHODOLOGY

Problems. The aim of the study was to answer the questions, (1) What is the extent of suitability of some identified potential fruit crops in Balidong R & D/E laboratory for extensive production based on their (crop) environmental adaptations?, and (2) What are the fertilizer and or fertilization and liming recommendations of some identified potential fruit crops using their established nutrient removals and or sufficiency levels of nutrient elements as index? Specifically, the study aimed to assess the suitability and fertilization, including liming, of pineapple, mango, and citrus for extensive production in Balidong R & D/E laboratory as these were among the identified potential fruit crops in the area.

Methods. Soil samples at plow depth (30 cm) were taken from the Balidong R & D/E laboratory following the standard procedure on soil sampling. A one-foot length La Motte soil sampling tube (saw-toothed) was used. The area was subdivided into four sampling sites and a composite sample of ten samples for each site was obtained.

The samples were air-dried at room temperature following the standard procedure on soil preparation. After one week of air-drying, the samples were analyzed of nitrate nitrogen, available phosphorus, available potassium and soil texture following the colorimetric method with the use of the LaMotte Soil Analysis Outfit and LaMotte Soil Test Kit. Soil texture determination was also carried out following another procedure

called the "roll and feel" method or field method for comparison with the LaMotte methodology and to serve as complementary analysis.

Existing land uses in each site (vegetation) was also noted for reference. In like manner, soil depth was observed in areas within each site like gullies and slope cuts from slides in correlation to observed tree growth and dominant vegetation type.

Climatic data were obtained from the Benguet State University—Philippine Atmospheric, Geophysical and Astronomical Services Administration (BSU—PAGASA), which is the nearest weather station to Balidong R & D/E laboratory (approximately 124 km away). BSU—PAGASA is located at km. 5, La Trinidad Benguet with an elevation of 1,317.4 m ASL and a geographical coordinates of 16 º 21' N Lat. and 120 º 35' E Long.

The data obtained were minimum and maximum air temperatures (ºC), relative humidity (%), and rainfall amount (mm & tenths). All data received were on daily basis; hence the average annual values were computed from computed mean monthly values in a year. On the other hand, mean annual values, which are the mean of computed average annual values from six years and six months duration, were calculated. Necessary informations were also obtained about the rainfall distribution type in the Philippines with its corresponding map called the "Climate Map of the Philippines Based on Modified Coronas Classification".

Determining the rainfall distribution type to which Balidong R & D/E laboratory belongs was made by rough plotting the coordinates of the field laboratory against the climate map of the Philippines and the geographic map of Mountain Province and the Philippines.

Potential crops in Balidong were also identified by matching the existing environmental conditions in the field laboratory with that of the environmental requirements of the crops. The suitability of some identified potential fruit crops for extensive production in Balidong was assessed by matching their specific environmental adaptations with the existing field condition in Balidong in more detail than was done in identifying the potential crops for the same site.

To better assess whether a crop is potentially suitable and or currently not suitable, suitable, and not suitable in a piece of land, a more detailed matching of the crop environmental adaptations and the land qualities and characteristics should be made. This, however, entail more research tools and equipments not to mention time. Yet, an equally reliable result can also be obtained by limiting the land qualities and characteristics to be gathered only to those environmental requirements/adaptations of the crops and utilizing the same when matching the crop environmental adaptations with the gathered data. Thus time and resources are in turn saved and maximized.

Bautista (1994) defined fruit crops according to Horticultural classification, and as was used for the purpose of this study, as crops bearing fruit that is edible, more or less fleshy botanical fruit of a perennial plant usually used in fresh form.

To assess the fertilization of some identified potential fruit crops in Balidong, their respective established rates of nutrient removals was first determined by cross-referencing available literatures followed by using these values together with the values obtained from the NPK analysis of the soil and NPK contents of commonly available fertilizers in the market to compute for their actual food requirement. Fertilization recommended rates of the crops were also determined and used to compute the predicted actual food requirement of the fruit crops.

Liming requirement was assessed using the pH preferences of the fruit crops and the texture of soil in the site. The liming material used for computations was 100% powdered limestone ($CaCO_3$).

RESULTS AND DISCUSSION

The soils at the Balidong R & D/E laboratory is generally low fertile with reference to the major plant-available nutrient elements; nitrate nitrogen, available phosphorus, and available potassium (data not shown).

Field observations during soil sampling revealed that rock outcrops or the presence of gravelly soils in lower portions of Balidong limits the suitability of the area for deep-rooted crops. Worse, clay pans seem to form in higher portions of Balidong, which might also hinder good root development for deep-rooted plants.

Areas containing rock outcrops have shallow soil depth of <2.5 cm to 5.0 cm for the average, while the rest of the areas have a depth of at least 50 cm or more.

Climatic data revealed that Balidong R & D/E laboratory and extreme western Mountain Province belong to the type 1 climate of the Philippines based on the modified coronas classification.

Extremes of mean monthly temperature were recorded in the months of June and December with 25 °C and 10.83 °C, respectively (data not shown). Mean annual temperature, on the other hand, ranges from 13.77 °C to 24.8 °C with an average annual temperature of 19.28 °C.

The computed mean average annual rainfall (total rainfall) from raw data obtained is equal to 111.81 mm while the computed average total rainfall is 1,988.35 mm (data not shown).

Lowest recorded average annual rainfall is 78.8 mm on 1997 while the highest recorded average annual rainfall is 157.45 mm the following year based on data recorded from 1993 to 1999. Moreover, the highest average monthly rainfall was recorded during the months of October (162.7 mm), August (119.6 mm), and July (117.8 mm), while the

least average monthly rainfall was recorded during the months of January (2.42 mm), February (2.66 mm), and December (5.4 mm) (data not shown).

On the other hand, the highest mean annual relative humidity is recorded both on 1993 and 1998 (84.92 %) while the lowest is on 1999 (83.5 %) and 1997 (83.83 %).

The low rainfall amount and low relative humidity recorded for the year 1999 was primarily due to incomplete data received—that is, it reflects only those data recorded from January to June.

Mean monthly relative humidity is generally higher than mean annual relative humidity with the lowest and highest mean monthly relative humidity of 80.57 % (February) and 88.33 % (August), respectively (data not shown).

After matching the environmental requirements of some crops with the results of soil properties gathered and climatic data obtained, the following crops were found to be potentially suitable in Balidong R & D/E laboratory for extensive production.

Table 1. Some potential crops in Balidong R & D/E laboratory for extensive crop production

Horticultural crop classification	Potentially suitable crops
vegetable crops	vegetable legumes, garlic, bittergourd, eggplant, soybean, carrots, green onion, pechay, squash, ginger, yam
fruit crops	citrus, pineapple, jack fruit, mango, banana
field crops	garlic, rice, sorghum, corn, ginger, yam, carrots, sweet potato, peanut, soybean
plantation crops	coffee, tea
timber or forest crops	pine tree, acacia, calliandra, cypress, leucaena or ipil-ipil, eucalyptus

Extent of Suitability of Pineapple, Mango, and Citrus. A more detailed matching of land qualities and characteristics, including climate, specific for pineapple, mango, and citrus, which are among the identified potential fruit crops in Balidong, is presented in table 2.

It should be noted that although some references mentioned that mango can grow under extremes of soil and climate conditions, economic yield might adversely be affected. Citrus, on the other hand, exhibits poor growth under extremes of soil and climate conditions (Philippine Science Encyclopedia, 1984).

Table 2. Extent of suitability of pineapple, mango, and citrus for extensive production in Balidong R & D/E field laboratory

Crop Environmental Adaptations					**On-field Environmental Conditions**	
Land and Climate Qualities	**Pineapple**	**Mango**	**Citrus**			
			Extremes	**Ideal**	**BSU-PAGASA** (16º 21'N, 120º 35'E)	**Balidong R & D/E** (17º 00'N, 120º 48'E)
Temperature	10-32 °C, 24-30 °C (ideal)	profitable between 26 °C & 28 °C	freezing and extremely high temperatures		14.19 °C-23.93 °C	16.07 °C-25.81 °C
Elevation	best grown at 150-240 m ASL; normal growth was reported at 1,555 m ASL	profitable below 600 m ASL		can be grown in the Philippines from sea level to 1,520 m ASL	1,317.4 m ASL	1,030 m ASL
Annual rainfall	best production areas have 1,000-1,500 mm (the plant is drought tolerant)	profitable in areas with type I climate		ideal in non-humid, irrigated, subtropical areas; can be grown in four types of climate in the Philippines	1,988.35 mm (Type I climate)	1,031.31 mm (Type I climate)
Soil	well-drained, pH= 3.3-6.2, grows in many soil types	profitable under well-drained deep loamy soil; pH= 6-8, optimal pH= 5.5-6	damp, wet and poorly drained soils; extremely dry and sandy soil unless irrigated	requires good soil aeration and structure, pH= 6.0	n/a	well-drained sandy clay loam to clay loam, shallow to deep soil, pH=5.5-6.0, low N & P, sufficient K

Fertilization and Liming Recommendations. During one cropping season, the crop obtains nutrients from the soil, applied manure, and fertilizer. However, plants will not take up all the available nutrients in the soil, as revealed by soil test, in one cropping season. This is also true from applied manure and fertilizer. More often, available nutrients in the soil are not enough to nourish the crop in one growing season. This is remedied with the need to apply nutrient supplements from manures and fertilizers. Thus, nutrients from soil taken up by plants during a cropping season are replenished during the succeeding cropping seasons through mineral weathering and organic matter decomposition, and applications of manure and fertilizer. In the case of applied manures and fertilizers, the farmer needs to apply the same every cropping, albeit in different amounts or rate depending on soil test results.

Nutrients are dynamic in soil. These undergo various processes rendering them unavailable to plants like leaching, volatilization, fixation (mechanical/physical, chemical, and biological), and are either carried away through eroded soils or surface water run-off.

The percentages of available nutrients and added fertilizer, which can be taken up by the plant during the growing season, are presented in table 3 (LaMotte Company, 1994).

Table 3. Percentages of available nutrients and added fertilizer which can be taken up by the plant during the growing season

Sources of : Nitrogen (N), Phosphorus (P), Potash (K)	**Percentages Obtained by Crop During One Season**		
	N	**P**	**K**
1. Soil, Available (present by soil test)	40	40	40
2. Manure (total present)	30	30	50
3. Fertilizer (available present)	60	30	50

Using table 3 above and the (rate of) nutrient removals of pineapple and citrus (table 4), one can now compute the actual plant food requirement of a crop in planning its fertilizer program. The fertilizer programs of pineapple and citrus are given below. Mango was not included because it is not suitable for extensive production in Balidong though it can be used for reforestation purposes as a means to conserve the soil.

Table 4. Nutrient removals of citrus and pineapple

Fruit Crop	Nutrient Removals Per Hectare (kg)		
Citrus (for a good yield of a mature tree, e.g. 300-500 oranges/tree or 71.4 t/ha for a planting distance of 6 x 7 m and a yield of 300 oranges): Oranges, Lemon, Tangerine, Grapefruit or Pomelo, Etc.	150	15	250
Pineapple (for 10 t fruit/ha): First fruit harvest	6	1	30
Second fruit harvest	25	8	80

Table 5. Fertilizer program for pineapple during first fruit harvest using common inorganic fertilizers

Source of Element	Kilograms N (kg/ha)		Kilograms P (kg/ha)		Kilograms K (kg/ha)	
	Present	Available to crop	Present	Available to crop	Present	Available to crop
Soil, available (by test)	16 (14 lb/acre)	6.4	11 (10 lb/acre)	4.4	112 (100 lb/acre)	44.8
Inorganic Fertilizer, available	n/a	n/a	n/a	n/a	n/a	n/a
Totals available to crop		6.4		4.4		44.8
Totals needed to produce 10 t fruit/ha (10,000-20,000 plants/ha)		6		1		30

For the purpose of simple computation, the $NP_2O_5K_2O$ values of inorganic fertilizer materials were not corrected to NPK values. Except for N, both the P_2O_5 and K_2O values of the fertilizer material should be converted to its P and K values by multiplying the P_2O_5 - K_2O values by 0.436 and 0.83, respectively, if desired. The reason for this is that, both the LaMotte Soil Test results and the nutrient removals given by Finck (1982) are in P and K values and not in P_2O_5 - K_2O values.

Table 6. Fertilizer program for pineapple during second (or last) fruit harvest using common inorganic fertilizers

Source of Element	Kilograms N (kg/ha)		Kilograms P (kg/ha)		Kilograms K (kg/ha)	
	Present	Available to crop	Present	Available to crop	Present	Available to crop
Soil, available (by test)	16 (14 lb/acre)	6.4	11 (10 lb/acre)	4.4	112 (100 lb/acre)	44.8
Inorganic Fertilizer, available						
100 kg 14-14-14	14	8.4	14	4.2	14	7
100 kg 20-0-0	20	12	0	0	0	0
100 kg 0-0-60	0	0	0	0	60	30
Totals available to crop		26.8		8.6		81.8
Totals needed to produce 10 t fruit/ha (10,000-20,000 plants/ha)		25		8		80

Table 7. Fertilizer program for citrus using common inorganic fertilizers

Source of Element	Kilograms N (kg/ha)		Kilograms P (kg/ha)		Kilograms K (kg/ha)	
	Present	Available to crop	Present	Available to crop	Present	Available to crop
Soil, available (by test)	16 (14 lb/acre)	6.4	11 (10 lb/acre)	4.4	112 (100 lb/acre)	44.8
Inorganic Fertilizer, available						
265 kg 14-14-14	37.1	22.26	37.1	11.13	37.1	18.55
1020 kg 20-0-0	204	122.4	0	0	0	0
635 kg 0-0-60	0	0	0	0	381	190.5
Totals available to crop		151.06		15.53		253.85
Totals needed to produce 300-500 oranges per mature tree for a planting distance of 6 x 7 m		150		15		250

It is advised that table 7 should be used only for citrus crops with large fruits like oranges and should not be used as guide for small-size fruit-bearing citrus like calamansi. However, Bondad, et al. (eds., 1984) stated that nutritional requirement of citrus is not yet well-established, hence the rates of fertilizer application cannot be ascertained. It varies from place to place. Yet, leaf and soil analyses are needed to avoid guess work (Ibid.).

The nutrient removals of pineapple and citrus presented in table 4 were those mentioned by Finck (1982).

Since the soil has a pH of 5.5-6.0, and pineapple and citrus prefer a pH of 3.3-6.0 and 6.0, respectively, liming is no longer recommended. Albeit, maintenance liming may be advisable in the case of citrus to maintain a pH of 6.0, it is not necessary.

CONCLUSION

1.) Both pineapple and citrus were found to be suitable in Balidong R & D/E laboratory based on their environmental preferences and existing conditions in the area under consideration.
2.) For the first harvest, pineapple need not be fertilized. But, fertilization is needed for good yield during the second harvest. Liming is not necessary.

RECOMMENDATIONS

1.) Good varieties of pineapple and citrus should be selected considering the existing condition in Balidong for better and higher assurance that the crop will grow well under optimum crop management for extensive production in the said field laboratory.
2.) When considering maintenance liming for citrus (or even pineapple), the reference pH for computing the right amount of lime should be 6.0. The soil texture should also be considered.

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