The Essential Nutrients Availability for Sustainable Production of Soybeans (*Glycine Max* [L.] Merril) in Garba Chede, Maihula District Bali Local Government of Taraba State, Nigeria

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Abstract: - **The availability of essential nutrient elements in soil of an area is a pointer to the fertility capacity in supporting agricultural productivity in sustainable manner. Macro and micro nutrients governs the fertility of soil that controlled crop growth and yield, the study was carried out to determine the availability of these essential nutrient elements as N P K Mg SCa Na Zn Mn Cu Fe in soil of Garba chede,Maihula District of Bali sufficient for production of Soy beans. Field survey was conducted where soil samples (0 – 15cm) were collected and analyzed for the levels of these macro and micro elements in the soil using the standard laboratory procedures.The Organic carbon, Soil pH, and Phosphorus levels in the soils were within low to medium (0.53 – 1.32, 4.6 -6.7 and 5.12 -27.21) respectively. The concentration of K (170 mg/kg – 459 mg/kg) and Mg (0.4 cmol/kg – 3.26 cmol/kg) analyzed in the soils are sufficiently higher while CEC and Ca contents of the soil are low (6.4 – 15.2 and 1.17 – 1.98).The levels of essential micro nutrient elements determined in the soils under studied were higher. The essential nutrient elements analyzed in the soil can support soybean production only few of these elements that indicated low availability needs to be supplied with organic manure and inorganic fertilizer in a balanced form to increase the yield of soybeans in Bali.**

Key words: **Evaluation, essential nutrients, level, Soybeans**

I. INTRODUCTION

Soybean (*Glycine max* [L] *merril*) is a family of papilionaceae (IITA, 1993). This crop is believed to have been originated from eastern Asia in North and Central China. The crop plant requires a medium loam soil with pH range of 6.0 – 6.5 are suitable for the production of soybean. (Koivisto, 2003; Adetiloye et al, 2000). The crop (Soybeans) is rich and high in protein contains than all the legumes cultivated in the world and it serve as the source of vegetable oil and protein for food and industrial application (FAO, 1989, Endress, 2001).

The availability of plant nutrient in soil at the right and balance amount is essential for production of crops. Certain crop like Soybeans required most of these essential nutrients in balanced amount for the growth and development leading to higher yield. For example, according to Bender et al, 2015 in their research work, reported that soybeans required 245 mg/ha, 63 mg/ha and 170 mg/ha of N, P205 and K2O while Sulphur; Zinc and boron are needed at 17, 4.8 and4. 6 respectively for its production maximally. Certain factors may be responsible for insufficient availability of plant nutrient elements in soil of an area. For example, when Nitrogen is exposed to certain temperature as a result of bush burning by fire, N is lost through volatilization. (Neil et al 2006). Temperature range of 300^{oc} to 400^{oc} about 75% to 100% of Nitrogen is lost while 200^{oc} to 300^{oc}, 50% of N is lost and below 200^{oc} only a small amount of the plant nutrient element Nitrogen is lost (Neil et al 2006).

Characterization of soil in relation to evaluation of the fertility status of soil of an area is an important aspect if crop production is to remain in a sustainable productivity. Nitrogen, Phosphorus, potassium and sulphur are essential plant nutrients in the soil that control the fertility and yield of crop (Singh and Mishra, 2012). Due to imbalance, inadequate fertilizers uses and low input of other material lead to decreased output in terms of productive capacity of the soil. Soil testing assess the current fertility status and provides information regarding nutrient availability in soils which forms the basis for the fertilizer recommendations for maximizing crop yields and to maintain the optimum fertility in soil year after year. (Singh *et al*, 2018). The differences in nutrient supply is a natural phenomenon and some of them may be sufficient where others deficient. Stagnation in crop productivity cannot be enhanced without proper use of macro and micro nutrient fertilizers to overcome the existing imbalance/deficiency (Singh and Mishra, 2012).

Low level of plant nutrients in the soil is a major constrain to crop production in sub- Saharan Africa as a result of soil fertility decline and loss of top soil through erosion (Shapiro and Sanders, 1998). Soil fertility and nutrient management is one of the important factors that have a direct impact on crop yield and quality. Irrespective of the size of your field or plots, supplying plant with the right amount of essential nutrients in balance form at the right time is a key to a successful crop production enterprise (Ajay 2018). Therefore, monitory of the essential soil nutrient levels through soil testing is needed as a first step in crop production practices.

Soil fertility is a dynamic natural property that can change through the impact of natural and human derived factors (Awanish*et al*,.2012) the use of chemical fertilizers inadequately with cultural practices, rapidly depletes the quality of soil. Soil fertility is an important factor that determines the growth of plant (Singh et al., 2018) .Having detailed knowledge about soil fertility is a prerequisite for assessing the long-term impact of intensive crop production technologies on soils of in the study area. The main goal in managing soil fertility is to enhance adequate supply of essential mineral nutrients for optimum crop growth and development. The sustainable productivity of a soil mainly depends upon it ability to supply essential nutrients to the growing plants. However, due to variation in the fertility of the soil throughout the growing season each year which brought about decrease in quantity and availability of nutrient elements by application of chemical fertilizers, manure, compost, mulch, high temperature as a result of bush burning and leaching. Therefore, determination of the fertility status of soil in an area or region is essential in the context of sustainable agriculture. Soil testing reveals the adequate and inadequate nutrients availability in the soil which form the basis for fertilizers recommendation for increasing crop yield especially Soybean and maintained the fertility of soil optimally year after year. (Singh *et al.,* 2018) The success of crop production depends largely on the macro and micro nutrients status of soils which are essential resources for agricultural production. However, conservation and management of these nutrient elements in the soil is necessary if Agriculture is to serve as the major drive of our economic development (Thien and Graveel, 1997). The level of plant nutrients in the soil which is the determinants of its fertility for farming practices must be handled comprehensively so as to solve the soil fertility problem which is a key to food security and to attend a significant number of millennium development goal (Verchot*et al,* 2007).

In many areas, low sesame yield is partly attributed to improper agronomic practices such as inappropriate fertilizer levels, dependence on lower yielding cultivars and poor planting systems (FAO, 1998). It has been shown that increased seed yields can be enhanced significantly by improving these management practices; for example, yield of up to 2 250 kg/ha is possible with improved agronomic practices in India and 2 000 kg/ha in USA, Central America and Venezuela under commercial production (Nantongo*et al*., 2000). These constraints to soybeans production need to be addressed in order to increase yields per hectare. Similarly, in order to achieve high yield of Soybean by farmers, both organic and inorganic fertilizers be made available depending on the quantity of the essential plant nutrient elements in the soil which play a vital role in increasing crop yield. According to Talaka et al, 2013 reported two varieties of Soybeans (Tax 1448 -2E and Tax 1904) performs better on soil of the study area However, no record of the nutrient elements requirement for growth, development and yield of soybeans in Bali Local Government Area of Taraba State. Therefore, this study isaimed at determining the availability of essential nutrient elements in soils of the study area sufficient for the production of Soy beans in satisfactory level for food security with a specific objectives of determining the concentrationsofthe essential nutrient elements N P K Mg Na Ca S Zn Cu Mn Fe and OC in the soil for soybeans production in Garba chede, Maihula District of Bali. Does the mean concentration of the essential nutrient elements in soils of the two locations statistically significant difference from each other?

II. MATERIALS AND METHODS

Location of the study area:

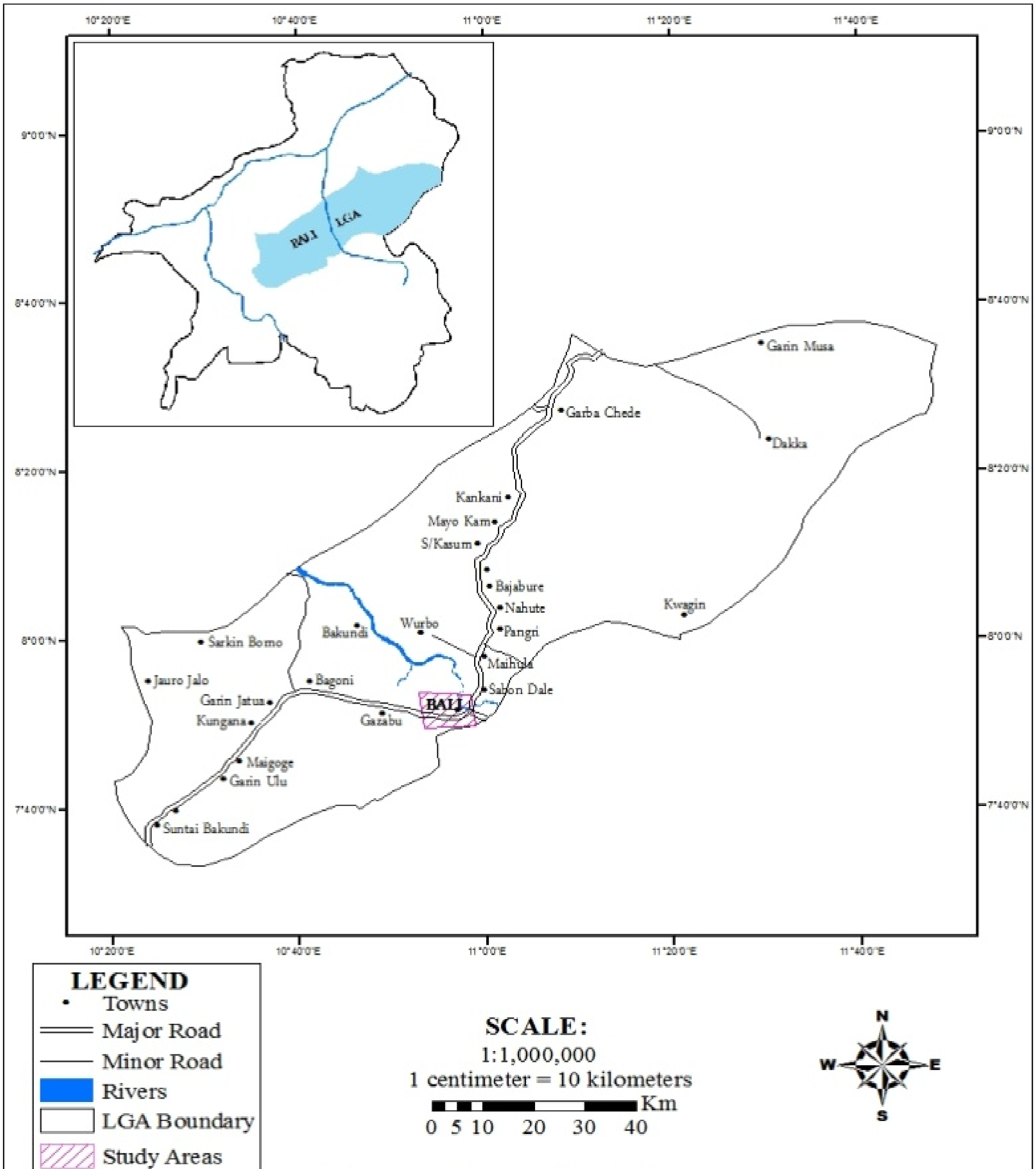
The study was carried out in Garba chede, Maihula District of Bali local Government Area. (figure 1). Bali is located in central part of Taraba State between latitude 7^o46 N and 7^o54 N of the equator and longitude 10 $^o30$ E and 11^o 00 E of the prime meridian (Topographic sheet, 1968). It is found in dry guinea savannah. It is the largest local Government in Taraba State, with an estimated land area of 11,540 km^2. The Soil is dominantly of ferruginous tropical type that lies on Sandy parent materials (Dada et al, 2006). It has some mountains like Gazabu, Dakka, Maihula, Bagoni, among others. Based on the results of the 2006 National Population Census, Bali local Government had a population of about 211,024 persons (NPC, 2006). It has a tropical climate marked by two seasons; dry and rainy seasons. The rainy season starts around April and ends November occasionally, with 1350 – 1500mm rainfall annually. The dry season is from December to March. The major ethnic groups in the area include; Jibawa, Tiv, Chamba, Fulani, Hausa, Itchen etc. The major occupation of the inhabitants is farming, fishing and nomadism. In addition, Public servants, traders and artisans also inhabit the area.

Soil Sampling and sample analysis

A field survey was carried out during the beginning of raining season in the area between April and May, where soil samples were collected from two locations of the study area (Garba chede and Maihula). In each of the location, about Ten (10) soil samples were collected diagonally in a quadrants using stratified method of sampling. A total of (20) soil samples were collected with soil auger at the depth of (0 – 15 cm) soil surface between April and May, 2019. The soil samples were air dried and pass through 2 mm sieve and were analyzed for theirs nutrient levels at Federal University of Technology Akure, Nigeria. PH (2:5 Soil water suspension), available N was determine by Alkaline KMnO method Subbiah and Asija (1956), available P by Spectrophotometer Bray and Kurtz (1945), available K using Flame photometer by CaCl extraction 2 method Tabatabai (1996) and were evaluated by Walkley and Black (1934) .

Statistical analysis

Data were subjected to normality and homogeneity of variance test on IBM SPSS using one way analysis of variance (ANOVA) to test the significance difference in concentration of the essential nutrient elements in soils of the two locations of the study area. Least significant difference was used to determine the mean difference in concentration of nutrient elements in the 20 soil samples collected from the two locations of the area studied and the (LSD) is significant at ($P < 0.01$)



MAP OF BALI LGA SHOWING STUDY AREAS

III. RESULTS

Table 1 shows the essential macro nutrient elements concentration in soil of Garba chede in Bali Local Government Area.

Table. 1

Samples	N Kg/ha	P kg/ha	K kg/ha	S mg/kg	C %	Mg cmol/kg	Ca Cmol/kg	Na cmol/kg	CEC cmol/kg
1	300	21.93	330	9.5	1.23	1.05	2.71	0.15	7.2
2	400	6.46	430	8.1	1.32	0.84	2.34	0.15	7.0
3	320	5.91	280	9.4	0.85	0.96	2.71	0.17	6.6
4	200	9.41	370	7.9	0.75	1.18	3.64	0.22	9.2
5	600	6.46	220	8.6	0.95	2.92	6.67	0.17	12.3
6	80	22.54	290	9.5	0.53	3.26	12.4	0.17	15.1
7	300	6.78	190	9.2	0.65	3.22	11.35	0.15	13.7
8	200	6.43	240	8.9	0.74	1.87	5.41	0.15	11.8
9	200	10.58	230	9.1	0.84	1.3	3.96	0.2	7.4
10	400	8.46	210	8.7	0.76	0.4	1.17	0.18	6.7

Table 2 indicates the amount of the nutrient elements present in soil of Maihula in Bali Local Government Area.

Table.2

Sample s	N Kg/ha	P kg/ha	K kg/ha	S mg/kg	C %	Mg cmol/kg	Ca cmol/kg	Na cmol/kg	CEC cmol/kg
1	135	18.12	340	7.8	0.68	1.88	5.41	0.2	8.4
2	200	20.23	220	9.1	0.74	1.1	2.8	0.16	8.2
3	115	27.21	395	7.7	0.66	1.18	2.98	0.18	6.6
4	225	5.12	170	8.6	0.74	2.14	6.67	0.16	9.4
5	85	18.28	420	6.9	0.58	1.17	3.61	0.16	11.8
6	124	18.00	320	7.1	0.57	1.68	3.87	0.13	7.6
7	250	19.11	210	8.5	0.62	0.8	1.98	0.17	12.6
8	105	25.10	384	9.3	0.65	2.65	8.21	0.16	6.4
9	214	5.31	190	8.5	0.75	2.56	2.72	0.18	6.8
10	810	18.13	450	8.2	0.79	2.9	6.62	0.28	12.2

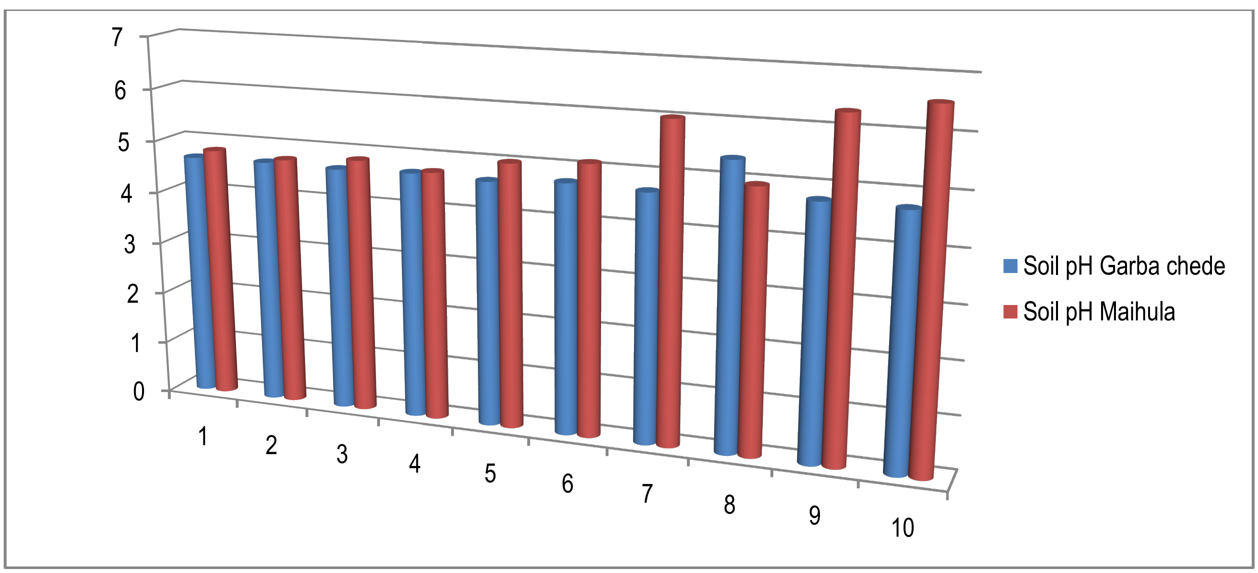


Figure 2: graphical representation of the soil pH level of Garba chede, Maihula soils in Bali local Government Area.

IV. DISCUSSIONS

Soil pH The essential macronutrient elements in the soil

The pH values of soils in Garba chede, Maihula village ranged from 4.6 to 6.7 as indicated in (figure 2). According to the categorization pH values by Landon (1991), that when the value is : > 8.5 = very high, 7.0 –8.5 = high, 5.5 –7.0 = medium and < 5.5 = low. In view of this, all soils in the study had low to medium pH. The pH of most of the soils in the study areas were within the satisfactory range for Soybeans production which is 5.5 –7.0, as reported by Ashri (1998). The acidic nature of the soils could probably be due to the acidic nature of the parent materials and somehow extensive weathering of the soils and leaching.

Cation exchange capacity (CEC)

The Cation Exchange Capacity (CEC) soil in Garba chede, Maihula ranged from 6.6 to15.2 cmol/kg and 6.4 to12.2 cmol/kg respectively as indicated in (Table 1 and 2). According to Landon (1991), all soils in the study had low CEC values. It appears that the low CEC levels in all soils may be due to the influence of soil texture and the type of clay minerals and the soil organic matter contents. Clayey soils are reported to have higher CEC than Sandy soils mainly due to charges resulting from isormorphous substitution (Rhoades, 1982)

Calcium

The tested values of calcium in soils of the study area as indicated in table 1 and 2, ranged from 1.17 to 12.4 cmol(+)/kg and 1.98 to 8.21 cmol/kg for both Garba chede and Maihula village of the study area. Landon (1991) categorized levels of exchangeable calcium and indicated that < 4 cmol (+)/kg is considered as low and > 10 cmol /kg is considered as high. This implies that all the ten (10) soil samples tested for Maihula are low in calcium supply to plants while in Garba chede only two soil samples are considered high in calcium, the remaining eight are low in calcium contents between 4 and 10 cmol(+)/kg. The low calcium content in the soils may be due to the low pH values. Soils with pH 5.0 or lower are likely to be deficient in calcium (Chapman, 1973).

Potassium

The results of the level of potassium in soils of the study area are indicated in Table 1 and 2. The exchangeable K^+ varies from 190 to 420 mg/kg in soils of Garba chede and 170 to 450 mg/kg K^2O in Maihula soils. Based on the research work of Bender et al,. 2015 that the required level of K^2O in soil for maximum yield of Soybeans is 170 mg/kg. Therefore, K^2O requirement in soils of the study area is sufficient for the growth, development and yield of Soybean.

Magnesium

The data for exchangeable magnesium are presented in Table 1 and 2. The exchangeable Mg ranged from 0.4 to 3.26 cmol (+)/kg in Garba chede soils and 0.8 to 2.56 cmol/kg in soils of Maihula. Landon (1991), reported that soils having < 0.5 cmol (+)/kg are magnesium deficient and soils having > 4.0 cmol (+)/kg had high magnesium content. According to Landon (1991), all soils in the study area are of adequate magnesium levels.

Available phosphorus

The ranges for P level in soil of the study area are shown in Table 1 and 2. The available P in Garba chede soils ranged from 6.43 to 22.54 mg/kg and 5.12 to 27.21 mg/kg P_2O_5 amount in maihula soils. Landon (1991) categorized extractable Bray-I-P as; > 50 mg/kg as high, 15 –50 mg/kg as medium and < 15 mg/kg as low. Based on this classification, ten soil samples out of 20 had medium available P; the rest had low P contents. The low P content in most of the soils studied could be due to the low pH values in many soils in the study area (figure 2). According to Tisdale *et al.* (1993), P availability is low in acid soils as well as in calcareous soils. In most cases, pH of 6 –7 is optimum for adequate P availability in soils. It is therefore evident that, P application will be necessary in those soils in order to increase and sustain soybeans production as it's requires 63 mg/ha P in soil for maximum yield. (Bender et al, 2015).

Total nitrogen

The values for total N as presented in Table 1 and 2 for soils in Garba chede and Maihula ranged from 80 kg/ha – 600 kg/ha and 85 kg/ha to 810 kg/ha respectively. According to Awanish*et al* (2014), suggested that soil with < 280 kg/ha is low, 280 kg/ha to 560 kg/ha is medium and > 560 kg/ha is high. Based on these rating, 11 out of the 20 soil samples tend to be low in total N while 8 of the soil samples were in medium level with only 1 showing high as indicated in table 1 and 2. The low availability of N in some soils of the study area may be as a result of bush burning by fire that resulted in the volatilization of N at higher temperature 200^{oc} to 300^{oc} can bring about the reduction of N in soil.(Eldiabani et al 2018). The nitrogen requirement for the production of soybeans according to Bender et al, (2015) is 245 mg/ha, therefore, soil in the study area can support the production of soybeans only few areas that indicated low availability of this nutrient element can be supplied with nitrogen fertilizers to increase the yield of the crop.

Organic carbon

The level of the organic carbon in soils of Garba chede and Maihula ranged from 0.53 to 1.32% and 0.58 to 0.79 % as presented in Table 1and 2. Baize (1993), categorized organic carbon contents of < 0.60% as very low, 0.60 –1.25% as low and (1.26 –2.50%) as medium. Based on these categories, soils in this study ranged from very low to medium organic carbon content (Table 1 and 2). These levels are similar to those from other studies done by Budotela (1995) in selected grape producing areas of Dodoma region (0.68% OC). Also a very low OC content (0.65%) was reported by Letayo (2001) in millet and groundnut soils of some areas from Dodoma region. Thus, many soils in the study area areseemed to be low in organic carbon

Essential micro nutrient elements in soil of the study area

The essential micro nutrient elements are needed in small quantity by plant for growth and yield.

The mean values of Iron, Copper, Manganese and Zinc in soil of Garba chede are 6033.6 mg/kg 3.26 mg/kg, 230.4 mg/kg and 53.58 mg/kg respectively while that of Maihula are 3681.8 mg/kg, 7.28 mg/kg, 302.4 mg/kg and 23.72 mg/kg respectively. All the micro nutrient elements analyzed in soil of the study area are sufficiently available to support soybean production. The essential micro nutrient elements concentration in soil of the study area is higher than the critical values as suggested by Awanish*et al* 2014; Tandon 1995; Tisdale *et a*l. (1993) and Landon (1991) for 1 mg/kg and 4.5 mg/kg of Zn, Cu, Mn and Fe.

V. CONCLUSIONS

Higher yield through improved management are fundamental to lowering the cost of production and generating higher profit. Maximum yield is possible when the essential plant nutrient requirement is met and the environmental stress is limited. Any restriction in root growth, decline in photosynthesis caused by diseases or serious nutrient shortage can prevent soybeans from achieving higher yield. A basic knowledge of what nutrients do and how much to apply is part of an important management program for achieving higher yielding soybeans crop. Therefore, in conclusion base on the results obtained from this study that the major essential nutrient elements N P Ca and Organic carbon were deficient in soil of the study area for soy bean production

VI. RECOMMENDATIONS

1. N, P, S and Ca must be applied to the rates of 46 kg/ha, 45 kg/ha, 20 kg/ha and 25 kg/ha, respectively, in order to increase the yields of soybeans in Garba chede, Maihula district of Bali.
2. The findings of this study may not cut across other crops. It would, therefore, be rational to extend this study to cover other crops.

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