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Evaluation of Nutrient Content in Soybean Growing Areas of Kohima and Dimapur Districts of Nagaland

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Abstract: Nutrient contents in soybean growing areas of Kohima and Dimapur districts of Nagaland were studied by conducting survey, collection of seed and soil samples from various fields in different villages of Kohima and Dimapur. Among the soil samples collected, the highest available of N was recorded in Rusoma soil under Kohima district of 455.53 kg ha^{-1} whereas the lowest was in New Chumukedima under Dimapur district with 221.52 kg ha^{-1}. The available P_2O_5 and K_2O were higher in Bade soil with 24.53 and 194.13 kg ha^{-1} while the lowest values were observed in Tsiesema under Kohima district with 5.82 and 67.20 kg ha^{-1}, respectively. In terms of soluble sulphur, the highest solubles was recorded in Diezephe soil under Dimapur district (1.5 g g^{-1}) while the lowest was observed in Kezoma under Kohima district with 0.27 g g^{-1} The percentage of oil and protein content of soybean seed were recorded highest in Dihoma and Nerhema soils (19.38% and 39.56%, respectively), while the lower values were recorded in Murise and Rusoma soils (16.88% and 32.56%, respectively).

Key words: *Survey, Soil status, Nitrogen, Phosphorus, Potassium, Oil, Protein*

Introduction

Soybean (*Glycine max* L. Merril) is a leguminous crop and it belongs to the family Leguminosae. It is called as vegetarian meat and wonder crop because it is a rich and cheap source of protein and fat (Protein 40-42%, oil 18-20%). Soybean has a very good adaptability towards a wide range of soils and climate. The north eastern region of India, including Nagaland, is an important soybean producing belt. It is grown on slopes, fallow jhum land, terraces and plains. In Nagaland, it is primarily utilized as a fermented product as well as a pulse crop. Despite of its popularity among the people and usage in various food items, there is less priority for cultivation in large scale and less importance has been given for commercial production. Cultivation can been found in all the districts and in almost all the villages but majority of the production is primarily for domestic home consumption only.

Study of the various physico-chemical conditions in which the tribal cultivators are growing soybean is required to understand the various cultivation patterns being followed and to suggest measures for improvement if required. The agro climatic conditions prevailing in Nagaland have been found to be highly favourable for soybean cultivation. Soil contains various nutrient sources that enables the plants to grow but these sources are exhaustible sources. Hence, knowledge and information's about the physico-chemical properties of the soil is necessary to obtain optimum returns from the field and for proper nutrient management. The pysico-chemical status of soils of various regions in Nagaland still remains to be critically evaluated and there is wide spread lack of basic information's and this becomes a hurdle in application of modern agricultural technologies, new farming practices and application of nutrient sources. The application and consumption of fertilizers in north east region of India in general and Nagaland in particular is still very low compared to the national average. Nagaland consumed 4.8 kg/ha of NPK and NEH region consumed 51.75 kg/ha of NPK, while the national average stood at 128.34 kg/ha of NPK (Anonymous. 2013). Hence, a study of the various field conditions becomes necessary to determine the various local situations.

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Materials and Methods

Study area

The investigation "Survey of Soybean growing areas of Kohima and Dimapur districts of Nagaland" consisted of survey, collection of seed and soil samples from various farmers' fields in different villages of Kohima and Dimapur. The soils were mixed thoroughly and about 500 gm were retained from each field by following the quartering process. About 100 gm seed samples were collected from each field for analysis purpose. Kohima district is situated at an elevation of 1444 above mean sea level (MSL). The district has unique hill ranges which break into wide chaos and spurs and ridges with an elevation ranging from 600 MSL to 3048 MSL at Japfü Peak. It is situated at 25° 31' 03" N - 26° 00' 32" N and 93° 58' 58" E - 94° 15' 24" E. Dimapur district is located in the foothills of the Patkai mountain ranges. It is situated at 25° 58' 24.19" N - 25° 39' 49.05" N and 93° 59' 20.89" E - 93° 37' 18.43" E and the elevation ranges from 136 to 657 mts above msl. Surface soil samples (0-15)cm were collected from the different fields at various locations. The samples were air dried, finely grounded and sieved through 2 mm sieve and then kept in polythene bags with proper labeling for analysis.

Determination of soil physical and chemical properties

Organic carbon was estimated by rapid titration method of Walkey and Blake as described by (Jackson 1973). The pH of the soil was determined in soil water suspension using glass electrode pH. The electrical conductivity (EC) of the soil samples was determined by taking supernatant solution of soil water (1:2) suspension using conductivity meter. The cation exchange capacity (CEC) of the soils was determined after leaching the soil with neutral normal NH_4OAC (Chapman 1965). Exchangeable Ca and Mg were determined in ammonium acetate extracts of soils by direct titration with Ethylenediaminetetraacetic acid (EDTA). Available N, P K and S were estimated by alkaline potassium permanganate method given by Subbiah and Asija (1956), Bray and Kurtz (1945), ammonium acetate (pH 7) described by (Jackson 1973) and Turbidemetric method as detailed by (Chesnin and Yien 1950), respectively. Sand, silt and clay percentage were determined by mechanical analysis using the principle of Stokes law. N in seeds was estimated by modified Kjeldhal method. Phosphorous was determined by vanado-molybdate yellow colour method as outlined by (Jackson 1973). Potassium was determined by flame photometry as described by Chapman and Pratt (1961) and S was determined by Turbidemetric method as detailed by Tabatabai and Bremner (1970). Seed samples of 5g each were taken for extraction of oil. The oil content was determined using a soxhlet extraction unit as per method described by Association of Official Agricultural Chemists (AOAC).The seed protein content was calculated by multiplying % N in seed with factor 6.25.

Results and Discussion

Physical characteristics of the soils in soybean growing areas

It is evident from the Table 1 that all the soil samples collected are high in sand content ranging between 46.0 to 80.0%. The lowest and highest sand content was recorded in the Murise and Diezephe soils under Dimapur district with 46.0 and 80.0%, respectively. In general, the sand content tended to decrease with an increase in altitude. This is due to the fact that water holding capacity (WHC) of sand is low which results in higher rate of leaching by heavy rainfall at higher altitudes.

As apparent from (Table 1), the silt content of all the soil samples collected are low ranging between 4.0 to 21.0%. The lowest silt content was recorded in the Seithekiema soil under Dimapur district whereas the highest was in Murise soil under Kohima district.

The clay content of the soil samples collected from different locations ranges between 8.0 to 38.0%. The lowest clay content was recorded in the Diezephe soil under Dimapur district whereas the highest in Tsiesema soil under Kohima district. The result is in conformity with the findings by (Zende 1987) who reported that the clay content ranges between 4 to 35% in five districts of Nagaland.

Table 1. Physical characteristics of soils collected from different locations in Nagaland

Sr. No.	Location	District	Altitude in m above msl	Sand	Silt	Clay	Textural class
					(%)		
1	Kezoma	Kohima	1531	48.20	14.20	37.60	sandy clay
2	Tsiesema	Kohima	1470	51.60	10.40	38.00	sandy clay
3	Nerhema	Kohima	1390	51.00	14.00	35.00	sandy clay loam
4	Kijumetouma	Kohima	1134	50.00	12.80	37.20	sandy clay
5	Kidima	Kohima	1646	53.20	9.60	37.20	sandy clay
6	Dihoma	Kohima	1357	49.20	13.00	37.80	sandy clay
7	Rusoma	Kohima	1469	50.20	12.00	37.80	sandy clay
8	Murise	Dimapur	171	46.00	21.00	33.00	sandy clay loam
9	Tsithrongse	Dimapur	180	59.40	11.20	29.40	sandy clay loam
10	Seithekiema	Dimapur	190	76.00	4.00	20.00	sandy loam
11	Diezephe	Dimapur	140	80.00	12.00	8.00	sandy loam
12	Bade	Dimapur	162	60.60	10.20	29.20	sandy clay loam
13	New Chumukedima	Dimapur	221	60.40	11.80	27.80	sandy clay loam

Chemical characteristics of the soils in soybean growing areas

It is evident from the Table 2 that all the soils samples collected are slightly acidic in nature with pH ranged between 4.90 to 6.25. Among the locations, the maximum pH was recorded in New Chumukedima under Dimapur district whereas the minimum was recorded in Kijumetouma under Kohima district. In general, the acidity of the soil tended to increase with the increase in altitude. This is due to the higher rate of leaching as a result of heavy rainfall at higher altitudes. The results were also in accordance with the findings by several workers (Chakravorty and Chakravarti1980; Zende 1987; Kumar and Rao 1990) reporting similar findings for Eastern Himalayan region.

The organic carbon content also increased with the increase in altitude of the study locations (Table 2). This is probably due to the fact that the gradual change in temperature and moisture favours the formation of humus like substances at faster rate in higher altitudes in comparison to lower altitudes. Among the locations, the maximum organic carbon was recorded in Kijumetouma of 2.55% under Kohima district whereas the minimum was recorded in Tsithrongse of 0.98% under Dimapur district. The results were also in conformity with the findings by several workers (Chakravorty and Chakravarti 1980; Zende 1987; Kumar and Rao 1990) reported that the organic carbon of the soils ranged between 0.68 to 2.05% in the Eastern Himalayan region.

The EC of the soil samples collected from different locations ranges between 0.04 to 1.16 dSm^{-1} (Table 2). The lowest EC was recorded in the New Chumukedima soil under Dimapur district whereas the highest in Nerhema soil under Kohima district. The result is in accordance with the findings of Misra and Saithantuaanga (2000) who reported that the EC ranges between 0.07 and 0.53 dSm^{-1} in the soils of Mizoram.

The cation exchange capacity (CEC) of the soil samples collected from different locations ranges between 5.00 to 26.60 $cmol(P^{+})kg^{-1}$ (Table 2). The lowest CEC was recorded in the Murise soil under Dimapur district whereas the highest in Kijumetouma soil under Kohima district. In general, the CEC of the soil increases with the increase in altitude. This may be due to low molecular weight of humus and intensive formation of new humus. The results were also in accordance with the findings of (Chenithung *et al.* 2014) who reported that the CEC of the soils ranged between 7.13 and 13.13 $cmol(P^{+})kg^{-1}$ in the cultivated land use systems in Wokha district of Nagaland.

Exchangeable Ca and Mg

The exchangeable Ca of the soil samples varied from location to location (Table 2). Among the locations, the highest and lowest exchangeable Ca in the soil was recorded in Nerhema and Rusoma soils with 9.60 meq/100gm and 2.20 meq/100gm, respectively under Kohima District. The result is conformity with the findings by Kumar and Rao (1990) who reported that the exchangeable Ca of the soils in Manipur ranges between 0.60 and 10.40 meq/100gm

The exchangeable Mg of the soil samples varied with location (Table 2). The highest exchangeable Mg was recorded in Dihoma soil under Dimapur district of 6.40 meq/100gm while the lowest was in Tsiesema of Kohima district and Tsithrongse of Dimapur district with 2.80 meq/100gm. The result is in accordance with the findings by Kumar and Rao (1990) who reported that the exchangeable Mg of the soils in Manipur ranges between 1.70 and 9.50 meq/100gm.

Table 2. Chemical characteristics of soils collected from different locations in Nagaland

Sr. No.	Location	District	Altitude in m above msl	pH	OC (%)	EC (dSm^{-1})	CEC (cmol (p+ kg^{-1})	Available nutrient in the soils: Ca (meq/ 100gm)	Mg (meq/ 100gm)	N ($kg\,ha^{-1}$)	P ($kg\,ha^{-1}$)	K ($kg\,ha^{-1}$)	S ($\mu g\,g^{-1}$)
1	Kezoma	Kohima	1531	6.03	2.18	0.13	15.40	8.80	3.40	386.55	8.13	156.60	0.27
2	Tsiesema	Kohima	1470	5.45	2.28	0.62	18.20	8.40	2.80	437.04	5.82	67.20	0.28
3	Nerhema	Kohima	1390	5.21	2.40	1.66	13.60	9.60	5.20	405.46	10.48	162.40	0.30
4	Kijumetouma	Kohima	1134	4.90	2.55	0.06	26.60	6.80	4.80	411.01	11.06	78.40	0.67
5	Kidima	Kohima	1646	6.01	2.40	0.15	12.00	8.60	5.60	448.58	8.82	184.00	0.33
6	Dihoma	Kohima	1357	5.11	1.45	0.10	10.80	6.60	6.40	449.94	8.59	167.20	0.34
7	Rusoma	Kohima	1469	5.70	1.10	0.32	12.20	2.20	3.10	455.53	10.12	123.30	0.26
8	Murise	Dimapur	171	6.10	1.65	0.17	5.00	6.80	3.60	229.70	22.02	184.80	0.24
9	Tsithrongse	Dimapur	180	6.05	0.98	0.30	13.00	8.20	2.80	229.88	28.50	179.20	1.15
10	Seithekiema	Dimapur	190	5.70	2.05	0.36	9.00	7.80	5.80	239.34	21.99	184.80	1.37
11	Diezephe	Dimapur	140	6.10	1.50	0.14	7.00	6.00	5.60	253.97	23.54	187.60	1.50
12	Bade	Dimapur	162	6.06	1.12	0.13	8.20	3.20	5.40	268.61	24.53	194.13	1.00
13	New Chumukedima	Dimapur	221	6.25	1.53	0.04	7.00	8.20	5.20	221.52	19.79	156.68	1.40

Available N, P, K and S in soil

The available N also varied with location (Table 2). The highest available N in the soil was recorded in Rusoma soils of Kohima district of 455.53 kg ha^{-1} while the lowest was in New Chumukedima under Dimapur district with 221.52 kg ha^{-1}. The results are in conformity with the findings of Chenithung *et al.* (2014) who reported that the available nitrogen of the soils ranged between 290.60 and 386.70 kg ha^{-1} in the cultivated land use systems in Wokha district of Nagaland.

The available P_2O_5 was medium to high with an average ranging between 5.82 to 24.53 kg ha^{-1} (Table 2). The highest available P_2O_5 in the soil was recorded in Bade soil under Dimapur district of 24.53 kg ha^{-1} while the lowest was in Tsiesema under Kohima district with 5.8 kg ha^{-1}.

The available K_2O was medium to high with an average ranging between 67.20 to 194.13 kg ha^{-1} (Table 2). The highest available K_2O in the soil was recorded in Bade soil under Dimapur district of 194.13 kg ha^{-1} while the lowest was in Tsiesema under Kohima district with 67.20 kg ha^{-1}.

The Soluble S of ranged between 0.24 to 1.50 kg ha^{-1} (Table 2). The highest and lowest Soluble S in the soil was recorded in Diezephe and Murise soils under Dimapur district with 1.50 and 0.27

Table 3. Coefficients of correlation between the soils properties collected from different locations in Nagaland

	Silt (%)	Clay (%)	p^H	OC (%)	N (kg ha^{-1})	P (kg ha^{-1})	K (kg ha^{-1})	S (kg ha^{-1})
Sand (%)	-0.656*	-0.933**	0.341	-0.218	-0.604*	0.624*	0.413	0.889**
Silt (%)		0.339	0.037	-0.054	0.008	-0.074	-0.011	-0.490
Clay (%)			-0.443	0.297	0.748**	-0.742**	-0.509	-0.874**
p^H				-0.461	-0.639*	0.577*	0.591*	0.398
OC (%)					0.442	-0.606*	-0.412	-0.353
N (kg ha^{-1})						-0.930**	-0.552	-0.760**
P (kg ha^{-1})							0.607*	0.761**
K (kg ha^{-1})								0.360

Note: ** Significant at the 0.01 level of significance
* Significant at the 0.05 level of significance

Quality characteristics of soybean collected from different locations

N, P and K content in soybean seed

As apparent from the (Table 4), the percentage of nitrogen content in soybean seed showed significant difference among the growing locations. The highest nitrogen content was recorded in Nerhema soil of 6.33% while the lowest was in Kezoma with 5.24% under the same district *i.e.* Kohima.

The percentage of phosphorus content in soybean seed ranged between 0.33 to 0.48% (Table 4). The highest phosphorus content was recorded in Dihoma soils under Kohima district of 0.48% while the lowest was in New Chumukedima under Dimapur district with 5.24%.

The percentage of potassium content in soybean seed ranged between 1.34 to 2.49% (Table 4). The highest potassium content was recorded in Kidima soils under Kohima district of 2.49% while the lowest was in Murise soil under Dimapur district with 1.41%.

Protein and Oil content in soybean seed

The percentage of protein content in soybean seed collected from different locations showed significant difference ranging between 32.56 to 39.56% (Table 4). The highest protein content was recorded in Nerhema soil under Kohima district of 39.56% while the lowest was in Rusoma under Kohima district with 32.56%. As apparent from the Table 3, the oil content in soybean seed showed significant difference among the growing locations ranging between 16.88 to 19.38%. The highest oil content was recorded in Dihoma soils under Kohima district of 19.38% while the lowest was in Murise under Dimapur district with 16.88%.

Table 4: Quality characteristics of soybean collected from different locations in Nagaland

Sr. No.	Location	District	Altitude in m above MSL	Nutrient content in seed (%)			Protein content	Oil content
				N in seed	P in seed	K in seed	(%)	
1	Kezoma	Kohima	1531	5.24	0.39	1.71	32.75	17.13
2	Tsiesema	Kohima	1470	6.12	0.40	1.95	38.25	18.04
3	Nerhema	Kohima	1390	6.33	0.42	2.23	39.56	18.37
4	Kijumetouma	Kohima	1134	6.20	0.43	2.33	38.75	18.35
5	Kidima	Kohima	1646	6.12	0.44	2.49	38.25	19.13
6	Dihoma	Kohima	1357	5.41	0.48	2.53	33.81	19.38
7	Rusoma	Kohima	1469	5.21	0.38	1.41	32.56	17.21
8	Murise	Dimapur	171	5.71	0.37	1.34	35.69	16.88
9	Tsithrongse	Dimapur	180	6.24	0.37	1.87	39.00	17.33
10	Seithekiema	Dimapur	190	5.31	0.40	2.09	33.19	16.90
11	Diezephe	Dimapur	140	5.87	0.41	1.96	36.69	18.02
12	Bade	Dimapur	162	5.97	0.42	2.03	37.31	18.10
13	New Chumukedima	Dimapur	221	6.14	0.33	2.11	38.38	18.82
	SEm±			0.016	0.0091	0.014	0.28	0.31
	CD (p=0.05)			0.046	0.027	0.042	0.82	0.92

Correlation between the quality characteristics of soybean seed and soil nutrient content

The correlation between the quality characteristics of soybean seed and soil nutrient contents are shown in Table 5. The protein content showed positive correlation with oil content, Ca, Mg, P and S content whereas on N and K it as negatively correlated. The oil content showed significant positive correlation with Mg whereas it showed positive correlation with Ca and N. Oil content was negatively correlated to P, K and S. The Ca content was positively correlated to Mg whereas on N, P, K and S it was negatively correlated. The Mg content showed positive correlation with P, K and S while it showed negative correlation with N. The soil N content showed significant negative correlation with P and S while it was negatively correlated to the K content. P content showed significant positive correlation with K and S content. The K content showed positive correlation with S content.

It may be noted that the alkaline potassium permanganate method given by Subbiah and Asija (1956) was based on analysis of soil samples which were mostly alkaline in nature and included only one acidic soil from Northeast India. Hence, it may be assumed that the commonly used alkaline permanganate method may not give dependable and reliable results as far as soils from Northeast India or acidic soils are concerned, resulting in negative correlation when samples from various farmers field are collected and analysed. This has also been reported by Bordoloi *et. al.* (2013).

The mineralization of organic sulphur in soil depends primarily on the N:S ratio and SO_4^{2-} formed may be fixed against extraction particularly if much Fe or Ba is present or the soil is very acidic as described by (Baruah & Barthakur 1997). Plants absorb S almost exclusively as SO_4^{2-} but mobility of SO_4^{2-} in soil may not always yield satisfactory results in accordance with the time of sampling, while assessing SO_4^{2-} availability. Also, turbidimetric method gives erroneous results in cases of soils containing high organic matter, as reported by (Baruah & Barthakur 1997). These reasons may therefore result in data which are showing negative correlations when samples from farmers' fields.

Table 5. Coefficients of correlation between the quality characteristics of soybean seed and soil

	Oil content	Ca (meq/100gm)	Mg (meq/100gm)	N (kg ha^{-1})	P (kg ha^{-1})	K (kg ha^{-1})	S (g g^{-1})
Protein content	0.430	0.380	0.019	-0.115	0.150	-0.147	0.169
Oil content		0.163	0.602*	0.398	-0.366	-0.073	-0.053
Ca (meq/100gm)			0.018	-0.010	-0.190	-0.023	-0.050
Mg (meq/100gm)				-0.046	0.059	0.431	0.336
N (kg ha^{-1})					-0.930**	-0.552	-0.760**
P (kg ha^{-1})						0.607*	0.761**
K (kg ha^{-1})							0.360

Note: ** Significant at the 0.01 level of significance
* Significant at the 0.05 level of significance

Correlation coefficient study between the quality characteristics of soybean

The correlations amongst the quality characteristics of soybean are presented in Table 6. The N content in the seeds showed significant positive correlation with protein content whereas the soluble S content in the soil showed significant positively correlation with oil content.

Table 6. Coefficient of correlation between the quality characteristics of soybean seeds.

	Protein content	Oil content
N in the seed	1.00 *	---
Soluble S in the soil		0.339

Note: ** Significant at the 0.01 level of significance
* Significant at the 0.05 level of significance

Conclusions

The study showed that the soybean crop in the region can be grown with very little input of additional nutrients and thus there is tremendous potential to increase the yield with integrated nutrient management. The low input use in the state combined with INM can make a very good contribution towards making the Nagaland state completely organic farming state.

References

Anonymous (2013). Consumption at state level. Consumption of fertilizers (State-wise, Nutrient-wise) during 2012-2013. Indian fertilizer scenario 2013, pp 72.

Baruah T. C. and Barthakur H. P. (1997). A textbook of soil analysis. Vikas Publishing House Pvt. Ltd., 576 Masjid Road, Jangpura, New Delhi – 110014.

Bordoloi, L.J., Singh, A.K., Manoj Kumar, Patiram and Hazarika, S. (2013). Evaluation of nitrogen availability indices and their relationship with plant response on acidic soils of India. *Plant, Soil and Environment.* **59(6)**, 235-240.

Bray, R.H. and Kurtz, L.T. (1945). Determination of total organic and available forms of phosphorus in soils. *Soil Science* **59**, 39-45.

Chesnin, L. and Yien, C.H. (1950). Turbimetric determination of available sulphates. *Soil Science Society of America Proceedings* **28**, 149-151.

Chakravorty, B. and Chakravarti, S.K. (1980). Studies on physicochemical characteristics of some soils of the Eastern Himalayan region. *Journal of the Indian Society Soil Science* **28(3)**, 319-322.

Chapman, H.D. (1965). CEC by ammonium saturation. *American Journal of Agronomy* **9**, 891-901.

Chapman, D.H. and Pratt, P.F. (1961). Methods of analysis of soils, plants and water University of California, Riverside Division of Agricultural Science

Chenithung, T.T., Sharma, Y.K. and Sharma, S.K. (2014). Fertility status and soil acidity under different land use systems in Wokha district of Nagaland. *Journal of the Indian Society Soil Science* **6(4)**, 414-418.

Jackson, M.L. (1973). *Soil Chemical Analysis,* Prentice Hall of India Private Limited., New Delhi.

Kumar, K. and Rao, K.V.P. (1990). Fertility status of Manipur valley soils. *Indian Journal of Hill Farming* **3(2),** 73-75.

Misra, K. and Saithantuaanga, H. (2000). Characteristics of acid soils of Mizoram. *Journal of the Indian Society Soil Science* **48(3)**, 437-446.

Subbiah, B.V. and Asija, G.L. (1956). A rapid procedure for the determination of available nitrogen in soil. *Current Science* **25**, 259-260.

Tabatabai, M. and Bremner, J. (1970). Comparison of some methods for determination of total sulphur in soils. *Soil Science Society of America Proceedings* **34.** 62-65.

Zende, N.A. (1987). Soils of Nagaland in relation to physiography, their characteristics and classification. *Journal of Indian Society Soil Science* **35**, 706-711.

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