Bringing laboratory (soil test kits) to the door steps of small holder Cocoa farmers

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ABSTRACT

Fertilizer use on cocoa increases productivity, however soil testing is necessary to avoid negative consequences of blanket fertilizer application. Many of the smallholders cocoa farmers cannot afford conventional soil testing because of cost and logistics involved, hence the need for more affordable and quick soil test kit. The study was carried out in four cocoa producing communities in Ondo and Osun states where cocoa farmers were trained on the use of LaMotte soil test kit to analyse for soil pH, N, P and K. The farmers were also taught on collection and processing of representative soil samples which were analysed using the soil test kit by placing the farmers in groups. The results indicated that farmers in each of the groups got similar values for the soil parameters (pH, N, P and K) measured. The study revealed that the soils of the four cocoa plantations required N, P and K fertilizer application at different levels. The soil test revealed that while the soil of Olorunranmilowo location required as much as 148.58kgK/ha, Ago-Owu location soil only required 31.28kgK/ha . This reflected the importance of soil testing before fertilizer recommendation compared with blanket fertilizer application which does not consider native fertility.

Key words: Soil test kits, soil testing, fertilizer, cocoa farmers.

Nigeria cocoa farmers are presently being sensitized to use fertilizer to boost cocoa production on their farms. This became necessary because of low cocoa bean yield (250-400kg/ha) in Nigeria compared with significantly higher yield being realized in other cocoa growing regions of the world majorly due to soil nutrient depletion of cocoa plantations across the country. With the cocoa fertilizer research effort being made in research station and in some farmers' farms in recent time, many of the farmers are now convinced, willing and ready to use fertilizer on their cocoa farms (Ogunlade *et al.,* 2009). However, fertilizer application could be counterproductive if its use is not properly guided and judiciously utilized. Indiscriminate or blanket fertilizer application could lead to low bean yield, poor quality beans, environmental (soil and water) pollution and nutrient imbalance among others. In order to avoid these negative effects, fertilizer should be applied based on recommendation made after soil testing. Soil testing facilities are neither accessible nor affordable to smallholder cocoa farmers who made up more than 70% of Nigerian cocoa farmers. Therefore this study was carried out to train farmers on how to collect and process representative soil samples from their cocoa farms, introduce quick, accessible and affordable soil test kits (Lamotte soil test kit model 5679) that has significant correlation with the conventional soil testing method for soil pH, N, P and K as reported by Ogunlade *et al.,* (2012) to the participating farmers, train the farmers on how to use the soil test kits to analyse for soil pH, nitrogen, phosphorus and potassium, use the results of soil analysis carried out with the test kits to recommend fertilizer, train the farmers on how and when to apply fertilizer and other farm operations such as weeding, shade management etc that should be done before fertilizer application to make the exercise achieve its purposes.

MATERIALS AND METHODS

The study was carried out in four cocoa farming communities in Ondo and Osun states in the Southwestern part of Nigeria. A cocoa farm was unanimously selected by participating farmers in each of the communities. The selected farm was used for the training. Twenty five cocoa farmers were

trained in each of the four cocoa communities- i.Ago Owu farm settlement and ii. Ikoromaja near Ilesa in Osun state, iii Olorunranmilowo and iv. Aponmu in Ondo state. Farmers were trained on how to collect and process representative soil samples in the selected cocoa farm. Random sampling technique was used and 15 core samples from 0- 20cm soil depths were collected per hectare of the selected cocoa plantation in each of the four cocoa communities (Fig 1). The 15 core samples/ha of cocoa plantation/selected community were thoroughly mixed to obtain a composite sample. Four composite soil samples were obtained. The soil samples were labeled, air dried and sieved to pass through 2mm sieve. The soil samples were labeled, air dried and sieved to pass through 2mm sieve. The LaMotte soil test kit was then introduced to the farmers (Ogunlade *et al.,* 2015) who were trained on how to use the test kits to analyse the soil samples for soil pH, nitrogen, phosphorus and potassium. Farmers were put into five groups of five farmers in each group and the training was done on group basis. Each group was later asked to use the test kits on their own to carry out the soil test using the composite soil sample generated from the selected cocoa plantation in their respective communities. The underlying principle of the soil testing using the LaMotte soil test kit involves the use of colorimetric chemical reactions. The process involves extraction of soil sample, colour developmet, and matching of colour that develops with colour charts to determine nutrient concentration. For example, available phosphorus in the soil extract is measured by the blue colour which results when the measured reagent is added. The intensity (light, medium, dark blue) indicates the amount of phosphorus present. In a similar manner, pH, nitrogen, and potassium are determined following the manufacturer's instructions. The result obtained was used to make fertilizer recommendation for the selected farm.

Fig 1. Introducing LaMotte soil test kit model 5679 to cocoa farmers in Olorunranmilowo community

RESULTS AND DISCUSSION

The pH of the soils in each of the locations on farmers' groups basis is shown in Table 1. The mean pH value for each location was used as the pH value for that location. There was little or no variation in the results of each group of farmers. The soils of Ikoromaja and Ago-Owu selected cocoa farms were more acidic than those of the two locations in Ondo state. The soils of the four locations were slightly acidic, therefore acidifying fertilizer or pesticide should not be used on these plots in order not to further increase the acidity of the soils.

The nitrate nitrogen content of the soils as obtained by farmers on group basis in each of the locations is shown in Table 2. The soil test indicated that nitrate nitrogen values of the soils in the four locations were very low- far below the critical value required. Nitrogen contents of the soils collected in the cocoa plantation at Ikoromaja, though not adequate, was more than 50% higher than other locations (Table 2). The results of soil test revealed that available phosphorus contents of the soils were grossly below the critical value of 12 mg/kg in all the locations studied (Egbe *et al.,* 1989). The available P values in Aponmu were higher than the values obtained in the other locations (Table 3). The exchangeable potassium contents of the soils in Ikoromaja and Aponmu were the same based on the results obtained by the different groups of farmers (Table 4).

Table 1. Soil pH values for different locations obtained by different groups of farmers

Locations	Farmers group1	Farmers group 2	Farmers group 3	Farmers group 4	Farmers group 5	Mean
Ikoromaja	5	5.1	5.2	5.0	5.1	5.1
Ago-Owu	5.5	5.6	5.4	5.3	5.5	5.5
Olorunranmilowo	5.9	5.8	5.9	5.7	6.0	5.9
Aponmu	6.8	6.8	6.7	6.8	6.8	6.8

Table 2. Soil nitrate nitrogen values for different locations obtained by different groups of farmers

Locations	Farmers group1	Farmers group 2	Farmers group 3	Farmers group 4	Farmers group 5	Mean
Ikoromaja	7.5	7.6	7.7	7.4	7.6	7.6
Ago-Owu	3	3.1	3.2	2.9	3	3
Olorunranmilowo	3	3	3	3	3.1	3
Aponmu	3	3	3	3	3.1	3

Table 3. Soil available phosphorus values for different locations obtained by different groups of farmers

Locations	Farmers group1	Farmers group 2	Farmers group 3	Farmers group 4	Farmers group 5	Mean
Ikoromaja	3	3.1	2.9	3	3	3
Ago-Owu	4	4.2	4	4.1	3.9	4
Olorunranmilowo	3	3	3	3.1	2.9	3
Aponmu	6	5.9	6.2	6.1	5.8	6

Table 4. Soil exchangeable K values for different locations obtained by different groups of farmers

Locations	Farmers group1	Farmers group 2	Farmers group 3	Farmers group 4	Farmers group 5	Mean
Ikoromaja	0.18	0.18	0.19	0.17	0.17	0.18
Ago-Owu	0.26	0.25	0.27	0.26	0.26	0.26
Olorunranmilowo	0.10	0.11	0.12	0.10	0.11	0.11
Aponmu	0.18	0.18	0.17	0.19	0.18	0.18

Table 5. Mean values of soil pH, N, P and K for the four locations

Soil Properties	Ikoromaja	Ago-Owu	Olorunranmilowo	Aponmu
pH	5.1	5.5	5.9	6.8
Nitrogen(mg/kg)	7.6	3	3	3
Available Phosphorus(mg/kg)	3	4	3	6
Exchangeable Potassium(cmol/kg)	0.18	0.26	0.11	0.18

Table 6. N,P,and K fertilizers required for different locations based on the results of soil test

Locations	Nutrients required(kg/ha)			Fertilizer recommendation(kg/ha)			
	N	P	K	NPK20:10:10	Urea	SSP	KCl
Ikoromaja	64.8	18	93.84	120	89	33	132
Ago-Owu	74.0	16	31.28	120	109	22	31
Oloruranmilowo	74.0	18	148.58	120	109	33	220
Aponmu	74.0	12	93.84	120	109	-	132

The values of exchangeable K in soil of Ago-Owu location was the highest, though not up to the critical value of 0.3 cmol/kg soil required by cocoa as reported by Egbe *et al.*, 1989. The study revealed that the soils of the four cocoa plantations required N, P and K fertilizer application. However, while Ago-Owu, Olorunranmilowo and Aponmu locations required equal dosage of nitrogen fertilizer (74kgN/ha), Ikoromaja required lesser amount of nitrogen (64.8kgN/ha). Phosphorus fertilizer application was needed in all the four locations based on the results of analysis because the available P values obtained were below the critical value required by cocoa as reported by Egbe *et al.*, 1989. Ikoromaja and Olorunranmilowo- having the least P content (3mg/kg) required highest amount of Phosphorus fertilizer (18kgP/ha), followed by Ago-Owu location that required 16kg P/ha while Aponmu with highest P content (6mg/kg), required 12kgP/ha. Soils of Ago-Owu location contained highest amount of exchangeable potassium (0.26cmol/kg) and thus required least K- fertilizer application (31.28 kg/ha). Olorunranmilowo with least exchangeable K (0.11cmol/kg) required highest amount of K –fertilizer (148.58Kg/ha) application to the soil. Ikoromaja and Aponmu locations had the same content of soil exchangeable K(0.18cmol/kg) and therefore required same dose of K-fertilizer (93.84kg/ha) application (Table 5).

The N, P and K required in each of the locations based on the results of soil analysis using the test kit and the fertilizer recommendation made to supply the required nutrients are shown in Table 6. The soils of Ikoromaja and Aponmu locations required 3 times more potassium than the soils of Ago-Owu. The soil of Olorunranmilowo was highly depleted in potassium and required highest amount of potassium. Compound and straight fertilizers were recommended because of the differences in the level of nutrients required in each location. The nutrients required in each location based on the results of soil analysis reflected the weakness of blanket fertilizer recommendation which does not consider the native fertility. The soil test revealed that while the soil of Olorunranmilowo location required as much as 148.58kg potassium/ha, Ago-Owu location soil only required 31.28kg potassium/ha (Table6). This confirms the findings of Fasina *et al.*, 2006; Shitu and Fasina, 2004; who reported that fertilizer application is best done after a soil test has been carried out to determine the native nutrient of the soil which reveals the nutrient status of the soil. Wessel, 1980; also reported that recommending fertilizer after soil test still remains the solid basis for applying fertilizer to

soils. This underscores the importance of soil testing before fertilizer recommendation.

CONCLUSION

Soil testing- a necessity for appropriate fertilizer recommendation and use, which has hitherto not being within the reach of small holder and resource poor cocoa farmers due to the logistics and cost involved in conventional soil testing, could be brought to the door steps of farmers through affordable and portable soil test kits. The nutrients required in each of the four locations based on the results of soil analysis reflected the weakness of blanket fertilizer recommendation which does not consider the native fertility. The soil test revealed that while the soil of Olorunranmilowo location required as much as 148.58kg potassium/ha, Ago-Owu location soil only required 31.28kg potassium /ha(Table6). This underscores the importance of soil testing before fertilizer recommendation.

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