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Nitrogen content and fertilizer quality in Central Myanmar

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Abstract

Nitrogen (N) fertilizer quality in local markets and factors influencing its quality control were assessed in Pyinmana, Tatkone and Taungoo townships of Central Myanmar. This study found that N-based commercial fertilizers in local markets are generally adequate, as only 6% of total inspected fertilizers, primarily nitrogen-phosphorus-potassium (NPK) compound fertilizers, were deficient in N content. All urea, ammonium sulfate (AS) and diammonium phosphate (DAP) samples contained the required levels of N. There was excellent agreement between the Yangon laboratory and the University of Melbourne laboratory for N fertilizer analysis. According to a survey of fertilizer inspectors and dealers the main factors influencing the quality of fertilizers were weak control of fertilizer imports at borders, insufficient and under resourced fertilizer inspectors, delays in providing up to date information on fertilizer products, limited knowledge of fertilizer dealers, and slow turnaround times from analytical laboratories.

1. Background

Fertilizer is an important agricultural input, whose use can increase agricultural productivity and profitability when used at the proper time and in an appropriate nutrient balance. In Myanmar, the application of mineral fertilizers for the first high yielding variety (IR8) was adopted in 1978 when the government encouraged fertilizer use by subsidizing fertilizer prices (Soe et al., 2015). At that time, the government of Myanmar encouraged farmers to apply urea fertilizers because the country had natural gas as a major raw material for urea production. Most farmers now use N fertilizers because they noticed a clear plant growth response and it is cheaper than other major nutrient fertilizers that contain phosphorus or potassium fertilizers. According to the Myanmar Department of Agriculture (DoA) Land Use Division (LUD) database (2017), the imported and domestically produced N fertilizers such as urea and ammonium sulfate (AS) in 2016 was almost half of total fertilizer use in the country, indicating N fertilizers are being used by most of the farmers that use fertilizer. Thus, N fertilizer has been recognized as a key fertilizer in fertilizer marketing.

Farmers are the main decision makers on the use of mineral fertilizers and they need reliable information on fertilizer quality. However, farmers and a majority of those involved in the fertilizer industry, such as sellers, distributors and end-users, are not well

trained on fertilizer specifications, labeling requirements, plant nutrient deficiencies, adulteration, and other issues such as misbranding in Myanmar.

Fertilizer quality issues such as low quality fertilizer through cross-border trade (Global Agriculture and Food Security Program, 2016) and improperly labeled bags are often found in local markets. Most dealers do not have any means to check the quality of fertilizer. According to LUD fertilizer quality inspection data in the domestic market (LUD, 2017), 211 and 651 fertilizer samples in 2014-2015 and in 2015-2016 respectively were different from the label specification. This can cause substantial losses to famers who usually have to purchase fertilizers (and other inputs) with a loan before planting. The application of below-specification fertilizer by farmers is a major constraint along the fertilizer supply chain. The sale of urea N fertilizers that are well below the correct content of 46% has been a problem in Uganda (Bold et al. 2015), where it can be expected that there is minimal regulation and lack of control of the importation of fertilizers. Similar conditions apply in Myanmar, and it has been speculated that fertilizers deficient in N are responsible for small than expected responses of crops to fertilizer.

Although quality assurance is crucial to maximize the profitability of fertilizer end-users, there is a lack of regular assessment in fertilizer quality control programs in the laboratories of LUD, which is responsible for the regulation of fertilizer in Myanmar. This is because of limited capacity. Despite the importance of fertilizer quality along the fertilizer supply-chain, there are limited studies of fertilizer quality, particularly in central Myanmar encompassing the Central Dry Zone and upper Bago District. Although it is one of the main agricultural regions, producing rice, maize, grain legumes, sesame, sunflower and sugarcane, grown in rotation or as intercrops, the yields of these major crops are limited by low soil fertility and sub-optimal agricultural management. Therefore, an evaluation of the quality of fertilizer inputs is essential, especially for N fertilizer. An assessment of fertilizer analysis capacity and performance of institutional laboratories is also valuable.

This study was conducted to assess the state of fertilizer quality and quality control in central Myanmar. We also assessed the performance of the laboratory analysis of N in fertilizers by the only laboratory responsible for fertilizer quality assurance in Myanmar.

2. Materials and Methods

This study focused on commercial inorganic fertilizer quality in Pyinmana (19º74’43”N, 96º21’78”E), Tatkone (20º09’81”N, 96º19’41”E) and Taungoo (18º09’81”N, 96º19’40”E) Townships. The study area is one of the largest agricultural production areas of central Myanmar where rice, maize, legumes and various kinds of vegetables were grown. These townships are some of the major fertilizer marketing centers in the Mandalay and Bago Regions. In this study, commercial fertilizer samples available in local markets were collected and tested for conformity with bag labels. In January 2017, a total of 233 commercial fertilizer samples were taken from fertilizer wholesalers, retailers and local distributors chosen at random from the surveyed townships. Seventy-five dealers and ten fertilizer inspectors from DoA were interviewed using a questionnaire. Extensive data were collected from each of the dealers interviewed

to capture their perceptions of fertilizer quality, sales in 2016 and dealer training requirements. Interviews were held with the owner of the shop who makes the decision on bulk fertilizer purchasing and selling activities. The field investigations of fertilizer physical characteristics such as caking, impurity, and granular degradation involved site visits to fertilizer dealer shops and warehouse locations.

In this study, a commercial N fertilizer is considered as deficient in quality if the analysis is below the guaranteed percentage by an amount exceeding the applicable value specified in the Schedule of the Fertilizer (Control) Order (2013), which is currently used for regulating fertilizer quality in the country.

To evaluate the quality of fertilizer analysis by institutional laboratories, the fertilizer samples were sent to both the LUD laboratory in Yangon, Myanmar and the University of Melbourne (UoM) soils laboratory in Melbourne, Australia for total N analysis. Total contents of N were determined by using Kjeldahl method in LUD laboratory (Horwitz et al., 1970) and C/N combustion method in UoM (LECO combustion at 1350 ˚C in a stream of oxygen).

In this study descriptive analysis was used to analyze the data. Simple linear regression analysis was used to investigate relationships between the two laboratories' results for N, between the laboratory results and bag label specifications of N content. These were conducted using the discrete sample data and the Regression (REG) procedure in SAS (SAS Institution, 2002).

3. Results and Discussion

3.1 Types of N fertilizer found in the local market

From the survey analysis of fertilizer sales in 2016, 12 wholesalers, 15 retailers and 11 local distributors sold about 1,614 metric tons, 4,009 metric tons and 173 metric tons, respectively in the surveyed area. Nitrogen fertilizers were the highest proportion of total nutrients sold (from 55 to 70% of total) in the surveyed area. The N content of fertilizers found in the local market is shown in Figure 1.

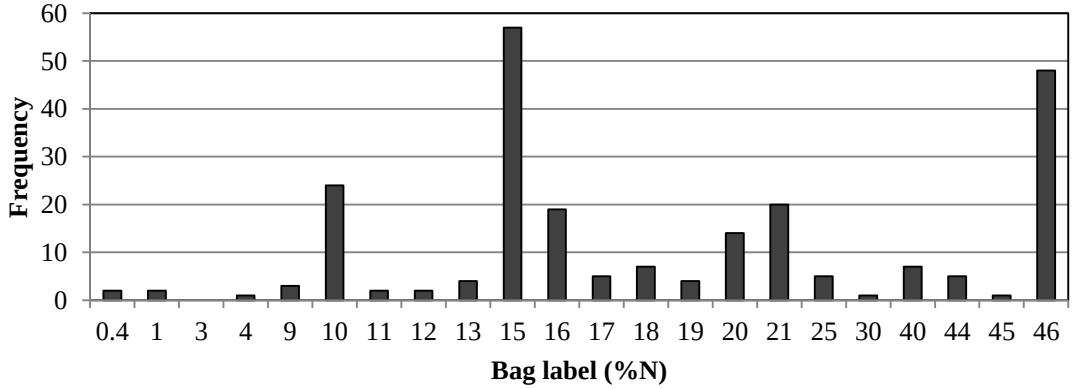

Figure 1. The stated N content (%) of fertilizers obtained in 2017 from the survey region (233 samples)

The results of this study show that compound fertilizers containing 15% N were the most common type that were sold in the surveyed area, followed by urea (46% N) and

compound fertilizers with 10% N. This is in accord with the perception of interviewed dealers who added that most farmers buy 15:15:15 NPK compound fertilizers, urea, and 10:10:5 NPK compound fertilizers for their crops. Dealers further stated that product sales were dictated by farmer preference. Based on the dealer interviews, fertilizer sales for individual townships in 2016 were dominated by N containing products followed by P, K and others nutrients such as calcium and sulfur (Table 1).

Table 1. Average fertilizer sales in the surveyed region in 2016

Townships	Sold N%	Sold P_2O_5%	Sold K_2O%	Others %
Pyinmana	58	18	19	5
Tatkone	61	20	18	1
Taungoo	70	11	6	13

3.2 Quality of inspected N fertilizers

3.2.1 Physical characteristics of fertilizers

Caking

About 17%, 13% and 9% of urea samples from Pyinmana, Tatkone and Taungoo Townships, respectively, showed evidence of caking and this would reduce its free flowing property. Improper storage conditions are the likely cause, as a much lower frequency of caking was found when urea had been repacked into polyethylene bags for home use.

Impurity/adulteration

Visual inspections suggested there were no obvious impurity/adulterations of the N fertilizers and this was in accord with the interviews of 75 dealers and 10 fertilizer inspectors in the surveyed area.

Granular degradation

Granular degradation was found in one brand of urea fertilizer produced locally in Myanmar. This degradation may reflect weak mechanical granular strength after manufacture and subsequent breakdown of product during handling.

3.2.2 Chemical characteristics of fertilizer

There was a strong correlation between the N content labeled on the bag and %N content of fertilizer determined by UoM (R^2=0.97, P<0.001) and LUD (R^2=0.99, P P<0.001) laboratories (Figure 2).

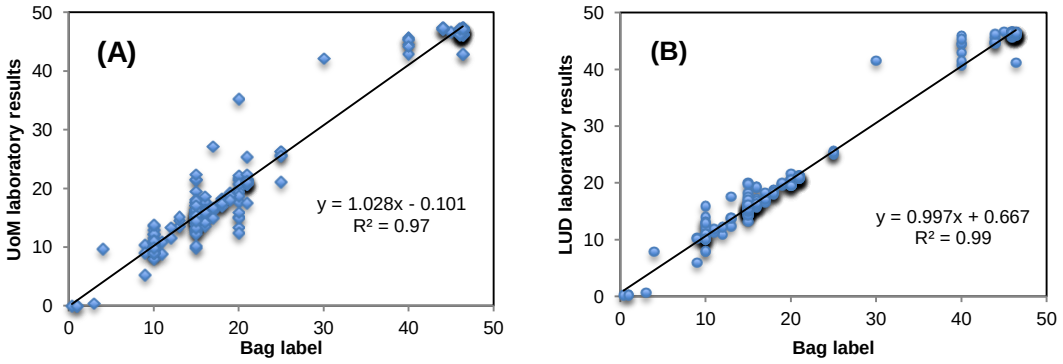

Figure 2. Relationship between % N figures for the UoM (A) and LUD (B) laboratories and bag label for commercial fertilizers obtained in the survey region

The slope of the regression line was close to one in both cases and suggests adequate labeling of the N content of the local fertilizer products. A few samples (14 out of total 233 samples) based on LUD results were N deficient, as shown in Table 2.

Table 2. Frequency of fertilizer samples deficient in N

Bag label (%N)	Sample size (n)	Deficient Products (n)	Average lab results* + Tolerance limit	SED
0.4	1	1	0.18	
1	2	2	0.76	0.05
3	1	1	1.13	
9	3	1	6.49	
10	24	2	8.42	0.02
12	2	1	11.36	
13	4	1	12.89	
15	57	4	14.85	0.29
46	61	1	41.43	

*Results based on those determined by LUD

Half of N deficient samples were found in each of Pyinmana and Tatkone townships whilst all samples collected in Taungoo township met acceptable N quality standard. Among them, 11 out of 14 samples are imported from China. A disproportionate number of samples were unregistered products (five in all) and suggests that restrictions on the sale of unregistered fertilizers into the local market would improve fertilizer quality.

All urea (60 samples), AS (19 samples) and DAP (4 samples) contained at least the designated levels of N, with the exception of one urea sample, which was 41.4% N. Almost 1 in 10 of NPK compound samples were N deficient. Further work will involve the analysis of the P and K content of these products by both laboratories.

3.3 General requirement on fertilizer bag labeling and storage facilities

In theory, the nutrient specification of fertilizer granules should be written on the label in Myanmar or English language. In practice, at least three different brands of products were improperly labeled. In these cases the list of nutrients were either stated only in Chinese script, or those with Myanmar language did not include the nutrient specification. Most dealer shops had inadequate storage conditions with high relative humidity (34%), poor ventilation (73%), and lack of pallets (77%).

3.4. Assessment of local fertilizer testing laboratory's capability

The regression analysis results provided relationship of total N content of commercial fertilizers between the LUD and UoM laboratories, as shown in Figure 3.

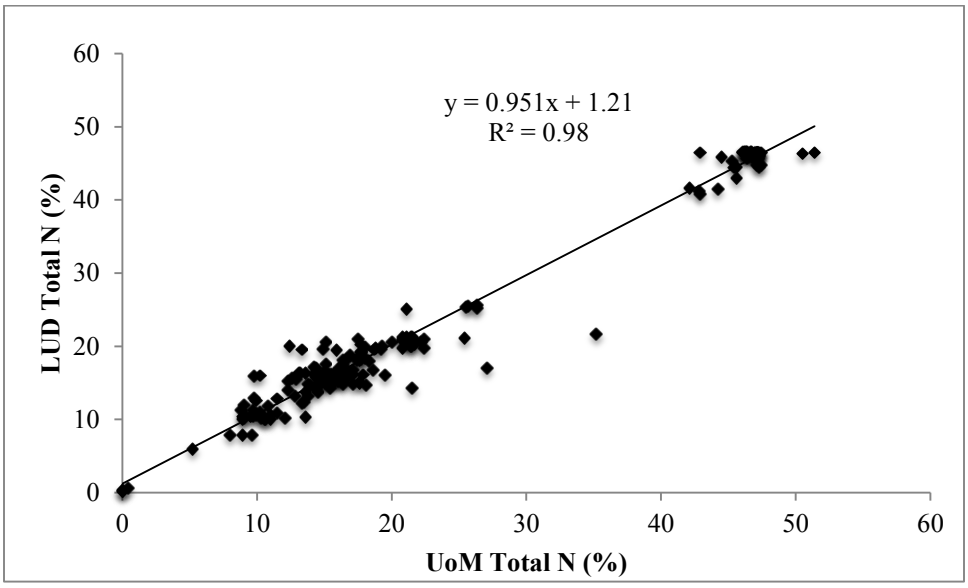

Figure 3. Comparison of total N content (%) of the commercial fertilizers as determined by the LUD and UoM laboratories

There was a strong linear relationship between %N content of fertilizer samples for the UoM and LUD laboratories (Root Mean Square Error of Estimate (RMSE)=1.003). The results indicate that the LUD laboratory in Yangon, a local laboratory, is at least as reliable as the UoM for analysis of total N content of fertilizer samples. Clearly the LUD laboratory is be competent for monitoring and regulation of fertilizer quality in terms of total N content.

3.5 Factors influencing fertilizer quality in the local market – survey results

3.5.1 Frequency of inspection

Dealers were asked how many times government fertilizer inspectors visited their shops annually and how many fertilizer samples were taken. On average there was one inspector visit a year with around one third of the dealer shops in Pyinmana and Tatkone townships visited and around two thirds of dealer shops visited in Taungoo township. On average, two fertilizer samples per shop per year were taken in Pyinmana and Taungoo townships. In Tatkone township inspectors took one sample per shop per year. The inspectors mainly check sale licenses, packing, and labeling. They also verify the products registration. There are three inspectors per township. None of the dealers surveyed had attended training, either from the government institutes or INGOs/NGOs, for fertilizer quality control. All fertilizer inspectors indicated that they were unable to properly train dealers about how to control fertilizer quality in their shops, mostly owing to time constraints.

3.5.2 Resourcing of inspectors

There are inadequate numbers of extension staff at township and village levels which means most dealers are infrequently inspected. On average, one agricultural extension officer covers between 1,500 and 1,600 farmers in Central Myanmar. Dealer visits and product sampling are secondary to the extension service activities. There are no additional budget allocations for inspection of dealer shops supported at regional and/or national levels. In addition, the LUD has field staff to inspect fertilizer shops at the district level, however most fertilizer shops are located at the township and village level.

3.5.3 Import controls

There are weak border controls for imported fertilizer owing to lack of facility for checking fertilizer quality especially entering through the border crossing at Muse in Shan State. According to the data from the Ministry of Commerce, Department of Trade, commercial fertilizers are mainly imported from the border area, which was about 77% of total fertilizer imported in 2015-2016. Gregory et al. (2014) reported that improperly labeled bags without Myanmar language were found with Chinese imported products. About 80% of the respondent inspectors stated that imported products should be sampled and analyzed at the border as a first line of defense. Controlling of fertilizer quality at township and village levels will be more efficient if there are effectively fertilizer quality control standards at the border.

3.5.4 Product information

About 70% of the inspectors interviewed claimed that one of the constraints to control fertilizer quality includes delay in providing up to date information of fertilizer products to dealers and farmers. This information should be provided in a timely way after the meetings of fertilizer committees, (which are responsible for product registration approval, registration of fertilizer business licenses and product import licenses, brand and bag/label specification approval and sampling and analysis of fertilizer imports and in retail stores), because retailers and local distributors mostly stock commercial fertilizers one month before the growing season and one month during the growing season. Supporting booklets of fertilizer information such as the registered and canceled product list is limited due to budget constraints. Many dealers (38 out of 75) also complained that verification was time consuming with over 3000 registered products on the lists. Consequently, they sometimes stock unregistered products in their shops.

3.5.5 Training

According to the surveyed results, most of the dealers in the surveyed area have limited knowledge of fertilizer quality control owing to the lack of training. For instance, the actual nutrient content of the products are never questioned by wholesalers as this is beyond their capacity. Verification of quality was limited to the inspection of the physical characteristics of fertilizer such as caking, obvious impurity and condition of the bag. Further, most retailers and all local distributors do not check the quality of the products as they only sell them based on famers' order. It was noted that there was no balance to verify the weight of fertilizer bags at most of the dealer shops in the surveyed area. Farmers have to pay based on the weight of fertilizer mentioned on the bag in local market. About 87% of dealers answered that they were interested to attend the training on fertilizer quality control in their own township.

3.5.6 Analytical response times

There are no regional laboratories at the Pyinmana and Tatkone townships and inspectors have to send the collected samples to the main laboratory at LUD headquarters in Yangon. Turnaround times are at least one month since the analysis of regular inspected samples is the low priority for the main laboratory service. Consequently, 40% of inspectors mentioned that little could be done to control substandard fertilizers for the current growing season.

5. Conclusion and Recommendations

N fertilizer is a major nutrient addition to crops such as rice, maize and legumes in the Central Zone of Myanmar. The main institutional laboratory (LUD) for analysis of N content in commercial fertilizer in Myanmar, is reliable when compared to that of UoM laboratory. The study concluded that N commercial fertilizers in local market are generally of good quality with only 6% of total inspected fertilizers deficient in N content. These were NPK compound fertilizers. Physical degradation of product was relatively minor (caking, 13%; granular degradation, 0.43% and: mislabeling, 1.29%). The analysis of fertilizer shop samples from this study appears to show that fertility quality for Myanmar farmers is generally satisfactory. The problems of the sale of urea fertilizers deficient in N described, as described by Bold et al. (2015) in Uganda, do not appear to apply in Myanmar.

Institutional factors influencing fertilizer quality control are weak border controls, inadequate numbers and poorly resourced fertilizer inspectors, delays in providing up to date information of fertilizer products, limited knowledge of dealers, and slow feedback from the laboratory.

The following recommendations are made as a way forward to maintain fertilizer quality at the township level:

1. In terms of N fertilizer quality control, fertilizer inspectors should concentrate their monitoring effort on NPK compound fertilizers and blended fertilizers;

2. Stringent import agreements should be entered into with neighbouring countries. Fertilizers without appropriate certification should be denied entry.

3. Since the number of fertilizer inspectors and budget are limited, policy makers should assigned more inspectors at township level and provide additional budget for increasing dealer visit and product sampling;

4. Regional laboratories should be established to provide quick feedback to the dealers;

5. The concerned institutes should provide dealer training including product characteristics, physical and fertilizer quality control, storage conditions and efficient use of fertilizer for sustainable crop production in conjunction with farmers. A joint training program of fertilizer quality control with private and public sectors should also be held; and

6. To update the commercial fertilizer information immediately after the meetings of fertilizer committee, the concerned institute should establish official website of the product information. This will be very efficient and convenient to assess the information of the products not only for the fertilizer inspectors but also for the dealers.

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