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# Integrated Application of Organic and Inorganic Fertilizer to Improve Nutritive Quality of Maize and Soybean Intercrop

**Almaz M. Gezahegn[1] and M.M. Yusoff[2]**

[1]Ethiopian Institute of Agricultural Research, 2300, Addis Abeba, Ethiopa
[2]Faculty of Agriculture, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia

**ABSTRACT**

A field experiment was conducted to evaluate the use of integrated fertilizers on the nutritive quality of maize and soybean in intercropping system in 2014 at field 2, Universiti Putra Malaysia (UPM) Serdang, Selangor, Malaysia. Fertilizer applications were either in the form of inorganic (NPK) or poultry manure (PM). Treatments comprised of combinations of three intercropping systems (sole maize, sole soybean, and maize + soybean) and four nutrient managements (control, 100% NPK, 100% PM and 50 % NPK + 50% PM). The experiment was laid out in a randomized complete block design (RCBD) with 3 replications. Results showed that intercropping maize with soybean significantly reduced protein and nutrient content of soybean; however, the oil content of soybean, sugar, oil, protein and nutrient content of maize were not significantly affected by intercropping. Sole and integrated application of NPK and PM increased the quality of both crops over control. Integrated application of 50% NPK and 50% PM fertilizer gave higher oil, protein and nutrient content of both crops. Use of 100 % PM gave better quality than the application of NPK fertilizer for both crops.

**Keywords:** intercropping, integrated, fertilizer, quality

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***Correspondence to Author:**
Almaz M. Gezahegn
Ethiopian Institute of Agricultural Research, 2300, Addis Abeba, Ethiopa

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## INTRODUCTION

Maize (*Zea mays* L) or corn is one of the most popular cereals next to wheat and rice in the world. Maize serves as a staple food and many people rely on it as a primary source of nutrition. Soybean (*Glycine max* L. Merril) is the most essential known oil seed and protein crop in the world. It is a great source of unsaturated fats, minerals like P and Ca and vitamins like A, B and D that meet the diverse nutritional needs (Alam et al. 2009). Despite maize and soybean are important crops, their production and nutritive quality are very low in developing countries (Njira and Nabwami 2015). Low soil fertility due to lack of adequate fertilizer application and monocropping is one of the causes of low production and quality of the crops (Macauley and Ramadjita, 2015). Sustainable crop production requires both adequate nutrient supplies to the growing crops as well as continual improvements to the soil nutrient status and quality. However, the use of inorganic fertilizer in developing countries is insignificant as most of the smallholder farmers who are resource poor cannot afford to buy one bag to apply for their crops (Odhiambo and Magandini 2008). Application of organic manure alone to increase crop productivity and nutritive quality of the crop is inadequate due to their relatively low nutrient content and slow release of nutrients (Negassa et al. 2007). To compensate for the shortage of chemical fertilizers in developing countries the integrated application of both organic and inorganic fertilizers is required. The better physiological and biochemical activity of the crop under adequate and balanced nutrient supply will enhance the quality of the crop. Therefore, the present study was aimed to evaluate the use of integrated fertilizers on the nutritive quality of maize and soybean in intercropping system.

## MATERIALS AND METHODS

### Site Description

A field experiment was conducted in 2014 at field 2, Universiti Putra Malaysia (UPM) Serdang, Selangor, Malaysia. The site is located at alatitude of 3: 02' N, a longitude of 101: 42' E and an altitude of 31m above sea level. Total annual rainfall in the year 2014 was approximately 2689 mm with a monthly average of 224 mm. The minimum and maximum average temperatures were 25.06 °C and 32.66 $^{o}$C, respectively. The soil of the experimental site was sandy loam in texture with pH 5.6, 1.14% organic carbon, 0.08 % N, 0.0068% S, 10 ppm P and 0.167 cmol/kg K.

### Experimental Design and Treatment

The experimental design was a 3 by 4 factorial combinations of cropping system (sole maize, sole soybean, and maize + soybean), and nutrient management (control, 100% NPK, 50% NPK + 50% poultry manure (PM) and 100% PM) and laid out in Randomized Complete Block Design (RCBD) with three replications. A plot size of 6.0 m x 3.6 m (21.6 m$^2$) was used for all treatments.

### Agronomic practices

The field was leveled and laid out prior to addition of poultry manure. After poultry manure application in the respective plots, each plot was covered with silver shine plastic sheet mulch in order to prevent the growth of weed within the plots. Maize and soybean were planted manually by placing two seed per hill in order to ensure maximum plant population and to account for germination failure. The planting was done on April 10, 2014. The plants were thinned to one plant per hill 2 weeks after emergence to maintain the recommended intra-row population for both crops. The sole maize was planted at 60 cm inter and 25 cm intra-rowspacing. The sole soybean was hand drilled with 60 cm and 15 cm inter- and intra-row spacing, respectively. Maize and soybean were intercropped in 1:1 alternate row, i.e. 60 cm row spaced between maize crop and soybean was planted between two rows of maize crops. The spacing between plants for maize was 25 cm and for soybean were 15 cm. The outermost two rows in each treatment served as border rows. The plant materials used for this study were the maize variety Sweet Corn 926 and the soybean variety Willis.

The amount of PM was calculated based on N equivalence (120 and 20 kg/ha for maize and soybean respectively) and applied on dry weight basis two weeks prior to planting. The amount of PM in sole maize, sole soybean and intercropping plot were 3 t ha$^{-1}$, 0.4 t ha$^{-1}$ and 2 t ha$^{-1}$, respectively. The chemical composition of PM is presented in Table 1. The amount of N: $P_2O_5$:$K_2O$ for 100% NPK treatment were 120:80:60 and 20:80:60 kg ha$^{-1}$ for maize and soybean respectively. The application rate of NPK for both crops was based on the result of the initial soil analysis and the nutrient requirement for the crops. Urea (46% N), triple super phosphate (TSP) (46% $P_2O_5$) and Muriate of potash (MOP) (46% $K_2O$) were used as the source of N, P and K respectively. The full dose of P and K and one-third of N fertilizer were applied at the sowing time. The remaining two- third of N fertilizer was added at 8-leaf stage of maize as a topdressing while for soybean plots full dose of N, P and K were applied at planting. Pesticide was sprayed to control pest when it needed. The crops were received supplemental irrigation during periods of low rainfall. Other agronomic practices were kept uniform for all treatments.

**Table 1: Chemical composition of poultry manure**

| Nutrient Element | Values (%) |
|---|---|
| **N** | 4.50 |
| **P** | 1.08 |
| **K** | 1.66 |
| **Ca** | 1.43 |
| **Mg** | 0.60 |
| **pH** | 7.10 |

### Measurement Taken

### Plant sampling and laboratory analysis

At harvest, maize and soybean plants were sampled for nutrient analysis. Five plants were sampled from the central rows of each plot. The plant was cut at the base simply over the soil surface and divided into various components (leaf, stem and grain). All components were oven-dried at 70ºC for 72 h and recorded for dry weight. The plant materials were ground to pass through <1 mm sieve in a Thomas-Wiley laboratory Mill (Thomas Scientific, Swedesboro, NJ). The ground materials were digested by $H_2SO_4$ and $H_2O_2$ using a digestion block at a temperature of 285ºC AOAC (1995). The N and P contents were determined by using an Autoanalyzer (Lachat instrument, Milwaukee, WI, USA) and K content were determined by using Atomic Absorption Spectrometer (Perkin Elmer, Waltham, Massachusetts, USA).

### Grain quality of maize and soybean

**Sugar content of maize-** Kernels from the middle of cob was squeezed and the juice was evaluated using a Digital Pocket Refractometer Pal (Atago CO, LTD) for total soluble sugar (ºbrix).

**Protein content of maize and soybean-** The protein content was determined from the percent N determined in the grain.

Protein content (%) = N content (%) X 6.25

**Oil content of maize and soybean -** The oil content was determined by extracting 3 g of each sample in a Soxhlet apparatus using petroleum ether (boiling point at 130ºC) as the extraction (AOAC, 2007). Then the oil content was determined by the following formula:

$$\% \text{ Oil (fat)} = \frac{(W2-W1)}{S} \times 100$$

Where,

W1= Weight of flask

W2 = Weight of flask and extracted oil/fat (g)

S= Weight of sample

**Statistical analysis**

The SAS Statistical Software Package (Version 9.4) was used to perform an analysis of variance appropriate for factorial experiment in RCBD. The Least Significant Difference (LSD) was used for mean separation at 0.05% probability levels. Pearson correlation was conducted to determine the association of parameters.

## RESULTS AND DISCUSSION

### Nutritive quality of Maize

The result showed that cropping system had not a significant effect on nutrient (N, P, K, Ca and Mg), sugar, protein and oil content of maize. However, nutrient management has a significant effect on nutrient (N, P, K, Ca and Mg), sugar, protein and oil content of maize (Table 2). The highest N, P, K, Ca and Mg content of maize were observed in the combined application of 50% NPK + 50% PM. In contrast, the lowest N, P, K, Ca and Mg content of maize were noted in the control. The N, P, Ca and Mg content of maize in application of 100% PM were greater than 100% NPK. However, K content of maize in application of 100% NPK and 100% PM was same ($P<0.05$). Overall, the sole application of inorganic and organic fertilizer and their combination were enhanced the N, P and K content of maize, but the combination of organic and inorganic was superior over the sole application. This was due to the increase in supply of nutrients directly through the organic and inorganic source to the crop, the reduction in losses of nutrient from the soil solution and the increase in nutrient use efficiency. Further PM gave higher nutrient content than inorganic fertilizer. This might be due to organic manure improved soil nutrient content and soil environment which was efficiently exploited by the maize plants as compared to the inorganic treatments (Table 6). Organic manure also supplied other nutrients like Ca and Mg. This result is in line with Sharma et al. 2012. In contrast, Enujeke (2013) reported the highest nutrient concentration of maize in inorganic treatments than organic manure.

Sole and combined application of organic and inorganic fertilizer resulted in increased of the sugar content of maize. The sugar content of maize from the combined application of 50% NPK +50% PM, 100% NPK and 100% PM treatments were not significantly different among each other, but were significantly greater than the control. The nutrients from NPK and PM might have a regulatory role on absorption and translocation of carbohydrates. The result is in agreement with Kumar et al. (2010) who reported fertilizer applications gave the highest sugar content (2.3-3.2%) over control.

**Table 2: Effect of cropping system and nutrient management on nutritive quality of maize**

| Treatment | N (%) | P (%) | K (%) | Ca (%) | Mg (%) | PC (%) | SC (°brix) | OC (%) |
|---|---|---|---|---|---|---|---|---|
| **Cropping system (C)** | | | | | | | | |
| Sole maize | 4.90 | 1.24 | 2.89 | 0.25 | 0.52 | 14.30 | 14.4 | 6.75 |
| Maize + soybean | 4.65 | 1.19 | 2.85 | 0.25 | 0.51 | 14.71 | 13.8 | 6.71 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| LSD ( p< 0.05) | ns | ns | ns | ns | ns | ns | ns | ns |
| **Nutrient Management (N)** | | | | | | | | |
| Control | 1.83d | 0.81d | 2.24c | 0.22d | 0.32d | 10.20c | 11.80b | 4.97d |
| 100% NPK | 4.00c | 1.08c | 2.57b | 0.24c | 0.46c | 14.71b | 14.53a | 6.28c |
| 100% PM | 4.74b | 1.50b | 2.56b | 0.27b | 0.59b | 16.03ab | 14.82a | 7.46 b |
| 50% NPK+ 50% PM | 5.33a | 1.79a | 2.94a | 0.29d | 0.70a | 17.34a | 15.13a | 8.22a |
| LSD ( p< 0.05) | 0.43 | 0.21 | 0.31 | 0.01 | 0.03 | 1.49 | 1.79 | 0.41 |
| C*N | ns | ns | ns | ns | ns | *** | ns | ns |

Means in the same column followed by the same letters are not significantly different (LSD 0.05), ns= non-significant, PC= protein content, SC= sugar content, OC= Oil content

The highest protein content of maize was observed in the combined application of 50% NPK + 50% PM, which was not significantly different (p>0.05) from the application of 100% PM. In contrast, control gave the lowest protein content. Application of 100% PM gave lower protein content than combined application of 50% NPK + 50% PM, but gave same protein content (p>0.05) with the application of 100% NPK. The availability of nitrogen during the grain filling stage of maize is necessary to improve the protein content. Nitrogen is an essential constituent of protein which makes up to 16% by weight and is required throughout the crop growth stages to enhance the formation of amino acids. Similar results in different crops were reported by Awad et al. (2014) and Singh and Rai (2004) who showed increased protein content in application of organic sources and their combinations.

The combined application of 50% NPK and 50% PM gave the highest oil content, followed by the application of 100% PM. In contrast, the control gave the lowest oil content. Application of 100% NPK gave lower oil content of maize compared to the combined application of 50% NPK + 50% PM and application of 100% PM. The better oil content of maize and soybean in a combined application of NPK and PM might be due to the balanced supply of nutrients and the release of micro-nutrients from organic sources in the soil such as sulfur (Table 6). Sulfur is responsible for oil content increment as it is required for the synthesis of coenzyme A which is involved in the oxidation and synthesis of fatty acids (Awad et al. 2014). This result agrees with Ghaffari et al. (2011) and Shoghi-Kalkhoran et al. (2013) who found a higher oil content of sunflower in the combined application of organic and inorganic fertilizer over chemical fertilizer. In contrast, lower oil content with the sole application of NPK compared to sole PM might be due to the antagonistic effect of nitrogen on the oil content, which is offset by an increase in protein content. The competition for carbon skeletons during carbohydrate metabolism is one of the physiological reason for lower oil content in NPK treatment (Rathke et al. 2005). Esmaeilian et al. (2012) also reported a reduction of seed oil of sunflower due to an increase in the rate of NP fertilizers.

Correlation between nutritive quality of maize and soil nutrient content after harvest is presented in Table 3. N, P, K, Ca, Mg, sugar, protein and oil content of maize were positively correlated with nutrient content of the soil. Izsáki (2011) also reported positive relationship between soil nutrient and gain quality of maize.

**Table 3: Pearson linear correlation coefficients between nutritive quality of maize and soil nutrient content after harvest**

| | | Nutritive quality of Maize (NQM) | | | | | | | | Soil nutrient content (SNC) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **N** | **P** | **K** | **Ca** | **Mg** | **Pc** | **Sc** | **Oc** | **TN** | **S** | **AP** | **EK** | **Ca** | **Mg** |
| **NQM** | **N** | 1 | | | | | | | | | | | | | |
| | **P** | 0.93 | 1 | | | | | | | | | | | | |
| | **K** | 0.91 | 0.91 | 1 | | | | | | | | | | | |
| | **Ca** | 0.94 | 0.99*** | 0.91 | 1 | | | | | | | | | | |
| | **Mg** | 0.96* | 0.99* | 0.94 | 0.99* | 1 | | | | | | | | | |
| | **Pc** | 0.99** | 0.93 | 0.92 | 0.93 | 0.96* | 1 | | | | | | | | |
| | **Sc** | 0.98* | 0.84 | 0.86 | 0.85 | 0.89 | 0.98* | 1 | | | | | | | |
| | **Oc** | 0.97* | 0.99* | 0.92 | 0.99* | 0.99** | 0.97* | 0.91 | 1 | | | | | | |
| **SNC** | **TN** | 0.71 | 0.69 | 0.40 | 0.69 | 0.68 | 0.69 | 0.68 | 0.72 | 1 | | | | | |
| | **S** | 0.84 | 0.93 | 0.70 | 0.93 | 0.91 | 0.82 | 0.74 | 0.92 | 0.87 | 1 | | | | |
| | **AP** | 0.70 | 0.72 | 0.42 | 0.73 | 0.71 | 0.69 | 0.65 | 0.74 | 0.99 | 0.91 | 1 | | | |
| | **EK** | 0.88 | 0.88 | 0.67 | 0.89 | 0.88 | 0.87 | 0.82 | 0.90 | 0.95* | 0.97* | 0.95* | 1 | | |
| | **Ca** | 0.54 | 0.60 | 0.24 | 0.78 | 0.56 | 0.52 | 0.48 | 0.60 | 0.96 | 0.85 | 0.98 | 0.88 | 1 | |
| | **Mg** | 0.76 | 0.77 | 0.49 | 0.60 | 0.76 | 0.74 | 0.71 | 0.79 | 0.99* | 0.93 | 0.99* | 0.98* | 0.96* | 1 |

*, **, *** significant level at P< 0.05, 0.001, 0.0001, TN= Total Nitrogen, AV. P= available P, Ex. K= exchangable K

### Nutritive quality of Soybean

Cropping systems and nutrient management were significant on the nutrient (N, P, K, Ca and Mg), and protein content of soybean (Table 4). However, oil content of soybean was significantly affected by nutrient management only. N, P and K content of soybean were higher in the sole soybean than intercropped with maize. Intercropping of soybean with maize reduced nutrient content of soybean. This might be due to the competition between maize and soybean was high.

Among nutrient management, the highest N, P, K, Ca and Mg content were observed in a combined application of 50% NPK and 50% PM. In contrast, the lowest N, P, K, Ca and Mg content of soybean were observed in control. The N, P, Ca and Mg content of soybean were higher in application of 100% PM than 100% NPK. However, the K content of soybean in the application of 100% PM was not significantly different (P>0.05) from the application of 100% NPK. The highest nutrient content in combined application of NPK and PM was due to the higher availability of the major nutrients in the soil reservoir and the additional quantity of nutrients supplied by organic manure and inorganic fertilizers. The result is in agreement with Jadhav et al. (2007) who reported that the highest N, P and K concentration of soybean were found in combined application of NPK and FYM.

**Table 4: Effect of cropping system and nutrient management on nutritive quality of soybean**

| Treatment | N (%) | P (%) | K (%) | Ca (%) | Mg (%) | PC (%) | OC (%) |
|---|---|---|---|---|---|---|---|
| **Cropping system (C)** | | | | | | | |
| Sole maize | 5.28a | 1.53a | 6.51a | 0.47a | 2.71a | 18.7a | 8.61 |
| Maize + soybean | 3.80b | 1.41b | 5.64b | 0.45b | 2.63b | 18.2b | 8.55 |
| LSD ( p< 0.05) | 0.53 | 0.10 | 0.99 | 0.006 | 0.019 | 0.35 | ns |
| **Nutrient Management (N)** | | | | | | | |
| Control | 3.81d | 1.23d | 4.83c | 0.43d | 2.48d | 14.1d | 6.44d |
| 100% NPK | 5.45 b | 1.56c | 5.79b | 0.45c | 2.62c | 18.8 b | 7.72c |
| 100% PM | 4.77c | 1.45b | 6.80b | 0.48b | 2.75b | 19.8 c | 9.00b |
| 50% NPK+ 50% PM | 7.09a | 1.74a | 8.37a | 0.49a | 2.86a | 21.0a | 11.17a |
| LSD ( p< 0.05) | 0.63 | 0.14 | 0.31 | 0.009 | 0.028 | 0.49 | 0.82 |
| C*N | ns | ns | ns | ns | ns | *** | ns |

Means in the same column followed by the same letters are not significantly different (LSD 0.05), ns= non-significant, PC= protein content, OC= Oil content

The protein content of soybean was higher in monocropped than intercropped soybean with maize. This probably due to the reduction of N content in intercropped soybean. A similar result was reported by Elsheikh et al. (2014) who reported the reduction of protein content in intercropping. Among nutrient management, the combined application of 50% NPK + 50% PM gave significantly highest protein content while control gave the lowest protein content. The protein content obtained from the application of 100% NPK was significantly higher than the application of 100% PM. The availability of nitrogen during the pod filling stage of soybean is necessary to improve the protein content. This finding is in line with Jadhav et al. (2007) who reported the highest in combination of organic and inorganic fertilizer.

The highest oil content was observed in the combined application of 50% NPK + 50% PM followed by application of 100% PM. In contrast, the lowest oil content was observed in control. Application of 100% NPK resulted in lower oil content of soybean compared to the combined application of 50% NPK + 50% PM and application of 100% PM. The better oil content of soybean in a combined application of NPK and PM might be due to the balanced supply of nutrients. The higher nutrient content in 100% PM compared to 100% NPK might be due to the higher sulfur content of the soil under PM treatment (Table 6). This finding is in line with Singh and Ghosh (2003) who found highest protein, oil and mineral content of soybean under combined application of NPK and FYM.

Correlation between nutritive quality of soybean and soil nutrient content after harvest is presented in Table 5. N, P, K, Ca, Mg, protein and oil content of soybean were positively correlated with nutrient content of the soil. Similarly, Sarker et al. (2002) found positive relationship between sulfur and oil content of soybean.

**Table 5: Pearson linear correlation coefficients between nutritive quality of soybean and soil nutrient content after harvest**

| | | Nutritive quality of soybean (NQS) | | | | | | | Soil nutrient content (SNC) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **N** | **P** | **K** | **Ca** | **Mg** | **Pc** | **Oc** | **TN** | **S** | **AP** | **EK** | **Ca** | **Mg** |
| **NQS** | **N** | 1 | | | | | | | | | | | | |
| | **P** | 0.98* | 1 | | | | | | | | | | | |
| | **K** | 0.89 | 0.87 | 1 | | | | | | | | | | |
| | **Ca** | 0.76 | 0.78 | 0.96* | 1 | | | | | | | | | |
| | **Mg** | 0.84 | 0.86 | 0.98 | 0.99* | 1 | | | | | | | | |
| | **Pc** | 0.83 | 0.90 | 0.89 | 0.92 | 0.94* | 1 | | | | | | | |
| | **Oc** | 0.89 | 0.87 | 0.99** | 0.95 | 0.98* | 0.89 | 1 | | | | | | |
| **SNC** | **TN** | 0.21 | 0.30 | 0.56 | 0.77 | 0.68 | 0.68 | 0.55 | 1 | | | | | |
| | **S** | 0.54 | 0.56 | 0.86 | 0.96 | 0.91 | 0.80 | 0.85 | 0.87 | 1 | | | | |
| | **AP** | 0.22 | 0.30 | 0.60 | 0.80 | 0.71 | 0.67 | 0.58 | 0.99 | 0.91 | 1 | | | |
| | **EK** | 0.50 | 0.57 | 0.80 | 0.94 | 0.88 | 0.85 | 0.79 | 0.96 | 0.97* | 0.95* | 1 | | |
| | **Ca** | 0.03 | 0.10 | 0.66 | 0.64 | 0.56 | 0.50 | 0.45 | 0.96* | 0.85 | 0.98* | 0.88 | 1 | |
| | **Mg** | 0.30 | 0.38 | 0.46 | 0.84 | 0.76 | 0.73 | 0.64 | 0.99* | 0.93 | 0.99* | 0.98* | 0.96* | 1 |

*, **, *** significant level at P< 0.05, 0.001, 0.0001, TN= Total Nitrogen, AV. P= available P, Ex. K= exchangable K

**Table 6: Effect of cropping system and nutrient management on soil chemical properties**

| Treatment | Total N (%) | S (mg/kg) | Av. P (mg/kg) | Ex. K (cmolc/kg) | Ca (mg/g) | Mg (mg/kg) |
|---|---|---|---|---|---|---|
| **Cropping system (C)** | | | | | | |
| Sole Maize | 0.13c | 49.2 | 21.2b | 0.51a | 2.76a | 0.86a |
| Sole Soybean | 0.22a | 50.1 | 22.4b | 0.45a | 3.12a | 0.77ab |
| Intercropping | 0.17b | 57.8 | 26.3a | 0.54a | 2.80a | 0.74b |
| LSD (p<0. 05) | 0.03 | ns | 4.05 | ns | ns | 0.12 |
| **Nutrient Management (N)** | | | | | | |
| Control | 0.11c | 31.3b | 15.6c | 0.26b | 2.20c | 0.65c |
| 100% NPK | 0.14c | 35.9b | 18.5c | 0.30b | 2.02c | 0.72c |
| 100% PM | 0.24a | 72.6a | 36.0a | 0.39a | 5.12a | 1.02a |
| 50% NPK+ 50% PM | 0.17b | 69.6a | 25.7b | 0.36a | 3.15b | 0.86b |
| LSD (p<0.05) | 0.04 | 10.1 | 4.49 | 0.50 | 0.76 | 0.15 |
| C*N | ns | ns | ns | ns | ns | ns |

Means in the same column followed by the same letters are not significantly different (LSD 0.05), ns= non-significant, AV. P= available P, Ex. K= exchangable K

## CONCLUSION

Based on the outcome of the study, intercropping of maize with soybean reduced nutritive quality of soybean but did not affect nutritive quality of maize. Combined application of 50% NPK + 50% PM gave higher nutritive quality than sole application of organic and inorganic fertilizer for maize and soybean. Therefore it can be concluded that balanced fertilizer application through the integration of NPK and PM increase the nutritive quality of maize and soybean.

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## REFERENCES

1. Alam, M. A., Siddiqua, A., Chowdhury, M. A. H., & Prodhan, M. Y. 2009. "Nodulation, yield and quality of soybean as influenced by integrated nutrient management." Journal of the Bangladesh Agricultural University, 7(2): 229-234.
2. AOAC, (1995). Official methods of analysis of AOAC International. 16th Edition. Cuniff, P. (Ed.), Washington DC: Association of Official Analytical Chemists.
3. AOAC, (2007). Official methods of analysis of AOAC international. 18thed. Washington DC: Association of Official Analytical Chemists.
4. Awad, M., Al Solaimani, S. G., & El-Nakhlawy, F. S. (2014). Effect of integrated use of organic and mineral fertilizer on some quality parameters of maize (Zea mays L.). International Journal of Innovation and Scientific Research, 9 (2), 228-236.
5. Elsheikh, E. A., Salih, S. S., Elhussein, A. A., & Babiker, E. E. (2009). Effects of intercropping, Bradyrhizobium inoculation and chicken manure fertilisation on the chemical composition and physical characteristics of soybean seed. Food Chemistry, 112(3), 690-694.
6. Enujeke, E. C. (2013). Nutrient Content (% Dry Matter) of Maize as Affected by Different Levels of Fertilizers in Asaba Area of Delta State. Sustainable Agriculture Research, 2(3), 76.
7. Izsáki, Z. (2011). Relationship between the Nmin content of the soil and the quality of maize (Zea mays L.) kernels. Research Journal of Agricultural Science, 43(3), 77-86.
8. Jadhav, P. M., Rane, S. D., Ranshur, N. J., & Todmal, S. M. (2007). Effect of integrated nutrient management on quality and yield of soybean. Asian Journal of Soil Science, 2(1), 68-73.
9. Kumar, A., S. K., Gali, and R. V. Patil. 2010. Effect of levels of NPK on quality of sweet corn grown on vertisols. Karnataka Journal of Agricultural Sciences, 20(1), 44 – 46.
10. Macauley, H., and Ramadjita, T. 2015. Cereal crops: rice, maize, millet, sorghum and wheat. Abdou Diouf International, Dakar Senegal.
11. Negassa, W., F. Getaneh, A., Deressa, and B. Dinsa. 2007. Integrated use of organic and inorganic fertilizers for maize production. Utilization of diversity in land use systems: Sustainable and organic approaches to meet human needs. A paper presented on International Research on Food Security, Natural Resource Management and Rural Development Conference, 2007, October 9-11, Witzenhausen, Germany.
12. Njira, K. O., and J. Nabwami. 2015. A review of effects of nutrient elements on crop quality. African Journal of Food, Agriculture, Nutrition and Development, 15(1), 9777-9793.
13. Odhiambo, J. J., and V. N. Mag. 2008. An assessment of the use of mineral and organic fertilizers by smallholder farmers in Vhembe district, Limpopo province, South Africa. African Journal of Agricultural Research. 3(5): 357-362.
14. Rathke, G.-W., O Christen, and W. Diepenbrock. 2005. Effects of nitrogen source and rate on productivity and quality of winter oilseed rape (Brassica napus L.) grown in different crop rotations. Field Crops Research. 94(2): 103-113.
15. Saracoglu, A., K. T. Saracoglu, B. Aylu and V. Fidan. 2011. Influence of integrated nutrients on growth, yield and quality of maize (Zea mays L.). American Journal of Plant Sciences. 2(01): 63-69.
16. Sarker, S. K., M. A. H. Chowdhury, and H. M. Zakir. 2002 . Sulphur and boron fertilization on yield quality and nutrient uptake by Bangladesh soybean-4. Journal of Biological Science. 2: 729-733.
17. Sharma, N. K., R. J. Singh, and K. Kumar. 2012. Dry matter accumulation and nutrient uptake by wheat (Triticum aestivum L.) under poplar (Populus deltoides) based agroforestry system. International Scholarly Research Notices Agronomy. 12(12): 1-7.
18. Shoghi-Kalkhoran, S., Ghalavand, A., Modarres-Sanavy, S. A. M., Mokhtassi-Bidgoli, and P. Akbari. 2013. Integrated fertilization systems enhance quality and yield of sunflower (Helianthus annuus L.). Journal of Agricultural Science and Technology. 15: 1343-1352.

19. Singh, A. B., and P. K. Ghosh. 2003. Effect of integrated nutrient-management practices on improvement in grain quality of soybean (Glycine max), sorghum (Sorghum bicolor) and wheat (Triticum aestivum) in multiple cropping systems in Vertisol. Indian journal of agricultural science. 73(2): 65-68.
20. Singh, R., and R. K. Rai. 2004. Yield attributes, yield and quality of soybean (Glycine max) as influenced by integrated nutrient management. Indian Journal of Agronomy, 49(4): 271-274.