academicJournals

Vol. 11(45), pp. 4654-4660, 10 November, 2016
DOI: 10.5897/AJAR2016.11619
Article Number: 23F1E3561613
ISSN 1991-637X

http://www.academicjournals.org/AJAR

African Journal of Agricultural Research

Full Length Research Paper

Effects of chemical and bio-fertilizers on yield, yield components and grain quality of maize (*Zea mays* L.)

Hashim A. Fadlalla, Hatim A. A. Abukhlaif and Somaya S. Mohamed*

Environment, Natural Resources and Desertification Research Institute, National Centre for Research, Sudan.

Received 29 August, 2016; Accepted 20 October, 2016

A field experiment was conducted in two consecutive seasons (2009 and 2010) to assess the effect of two microbial fertilizers, chicken manure, urea and their possible combinations on the performance of a maize variety (Hudeiba 45). The bio fertilizers used were *Azospirillum brasilense* (A), *Azotobacter* sp (B) and chicken manure (CM) at a rate of 7t/ha). Urea (46% N) was applied at rates of 120kg/ha (N) and 40kg/ha (T). The combinations used were *Azospirillum brasilense* with urea (A+T), *Azotobacter* sp with urea (B+T), A+CM and B+CM in addition to control. The field experiment was laid out in a Randomized Complete Block Design with four replicates. Four seeds were sown in holes with 20 cm between holes in 4×4 m^2 plots with 5 ridges 70 cm apart. Sowing was carried out in the last week of October in 2009 and the first week of November in 2010. The fertilizers were applied on one side of the ridge and plants were irrigated at seven days intervals. Data were collected on cob length, cob diameter, number of rows/cob, number of seeds/row, 100-grain weight, grain yield/plant and grain yield/ha. Data were collected for yield components at physiological maturity and for grain yield after harvesting. The moisture, ash, fat, crude fiber, crude protein, tannins and carbohydrates contents of the grains were determined. Results showed that biofertilizers have significantly ($p < 0.05$) increased crop productivity. CM increased the grain yield (t/h) by 20 and 30% over the control in 2009 and 2010, respectively. Application of chicken manure solely or in combinations with *Azosprillum barasilence* or *Azotobacter* sp have also increased grain yield and its components. The combinations of N_2 fixer inoculants with manure and/or urea improved grain quality of maize under field conditions.

Key words: *Azosprillum barasilence*, *Azotobacter* sp, maize, chicken manure, grain yield.

INTRODUCTION

Maize (*Zea mays* L.) or corn is a cereal crop that grown over a wide environmental range .It is considered as a multi-purpose crops that have a lot of uses such as human diet and animal and poultry feed. It can be used as grain, green fodder or silage (Haque, 2003).In developing countries including Sudan maize is a major source of income to many farmers (Tagne et al., 2008). Moreover, the possibility of blending maize with wheat for

*Corresponding author. E-mail: somasirmo@gmail.com. Tel: + 249-912765151.

Table 1. Some physical and chemical properties of Shambat soil.

Parameter	Particle size distribution (%)			Total K (ppm)	Total P %	Total N%	EC ds/m	pH (paste)
	Clay	Silt	Sand					
value	69.74	9.00	21.24	0.140	0.076	0.069	1.87	7.8

bread making has also increased the demand of maize in Sudan (Ali et al., 2009). Therefore, farmers are encouraged to incorporate the crop into the farming systems under both irrigated and rain fed agriculture. Nitrogen (N) is generally deficient in Sudan's soils as in most other semi-arid regions. In such regions nitrogen is usually added to the soil in large quantities. Therefore, intensive farming practices that aim at producing higher yield require extensive use of nitrogen fertilization which are costly and create environmental pollutions (Baser et al., 2012). Biofertilizers which are eco-friendly play an important role for supplementing the essential plant nutrients for sustainable agriculture and economy (Mugilan et al., 2011). Moreover, microbial fertilizers can clean the environment, enhance the productive capacity of land and reducing the amount of chemical fertilizer consumption (Hossein and Farshad, 2013) and improve plant growth and health (Raaijmakers et al., 2002). Enhancement of cereals yields by inoculation with non-symbiotic nitrogen fixing bacteria was recorded by many researchers (Salantur et al., 2006). *Azospirillum* species have been potentially studied to the greatest extent and appeared to have significant potential for commercial production (Kumaresan and Reetha, 2011). *Azotobacter* species besides playing a role in nitrogen fixation, it has the capacity to synthesize and secrete considerable amounts of biological active substances like vitamins, gibberellins and auxins (Suhag, 2016). Chicken manure is an excellent source of nutrients and can be incorporated into most of the fertilization programs. Ayeni and Adetunji (2010) reported that, the mean increase in grain yield of maize due to application of poultry manure alone varied between 34 and 68% compared to 11-57% gained by application of NPK fertilizers. Corn is considered as one of the most important cereal crops over the world that needs large quantities of chemicals. In Sudan few reports on the importance of biofertilizers inoculation in increasing maize production and improving the physical and chemical quality of maize grains are available. Therefore, the objective of this study is to estimate the effects of microbial inoculation, chicken manure and urea fertilization on maize grain yield, components and quality.

MATERIALS AND METHODS

Site

The field experiment was conducted at the experimental farm of the college of Agricultural Studies, Sudan University of Science and Technology, Shambat (Latitudes 15° 40´ N, Longitude 32° 32´ E and 380 m above the sea level) for two consecutive years (2009 and 2010). Shambat climate is tropical, usually hot and humid in summer and cold and dry in winter. The temperature reached a maximum value (45.9°C) in June and a minimum value (22°C) in January. The temperature usually drops during July to October due to the incidence of the rainy season. The soil of Shambat was analyzed to determine the physical and chemical characteristics according to Richard (1954). Nitrogen was measured using Kjeldahl method as described by Anderson and Ingram (1993). Data are shown in Table 1.

Source of inoculants and biological materials

A variety of maize (Hudeiba 45) was obtained from the Agricultural Research Corporation, Sudan. The effects of chemical and biofertilizers on the performance of maize were studied. *Azospirillum brasilence* and *Azotobacter* sp inoculants were obtained from Biofertlization Department, Environment and Natural Resources Research Institute, National Centre for Research, Sudan. Chicken manure was obtained from the Animal Research Centre, Sudan.

Land preparation

The land was disc ploughed, harrowed, leveled and then ridged. The area was divided into 4×4 m² plots with 70 cm apart five ridges. Four seeds were sown per hole and 20cm distance between holes was maintained. Sowing was carried out in the last week of October in 2009 and the first week of November in 2010. Seeds inoculation was performed by coating the seeds with the charcoal- based inoculants. Gum Arabic was used as an adhesive. Chicken manure was applied at a rate of 7 t/ha, distributed on the ridged-plot and mixed with soil. The plots were then irrigated weekly for two weeks before sowing date. Plants were irrigated immediately after sowing then every seven days interval. Plants were thinned to one plant/hole after a week from sowing. Weeding was carried out manually when needed. The nitrogen content and mineral contents of chicken manure were determined by Kjeldahl method and Atomic Absorption Spectrophotometer, respectively.

Experimental design and data collection

The field experiment was laid out in a Randomized Complete Block Design with four replicates .The treatments used were *Azospirillum brasilense* (A), *Azotobacter* sp (B), chicken manure (CM) at a rate of 7t/ha and nitrogen (N) in the form of urea (46% N).Urea was applied at two rates: 120kg/ha (N) and 40 kg/ha (T) , *Azospirillum brasilense* + urea (A+T), *Azotobacter* sp + urea (B+T), A+CM and B+CM in addition to the control. Data were recorded using a sample of six plants taken randomly from the outer two ridges in each plot. The data were collected at physiological maturity for yield components and after harvesting for grain yield. The data were collected to measure cob length, cob diameter, number of rows/cob, number of seeds/row, 100-seed weight, grain yield/plant and grain yield(t/ha). For the chemical composition, a sample of

Table 2. Effects of bio and chemical fertilizers on yield and yield components of maize at Shambat in 2009.

Treatments	Cob length (cm)	Cob diameter (mm)	No. of rows/cob	No. of grains/row	100-grain weight (g)	Grain yield/plant (g)	Grain yield (t/ha)
Control	11.23^{c}	30.21^{d}	12.25^{c}	26.50^{d}	9.88^{c}	24.13^{d}	2.00^{c}
N	11.58^{c}	32.27^{c}	12.75^{bc}	30.00^{bc}	11.83^{ab}	27.25^{bc}	2.20^{b}
A	11.00^{c}	29.90^{d}	12.75^{bc}	28.75^{cd}	10.81^{bc}	24.40^{cd}	1.98^{c}
B	11.49^{c}	31.55^{c}	13.00^{bc}	29.00^{cd}	10.14^{c}	24.12^{d}	1.96^{c}
CM	13.67^{a}	35.09^{a}	14.50^{a}	33.75^{a}	12.56^{a}	32.75^{a}	2.40^{a}
A+CM	11.59^{c}	32.60^{bc}	13.00^{bc}	30.50^{bc}	12.44^{a}	29.25^{b}	2.32^{ab}
B+CM	12.75^{b}	33.51^{b}	13.25^{bc}	32.50^{ab}	12.11^{a}	32.39^{a}	2.40^{a}
A+T	11.57^{c}	32.55^{bc}	12.50^{bc}	30.25^{bc}	11.61^{ab}	27.75^{b}	2.25^{b}
B+T	11.58^{c}	32.00^{c}	13.50^{ab}	30.00^{bc}	11.49^{ab}	27.97^{b}	2.26^{ab}
Mean	11.83^{a}	32.19^{a}	13.06^{a}	30.14^{a}	11.43^{a}	27.78^{a}	2.19^{a}
C.V%	5.02	2.37	5.29	6.04	7.35	7.52	4.81

Within each column, means have the same letter(s) are not significantly different according to DMRT at 5% level of significance.

Table 3. Effects of bio and chemical fertilizers on yield and yield components of maize at Shambat in 2010.

Treatments	Cob length (cm)	Cob diameter (mm)	No. of rows/ cub	No. of grains/row	100-grain weight (g)	Grain yield/plant (g)	Grain yield (t/ha)
Control	12.50^{a}	29.75^{c}	12.75^{a}	26.00^{cd}	12.41^{a}	29.73^{d}e	2.48^{cd}
N	12.79^{a}	34.75^{a}	12.50^{a}	28.50^{abc}	13.43^{a}	31.00^{cd}	2.58^{bc}
A	11.25^{a}	29.00^{c}	12.00^{a}	24.25^{d}	12.49^{a}	25.15e	2.10^{d}
B	12.39^{a}	30.75^{bc}	13.25^{a}	27.25^{bcd}	12.40^{a}	28.87^{d}e	2.40^{cd}
CM	12.68^{a}	35.50^{a}	13.50^{a}	30.75^{a}	13.30^{a}	38.75^{a}	3.20^{a}
A+CM	12.18^{a}	33.75^{ab}	12.25^{a}	29.75^{ab}	12.34^{a}	35.75^{abc}	2.97^{ab}
B+CM	12.29^{a}	34.50^{a}	12.75^{a}	30.50^{ab}	12.45^{a}	37.89^{ab}	3.06^{a}
A+T	12.04^{a}	35.00^{a}	12.25^{a}	28.25^{abc}	12.26^{a}	29.95^{cd}e	2.48^{cd}
B+T	12.42^{a}	34.28^{a}	12.50^{a}	29.25^{abc}	12.60^{a}	32.39^{bcd}	2.56^{bc}
Mean	12.28^{a}	33.03^{a}	12.64^{a}	28.28^{a}	12.63^{a}	32.16^{a}	2.65^{a}
C.V%	6.36	7.00	7.91	8.40	6.49	12.43	11.09

Within each column, means have the same letter(s) are not significantly different according to DMRT at 5% level of significance.

seeds (50g) was taken from grain yield of each plot, mechanically ground and 5 g was taken to determine the moisture, ash, fat, crude fiber, crude protein and carbohydrates contents according to the methods of AOAC (1984). Tannins content was estimated quantitatively using modified vanillin HCl method (Price et al., 1978).

Statistical analysis

The data were subjected to standard statistical analysis following the procedures described by Gomez and Gomez (1984). Means were separated for significance using Duncan Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

Grain yield components

The effect of various studied treatments on yield and its components was presented in Tables 2 and 3 for the years 2009 and 2010, respectively. Significant increments of the studied parameters were obtained mostly due to the application of chicken manure in the two years, compared to the control. Moreover, positive association effects due to the combined application of chicken manure with *Azospirillum brasilence* and/or *Azotobacter* sp were observed in some studied parameters. It is generally assumed that grain yield was influenced mainly by yield attributing components like length and diameter of cob, number of grains per cob and per row, grain weight, weight of 100 grains and filled and unfilled ratio.

Cob length and cob diameter are parameters that influence the number of grains per cob, grain size and subsequently grain yield. Application of CM increased cob length by 21% over the control in 2009 while in 2010

Table 4. Effects of bio and chemical fertilizers on biochemical characters of maize at Shambat in 2009.

Treatment	Moisture (%)	Dry (g)	Ash (g)	Fat (%)	Fiber (%)	Protein (%)	Tannin (%)	C (%)
Control	5.67[a]	94.33[a]	1.58[a]	3.38[a]	3.54[a]	6.13[a]	0.07[a]	79.71[ab]
N	5.70[a]	94.30[a]	1.63[a]	3.48[a]	3.99[a]	8.10[a]	0.08[a]	77.12[c]
A	5.72[a]	94.28[a]	1.70[a]	3.05[a]	3.14[a]	6.34[a]	0.09[a]	80.04[ab]
B	5.55[a]	94.45[a]	1.73[a]	3.13[a]	4.11[a]	7.00[a]	0.08[a]	78.49[abc]
CM	5.85[a]	94.15[a]	1.63[a]	3.53[a]	3.40[a]	6.71[a]	0.09[a]	78.89[abc]
A+CM	5.75[a]	94.25[a]	1.63[a]	3.10[a]	3.06[a]	6.13[a]	0.08[a]	80.34[a]
B+CM	5.50[a]	94.50[a]	1.80[a]	3.68[a]	3.18[a]	6.57[a]	0.09[a]	79.28[ab]
A+T	5.77[a]	94.23[a]	1.53[a]	3.93[a]	2.85[a]	6.35[a]	0.06[a]	79.58[ab]
B+T	5.62[a]	94.38[a]	1.85[a]	3.50[a]	3.62[a]	7.00[a]	0.06[a]	78.41[bc]
Mean	5.68[a]	94.32[b]	1.67[b]	3.42[b]	3.43[a]	6.70[b]	0.08[a]	79.10[a]
C.V%	4.07	0.25	11.34	19.73	20.79	13.99	47.97	1.60

* Within each column, means have the same letter(s) are not significantly different according to DMRT at 5% level of significance.

the treatments did not show significant increase in cob length. Comparison of individual treatments means indicated that maximum cob diameters were recorded for CM in both 2009 and 2010. Therefore, application of chicken manure was found to increase cob length and cob diameter. Such results could be attributed to the more availability and supply of nutrients which might have increased the production and enhanced the transfer of assimilates (Anees et al., 2016). Similarly, application of CM significantly ($p < 0.05$) increased the number of rows per cob. This result might be attributed to the stimulation effects of chicken manure on cell division and/or cell expansion or cell elongation (Yu et al*.,* 1999). Previously, Farhad et al. (2009) reported that number of rows per cob in maize was significantly ($p < 0.05$) affected by the application of different levels of poultry manure and the maximum values were recorded when applied at a rate of 12 t/ha. Number of grains/row is an important yield determining factor in maize. CM increased the number of grains/row by 27% and 18% compared to the control in 2009 and 2010, respectively. The combined application of chicken manure and the biofertilizres significantly ($p < 0.05$) increased the number of grains/row compared to the sole application of each biofertilizer. A + CM increased the number of grains/row by 12% compared to the sole application of A in 2009. Also, B+CM increased the number of grains/row by 22% compared to the sole application of B in 2010. Unexpectedly, the combined application of CM and biofertilizers showed non significant increase in number of grains/row compared to the sole application of CM. It has been previously reported that application of biofertilizer had significant effects on number of grains per row (Tarang et al*.,* 2013).

The results also indicated that maximum 100- grain weight (12.56) was recorded for CM application compared to the other treatments. Moreover, the combined effects of the application of chicken manure with the biofertilizers were superior to the use of biofertilizers alone in 2009. The percentages of increment were 15.07 and 19.42% for A+CM and B+CM, respectively, as compared to the sole application of A and B in 2009. This improvement in 100- grain weight could be attributed to the energy source provided to the microbes via organic manure thereby enhancing biological activities and availability of nitrogen. Similar observation and conclusions were also reported by Abdullahi et al. (2014). As shown in Tables 4 and 5, application of CM solely or in combination with A and B significantly ($p < 0.05$) increased grain yield/plant and grain yield (t/ha) in both years. CM increased the grain yield (t/h) by 20 and 30% over the control in 2009 and 2010, respectively. Several studies have revealed the positive effects of biofertilizers in combination with organic amendments to increase plant nutrients availability, up take and an increase in crop yield (Abdullahi et al., 2013). In 2009, the integrated application of A and B with 40kgN/ha produced grain yield/plant and grain yield/ha comparable to those obtained by the application of the recommended dose of Urea (120kgN/ha). This promoting effect of *Azospirillum brasilense* and *Azotobacter* sp could be attributed to their ability to produce biologically active substances, provide significant amount of available nitrogen through biological nitrogen fixation, improve photosynthesis performance and promote root growth which in turn enhance nutrients and water uptake there by resulting in crop improvement. Similar results were recorded previously by Naserirad et al. (2011) and Tarang et al. (2013).

Grain quality

The measured parameters of grain quality showed different responses towards the different treatments

Table 5. Effects of bio and chemical fertilizers on biochemical characters of maize at Shambat in 2010.

Treatments	Moisture (%)	Dry (g)	Ash (g)	Fat (%)	Fiber (%)	Protein (%)	Tannin (%)	C (%)
Control	6.97^{a}	93.03^{a}	1.99^{a}	3.85^{ab}	2.85^{a}	9.19^{b}	0.11^{a}	75.15^{cd}
N	7.15^{a}	92.85^{a}	1.67^{bc}	3.50^{bc}	2.42^{a}	8.56^{b}	0.08^{a}	76.70^{abc}
A	7.18^{a}	92.82^{a}	1.85^{ab}	3.60^{bc}	2.70^{a}	7.88^{b}	0.14^{a}	76.73^{abc}
B	7.27^{a}	92.73^{a}	1.62^{bc}	3.85^{ab}	2.89^{a}	8.32^{b}	0.08^{a}	76.05^{bc}
CM	6.59^{a}	93.41^{a}	1.62^{bc}	3.72^{b}	2.48^{a}	12.13^{a}	0.08^{a}	73.46^{d}
A+CM	6.68^{a}	93.32^{a}	1.58^{bc}	3.90^{ab}	3.04^{a}	8.31^{b}	0.08^{a}	76.50^{abc}
B+CM	6.55^{a}	93.45^{a}	1.85^{ab}	2.52^{bc}	2.79^{a}	7.88^{b}	0.10^{a}	77.40^{ab}
A+T	6.87^{a}	93.13^{a}	1.63^{bc}	4.25^{a}	2.65^{a}	8.46^{b}	0.12^{a}	76.14^{bc}
B+T	6.73^{a}	93.27^{a}	1.56^{c}	3.20^{c}	2.37^{a}	7.88^{b}	0.04^{a}	78.26^{a}
Mean	6.89^{a}	93.11^{b}	1.71^{b}	3.71^{a}	2.69^{b}	8.73^{b}	0.09^{b}	76.27^{a}
C.V%	9.52	0.70	11.63	5.59	14.40	12.38	76.81	1.75

* Within each column, means have the same letter(s) are not significantly different according to DMRT at 5% level of significance.

(Tables 4 and 5). In both years, microbial fertilizers, chicken manure and urea did not significantly ($P<0.05$) affect moisture, ash and dry matter contents of maize seeds. However, the highest values of moisture content (5.85 and 7.28%) were observed in 2009 when CM was applied and in 2010 when *Azotobacter* inoculum was used. The highest percentages of dry matter contents were recorded in 2009 (94.50%) and (93.45%) in 2010 under the application of B+CM. The highest values of fat contents were recorded in both years under the combined application of A and T. The percentages of increment in fat content were 16.27 and 10.38% over the control in 2009 and 2010, respectively. Fiber content is an important constituent for human food and animal feed. It is generally affected by environmental conditions, varietal characteristics and fertilizer treatments (Elsheikh and Mohameszein, 1998). The highest fiber contents were 4.11% recorded for B with an overall mean of 3.43 and CV 20.79% in 2009 and 3.04% for A+CM with an overall mean of 2.69% and CV 14.40% in 2010. Protein is the most important biochemical character. The highest percentage of protein content (12.13%) was recorded under the application of CM in both years. Such superior effect was achieved due to the increase of nitrogen supply which has paramount effect in the synthesis of protein (Anees et al., 2016). Tannins content is usually affected by many factors such as genotype, time of harvest and temperature .Tannins have been reported to possess anti carcinogenic and antimicrobial properties as well as anti-oxidant activities. The highest value of tannins content (0.14%) was recorded for A in 2010 and the lowest value (0.04%) was recorded for B+T in both years.

The highest values of carbohydrates were 80.34% recorded for A+CM in 2009 and 78.26% for B+T in 2010. These results indicated that carbohydrate content has increased due to the combined effects of the biofertilizers with either chicken manure or urea. These findings are previously reported by Mahfouze and Sharafeldin (2007) who recorded an increase of the total carbohydrate content by the application of biofertilizers combined with 50% nitrogen fertilizer. However, the combined analysis of variance for yield and its components across 2009 and 2010 (Table 6) indicated highly significant differences between the years (environment) and treatments and non-significant for Y×T interactions for the grain yield and its components except for the number of rows/cob .The combined analysis (Table 7) for grain quality indicated significant difference across the years for moisture, dry matter, fiber, protein and carbohydrate contents. Moreover, significant differences between the treatments and Y×T interaction for protein and carbohydrate contents were recorded. The significant differences in maize productivity observed in the two years indicate the strong environmental impact on the treatments. Our findings were in accordance with the previous reports which highlighted the positive effect of chicken manure in improving soil physical properties which enhances root development, water and nutrients uptake and consequently improve maize yield and grain quality (Brady and Weil, 2005; Habashy and Hemeid, 2011) The promoting effect of *Azospillium brasilense* and *Azotobacter* sp besides being nitrogen fixers could be attributed to the biologically active substances produced by these organisms such as auxin, cytokinin and amino acids.

Conclusion

The result of this study revealed that, maize grain yield and components are affected positively by the application of chicken manure and the combined application of nitrogen fixing bacteria with chicken manure or urea.

Table 6. Means some of squires from combined analysis of variance for yield and yield components of maize across 2009 and 2010

Characters	Source of variation			
	Year (Y) d.f=1	Treatment (T) Df=8	Y xT d.f=8	Pooled error df=48
Cob length/cm	3.68**	2.49**	1.14ns	0.51
Cob diameter/mm	12.84ns	30.96**	3.76ns	2.90
No of rows per cob	3.13ns	2.12ns	0.56ns	1.00
No of grains per row	62.35**	32.78**	3.19ns	5.10
100 grains wt(g)	25.87**	2.87**	1.56ns	0.74
Yield/ plant (g)	346.24**	116.88**	7.08ns	6.57
Yield ton/ha	3.70**	0.53**	0.10ns	0.04

* =highly significant at 1% level of probability, ** =significant at 5% level of probability, ns= is non- significance.

Table 7. Means some of squires from combined analysis of variance for grain quality of maize across 2009 and 2010.

Characters	Source of variation			
	Year (Y) d.f=1	Treatment (T) Df=8	Y xT d.f=8	Pooled error df=48
Moisture content	26.16**	0.15ns	0.18ns	0.34
Dry matter content	26.16**	0.15ns	0.18ns	0.34
Ash content	0.02ns	0.06ns	0.07ns	0.05
Fat content	1.56ns	0.40ns	0.29ns	0.26
Crude fiber content	9.77**	0.36ns	0.57ns	0.36
Crude protein content	74.24**	4.31**	4.41**	1.16
Tannin acid content	0.001ns	0.003ns	0.002ns	0.001
Carbohydrate content	144.13**	5.01**	6.37**	2.07

* =highly significant at 1% level of probability, ** =significant at 5% level of probability, ns= is non- significance.

Furthermore, considerable effects on the biochemical attributes used to measure the grain quality were also recorded. Environmental conditions had a clear impact on maize productivity.

Conflict of Interests

The authors have not declared any conflict of interests.

ACKNOWLEDGMENTS

The authors are indebted to the Collage of Agricultural Studies, University of Sudan, Agricultural Research Corporation, Sudan and to Animal Research Center for effective cooperation.

REFERENCES

Abdullahi R, Sheriff HH, Buba A (2014). Effect of bifertilizer and organic manure on growth and nutrients content of pearl millet.ARPN. J. Agric. Biol. Sci. 9(10):351-355.

Abdullahi R, Sheriff HYH, Lihan S (2013). Combine effect of bio-fertilizer and poultry manure on growth, nutrients uptake and microbial population associated with sesame (*Sesamumindicum* L.) in North-eastern Nigeria. Int. Environ. Sci. Toxicol. 5(5):60-65.

Ali MA, Nazi S, Abbes A, Saber W, Jabbing K (2009). Genetic diversity and assessment of drought tolerance sorghum landraces based on morphological traits at different growth stages. Plant Omits. J. 2(5):214-227.

Anees MU, Khan HZ, Ahmed Z (2016). Role of amendments and micronutrients in maize (*Zea mays* L.) sown in calcareous soils. Am. Eur. J. Agric. Environ. Sci. 16(4):795-800

AOAC (1984). Association of Official Analytical Chemists. Official Method of analysis. 14 th eds., Washington DC.

Anderson JM, Ingram JS (1993). Tropical soil biology and fertility.A Handbook of Methods.2nd edition.CAB. International Wallingford UK.

Ayeni LS, Adetunji MT (2010).Integrated application of poultry manure and mineralfertilizer on soil Chemical properties, nutrient uptake, and yield and growth components of maize**.** Nat. Sci. 8:1.

Baser KS, Mirshekari B, Farahvash F (2012) . Improvement of corn yield by seed biofertilization and urea application. World App. Sci. J. 16(9):1239-1242.

Brady NC, Weil R (2005). The Nature and Properties of Soil, 13rd. edition. Macmillan Publishing Co, New York.

Elsheikh EAE, Mohameszein ME (1998). Effect of *Bradyrhizobium*, VA mycorhiza and fertilizers on seed composition of groundnut. Ann. Appl. Biol. 132:325-330.

Farhad W, Saleem MF, Cheema MA, Hammad HM (2009). Effect of poultry manure levels on the productivity of spring maize (*Zea mays* L.). J. Anim. Plant Sci. 19(3):122-125 .

Gomez KA, Gomez AA (1984). Statistical Procedures for Agricultural Research. John Wiley and Sons, Inc., New York, USA.

Habashy NR, Hemeid NM (2011). Effects of elemental sulphur and partial substitution of N-mineral fertilizer by organic amendments on some properties of slight saline soils. J. App. Sci. Res. 7(12):2102-2111.

Haque MM (2003). Variety development of maize and its characteristics in Bangladesh. Production and uses of maize in Bangladesh. Published by BARI, CIMMYT and Integrated Maize Development Project, Bangladesh pp. 17-22.

Hossein S, Farshad G (2013). Response of growth and yield of maize to biofertilizers in organic and conventional cropping systems. Int. J. Agric. Crop Sci. 5(7):797-801.

Kumaresan G, Reetha D (2011). Survival of *Azospirillum brasilense* in liquid formulation amended with different chemical additives. J. Phytol. 3:48-51.

Mahfouze SA, Sharaf-Eldin MA (2007). Effect of mineral vs. biofertilizer on growth, yield and essential oil content of fennel (*Foeniculum vulgare* Mill.). Int. Agro. Phys. 21:361-366.

Mugilan I, Gayathri P, Elumalai EK, Elango R (2011). Studieson improve survivability and shelf life of carrier using liquid inoculation of *Pseudomonas striata*. Int. J. Pharm. Biol. Arch. 2(4):1271-1275.

Naserirad H, Soleymanifard A, Naseri R (2011). Effect of integrated application of bio-fertilizer on grain yield, yield components and associated traits of maize cultivars. Am. Eur. J. Agric. Environ. Sci. 10(2):271-277.

Price ML, Scoyoc VC, Butler LO (1978). A critical evaluation of vanillin reaction as an assay for tannin in sorghum grain. J. Agric. Food Chem. 26:1214-1248.

Raaijmakers JM, Vlami M, Souza JT (2002). Antibiotic production by bacterial biocontrol agents. Antonie van Leeuwenhoek 81:537-547.

Richard LA (1954). Diagnosis and improvement of saline and alkali soils. Handbook No. 60.U.S. Dept. of Agriculture. Washington.

Salantur A, 0zturk A, Akten S (2006). Growth and yelid response of spring wheat (*Triticumaestivum* L.) to inoculation with Rhizobacteria. Plant Soil Environ. 52:11-118.

Suhag M (2016). Potential of biofertilizers to replace chemical fertilize. Int. Adv. Res. J. Sci. Eng. Tech. 3(5):163-167

Tagne A, Feujio T P, Sonna C (2008). Essential oil and plant extracts as potential substitutes to synthetic fungicides in the control of fungi. International Conference Diversifying crop protection, 12-15 October La Grande-Motte, France.

Tarang E, Ramroudi M, Galavi M, Dahmardeh M, Mohajeri F (2013). Effects of Nitroxin bio-fertilizer with chemical fertilizer on yield and yield components of grain corn (cv. *Maxima*) Int. J. Agric. Sci. 3(5):400-405.

Yu L, Chen B, Yu S, Li Z, Min Z (1999). Effects of organic and chemical complex fertilizers treated with EM. Sixth International Conference on Kyusei.Nature Farming Pretoria, South Africa, 28-31 October.