SUST Journal of Agricultural and Veterinary Sciences (SJAVS)
Vol. 20 No.(2)
ISSN: 1858 6775
December 2019

SUST
Journal of Agricultural and Veterinary Sciences
Journal homepage:
http:// journals.sustech.edu

Addition of Natural Plant Products for Efficient Nitrogen Uptake in Maize (*Zea mays* L.)

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Article history: Recieved: March 2019
Accepted: August 2019

Abstracts

The experiment was carried out for tow season summer and winter of 2016/2017 at the Demonstration Farm of College of Agricultural Studies, Sudan University of Science and Technology, Shambat, Sudan, to study the Addition of Natural Plant Products for Efficient Nitrogen Uptake in Maize (*Zea mays* L.) The layout of the experiment was factorial randomized complete block design (RCBD) with three replications. Hudiba -1, cultivar was grown under two levels of nitrogen in (urea 45%) Vi3.N (40kgN/ Ha) and N_2 (80 kg N /Ha) with five plants powder each weight 40kg/ha of the following plants 40kg/ Ha): Neem seeds (*Azadirachta indica* L., Mint leaves (*Mentha spicata* L.) Moringa leaves (*Moringa olifera* L.) and Shaih seeds (*Artimissia annua* L.) with control. The treatments were ten combinations in a randomized as follows: Urea (40 kg N/Ha), Urea (80kgN/ Ha), Urea (40kgN/ Ha+Neem powder),Urea (40kgN/ Ha + Moringa powder), Urea (40kgN/ Ha+ Mint powder), Urea (40 kg N/Ha + Shaih powder), Urea (80kgN/Ha+ Neem powder), Urea (80kgN/Ha+ Moringa powder), Urea (80kgN/Ha +Mint powder) and Urea (80 kg N/Ha +Shaih powder) Six yield compontes were measuared in chuded, number of rows,cob,lengthof cob (cm),number of seeds,row,plant,seed weight (gm)and grain yield(t/ha). The results showed only significant difference in number of row per cob, length of cob, seed per plant and 100 seed weight. The natural products were significant for only number of seeds per row. 80 kgN/Ha fertilization was generally better than 40 kg N/Ha, fertilization. However, different plant products increased nitrogen uptake and utilization by maize plant. Neem at 80 kgN/Ha nitrogen had the highest maize yield (1.8 T/Ha).

Keywords: Maize Hudiba -1, Nitrogen levels, Natural plant products

Introduction

is one of the important cereal crops because of the increasing demand for food and livestock feed. Nitrogen is an essential nutrient for plant growth and development in corn (Upadhyay *et al*., 2011). Large quantities of chemical fertilizers are used to replenish soil N resulting in high costs and severe environmental contamination. Nitrogen is a major limiting nutrient for crop production. It can be applied through chemical or biological means. Over application can result in negative effects such as leaching, pollution of water resources, destruction of microorganisms and friendly insects, crop susceptibility to disease attack, acidification or alkalization of the soil or reduction in soil fertility,thus causing irreparable damage to the overall system. Nitrification, a microbial process, is a key component and integral part of the soil nitrogen (N) cycle. It is the biological oxidation of ammonia (NH_3) to nitrate (NO_3) and is carried out by two groups of chemolithotrophic bacteria (*Nitrosomonas* spp. and *Nitrobacter* spp.), which are ubiquitous on earth (Norton *et al*., 2002). In agricultural systems, rapid and unchecked nitrification, however, results in inefficient N use, N leakage, and environmental pollution (Subbarao *et al*., 2009). The NO_3 formed, is highly susceptible to losses from the root zone by leaching and/or denitrification (Subbarao *et al*., 2006). Loss of N from the root zone has large economic implications, as fertilizer losses, besides the unknown cost of environmental consequences such as nitrate (NO_3) pollution of ground water, eutrophication of surface waters, and atmosphere pollution.

Management of nitrification by the application of chemical inhibitors is a proven strategy to improve N recovery, agronomic N use efficiency (NUE) and for limiting environmental pollution (Subbarao *et al.*, 2006; Prasad, 2009). Several synthetic chemicals capable of inhibition of urea hydrolysis or nitrification in soils have been evaluated.These examples include N-serve (nitrapyrin), dicyandiamide (DCD), AM (2-amino-4 chloro-6 methyle pyrimidine), sodium chlorate, sodium azide, and benzene hexachloride (C6H6Cl6). Many of these products, however, have been restricted to the experimental stage because of the high cost, limited availability, and adverse influence on beneficial soil microorganisms and, above all, poor extension and promotional activities for taking the technology to the farmers. Plant based nitrification inhibitors, which are eco-friendly and biodegradable, therefore hold considerable promise. Indeed, suppression of soil nitrification has been observed in some natural ecosystems (natural nitrification inhibition). It aims to conservation of soil N and improved N status through development of low NO_3 – ecosystems (Lata *et al.*, 2004; Subbarao *et al.*, 2006).

Several empirical studies have indicated that some plants and their byproducts inhibit nitrification (Lata *et al.*, 2004; Patra *et al.*, 2006 patra et al., 2009).*Brachiaria humidicola* (Rendle) Schweick, Karanj (*Pongamia glabra* Vent.), sweet sorghum (*Sorghum bicolor* (L.) Moench), neem (*Azadirachta indica* Adr. Juss.), tea (*Camellia sinensis* (L) O'kuntze), linseed oil (*Linum usitatissimum* L.), mahuwa (*Madhuca latifolia* (Roxb.) J.F. Macbr.), *Pyrethrum* spp., *Artemisia annua* L. and mint (*Mentha spicata* L.) are important sources of natural nitrification inhibitors (NNI). However, the concept remained largely unsupported for lack of an appropriate methodology to conclusively demonstrate *in situ* inhibition of nitrification by such plant derived chemicals (Subbarao *et al*.,2006). The reason may be lack of commercial product development using such chemical compounds. Natural nitrification inhibitors are also cheaper than the synthetic nitrification inhibitors because it is sourced from various types of grasses, agricultural crops, essential oil crops, plants or by their byproducts. Recent work on medicinal and aromatic plants and their oils/ derivatives indicated strong ability to reduce nitrification (Patra *et al*., 2006; part et al.,2009). As the products (NNI) are obtained from naturally growing plants, they are eco-friendly, and are also easily available in the rural areas or can be included in the farming systems, implying lower cost of production compared to synthetic nitrification inhibitors. There are, however, certain constraints which make NNI less acceptable. Lack of research and product development (RPD), poor extension and inefficient promotional activities, absence of regulatory control on its use in agriculture, and difficulties in the extraction and purification of the compounds are important in this context; most of these, however, can be overcome by organized research, extension, and marketing efforts. The objective of this work is to study some of the Natural Nitrification Inhibitors (NNI) and to promote N use efficiency of maize yield and yield component.

Materials and Methods

The experiment was carried out for tow season summer and winter of 2016/2017 at the Demonstration Farm of Collage of Agricultural Studies Sudan University of Science and Technology at Shambat, Sudan to study the effect of natural plant products on maize yield and yield compound `Shambat is located (LAT: 15º 40'N LONG: 32º 32'E and ALT.: 380 M), and altitude 380 m above sea surface, it climate it semi-desert region (Adam, 2002). The soil of the site is described by (Abdelhafiz, 2001) as loom clay, it is characterized by a deep cracking moderately alkaline clay, and bad texture and water holding capacity, and low permeability, low nitrogen content and pH (7.5-8) and high exchangeable sodium percentage (ESP), in sub soil.

The layout of the experiment was conduted by using factoral randomized complete block design (RCBD) with three replications. Hudiba -1, cultivar was grown under five treatments and two, Nitrogen levels in (urea 45%) plant powder of the following plants (20kg/ Ha): was used is the following :

1. Neem seeds (*Azadirachta indica* L.)
2. Mint leaves (*Mentha spicata* L.)…..
3. Moringa leaves (*Moringa olifera* L.)
4. Shaih seeds (*Artimissia annua* L.).
5. The treatment were ten combinations in a randomized complete block design (RCBD) with three replications as follows:
   1-Urea (40 kg N/Ha)
   2-Urea(80kgn/Ha)
   3-Urea (40kgN/Ha+Neem powder)
   4-Urea (40kgN/Ha +Moringa powder)
   5-Urea (40kgN/Ha +Mint powder)
   6-Urea (40 kg N/Ha +Linseed or Shaih powder)
   7-Urea (80kgN/Ha+Neem powder)
   8-Urea (80kgN/Ha +Moringa powder)
   9-Urea (80kgN/Ha +Mint powder)
   10-Urea (80 kg N/Ha +Linseed or Shaih powder)

Source of seeds

Cultivar Hudiba-1 used in the experiment was obtained from Environmental Natural Resources and Desertification Research Institute, Khartoum, Sudan.

The studied parameters include

Number of rows per cob (N.R.C.), length of cob (cm) (L.C.), number of seeds per row (N.S.R.),number of seeds per plant (NS/Plant), 100 seed weight (g), (100 seed W.T.) (g) and seed yield (t/ha).

Results

The results Showed Significant differences for number of rows per cob, Length of cob, seeds per plant and 100 seed weight for fertilization, number of seeds per row for plant product, and non significant for the interaction (table 1). The results, showed significant difference among all treatment, for fertilizer except number of seeds per row Natural Products was significant only for number of seeds per row and interaction showed no significant difference for all (table 1).

Table 1. Summary of the ANOVA table for fertilizer, Natural Products of Maize

Source	D.f.	N.R.C	L.C	N S.R	N S/plant	100SEEd WT	Yield t/ha
		F-table	F-table	F-table	F-table	F-table	F-table
Refraction	2	0.28	0.22	0.98	0.01	1.51	0.10
Fertilizer	1	0.01*	5.55*	2.21^{NS}	4.11*	7.77*	2.54^{NS}
Natural Product	4	4.58^{NS}	0.33^{NS}	3.79*	0.69^{NS}	1.37^{NS}	0.80^{NS}
F*N	4	2.28^{NS}	0.87^{NS}	0.48^{NS}	1.09^{NS}	1.40^{NS}	1.80^{NS}
Error	18	-	-	-	-	-	-
Total	29	-	-	-	-	-	-
CV%	-	8.33	15.2	23.2	36.88	12.91	34.6
EMS	-	1.03	12.8	20.3	139.81	5.80	0.17

NS= not significant, *= significant at 0.05%

Grain Parameters:

Weight of seed per plant at 80kg nitrogen was more than 40kgnitrogen(36.44g).while the weight of seed per plant was higher for shih(36.62 gm).The interaction showed that moringa at80kg had the highest weight per plant (43.05gm) (table2). 100 seed weight was higher for 80kg nitrogen than 40kg while the control showed the highest 100 seed weight. The interaction showed that mint at 80kg nitrogen had the highet 100seed weight (table3). Yield was higher for 80kg than 40kg.while the yield of moringa was the highest. Interaction showed that moringa at 80kg nitrogen had the highet yield (1.68t/h) (table4).

Table 2. Yield and Yield components of Maize at Different Plant products.

Plant Products	Yield and yield compound					
	Seeds/ Plant	100seeds of weight(gm)	N of seeds / Cob	Length of Cob	N of S/ R	Yield (t\ha
Control	25.94^{B}	20.03^{A}	11.40^{B}	22.23^{A}	20.46^{AB}	0.95^{B}
Mint	34.46^{A}	19.53^{B}	12.11^{B}	23.48^{A}	14.70^{C}	1.14^{A}
Neem	32.04^{A}	17.15^{B}	12.25^{B}	23.91^{A}	24.30^{A}	1.24^{A}
Moringa	31.24^{A}	18.20^{B}	11.53^{B}	24.51^{A}	17.56^{BC}	1.33^{A}
Shaih	36.62^{A}	18.32^{B}	13.63^{A}	23.73^{A}	20.25^{AB}	1.27^{A}
Mean	32.06	18.64	12.18	41.59	19.45	25.73
CV%	36.88	12.91	8.33	15.15	23.17	34.6

Table 3. Yield and Yield components of Maize at Different Nitrogen Levels.

Nitrogen levels	Yield and yield compound					
	Seeds/ Plant	100seeds of weight	N of rows of Cob	Length of Cob	N of Seeds/ row	Yield
40kg	27.68^{B}	17.43^{B}	12.20^{A}	25.11^{A}	20.68^{A}	1.07^{B}
80kg	36.44^{A}	19.88^{A}	12.16^{B}	22.04^{B}	18.23^{B}	1.30^{A}
Mean	32.06	18.65	12.18	23.57	19.45	1.18
CV%	36.88	12.91	8.33	15.15	23.17	34.6

Table 4. Interaction of Yield and Yield components of Maize at Different Nitrogen Levels and Plant Product.

Nitrogen levels	Plant Products	Yield and yield compound					
		Seeds/ Plant	100seeds of weight	N of Seeds Per Cob	Length of Cob	N of Rows of cob	Yield
40kg	Control	22.98^{D}	18.77^{B}	11.96^{B}	18.63^{D}	21.20^{A}	0.86^{B}
	Mint	35.03^{B}	17.97^{C}	12.60^{B}	22.66^{C}	13.86^{C}	1.32^{A}
	Neem	21.03^{D}	17.67^{C}	11.30^{B}	23.96^{C}	21.96^{A}	0.79^{B}
	Moringa	30.53^{C}	17.13^{C}	11.30^{B}	22.63^{C}	16.26^{B}	1.59^{A}
	Shaih	28.52^{C}	15.50^{D}	13.86^{A}	22.30^{C}	17.86^{B}	1.20^{B}
	Mean	36.88	12.91	8.33	15.15	23.17	1.15
	CV%	34.99	19.99	13.87	25.06	22.86	34.6
80kg	Control	28.9^{C}	21.30^{A}	10.83^{C}	25.83^{A}	19.73^{A}	1.04^{B}
	Mint	33.55^{B}	21.17^{A}	11.63^{B}	24.30^{B}	15.53^{C}	0.96^{B}
	Neem	43.05^{A}	16.63^{C}	13.20^{A}	23.86^{B}	18.86^{B}	1.68^{A}
	Moringa	31.95^{C}	19.27^{B}	11.63^{B}	26.40^{A}	18.86^{B}	1.50^{A}
	Shaih	44.72^{A}	21.03^{A}	13.40^{A}	25.16^{A}	22.63^{A}	1.34^{A}
	Mean	36.43	19.95	12.13	25.11	19.12	1.30
	CV%	36.88	12.91	23.17	15.15	8.33	34.6

Discussion

The nitrogen levels showed significant differences for number of row/cob, length of cob, seeds /plant and 100seed weight which indicates that these Nitrogen levels for all character were greatly flounced except numbered of seed /row and yield kg/ha almost all characters were adversely affected by 80kg/ha, and control on were found to decrease in all characters for yield and its components. The characters as influenced by 80kg/ha showed significantly maximum effects for number of row/cob (12.2), length of cob (25.1), number of seeds/row (20.7), seeds /plant and 100seed weight. Maize yield is high with fertilizer dose as maize grain yield is highly responsive to supplemental nitrogen (Moose and Below,2008).In this study significant difference were detected in 100 seed weight, and grain yield and harvest index due to nitrogen fertilizer .significant different in nitrogen levels ,plant products and interaction.plant products a significant in number of seed per row.the .result of this study indicated that the difference plant products affects nitrogen uptake and increase it utilization by maize plant .yield was increased for the higher nitrogen application (80kg/ha) when we add neem moringa and shaih However when mint was added the yeld of maize was higher at 40kg/ha nitrogen .Nitrogen use efficiency decreased significantly with the increase of nitrogen rate . probably this could be attributed were unable to assimilate all of nitrogen taken up .similar result was reported by ciambalvo et al.,(2009) who indicated that nitrogen use efficiency decreased with increase taken up. Addtion f plant productes may increase this efficiency.

Optimization of nitrogen used to sustain life and to minimize the negative impacts of nitrogen on the environment and human health is most important. Nitrogen use efficiency (NUE)which is considered an important factor in the management of nitrogen applications in crop production, is expressed as the ratio between the grain yield and the total nitrogen accumulation. The assessment of the suitable nitrogen applications is a vital concern. the nitrogen uptake efficiency. Nitrogen is lost merrily through leaching, denitrification, volatilization crop removed sad erosion and run off. To minimize losses and increase nitrogen uptake, powder of some plants Vi2 ,moringa, shih,neem,mint. the efficiency and cut the cost of production. They act a natural nitrification inhibitors. The natural plant used showed a variable results. At 80kg nitrogen Moringa had the height and length of cob while neem gave the highet stem diameter and yield while shih the height seed per plant and seed per row. However at the pot experiment most of the nitrogen was lost and less nitrogen uptake was used by the plant at the lowest nitrogen rate (40kg). Moringa had the highest plant height and the control showed the highest number of leaves, fresh and dry weight. This might be due to the lesse benefit of the nitrogen uptake by maize as most of the nitrogen is lost merrily through dnitification. This was supported by the findings of Raun and Johnson (2017) and Abera *et al* 2016. Sevral other empirical studies have indicated that some plants and their byproducts inhibit nitrification (Lata *et al* 2004, Patra *et al* 2006, 2009).

As a conclusion, the following fact: can be mentioned:

1. The nitrogen significant increased most of vegetative growth characters.
2. Shih gave the highet seed per plant of maize at they no significant difference between plant products.
3. 80kg\ha nitrogen was better for all character measured with the use of Plant products.
4. Different plant products increase nitrogen uptake and utilization by maize.
5. Neem, Moringa and Shiah gave the highet Maize yield at 80kg\ha nitrogen.
6. More studies are needed on the study of nitrogen use efficiency and nitrogen uptake.

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إضافة مسحوق النباتات الطبيعية لزيادة إمتصاص النتروجين في الذرة الشامية (.*Zea mays* L)

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المستخلص

أجريت التجربة في موسمي الشتاء والصيف 2016–2017م بمزرعة كلية الدراسات الزراعية (شمبات) جامعة السودان للعلوم والتكنولوجيا لدراسة أثر إضافة المواد النباتية الطبيعية لتثبيت النتروجين وزيادة إمتصاصه بواسطة النبات لمحصول الذرة الشامي. صممت التجربة بواسطة التجربة العاملية بتصميم القطع العشوائية بثلاثة مكررات. زرعت الذرة الشامية صنف حديبة 1 تحت مستويات نتروجين (يوريا 45%) 40 كيلوجرام و 80 كيلوجرام للهكتار وخمسة مساحيق من بدرة النباتات (40 كلجم للهكتار) النيم، النعناع، المورينقا، الشيح مع شاهد بدون إضافة وكانت المعاملات 10 مكونات من اليوريا بمستويين و 5 نباتات طبيعية وتم قياس الأنتاجية ومكوناتها وهي طول النبات ,طول الورق ,سمك الساق وعدد الصفوف في القندول الواحد وطول الصف و عدد البذرة في الصف و الوزن الرطب والوزن الجاف والأنتاجية الطن/ هكتار. أوضحت النتائج وجود فروقات معنوية لعدد الصفوف بالكوز وطول الكوز وعدد البذور بالنبات ووزن المائة بذرة. وكانت بدرة النباتات الطبيعية معنوية لعدد البذور في الصف.وكانت إضافة 80 كلجم للهكتار أفضل من 40 كلجم للهكتار. وقد زادت بدرة النباتات الطبيعية زيادة إمتصاص النتروجين بواسطة محصول الذرة الشامية. مسحوق النيم مع 80 كلجم للهكتار نتروجين أعطى أعلى معدل إنتاج.