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Crops Response to Application of "Elixir" a New Bioactivator and Organic Fertilizer underTropicalConditions of Khartoum State

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Abstract

Three experiments were conducted under field and on-farm conditions at different locations in Khartoum State, Sudan in 2013 and 2014. The main objective was to study the effect of a new bioactivator and organic fertilizer ''Elixir'' on growth and yield of table grapes, alfalfa and muskmelon. Treatments were arranged in four blocks in a randomized complete block design for table grapes and muskmelon and in completely randomized design with three replicates for alfalfa. The results showed that application of Elixir, at the rate of (36 l/ha) split in five weekly doses under tropical conditions of Khartoum, significantly improved growth and yield parameters of table grapes *Vitis vinifera* L. Yield of table grapes increased steadily with increase in number of applications in both sites. High fruit cluster weights of 565.1 and 600.0 g and total yields of 27.7 and 41.3 t/ha, were recorded by variety Cardinal, from sites I and II, respectively. Fruits TSS was not significantly affected by Elixir. Supporting noticeably high yield increases were attained from on-farm trials by Elixir at Dal Agric. project on a new alfalfa (*Medicago sativa* L.) crop by 30.4% and the old crops by 42.0% and 35.1% in Dal and 72.7% and 169.6% in Inmaa project for first and second cuts, respectively. Likewise, application of 36l/ha of Elixir significantly increased muskmelon (*Cucumis melo* L.), variety Green Star; yield to 24.7 t/ha. Based on the above results, Elixir at the rate of 36 l/ha split in equal weekly doses significantly improved growth and productivity of table grapes, alfalfa and muskmelon under hot tropical conditions of Khartoum State.

Keywords: biofertilizer, Elixir, field crops, tropical conditions, yield increase

Introduction

Heavy use of agrochemicals since the "green revolution" of the 1960s boosted food productivity at the cost of environment and society (Sujit, 2012). Harmful effects of these chemicals on human, animals and environment started to be claimed and reported for the last three decades. Consequently, scientists looked back to nature and organic inputs gained more attention and support from the International Federation of Organic Agriculture Movements (IFOAM) and other environment concerned bodied all over the world.

Organic farming is a method of farming system which primarily aims at cultivating the land and raising crops in such a way, as to keep the soil alive and in good health. Organic wastes (crop, animal and farm wastes, aquatic wastes) and other biological materials along with beneficial microbes (bio-fertilizers) are used to release nutrients to crops. Organic farming increase sustainable production in an eco-friendly pollution free environment (Willer, 2009). In view of increasing global awareness, there are also growing research activities worldwide concerning organic inputs. The advantages of the organic system in terms of ecosystem conservation, food quality and economic performance have been demonstrated by numerous studies (Pimentel et al. 2005, Offermann and Nieberg 2000, Stolze et al. 2000). In low-income countries of the tropics, Non Governmental Organizations and farmers' groups are now increasingly adopting organic techniques as a means of improving productivity and food quality and security. Total global land area under organic farming increased steadily from 11.0 million ha in 1999 to 35.3 million ha in 2008. These 35.3 million hectares of agricultural land are managed organically by almost 1.4 million producers. The largest organic land areas are in Australia, Argentina and Brazil (Helga, 2010). Area under organic farming in Sudan is only 54.8 thousand ha (FiBL-IFOAM, 2012).

The soil microbial biomass is a small but key component of the active soil organic matter pool and serves as a source and sink of soil nutrients (Smith, and Paul, 1990). According to Castro and Pereira (2008), bio-activators are defined as a complex organic substance that can alter the growth, capable of acting on the DNA transcription into the plant, gene expression, membrane proteins, metabolic enzymes and mineral nutrition. Arief Budiono *et al.*(2013) reported that composting process can be accelerated by adding a mixture of various cultures microorganisms as decomposers. They added that decomposers of organic materials on the market and containing various types of microorganisms are EM4, Stardec, Biocompos, Orgadec, Starbio, Messbio. Mixture of microorganisms in bioactivators can be bacteria, actinomycetes, yeasts, and molds (Arief Budiono *et al.* 2013). Based on the experimental results carried out by Yun Sondang *et al.* (2014) it can be concluded that giving of bio-activators can accelerate the composting of livestock feces and lower C/N ratio. Mejbah Uddin *et al.* (2012) reported that phosphorus concentration in plant parts increased with organic amendments. In the last ten to fifteen years the importance of micro-organisms in decomposition of organic residues, release of nutrients, availing of nutrients to the plants in available forms and conditioning of soils were recognized and started to be utilized (Yousif et al. 2009). Reports by Arief Budiono *et al.* (2013) indicated that addition of bioactivators increased the amount of apple fruit per tree by 58.57 to 67.14%, and increased the of fruit weight by 74.51 to 135.91% compared to control. Studies carried out by Netsanet Ayele *et al.* 2014) on sugar cane indicated that sole application of bioactivators Agrostemin and Crops® resulted in a 13.56 and 12.86 % increase in sucrose percent cane against the check (200 kg /ha urea) as well as the possibility of harvesting cane earlier at the age of 12 months.

Elixir is a new bioactivator and organic fertilizer produced in Sudan. All inputs of Elixir are organic and are readily available locally in Sudan. The product is proved eco-friendly and 100% safe for human beings, animals and plants and does not contain any

harmful synthetic chemicals that cause allergy, toxicity or diseases. It contains considerable amounts of macro elements and sufficient amounts of micro and trace elements and it also contains Millions of beneficial microorganisms which are living organisms produced from, and adapted to, tropical environments.

Availability of nutrients is a problem in heavy clay soils which are predominant along the main plant producing schemes in Sudan as well as in many tropical countries. Organic inputs are generally in short in this part of the world. Converting our agricultural products, mainly the exports, from conventional to high paying organic products requires availability of organic inputs and at affordable prices. The main objective behind these experiments was to study the ability of a new bio-activator and organic fertilizer "Elixir" to increase productivity and quality of plant crops.

Materials and Methods

Three experiments were carried out under field and on-farm growing conditions at different sites in 2013 and 2014 in Khartoum State (coordinates: 15:26 to 15:45 N, 32:25 to 32:40 E and 380 to 405 m asl). The annual mean temperature in Khartoum is 29.9^{0}C, the average maximum is 37.3^{0}C and the average minimum is 22.3^{0}C. The bio-activator and organic fertilizer "Elixir" was supplied by Bioactivator Factory for Agricultural Fertilizers, the Industrial Area, Khartoum North. Soil and plant analysis and the microbiological and chemical analysis of Elixir were carried out at the laboratories of the Department of Soil and Environment Science, Faculty of Agriculture, University of Khartoum. All micro-organisms in Elixir are indigenous beneficial bacteria and the main ones are: Photosynthetic Bacteria, Lactic Acid Bacteria, Yeast,Actinomycetes and Fungi. It is acidic with pH between 3.0 and 4.5. Themain nutrients in Elixir are shown in (table1).

Table 1: The chemical analysis of Elixir

ECe dSm^{-1}	N (mg/l)	P	K	Ca	Mg	S	Fe	Mn	Na	Cu	Zn
		(ppm)									
6.0	1540.0	18.0	272.5	300.0	120.0	137.2	343.96	102.1	73.9	0.51	1.73

Elixir was applied at the rate of 36 l/ha (15 l/Fed) split into equal weekly doses. Application means of Elixir were shown for each experiment. The studied parameters were growth and yield parameters. All collected data were summarized and statistically analyzed for each experiment.

Effect of Elixir on productivity and fruit quality of table grapes:

Two experiments were carried out on two different sites in Elsilate North, Khartoum North, Sudan, in 2013. Site-I soil was classified as clay soil with 41, 45 and 14%, clay, sand and silt, respectively. Site-II soil was sandy clay loam with 32, 47 and 21%; clay, sand and silt, respectively. In both experiments, the effect of applying Elixir on productivity and fruit quality of table grapes cultivar Cardinal was evaluated. Five, two years old, plants per treatment at 2mx2.5m spacing within and between plants were used. A basal dose of 120 NPK (20:20:20) was applied for all plots. Elixir was applied after winter pruning in the last week of November by soil spraying at root zone immediately before irrigation. Four treatments were arranged in a randomized

complete block design repeated in four blocks. Application rate was 4.0 ml/plant on one week intervals and the four treatments were (0, 1, 3 and 5application times) that add-up to, 0.0, 7.2, 21.6 and 36.0 liters of Elixir per hectare, respectively. The studied parameters were cluster weight (g), total yield (t/ha) and fruit quality (TSS) of table grapes. Collected data was statistically analyzed and mean yields were separated using DMRT.

On-farm trials on Elixir

On-farm experiments were carried out on Alfalfa at the central pivots at two locations, Dal Agri. Waha Project, Khartoum North and Inmaa Project, West of Omdurman in season 2013/2014. A basal dose of 47 kg/ha Urea + 120 kg/ha Dap was applied for all pivots. Elixir, at the rate of 36l/ha was applied to half pivots using completely randomized design replicated in three pivots in each project on a new crop and on a one year old crops. The other halves of the pivots were left untreated as controls. The area of each pivot was 60 hectares. Elixir was applied split into three weekly doses with irrigation water through the fertivigation tank of the pivot. Alfalfa yield was expressed in t/ha/cut and percentage yield increase for each cut was calculated.

Another onfarm trial was carried out in 2013 at Esilate Scheme, Khartoum North to study the effect of Elixir on yield (t/ha) of muskmelon cultivar, green star. A basal dose of 120 NPK (20:20:20) was applied for all plots. Elixir was applied using a knapsack sprayer in three rates (0, 36 and 71 l/ha) split in three equal doses. Randomized organic fertilizers werereported by Offermann and Nieberg (2000). Moreover, addition of bio-activators increased the amount of apple fruit per tree and fruit complete block design with four replicates was used. Yield in t/ha was evaluated.

Results and Discussions

Results from the three crops were collected, summarized and analyzed as shown on the tables below.

Effect of Elixir on productivity and fruit quality of table grapes

Application of 36 l/ha of Elixir at the rate of 4.0 ml/plant resulted in significantly high cluster weight at both sites with five weekly applications. Cluster weight increased with increase in application times of Elixir (table 2). However, Elixir at both sites didn't show significant differences for total soluble solids (TSS). Productivity of grapes was improved markedly by Elixir and high yields were recorded at site II (41.3 t/ha) and site I (27.7 t/ha) at high times of applications (five times). Elixir, being rich in nutrients (table I), might have improved the supply of nutrients to table grape plants. Furthermore, the combination of low pH and high counts of indigenous beneficial micro organisms in
Elixir, likely, improved nutrients availability and the physical and biological soilproperties that ended to high increase in yields. Similar altering of growth andimproving of metabolic enzymes and mineral nutrition by bio-activators was reported by Castro and Pereira (2008).
Additionally, significant phyto availability of Phosphorus by organic amendments was reported by Mejbah Uddin *et al.* (2012). Supporting remarkable yield increases from application of
weight as found by Arief Budiono *et al.* (2013) while, Netsanet Ayele *et al.* 2014) reported increase in sucrose percent in sugar cane.

Table 2: Effect of Elixir, (4ml/plant) applied 0, 1, 3 and 5 times on cluster weight (g) and TSS of table grapes variety Cardinal at two sites at Elsilate, Khartoum North (2013)

Parameter	Cluster wt. (g)		TSS	
Site	Site I	Site II	Site I	Site II
Zero Applications	278.1	366.7	15.67	17.17
1 time	251.9	443.3	16.00	16.67
3 times	291.7	516.6	17.00	18.00
5 times	565.1	600.0	16.67	18.00
P. value	<.001	0.001	0.812	0.284
SE	22.25	39.20	1.51	0.59
LSD	516.9	88.80	3.42	1.33
CV%	9.3	11.4	13.1	4.8

The overall performance at site:II was better than at site:I (table 3). This may be due to the relatively better physical soil conditions at site II. Soils of site I was classified as clay soils while that of site II was sandy clayloam.Application of the organicfertilizerandbioactivator, Elixir, at the rate of (36 l/ha), split in five weekly doses under tropical conditions, significantly improved growth and yield parameters of table grapes.

Table 3: Effect of Elixir, (4ml/plant) applied 0, 1, 3 and 5 times on productivity (t/ha) of table grapes variety Cardinal at two sites at Elsilate, Khartoum North (2013)

Application times	0	1	3	5
Site – I	14.4(b)	13.7 (b)	16.9 (b)	27.7(a)
Site – II	14.7(c)	21.9(bc)	25.3(b)	41.3(a)

Means with the same letters along the same raw are not significantly different at (0.05).

Economically, the increase in table grapes yield was 13.3 and 26.6 t/ha in sites I and II, respectively, which add up to 133 and 266 thousand Sudanese pounds (SDP) extra profit/ha with the assumption of a farm gate price of 10 Sudanese pounds/kilogram of grapes. The total cost per hectare including Elixir (10 pounds/l) and labor (70 pounds per working day) is about 700 pounds/ha. The net profit and marginal rate of returns are, 132.3 thousand SDP and 18900% and 265.3 thousand SDP and 37900% per hectare for sites I and II, respectively. It is remarkably feasible even under the margins of 10% yield reductions and 10% increase in costs (table 4).

Table 4: The economical analysis of the effect of Elixir on table grapes (varietyCardinal) yield at two locations at Elsilate, Khartoum North (2013)

	Control	Elixir	Difference
A-Total cost that vary (SDG/ha)			
Cost of Elixir (SDG/ha)	0.00	350	350
Cost of labor (SDG/ha)	0.00	1000	1000
Total cost that vary (SDG/ha)	0.00	1350	1350
B- Total gross field benefits			
Combined average yield (t/ha)	14.5	34.5	20.0
Farm gate price (SDG/t)	10000.0	10000.0	10000.0
Gross benefits (SDP/ha)	145000	345000	200000
Net benefit (SDG/ha)	145000	343650	198650
MRR%			14715

On-farm trials on Elixir

The on-farm trials on Elixir at Dal Agric. project increased the yield of the new alfalfa crop by 30.4% and the old crop by 42.0% and 35.1% for the first and second cuts, respectively (table 5). The percentage yield increase of the old crop was even higher in Inmaa project and was 72.7% and 169.6% for first and second cuts, respectively (table5). Supporting remark-able yield increases from application of bioactivators were reported by Offermann and Nieberg (2000), Arief Budiono *et al.* (2013) and Netsanet Ayele *et al.* 2014). The high increase percentage in Inmaaprojectcompared to that in DAl may bedue tothe high level of crop management by highly trained staff with long experience on central pivot system at Dal.

Table (5): Effect of Elixir on productivity of Alfalfa old and new crops (t/ha/cut.) at Dal Agric. and Inmaa Projects, Khartoum State, 2014

Parameter	First Cut			Second Cut		
	Not-treated	Treated	% increase	Not treated	Treated	% increase
DAL Agric(New)	1.02	1.33	30.4%			
DAL Agric.(Old)	1.07	1.52	42.0%	1.19	1.62	36.1%
Inmaa (Old)	0.55	0.95	72.7%	0.69	1.86	169.6%

In another confirming onfarm experiment, application of 36 l/ha and 71 l/ha of Elixir significantly increased musk melon yield to 24.7 and 27.3 t/ha, respectively, compared to zero control (18.6 t/ha). However, no significant differences were noticed between both high rates (table 6). Simmilar yield increases from application of bioactivators were reported earlier by Offermann and Nieberg (2000), Arief Budiono *et al.* (2013)

and Netsanet Ayele *et al.* 2014). These onfarm results confirmed the results from the main experiment that Elixir at the rate of 36 l/ha increased growth and productivity of field crops.

Table (6): Muskmelon yield (t/ha) as affected by Elixir at Elsilate, Khartoum North, 2013

Elixir (l/ha)	Zero	36	71	LSD
Yield (t/ha)	18.6 (b)	24.7 (a)	27.3 (a)	5.2

Means with the same letters along the same raw are not significantly different at (0.05).

Recommendations

Based on the above results we recommend: Application of Elixir at the rate of 36 l/ha in equal split weekly doses for: table grapes (5 doses), Alfalfa and muskmelon (3 doses) under heat stress conditions in thetropics.

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استجابة المحاصيل لاضافة المحفز الحيوي و السماد العضوي الجديد "الاكسير" تحت الظروف المدارية لولاية الخرطوم

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المستخلص:

اجريت ثلاثة تجارب تحت ظروف المزرعة و ظروف المزارع بمواقع مختلفة بولاية الخرطوم بالسودان في الاعوام 2013 و 2014.كان الهدف الاساسي دراسة اثر المحفز الحيوي و السماد العضوي الجديد "الاكسير" في نمو و انتاجية عنب المائدة (*Vitis vinifera* L.) و البرسيم (*Medicago sativa* L.) و الشمام (*Cucumis melo* L.) تحت ظروف اجهاد حراريبولاية الخرطوم. اجريت التجارب في اربعة مكررات بتصميم القطاعات الكاملة العشوائية لعنب المائدة و الشمام و بتصميم عشوائي كامل و ثلاث مكررات للبرسيم. اظهرت التجارب ان اضافة الاكسير بمعدل 36 لتر للهكتار مقسومة على خمسة جرعات اسبوعية تحت الظروف المدارية للخرطوم ادت الى تحسن معنوي لنمو و مؤشرات انتاج عنب المائدة . ازداد انتاج عنب المائدة زيادة مطردة مع زيادة عدد الجرعات في الموقعين. تم تسجيل اوزان عالية لعناقيد العنب الصنف كاردينال وصلت 565.1و 600.0 جم و جملة انتاج 27.7 و 41.3 طن للهكتار للموقعين (أ و ب) على التوالي. لم تتاثر جملة الاملاح الذائبة للثمار بالاكسير. تمت ملاحظة زيادات كبيرة و مماثلة في التجارب بحقول المزارعين بمشروع دال الزراعي لمحصول البرسيم الجديد بنسبة 30.4% و القديم بنسبة 40.0 % و 35.1% و لمشروع

انماء بنسبة 72.7% و 169.6% للقطعتين الاولى و الثانية على التوالي. و على المثل ادت اضافة 36 لتر للهكتار من الاكسير على محصول الشمام الصنف قرين استار الي زيادة معنوية في الانتاج بلغت 24.7 طن للهكتار. بناء على النتائج اعلاه ادت اضافة الاكسير بمعدل 36 لتر للهكتار على جرعات اسبوعية متساوية الى زيادة معنوية في نمو و انتاجية عنب المائدة و البرسيم و الشمام تحت ظروف الاجهاد الحراري لولاية الخرطوم.