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Research paper

Effect of Organic and Chemical Fertilizers on Vegetative Growth and Fruit Characteristics of Banana, Grand Nain and Dwarf Cavendish Group

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ABSTRACT

Banana is one of the oldest tropical fruits cultivated by man from prehistoric times in India with great socio-economic significance, interwoven in the cultural heritage of the country. Banana fruit production in the Sudan, cover a wide spectrum of activities ranging from local utilization of fruit with self-sufficiency through small farming for local market to large plantation for export. It is one of most important fruits of Sudan. Therefore, a field experiment was conducted at two locations in Aliab, River Nile State during 2009/10 and 2010/11 seasons in split plot design with four replications. Assigned to the main plots two varieties of banana (Cavendish dwarf and Grand Nain, AAA) and to the sub –plots the fertilizer treatments arranged randomly, consisted of Urea., NPK, and combination of organic fertilizers, compost and manure. The results indicate that there were highly significant differences in pseudo stem length in the two cultivars due to fertilizer treatments especially chemical and organic fertilizers, also there were significant effect in fruit parameters (weight of bunch, finger and number of hands per bunch and finger per bunch) due to the fertilizer treatment at least in one season.

Keywords: Banana, Grand Nain, Cavendish, compost, fertilizer

تأثير التسميد العضوي والكيميائي على النمو الخضري وخصائص الثمرة للموز صنفي كافندش المتقزم والقراندنين

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يعتبر الموز من أقدم المحاصيل المدارية ذات الاهمية الاقتصادية والاجتماعية المستأنسة بواسطة الانسان من عصور ما قبل التاريخ. ومتصلة في موروث البلدان. انتاج الموز في السودان يغطي طيف واسع من الانشطة من مزارع الاكتفاء للسوق المحلي الي المزارع الواسعة المنشاة للتصدير. ويعتبر واحد من المحاصيل المهمة لذلك اجريت هذه التجارب بموقعين بالعلياب، ولاية تهر النيل في موسمي 10/2009 و11/2010 بتصميم القطع المنشقة بأربعة مكررات لتشمل صنفين من الموز كافندش المتقزم والقراندنين على القطع الرئيسة والتسميد على القطع الفرعية. اوضحت النتائج فروق عالية المعنوية في طول الساق الكاذبة في الصنفين كاستجابة للتسميد بنوعيه العضوي والكيماوي كما اوضحت النتائج ايضا فروق معنوية في المؤشرات الموصفة للإثمار (وزن السباطة والاصابع وعدد الكفوف في السباطة وعدد الاصابع في الكف) كاستجابة للتسميد على الاقل في موسم واحد.

كلمات مفتاحية: الموز، القراندنين، كافندش المتقزم، الكمبوست، السماد

Introduction

The word "banana" is a general term embracing a number of species or hybrids in the genus Musa of the family Musaceae, most edible-fruited banana, usually seed less. It belongs to the species *M-acuminata*. Banana can be divided into two main groups. Dessert bananas which constitutes 43% of world production (Anon., 19920 and the fruits of this group are chiefly eaten raw when ripe, as a dessert fruit. They are sugary and easily digestible. The most important example of this group are fruits from cultivars of the common Cavendish group. The second group of bananas which account for the other 57% of world production are the cooking banana (Anon, 1992). The experiment was done with two cultivars of Cavendish group, dwarf and giant Cavendish. Dwarf is the smallest or short and better adapted to a cool climate than any other cultivar. "Giant Cavendish" compared to dwarf is slightly taller and its French name is "Grand Nain (Samson, 1980). Grand Nain is an outstanding banana variety growing from 6 to 8 feet tall and solid green in color. It is very attractive for its landscaping potential and good wind resistance.

The 'Grand Nain' produces very large heads of delicious fruit. Bunches may weight up to 150 Lb. This is a commercial variety that you buy in the grocery store. The full sized fruit ripen rapidly. The fruits of this group are chiefly eaten raw when ripe, as a dessert. Banana fruit production in the Sudan covers a wide spectrum of activities ranging from local utilization of fruit with self-sufficiency through small farming for local market to large plantations for export. The organic manure which is made from compost provides the ingredients necessary for the crop as well as nitrogen, phosphorus, potash etc., which improves the important functions of the organic, chemical and physical characteristics of the soil. The soil fertility increases and it becomes soft and porous. Humidity is also maintained. In Sudan commercial banana production is for local market. The cultivation is concentrated on alluvial Delta of Gash River in Kassala State. The central production in Khartoum State is restricted to Wad Ramli Suburb, in River Nile State, and in the Blue Nile State, South of Sennar. In Kassala there is reduction in acreage. This reduction was mainly attributed to scarcity of irrigation water and to poor husbandry practice (Shomo, 1974 and Osman *et al*., 2015). There are many problems hindering the production of banana such as nematode infestation, scarcity of suckers and the dependence on one variety, in addition to the lack of knowledge about the cultural practices, and absence of detailed agricultural operations, such as, planting methods, variety, spacing, and pruning, ripening and marketing programs of the crop. Therefore, to stimulate banana crop production and make it commercially feasible, considerable research should be geared towards investigating, recognizing and solving the problems facing

banana industry in the country. Fertilization is an important and limiting factor for growth and productivity of banana plants which remove large amounts of nutrients from the soil, it is well known that banana needs large amounts of fertilizers especially nitrogen. So, the major problems facing banana growers are the high costs of excessive manufactured fertilizers. Besides, these chemical fertilizers are considered as air, soil and water polluting agents during their production and utilization. Consequently, it has drawn the attention of researchers and banana growers to use the organic fertilizers, which are safe for human, animal and environment, as a partial substitute for mineral source. Thus, it is preferred to use these natural fertilizers to avoid pollution and to reduce the costs of chemical fertilizers. In this experiment, application of two type of fertilizers, organic manure (cow and chicken compost) and chemical fertilizer (urea +NPK), and their combination was used. The objective of this study is to investigate the effect of organic manure and chemical fertilizers on growth and yield of two banana cultivars namely, dwarf Cavendish and Grand Nain, and determining the best dose of fertilizers that influence the yield and fruit characteristics like total bunch weight, middle-hand weight and number of fingers per middle-hand, of Grand Nain Dwarf Cavendish banana.

Materials and Methods

The study was carried out at Alliab area in the River Nile State, Sudan (lat. 17°,30′; long. 33°,15′), during the period from June to September 2009/10 and 2010/11. The climate of the area is desert with summer rain and warm winter (Van Der Kevie, 1976). The soil samples from the experimental site were analyzed for physical and chemical characters according to the standard procedures. The experiment was carried out as split plot design based on randomized complete block design (RCBD) with four replications, total of 18 treatments including, in the main plots, the two varieties of Cavendish Dwarf and Grand Nain [AAA], and in the sub –plots, the fertilizer treatments, arranged randomly.

Planting materials are suckers of banana cultivar ‘Dwarf Cavendish and Grand Nain’ four months old, sword type. The suckers of Dwarf Cavendish were selected from banana plantation in Shendie Locality. The Grand Nain from tissue culture lab in Medani Research Station. The sub plots consisted of Urea, 400g/plant/yr., NPK, 200 g/plant/yr. and the organic fertilizers, compost (10) kg/plant/yr, manure 5 kg/plant/yr. In this experiment growth parameters of the plant crop and

first ratoon crop were measured and recorded. They include plant height (cm), pseudo stem girth (cm) and number of leaves.

Weight of bunch (kg), Weight of hand/ Bunch (kg), and Weight of finger/ hand (kg), were recorded in addition to No. of hand/ bunch and No. of finger/ hand, as yield parameters.

The bunches were weighed using spring balance to determinate the weight of fingers, then the weight of all hands in a bunch was divided by the total number of fingers in that bunch.

Results and Discussion

Generally, the results in the two seasons indicated that there was high significant difference between the two cultivars, Grand Nain and Dwarf Cavendish through all parameters, plant high, pseudo stem girth and number of functional leaves. Significant increase (p=,0.05) in weight of bunch, number of hands/bunch, number of fingers/bunch, and weight of hands/bunch were recorded due to fertilizer treatments especially manure, (M+U), Compost + Urea (C+U) and urea alone, (table 1and 2). Also there was significant difference between the two varieties. The best growth (height, girth of pseudo stem and number of leaves) and bunch yield were observed following application of 200gN/plant in 4 split doses (2, 4,6 and 8 months after planting). This result is supported by many workers like, Singh and Suryanaryana (1999) who studied the response of application of 200 or 250 g N/plant in 4 split doses. Irizarry and Rico (1989) studied the effects on growth and yield of banana CV "Dwarf Cavendish". They found that Williams's cultivar had significantly higher vegetative growth than Dwarf Cavendish.

Results indicated that the effect of urea on Grand Nain is more than on Dwarf Cavendish in all parameters. This seems to agree with Gangwar and Niranjan (1990) who studied the effect of inorganic fertilizers and FYM on the rain-fed fodder sorghum. They found that addition of FYM+50% recommended doses of inorganic fertilizer resulted in significantly higher plant height, dry weight, and fresh weight and increased the uptake of N, P and K compared with the control.

Results in Table (3) and (4) indicated significant effect of fertilizer on bunch, finger weight, finger number/ hand and hand number/ bunch in both seasons. However, the differences between varieties in all studied parameters, were only significant in season 20010/11. Results were in line with Singh and Suryanaryana (1999) and Munica *et al.* (1978) who recorded highest bunch weight and fruit yield by 200g N and 300g N per plant. Akyeambong and Hitamana (1979) found that the best growth and bunch yield followed application of 200g/plant. Butler (1960) reported that

substantial increase in mean weight of bunch and total production per ha were mainly obtained by application of nitrogen –containing compounds especially when those applied in small quantities. The treatments were manure (M+U), Compost + Urea (C+U) and Urea affected bunch weight and number of finger per hand compared to control are shown in figure (1) and (2). Comparing the two cultivars, Grand Nain responded to fertilization better than Dwarf Cavendish on all parameters. As indicated by Abdel Monieum *et al*. (2008), application of fertilizer combinations influenced the reproductive characteristics of Grand Nain. The best results with regard to quality of fruit were obtained from plants received 50% compost plus 50% out of recommended rate of N mineral source. Bakheit (1994) also reported that application of organic manure resulted in higher leaf NPK contents of both banana and the first ratoon crop.

The results indicated that application of organic manure only was not enough for banana plant growth and yield, so the chemical fertilizers are important in the soil in the Sudan. This agrees with Dawoud *et al*. (1999) who studied the response of dwarf Cavendish banana to nitrogen fertilization on heavy clay soils.

Table (1): Effect of fertilizers (organic +N fertilizer) and two varieties on vegetative growth in plant crop of banana, season (2009/10).

Treatments	Plant high	Plant Girth	No. leaves
U	113,9^{bc}	60.5^{c}	14.3^{a}
NPK	122^{bc}	54.8^{c}	13.6^{a}
M	135^{bc}	59.8^{c}	12.1^{a}
C	177.6^{b}	65.9^{c}	10.9^{a}
M+U	180.3^{b}	83.9^{b}	11.1^{a}
M+NPK	190^{a}	89.6^{b}	13.^{a}4
C+U	180^{b}	100.3^{a}	14.3^{a}
C+NPK	176.3^{b}	88.4^{b}	12.5^{a}
C_0	21.5^{d}	42.6^{d}	9.1^{a}
LSD	61.04	10.57	41.9^{a}
CV%	39.61	14.66	7.59
SE±	21.46	3.71	14.74

Means in columns followed by the same letter (s) are not significantly different at P≤ 0.05, according to Duncan's Multiple Range Test

Key: M: manure, U: urea, C: compost, C_0: control

Table (2): Effect of fertilizer (organic and N applications on vegetative growth in plant crop of two cultivars, season (2010/11) in Ratoon crop

Treatments	Plant high	Plant Girth	No. leaves
U	152.6^{de}	68.3^{cd}	13.4^{bcd}
NPK	132.9^{e}	61.0^{d}	13.9^{abcd}
M	144.9^{de}	57.8^{cd}	13.6^{abcd}
C	168.8^{cd}	62.6^{c}	13.1^{cd}
M+U	184.8^{bc}	74.3^{b}	14.4^{abc}
M+NPK	190.5^{bc}	76.9^{b}	14.9^{abc}
C+U	224.0^{a}	87.0^{a}	15.8^{a}
C+NPK	203.4^{ab}	77.6^{b}	15.1^{ab}
C0	96.0^{f}	43.1^{e}	12.0^{d}
LSD	27.64	8.17	1.73
SE±	9.72	2.87	0.61
CV%	16.53	10.33	12.37

Means in columns followed by the same letter (s) are not significantly different at P≤ 0.05 according to Duncan's Multiple Range Test

Key: M (manure), U (urea), and C (compost).

Table (3): F-values of the yield for the treatments and their interactions in main plant crop (2009/10)

Sources	Weight of bunch	Weight of hand/ Bunch/kg	Weight of finger/ hand (kg)	No of hand/ Bunch	No of finger/ Hand
Fertilizer	4.12**	1.47^{ns}	1.29*	2.59*	2.12*
Varieties	1.28^{ns}	0.94^{ns}	0.09^{ns}	2.14^{ns}	0.49
Fertilizer x variety	0.93	1.47^{ns}	0.66^{ns}	0.20^{ns}	2.49*
Cv%	34.51	43.66	22.88	21.66	17.56

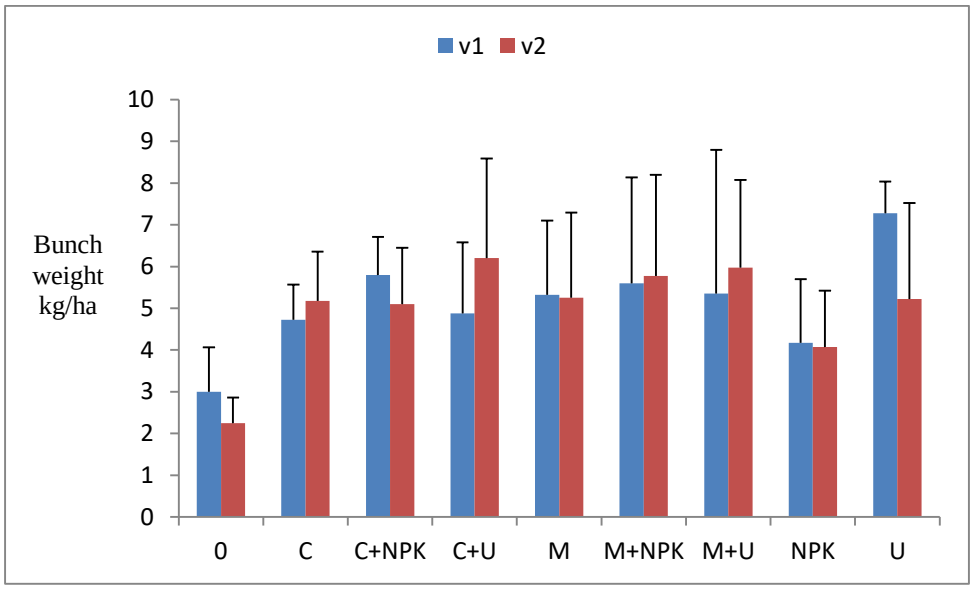
Means in columns followed by the same letter (s) are not significantly different at P≤ 0.05 according to Duncan's Multiple Range Test.

Key: fertilizer (organic+N fertilizer), varieties (Grand Nain and Dwarf Cavendish)
*, **, ***: significant at 0.05, 0.01and 0.001 probability levels, respectively
^{ns} :Not significant at probability ≤ 0.05

Table (4): F-value of yield and yield components for the treatments and their interactions of Plant crop in seasons (2010/11)

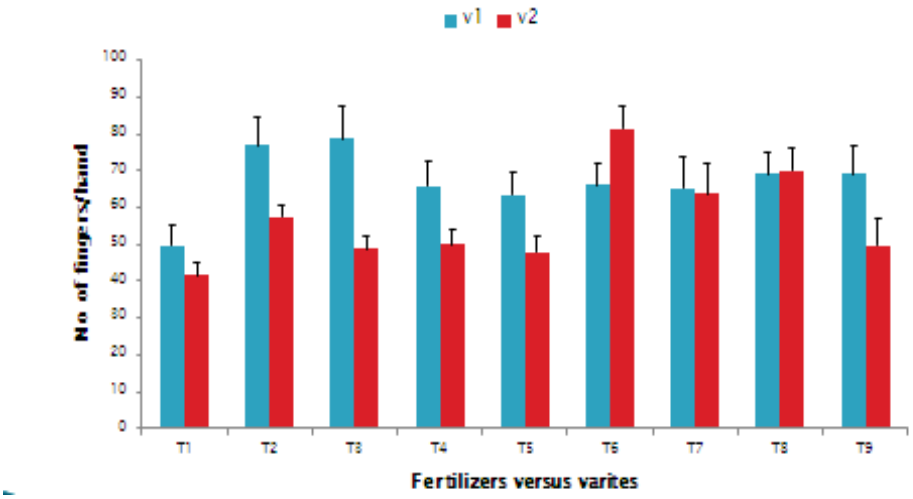
Sources of Variation	Weight of bunch	Weight of hand/ Bunch/kg	Weight of finger/ hand (kg)	No of hand/ Bunch	No of finger/ Hand
F	0.62^{***}	1.48^{ns}	1.81^{*}	3.72^{**}	2.06^{*}
V	0.17^{***}	0.002^{***}	0.041^{***}	2.21	18.44^{**}
FXV	1.11	1.35^{ns}	1.31^{ns}	1.23	1.81^{*}
CV%	43.83	29.89	17.28	18.47	16.89

*, **, *** significant at 0.05, 0.01and 0.001 probability levels, respectively
Ns: Not significant at probability ≤ 0.05
Key: F= fertilizers (organic and N applications), V: varieties Grand Nain and Dwarf Cavendish.



Key: V1, Grand Nain.V2, Dwarf Cavendish, T1-T9, fertilizer treatment

Fig.1: Bunch weight kg/ha for plant crop



Key: V1, Grand Nain.V2, Dwarf Cavendish, T1-T9, fertilizer treatment

Fig. 2: Number of fingers/hand

Conclusion and Recommendations

The best fertilizer program for better growth and yield of banana is application of organic fertilizer (compost and manure) with urea or NPK. The increase in fertilizer dose significantly increased the plant height, pseudo stem girth and leaf production in plant crop and first Ratoon crop. The highest values of yield components were significantly greater in weight of bunch, hand and fingers and in the average number of hands and fingers per bunch and fingers per hand. There were highly significant differences between the two cultivars. However, Grand Nain is the best in vegetative growth\ also had highest values of yield components.

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