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Full Length Research Paper

Evaluation of cattle manure application rate on the growth rate and fruit yield of cucumber (*Cucumis sativas* L.)

Collen Musara[1*], James Chitamba[2,3]

[1]Department of Genetics, University of the Free State, P.O. BOX 339, Bloemfontein 9300, Free State, Republic of South Africa.
[2]Publishing Department, Zimbabwe Publishing House (ZPH) Publishers, P.O. Box GD510, Greendale, Harare, Zimbabwe
[3]Department of Educational Foundations, Faculty of Science Education, Bindura University of Science Education, P. Bag 1020, Bindura, Zimbabwe
[*]Corresponding Author's E-mail: collinmusara@gmail.com

ABSTRACT

Cucumber responds well to organic fertilizers preferably cattle manure. However, the production requirements of this crop are seldom known. The study was conducted to investigate the effects of cattle manure on the growth rate and fruit yield of cucumber (*Cucumis sativas L.*). A field experiment was conducted at University of Zimbabwe Farm, under dry land conditions during the 2006-2007 season, laid in a randomized complete block design with 4 treatments replicated 5 times. Clay soils were used while cattle manure was applied to all the soils at levels of 0 t ha^{-1}, 5 t ha^{-1}, 10 t ha^{-1}, and 20 t ha^{-1}. Cattle manure was broadcasted using a spreader and growth measurements were taken as from 4 weeks after crop emergence and at 2 weeks subsequent intervals up to the senescence of the vines. Results showed that vine length, number of branches, leaf number, both female and male flowers per main vine and total fresh yield significantly increased ($p<0.05$) with an increase in the amount of cattle manure applied. Cattle manure application rate of 20 t ha^{-1} gave the highest growth rate and fruit yield followed by 10 t ha^{-1} and then 5 t ha^{-1}. The control treatment gave the least of all the rates. The study showed that application of 20 t ha^{-1} of cattle manure enhances the production of *C. sativus* crop.

Keywords: *Cucumis sativas*, Cattle Manure, Application Rates, Growth, Establishment

INTRODUCTION

Cucumber (*Cucumis sativus* L.) is an important vegetable and one of the most popular members of the Cucurbitaceae family (Eifediyi and Remison, 2010). It is a high nutrient demanding crop which performs poorly on nutrient deficient soils leading to low yields, bitter and misshapen fruits (Grubben and Denton, 2004). Soft and succulent, the vegetable crop is cherished by man and eaten in salads or sliced into stew in tropical regions (Enujeke, 2013). Cucumber is a very good source of vitamins A, C, K, and B6, potassium, pantothenic acid, magnesium, phosphorus, copper and manganese (Vimala *et al.*, 1999). Okonmah (2011) reported that the ascorbic acid and caffeic acid contained in cucumber help to reduce skin irritation and swollen.

Cucumber responds well to organic fertilizers preferably cattle manure. Most of smallholder farmers' manure application rates depend on availability with households having more manure applying higher rates per unit area than those with a limited supply. Crop yields in most smallholder sectors have remained low compared to similar crops in commercial agriculture because fertilizers use has been declining owing to unavailability, increased prices and financial constraints. With fertilizer industry facing a lot of challenges lately in the country, most farmers resort to the use of organic fertilizers. Chivinge and Mariga (1998) reported that most Zimbabwean smallholder farmers cannot afford to apply the recommended fertilizer application rates and

frequently apply 30-50% of the recommended inorganic fertilizer application rates. This has resulted in communal farmers relying on livestock manure as a source of nutrients for their crops.

Cattle manure is a potential source of nutrients and also a potential benefit to soil amelioration especially for communal farmers who cannot afford fertilizers. However, getting the maximum value out of the manure requires applying it at proper rates and frequency in conjunction to a particular soil (Pahla *et al*., 2013). Currently, in Zimbabwe there are no general specifications on cattle manure application rates in cucumber as a sole crop or as an intercrop since little work has been done on the effects of manure on cucumber. However, in maize, the rate of broadcasted manure recommended by AREX in the small holder farming sector in Zimbabwe is about 8 tonnes per hectare annually supplemented with 122 kg N ha^{-1} as side dressing to obtain a maize grain yield in excess of 3.25 t ha^{-1} (Mataruka and Whingwiri, 1987). Mineral fertilisers have become affordable for most smallholder farmers since the removal of subsidies in 1991 when the Zimbabwean government embarked on the Economic Structural Adjustment Programme (ESAP). Smallholder farmers in Zimbabwe have returned to the use of manure as a low cost option (Mutiro and Murwira, 2004).

Considering the economic importance of cucumber, the unaffordability of inorganic fertilisers by smallholder Zimbabwean farmers as well as the availability of cattle manure in the country, the present study was carried out with the objective of determining the most appropriate rate of application of cattle manure for enhanced growth and yield of cucumber.

MATERIALS AND METHODS

Site characteristics

The field trial was conducted at the University of Zimbabwe Farm during the 2006-2007 rainy season. The University farm, latitude (31°03E) and (17°48S), is situated about 14 km north of Harare, along Harare-Mazowe road. The altitude is 1450 m above sea level and the arable land is flat with a slope of 2% or less. The soils are moderately deep-to-deep well-drained fersiallitic red clays. The farm is in agro-ecological zone IIa of Zimbabwe, characterized by high rainfall of about 700-1050 mm per annum confined to summer months of between November and April (Rukuni and Eicher, 1994).

Experimental design and procedure

The experiment was laid in a randomized complete block design with 4 treatments replicated 5 times, giving a total of 20 experimental units. The treatments were randomly assigned to the plots using random number tables. Four rates of well decomposed cattle manure levels (0 t ha^{-1}, 5 t ha^{-1}, 10 t ha^{-1}, and 20 t ha^{-1}) were used. Organic matter content, soil pH, soil texture, inherent N, P and K for the four soil types and nutrient quality for manure were evaluated prior to crop establishment. Cattle manure was sent for nutrient analysis (0.95% N, 0.17% P, 0.63% K, 1.52% Ca, 4.7% Zn and a pH of 6.7) before application.

Well decomposed cattle manure, from cattle feedlots with no visible straw was used in the experiment. The manure was spread evenly on the soil surface in each plot according to their application rates and then incorporated into the soil using hoes at a depth of 15 cm within the plots. No manure was applied in the control plots. Inherent manure in the different soil types was used as the 0% manure control treatment.

Data collection and analysis

The 12 plots in each block were watered to field capacity and left for 4 days prior to seedlings transplanting. The variety Ashley (determinate) was planted 80 cm within the rows and 1.0 m between rows giving a total 18 plants per plot and 12500 plants per hectare. A meter rule was used along with a string to measure vine length from 4 weeks after crop emergence at two weeks intervals up to senescence. Male and female flowers, branch number and leaf number were physically counted from 4 weeks after crop emergence at a two-week interval up to senescence of the vine. Fruits were harvested from 10 weeks after crop emergence and a digital scale was then used to weigh the fruit mass. The yield for each treatment was determined in kilograms 18 m^{-2} plot.

The data on cucumber yield (kg) together with yield components such as male and female flower number, leaf number and vine length (cm), were subjected to analysis of variance (ANOVA) using GenStat version 8.1 statistical package. Least significant difference (LSD) was used in mean separation at 5% significance level.

RESULTS AND DISCUSSION

Cucumber growth parameters

Manure application rate significantly ($p<0.001$) affected cucumber growth parameters (vine length, branch number, leaf number, female and male numbers per vine) up to 12 weeks after crop emergence. All the parameters generally showed an increase with increased rates of cattle manure (Table 1).

Significant variation ($p<0.001$) in mean vine length was noted among the treatments, with the highest mean vine length of 145.14 cm being recorded on 20 t /ha^{-1} with the lowest being recorded on 0 t ha^{-1} as 101.50 cm. Treatment 0 t ha^{-1}, (i.e. without cattle manure) could not support appropriate growth of the plants because the

Table 1. Effect of cattle manure application rate on cucumber growth parameters

Treatment	Vine length	Branch number	Leaf number	Female flowers	Male flowers
0 t ha^{-1}	101.50^{a}	20.00^{a}	21.00^{a}	45.00^{a}	20.82^{a}
5 t ha^{-1}	120.06^{b}	22.00^{b}	23.00^{b}	49.00^{b}	24.04^{b}
10 t ha^{-1}	135.84^{c}	25.00^{c}	25.00^{c}	53.00^{c}	31.17^{c}
20 t ha^{-1}	145.14^{d}	28.00^{d}	27.00^{d}	56.00^{d}	36.50^{d}
Grand mean	125.63	23.55	24.0	50.75	40.75
Fprob	<0.001	<0.001	<0.001	<0.001	<0.001
l.s.d.	10.82	1.78	0.92	1.082	1.082
CV%	6.25	5.49	2.77	1.55	1.93

residual nutrient content of the soil was inappropriate to support growth of cucumber, probably the nutrient content of the soil was below the critical level hence poor performance of the crop (Hamma *et al*., 2012) thereby making the plants to produce shorter vine length. However, those plants that received 20 t ha^{-1} of cattle manure supplied enough nutrients that could support appropriate nutrition and growth of the test plant. Therefore, ability by these plants to photosynthesise, has led to an increase in growth and development of the crop resulting in the production of longer vine length per plant. These findings are in agreement with Eifediyi and Remison, (2010); and Ayuso *et al*., (1996) who observed that organic manures can sustain cropping systems through better nutrient recycling which would give rise to crop improvement in growth and development as well as yield.

Highest branch number of 28 branches per main vine number was recorded at the rate 20 t ha^{-1} 12 weeks after crop emergence followed by 10 t ha^{-1}, which had 25 branches per main vine and 5 t ha^{-1} had 22 branches per main vine, and lastly the control gave the least mean branch number of 20 branches per main vine (Table 1). Cucumber plants that received cattle manure application rate of 20 t ha^{-1} had higher number of branches per main vine than other plants possibly because higher rate of cattle manure improved moisture availability which enhanced the release of more nutrient elements (Enujeke, 2013) for increased bud initiation and subsequently branch growth. This is in agreement with the Ewulo *et al*., (2008) who reported and attributed increased growth of crop plants to the release of more nutrient elements through the moisture that has been made available by the manure.

There was significance difference in leaf number among the different rates of cattle manure and the highest mean leaf number of 27 per main vine was recorded at 20 t ha^{-1} with the least 21 per main vine being recorded at 0 t ha^{-1}. These results are consistent with Eifediyi and Remison (2010) who observed a similar trend when he was working with farmyard manure. These findings are also similar to those by Hamma *et al*. (2012) who observed highest leaf number in cucumber plants treated with the highest rate of 12 t ha^{-1} while the least number was recorded at 0 t ha^{-1} of poultry manure. Lowest leaf number recorded in the 0 t ha^{-1} could be attributed to the fact that it could not support appropriate growth of the plants because the residual nutrient content of the soil was inappropriate to support growth of cucumber, probably the nutrient content of the soil was below the critical level hence poor performance of the crop. This means that the higher the nutrients applied to the soil, the higher the number of leaves/plant. This observation is consistent with works of Aduloju *et al*. (2010) and Dada and Fayinminnu (2010).

Highest mean numbers of female and male flowers were recorded at the rate of 20 t ha^{-1} while the lowest flower numbers were recorded at 0 t ha^{-1} (Table 1). This can be attributed to the fact that the cucumber plants had enough nutrients for rapid growth and floral development considering the composition of the cattle manure (from initial nutrient analysis prior to the experiment) which had higher K content responsible for flower formation. It was observed that the higher the nutrients in cattle manure applied, the higher the values of the male and female flowers produced per plant.

Cucumber fruit yield

There was significant difference ($p<0.001$) in cucumber fruit yield per plot up to 12 weeks after crop emergence. All the experimental plots generally showed an increase in yield with increased rates of cattle manure. Fruit yield increased as manure rates increased (Figure 1) with the highest mean yield of 36.5 kg being recorded at 20 t ha^{-1} while the lowest yield of 20.82 kg was recorded at 0 t ha^{-1} (Figure 1). Low cucumber yields and little vigorous growth obtained with low manure application rate of 5 t ha^{-1} and 0 t ha^{-1} could be attributed to insufficient levels of nutrients supplied by 5 t ha^{-1} and 0 t ha^{-1} to the plants for normal growth. The highest manure rate of 20 t ha^{-1} gave the highest yields and vigorous vegetative growth; this could be attributed to a high nutrient level supplied by the treatment per unit volume of soil resulting in high crop growth rate and vigor. This observation may indicate that the increase in cattle manure will result to significant

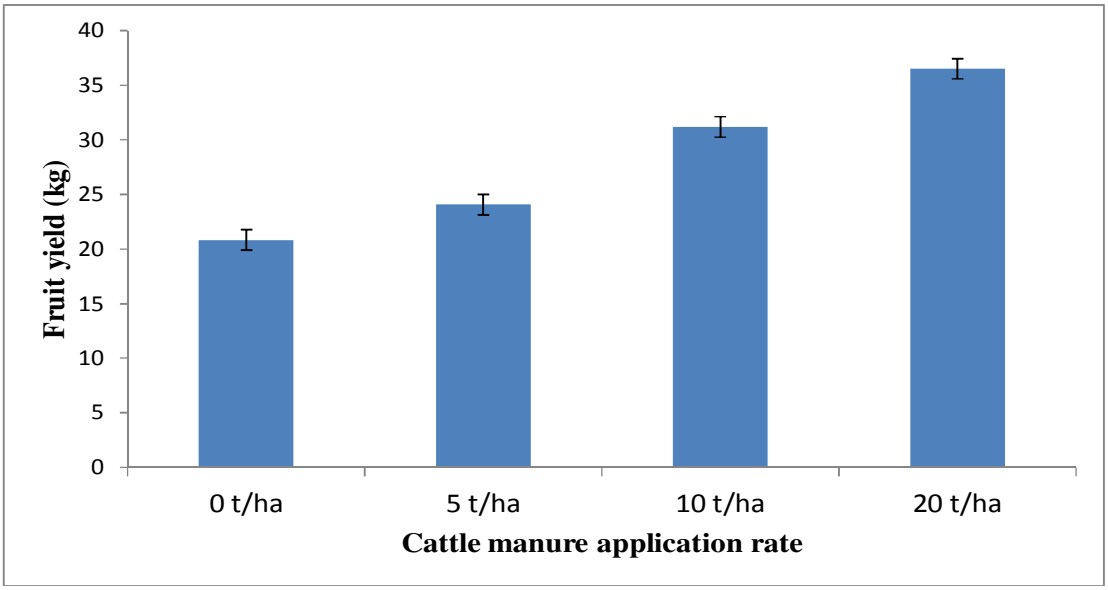

Figure 1. Effect of cattle manure application rate on cucumber fruit yield

increase in fruit yield per plant. This observation concurs with the works of El- Shakweer *et al*. (1998) who earlier reported that an increase in manure among treatments will lead to a significant increase in treatment means. The results are also similar to Hamma *et al*. (2012) who observed the same trend when he studied the effect of different poultry manure levels on cucumber. Similar work by Enujeke (2013) indicated that higher fruit mass was obtained from cucumber plants that received 20 t ha^{-1} of poultry manure possibly because higher rates of manure improved the soil conditions for crop establishment as well as released adequate nutrient elements for yield enhancement

CONCLUSION

There was a strong linear relationship between growth rate and fruit yield of *C. sativus* and manure application rates. It was concluded that manure application rates had effects on *C. sativus* growth rate and fruit yield in terms of vine length, leaf number, branch numbers, male and female flowers, as well as the fruit yield. Cattle manure application rate of 20 t ha^{-1} gave the highest growth rate and fruit yield of *C. sativus* hence could be adopted by resource poor smallholder cucumber farmers in the country where the manure is readily available.

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