International Journal of Agricultural Technology 2016 Vol. 12(7.1):1367-1373
Available online http://www.ijat-aatsea.com
ISSN 1686-9141

Effects of Different Types of Manures and Levels of Applications on Growth and Yield of Stevia (*Stevia rebaudiana*)

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Chumthong B. and S. Detpiratmongkol (2016). Effects of Different Types of Manures and Levels of Applications on Growth and Yield of Stevia (*Stevia rebaudiana*). International Journal of Agricultural Technology 12(7.1):1367-1373.

Stevia (*Stevia rebaudiana* (Bertoni.) Hemsl.) is a medicinally important plant, a sweet herb and is a natural non caloric bio-sweetener, which offers a solution for complex diabetic problems and obesity in human. The objective of this study was to investigate the effect of two animal manures on growth of stevia. A pot experiment was conducted in the net house of Faculty of Agricultural Technology, King Mongkut's Institute of Technology Ladkrabang, Bangkok, Thailand, during July to November, 2011. A split plot in randomized complete block design with 4 replications was employed. Two organic manures (cow and chicken manures) and four rates of organic manure applications (6.25, 12.50, 18.75 and 25.00 ton ha^{-1}) were as main plots and sub plots, respectively. The results disclosed that stevia applied with chicken manure gave significantly higher growth (such as stem, leaf and root dry weight and total dry weight) and leaf dry weight yield than those applied with cow manure. The 25.00 ton ha^{-1} of animal manure gave the highest of total dry weight and leaf dry weight yield while 6.25 ton ha^{-1} of animal manure gave the lowest. Increasing chicken manures rates increased growth and total dry weight of stevia. However, it may be concluded that the stevia crop may be applied with 25.00 ton chicken manure ha^{-1}.

Keywords: Stevia, manure, growth, yield.

Introduction

Stevia (*Stevia rebaudiana* (Bertoni) Hemsl.) is a sweet herb belonging to Asteraceae family. It is native to certain regions of the South America particularly Paraguay and Brazil where its leaves have long been known to be sweet tasting and is a natural non caloric bio-sweetener, which offers a solution for complex diabetic problems and obesity in humans. (Brandle *et al.*, 1998; Ramesh *et al.*, 2006). The leaves of stevia contain around ten sweetening glycosides, of which stevioside (3-10%), rebaudioside-A (13%), rebaudioside-

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B, rebaudioside-C, and rebaudioside-D are important (Brandle *et al*., 1998; Rank and Midmore, 2006). Stevia and stevioside have been applied as substitutes for saccharose, for treatment of diabetes mellitus, obesity, hypertension and caries prevention and a number of studies have suggested that, besides sweetness, stevioside, along with related compounds which include rebaudioside-A, steviol and isosteviol, may also offer therapeutic benefits, as they have anti-hyperglycemic, anti-hypertensive, anti-inflammatory, anti-tumour, anti-diarrhoeal, diuretic, and immunemodulatory effects (Chatsudthipong and Muanprasat. 2009). The leaves of Stevia has functional and sensory properties superior to those of many other high-potency sweeteners, and is likely to become a major source of high-potency sweetener for the growing natural food market in the future (Goyal *et al,*. 2010). Therefore, there has been a large interest in Stevia although information concerning organic manure in Stevia and the effect on growth is lacking.

However, the effects of organic manure on physiological of Stevia in Thailand have rarely been studied. Therefore, the investigate of the present work was to determine the effects of organic manure on growth and yield of Stevia.

Materials and methods

Location and climate of the experimental site: pot experiment was conducted under glass house condition during July, 2011 to November, 2011 at Faculty of Agricultural Technology, King Mongkut's Institute of Technology Ladkrabang, Bangkok, Thailand. The experimental site is situated at an elevation of 50 m above mean sea level, 13 °43' 36.21" N latitude and 100 °46' 48.45" E longitude. The used soil in this study was Bangkok series, clay in texture, slightly acidic with pH 6.12. Total N, P and K were 0.19, 0.27 and 0.25 present, respectively (Table 1). A mean of 33.70 ℃ maximum temperature, 25.60 ℃ minimum temperature and 81.00% RH were recorded during the period of experimentation. The experiment was laid out in split plot in randomized complete block design with 3 replication. Treatments consisted of two organic manure types (chicken and cow manures) were used as main plot and 4 organic manure application rates (6.25, 12.50, 18.75 and 25 tones ha^{-1}) were used as subplot. The organic manures were analyzed for their nutrient contents in Table 1. The harvest of crop was done after 120 days of planting by cutting plants 10 cm above ground level. Then, number of branches $plant^{-1}$, branch dry weight, stem dry weight, leaf dry weight, total dry weight leaf fresh and dry weight yield were reccorded. Leaf area was measured using Li-cor 300 leaf area meter.

Table 1 Soil properties and chemical properties of chicken manure and cow manure were used in this study.

Parameter	Soil property	Chicken manure	Cow manure
pH (1:2.5)[1)]	6.12	6.08	6.78
Total N (%)[2)]	0.19	2.74	0.19
Total P (%)[3)]	0.27	0.68	0.25
Total K (%)[4)]	0.25	1.70	0.24

[1)]1:2.5 water: fertilizer measured by pH meter , [2)]Kjeldahl method , [3 and 4)] method by spectrophotometer and atomic absorption spectrophotometer.

Results and Discussion

Number of branch and branch dry weight

Number of branch and branch dry weight varied with types of manures and application levels. Number of branch and branch dry weight of chicken manure were significantly higher at the similar application levels of cow manure. For application manure at different levels, a significantly highest number of branch plant^{-1} (28.13) and branch dry weight (8.99 g plant^{-1}) registered under 25.00 ton organic manure ha^{-1} which were statically higher than other lower levels (Table 2).

Leaf area and leaf dry weight

The effect on leaf area remained significant under difference types of organic manure and application levels (Table 2). The higher leaf area (715.27 cm^2) was recorded under chicken manure which was statistically at par with cow manure (621.78 cm^2). In the case of different levels of organic manures, maximum leaf area (1,022.60 cm^2) was obtained at 25.00 ton ha^{-1} which was statistically higher than 18.75 ton ha^{-1} (808.10 cm^2), 12.50 ton ha^{-1} (668.20 cm^2) and 6.25 ton ha^{-1} (175.20 cm^2), respectively.

The leaf dry weight was significantly affected by the different type of manures and levels of manure application. Leaf dry weight of chicken manure (5.87 g plant^{-1}) was significantly higher at the similar application levels of cow manure (4.46 g plant^{-1}). For application manure at different levels, leaf dry weight increased with increasing rates of organic manure. The highest leaf dry weight (8.37 g plant^{-1}) was recorded at 25.00 ton ha^{-1} and followed by 18.75 ton ha^{-1} (6.38 g plant^{-1}), 12.50 ton ha^{-1} (4.25 g plant^{-1}) and 6.25 ton ha^{-1} (7.66 g plant^{-1}).

Table 2 Number of branch, branch dry weight, stem dry weight, leaf area and leaf dry weight of *Stevia rebaudiana* Bertoni at harvest grown under different manure types and manure rates.

Treatments	No. of branch (branch plant^{-1})	Branch DW (g plant^{-1})	Stem DW (g plant^{-1})	Leaf area (cm^2)	Leaf DW (g plant^{-1})
Organic Manure Types					
Chicken	17.44	5.57	9.99	715.27	5.87
Cow	15.13	3.96	8.16	621.78	4.46
Organic Manure Rates					
6.25 ton ha^{-1}	5.13	1.64	3.02	175.20	1.66
12.50 ton ha^{-1}	12.75	2.87	7.09	668.20	4.25
18.75 ton ha^{-1}	19.13	5.67	10.23	808.10	6.38
25.00 ton ha^{-1}	28.13	8.99	15.98	1,022.60	8.37
Mean	16.29	4.79	9.08	668.52	5.16
LSD (0.05)(Manure Types)	1.31	1.25	1.48	91.36	1.09
LSD (0.05)(Manure Rates)	2.25	1.35	1.56	120.08	1.18
LSD (0.05)(Manure Types × Manure Rates)	ns	ns	ns	ns	ns
C.V. (%)(Manure Types)	7.17	23.27	14.51	12.15	18.83
C.V. (%)(Manure Rates)	13.17	26.88	16.34	17.10	21.75

ns = no significant at the 0.05 probability level; DW = dry weight.

Root length and root dry weight

Root length and root dry weight varied with types of manures and application levels. Root length and root dry weight of chicken manure were significantly higher at the similar application levels of cow manure. For application manure at different levels, the highest root length (21.36 cm plant^{-1}) and root dry weight (5.20 g plant^{-1}) were recorded at 25.00 ton organic manure ha^{-1}.

Total dry weight

Total dry weight different significantly due to application of different types of manures and application levels. Total dry weight of chicken manure was significantly higher at the similar application levels of cow manure.

The application of increasing levels of organic manure increased total dry weight. Similar results have also been reported by Roy *et al.*, (2010); Dinesh *et al*,. (2010) and Mohapatha and Das (2009). Inaddition, Manhas and Gill (2010) also reported that increment of application of organic manure increased dry matter accumulation and yield (Mishra and Jain, 2013).

Table 3 Root length, root dry weight, total dry weight and leaf dry weight yield of *Stevia rebaudiana* Bertoni. at harvest grown under different manure types and manure rates.

Treatments	Root length (cm plant^{-1})	Root DW (g plant^{-1})	Total DW (g plant^{-1})	LDW Yield (g m^{-2})
Organic Manure Types				
Chicken	18.49	3.30	15.32	42.13
Cow	13.73	2.72	11.62	38.48
Organic Manure Rates				
6.25 ton ha^{-1}	11.60	1.30	4.67	7.93
12.50 ton ha^{-1}	14.60	2.40	12.59	30.51
18.75 ton ha^{-1}	16.86	3.15	17.19	53.64
25.00 ton ha^{-1}	21.36	5.20	25.42	69.14
Mean	16.11	3.01	14.46	40.31
LSD (0.05)(Manure Types)	1.30	0.33	0.25	1.14
LSD (0.05)(Manure Rates)	3.64	0.38	0.51	4.02
LSD (0.05)(Manure Types× Manure Rates)	ns	ns	ns	ns
C.V. (%)(Manure Types)	30.15	9.75	14.67	17.98
C.V. (%)(Manure Rates)	17.19	11.91	16.84	19.97

ns = no significant at the 0.05 probability level; DW = dry weight; LDW = leaf dry weight.

Leaf dry weight yield

Leaf dry weight yield varied with types of manure and application levels. Leaf dry weight yield of chicken manure was significantly higher at the similar application level of cow manure. This might be attributed to the stimulating effect of chicken manure that supplies plant with nutrients required for better leaf dry weight yield (Detpiratmongkol, 2014; Abdelrazzag, 2002)

The perusal of data indicates that in general, higher organic matter resulted in more plant growth compared to the lower levels. The highest leaf dry weight yield (69.14 g m^{-2}) was recorded at 25.00 ton organic manure ha^{-1} the lowest (7.93 g m^{-2}) was obtained at 6.25 ton organic manure ha^{-1}.

In general, the treatments which included higher doses of organic manure were optimum in increasing different growth parameter of stevia. The maximum growth obtained may be attributed to the role of organic manures in better mobilization of plant nutrients that led to vigorous growth of plant in these treatments. Charam Kumar (2009) in stevia, Joy *et al.*, (2005) in *Curculigo orahioodes* and Sudhakara (2005) in *Coleus barbatus* also recorded that the use of organic manures alone improved growth parameter of different medicinal plants. Besides, these manures cause better physical, chemical and

biological function, which provides carbon as an energy source to soil microbial resulting in enhanced plant growth and yield (Umesha *et al.*, 2011)

Conclusion

From the results of present investigations on the bases of plant growth and leaf dry weight yield it may be concluded that chicken manure gave the significantly higher number of branch and branch dry weight, leaf area, leaf dry weight, stem dry weight, root dry weight, total dry weight and leaf dry weight yield compared with cow manure used. Increasing the rate of applied manure from 6.25 ton ha^{-1} to 25.00 ton ha^{-1} significantly increased all the growth and yield attributes measured. In addition, stevia crop may be supplied with 25.00 ton chicken manure ha^{-1}.

Acknowledgement

The authers would like to thank Faculty of Agricultural Technology, King Mongkut's Institute of Technology Ladkrabang (KMITL), Bangkok, Thailand for financial support. Additionally, the authors are grateful to laboratory staffs of the Plant Preduction Technology Section, KMITL, for their assistance in organic manure analysis.

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