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ALTERNATIVE GROWTH ENHANCERS FOR CORN PRODUCTION: EFFICACY OF VERMITEA ON SWEET CORN (Z. SACCHARATASTURT) PRODUCTION

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ABSTRACT

This study was conducted at the MinSCAT Main Campus Horticulture Production Area, Alcate, Victoria, Oriental Mindoro, Philippines from July to September, 2016 to determine the efficacy of varying dilution of vermitea such as: 1% (1L vermitea:100L water); 0.5% dilution (1L vermitea:200L water); and, 0.33% dilution (1L vermitea:300L water) on the production of sweet corn.

Results of the study revealed that 1% dilution of vermitea could be an alternative vegetative growth enhancers for corn considering that it produces significantly the tallest plants from the very beginning until the last measurement with 37.82cm and 198.77cm, compared to the untreated plants with a variations in height of 4cm and 51.88cm, respectively. It could also influence the growth of other vegetative parts such as number of leaves and diameter of stalk because plants supplied with 1% dilution produced 10.5 leaves compared to only 9.2 of the control. The stalk diameter of plants supplied with 1% vermitea was significantly bigger than that of the untreated plants having 10.47mm compared to only 7.17mm with a difference of 3.3mm.

Relative to the diameter of dehusked corn ears, plants supplied with 1% dilution exhibited the biggest and longest ears with 6.6cm and 13.03cm, respectively with mean differences of 1.92mm and 2.11cm against the untreated plants.

As regards to the yield per plot and per hectare, the same trend were noted with plants with the highest level of dilution garnered the heaviest yield with 5.022kg and 3348kg followed by the other treatments in descending orders with the control plants with the lightest having only 2.655kg and 1770kg per plot and per hectares, respectively.

As to the net income and return on investment, considering that these are directly correlated to the yield, it is therefore imperative that plants with the heaviest yield per plot and per hectare (1% vermitea dilution) have the highest net income of PhP152,530.00 and ROI of 315.47% compared to PhP61,950.00 and 140% for the control plants.

In the pest and diseases occurrence, dilutions of vermitea of varying levels could be an effective pesticides considering that all plants grows vigorously from its emergence until harvesting as no disease was noticed and few cutworms was only observed during the plants early vegetative growth but disappeared after several applications of vermitea.

Key Words: vermicast, vermitea

Rationale

Approximately 75 countries in both the industrial and developing world, each grow at least 100,000 hectares of corn (James, C. 2002); the total of 140 million hectares produces 600 million MT of corn grain per year. Developing countries plant two-thirds of the global corn area, and industrial one-third. The top five producers of corn are the US-229 MMT, China—124 MMT, Brazil-35.5 MMT, Mexico-19 MMT and France 16 MMT.

Corn is the second most important crop in the Philippines after rice. About 20% of the population use corn as staple food. Corn production involves about 7 million farm households and benefits downstream industries in the feed and livestock sectors.

The crop is grown throughout the year. But in spite of favorable climate and available technology, corn production in the country is not adequate to meet the need for food, feed, seed and industry.

In Oriental Mindoro alone, corn production is very low compared to its high demand in the market (Oriental Mindoro-Facts and Figures, 2011). Although there is available supply, the price is very high most especially the green or boiled corn. Likewise, the corn producers are using synthetic fertilizers and pesticides just to increase production and income. Considering that consumers today are becoming increasingly aware of the issues concerning food safety, there is a need to produce an organically grown green corn that is safe for human consumption.

The food produced organically increases the nutritional quality and improved the flavour of the vegetable (Ingham, 2004). The flavor of naturally-farmed food products is much better than those applied with chemical pesticides and chemical fertilizers.

In the Philippines, the use of organic fertilizer such as vermicompost, vermitea, animal manures, human waste, food wastes, yard wastes, sewage, sludges and composts has long been recognized in agriculture as beneficial for plant growth and yield and the maintenance of soil fertility.

Vermi composting is the process of turning organic debris into worm castings. Application of aqueous extract of vermicompost (vermicompost tea) has been shown to improve plant health, crop yield, and nutritive quality (Gamaley*et al.* 2001; Pant *et al.* 2009).

Nowadays, vermitea is a new technology in agriculture which is practiced in the country. It is done on a domestic, farm or industrial scale in waste-processing facilities and could be sited near residential areas, minimizing waste and fertilizer transportation costs.

It is believed that soluble mineral nutrients, organic acids and water soluble plant growth regulators extracted in the tea have positive effects on initial root development and plant growth with both foliar and soil application (Keeling et al. 2003; Edwards *et al.* 2006; Aranco*et al.* 2007). Living microorganisms present in compost tea may also induce disease resistance as well as stimulate nutrient uptake and plant growth (Scheuerell and Ma-haffee 2002; Ingham 2005; Hargreaves *et al.* 2008).

Vermitea is a lateral product of vermicomposting process which contains nitrogen, phosphorous and many micronutrients, hormones; etc. Also it contains earthworm enzyme and promote plant growth and yield and increase resistance of plant to disease and pests. It also contains dissolved nutrient, some organic acids and earthworm mucus (Shivsubramanian and Ganeshkumar, 2004). It includes powdered minerals such as: granite, limestone and rock phosphate which have been through the gut of a worm is then immediately available to your plants will supply 95% of everything the soil needs. The other 5% is organic material applied as mulch or litter on the surface of the soil or as dead root material under the soil surface (M and B William 2010).

Aside from the nutritional contents, vermitea has ability to decrease plant disease when used as soil drenches or foliar sprays (Scheuerell and Mahaffee, 2004). Vermiteas are viewed as potential alternatives to the use of synthetic chemical fungicides as they provide a means of controlling plant pathogens that are deemed safer for health and the environment (Siddiquiet al., 2008). Although disease suppressive effects of compost teas have been reported in numerous agricultural systems, their efficacy remains variable (Scheuerell and Mahaffee, 2006).

It is also an excellent plant growth promoter and soil amendment. According to soil scientists, using vermitea produces major growth differences between plants grown on soil and water and those grown on soil and vermitea. "The presence of plant growth regulators in the teas...can influence plant growth significantly *independent* of nutrient availability." (Arancon, et al, 2007)

As cited by Shivsubramanian and Ganeshkumar (2004), vermitea is lateral product of vermicomposting process which contains nitrogen, phosphorous and many micronutrients, hormones and etc. Also it contains earthworm enzyme and promote plant growth and yield and increase resistance of plant to disease and pests. It also contains dissolved nutrient, some organic acids and earthworm mucus.

With high potential to earn income for farmers and in full support with the local agencies on the conservation and promotion of the country's corn production, the researcher will focus on the production of one of the province's important high value commercial crop, "corn". With

regards to continuous health and environmental awareness, the researcher chose to use vermin-tea as an organic fertilizer and pesticide that is already available in the locality and have proven its potential in improving the growth of various crops.

It is deemed wise to undergo a research study that will help farmers to produce a crop at a very low production cost to obtain high profit and at the same time to supply the consumers with a healthy and nutritious pesticide free boil corn, hence, this study.

Objectives of the Study

General: To determine the growth and yield performance of Supersweet corn *(ZeasaccharataSturt))* applied with varying levels of vermitea solutions.

Specific:

1. To determine the effects of vermitea on the growth of super sweet corn.
2. To determine the effects of vermitea on the yield of corn.
3. To determine the occurrence of pests and diseases on corn applied with vermitea.
4. To determine which among the three solutions will give the highest return on investment.

Materials and Methods

Randomized Complete Block Design (RCBD) with three replications and four treatments was used in this study. Before planting, soil sampling and analysis and other important field practices was performed.

Vermicast were applied evenly in the area before final harrowing and incorporated thoroughly into the soil. Planting was done right after furrowing and laying of the area into replications and treatments. Three (3) different solutions of vermitea with ratio of 1:100, 1:200 and 1:300 (vermitea and water) were prepared and sprayed to the plants and the soil accordingly using knapsack sprayer. The first application was done right after planting, and every two weeks thereafter and the last application was a week before harvesting.

Three weeks after planting, cultivation by hilling-up using carabao-drawn native plow was done to cover the base of the plants and to control weeds.

Data on growth and yield parameters were determined using ten sample plants per plot and were analyzed using Analysis of Variance for Randomized Complete Block Design (RCBD)

and were tested at 1% and 5% level of significance. Mean comparison for significant differences were done using Duncan's Multiple Range Test (DMRT) and tested at 5% level of significance.

Net income was also evaluated as well as the occurrence of pests and diseases on corn as affected by varying concentrations of vermitea.

Results and Discussion

Vermitea is an excellent plant growth promoter and soil amendment. According to soil scientists, using vermitea produces major growth differences between plants grown on soil and water and those grown on soil and vermitea. "The presence of plant growth regulators in the teas...can influence plant growth significantly *independent* of nutrient availability." (Arancon, et al, 2007)

Results of the study revealed that levels of vermitea has profound effects on sweet corn's growth performance such as plant height considering that the plants supplied with the highest level of 1% solution (1:100 vermitea and water) consistently produced the tallest plants from the very beginning of height determination (five days after emergence) with mean of 37.82cm until it was harvested seventy-two(72) days after emergence with the height of 198.77cm. The untreated plants (control-no vermitea) on the other hand, had the shortest plant with 33.55cm on the initial determination and a final height of 146.89cm.

Statistical analysis showed that the 4.27cm and 51.88cm differenceson heightsof the tallest and the shortest plants on the initial and final determination were significant.

Corn supplied with 0.5% and 0.33% vermitea however, showed variations in height with the former producing slightly taller plants than the latter,but were comparable to each other, however itwas taller than the control plants (Table 1).

Table 1.Summary of Table of the Height of Sweet Corn (cm) from the First to the Last Determination

Treatment	I	II	III	IV	V
T_1	33.5b	75.72b	98.82b	121.61b	146.89c
T_2	34.48b	84.42ab	98.29b	128.54b	161.15b
T_3	37.06a	90.63ab	105.67ab	135.30ab	163.56b
T_4	37.82a	105.33a	120.33a	147.41a	198.77a
Fc = 175.07 CV= 7.03					

As regards to the number of leaves generated by the corn plants that produced photosynthates, plants supplied with 1% vermitea had the most number of leaves with 10.5 while the least was that of without vermitea with 9.2. Corn supplied with 0.5% and 0.33% vermitea had comparable leaves with 9.8 and 9.57, respectively.

Table 2. Mean number of leaves of corn plants a day before harvesting (10 sample plants)

Treatment	Replication			Total	Mean	Rank
	1	2	3			
1	8.9	9.7	9.0	27.6	9.2	4
2	9.3	9.8	9.6	28.7	9.57	3
3	9.3	10.2	9.9	29.4	9.8	2
4	10.1	10.8	10.6	31.5	10.5	1
Rep. Total	37.6	40.50	39.1			
Grand Total				117.2		
Grand Mean					9.77	

Table 2.1.Analysis of Variance on number of leaves a day before harvesting

SV	DF	SS	MS	Fc	Prob>F
Replication	2	1.05166667	0.52583333	23.37	0.0015*
Treatment	3	2.70000000	0.90000000	40.00	0.0002*
Error	6	0.13500000	0.02250000		
Total	11	3.88666667			

CV=1.54% ns=not significant *-significant

Table 2.2. Mean Comparison on number of leaves a day before harvesting

Treatment	Mean	Rank
T1	9.2c	4
T2	9.57b	3
T3	9.8b	2
T4	10.5a	1

Means with the same letter are not significantly different at 5% level

In terms of stalk diameter, the same trend was noted with corn plants supplied with the highest level (1%) of vermitea exhibited the biggest with 10.47mm while the smallest was the untreated plants with only 7.17mm. Analysis of variance showed significant variations between treatments.

Table 3. Average Diameter of corn stalk (10 sample plants) (mm)

Treatment	Replication			Total	Mean	Rank
	1	2	3			
1	6.17	7.87	7.46	21.15	7.17	4
2	7.90	10.07	8.64	26.61	8.87	3
3	9.15	11.00	10.98	31.13	10.38	2
4	9.31	11.04	11.07	31.42	10.47	1
Rep. Total	32.53	39.98	38.15			
Grand Total				110.31		
Grand Mean					9.22	

Table 3.1. Analysis of variance on the diameter of corn stalk

SV	DF	SS	MS	Fc	Prob>F
Replication	2	7.53631667	3.76815833	29.78	0.0008
Treatment	3	21.74216667	7.24738889	57.27	<.0001**
Error	6	0.75928333	0.12654722		
Total	11	30.03776667			

CV=3.86% ns=not significant **-highly significant

Table 3.2. Mean comparison on the diameter of corn stalk

Treatment	Mean	Rank
T1	7.17c	4
T2	8.87b	3
T3	10.38a	2
T4	10.47a	1

Means with the same letter are not significantly different at 5% level

Seventy-two (72 DAE) days after emergence, the corn ears achieved its boiling stage and was harvested early in the morning by detaching the ears from the plant using sharp bolo. Right after harvesting, corn ears of ten sample plants were immediately dehusked and measured individually at its middle portion using digital vernier caliper to determine its size. Length of corn ears were also determined individually using foot rule, and as

expected, the tallest plants with the most number of leaves and the biggest stem (1% vermicast) produced the biggest and the longest corn ears with 6.6mm and 13.02cm, while the shortest plants with the least number of leaves and having the smallest stem diameter, (control) the smallest and shortest ears with only 4.68mm and 10.91cm, respectively.

Table 4. Average Diameter of dehusked corn ears (10 sample plants) (cm)

Treatment	Replication			Total	Mean	Rank
	1	2	3			
1	4.77	5.19	4.07	14.03	4.68	4
2	6.02	6.47	5.15	17.64	5.88	3
3	6.22	6.58	5.75	18.55	6.18	2
4	6.59	6.67	6.54	19.8	6.6	1
Rep. Total	23.6	24.91	21.51			
Grand Total				70.02		
Grand Mean					5.84	

Table 4.1. Analysis of Variance on diameter of dehusked corn ears

SV	DF	SS	MS	Fc	Prob>F
Replication	2	1.47035000	0.73517500	10.36	0.0113
Treatment	3	6.15096667	2.05032222	28.91	0.0006
Error	6	0.42558333	0.07093056		
Total	11	8.04690000			

CV=4.56% ns=not significant *-significant

Table 4.2. Mean comparison on the diameter of dehusked corn ears

Treatment	Mean	Rank
T1	4.68c	4
T2	5.88b	3
T3	6.18ab	2
T4 6.6a	1	

Means with the same letter are not significantly different at 5% level

Table 5. Average Length of dehusked corn ears (10 sample plants) (cm)

Treatment	Replication			Total	Mean	Rank
	1	2	3			

1	11.02	10.9	10.8	32.72	10.91	4
2	11.1	10.93	11.02	33.05	11.02	3
3	11.5	11.9	11.65	35.05	11.68	2
4	13.25	12.78	13.04	39.07	13.02	1
Rep. Total	46.87	46.51	46.51			
Grand Total				139.89		
Grand Mean					11.65	

Table 5.1. Analysis of Variance on the length of dehusked corn ears

SV	DF	SS	MS	Fc	Prob>F
Replication	2	0.02160000	0.01080000	0.31	0.7452^{ns}
Treatment	3	8.52175833	2.84058611	81.29	<.0001**
Error	6	0.20966667	0.03494444		
Total	11	8.75302500			

CV=1.60% ns=not significant **-highly significant

Table 5.2. Mean comparison on the length of dehusked corn ears

Treatment	Mean	Rank
T1	10.91c	4
T2	11.02c	3
T3	11.68b	2
T4	13.02a	1

Means with the same letter are not significantly different at 5% level

In theyield performance of corn as affected by vermitea(Table 6), the same results were noted with plants supplied with the highest concentration of vermitea (1%) produced significantly the heaviest plot yield of 5.2kg, and highest yield per hectare with 3348kg (3.348MT) while the lowest was the unsupplied plants with a plot and hectare yields of only 2.65kg and 1770kg (1.77MT), respectively. The significant yield advantages of corn supplied with the highest concentration of vermitea (1%) over the other treatments could be explained by the findings of Gamaley*et al.* 2001; Pant *et al.* 2009 which states that application of aqueous extract of vermicompost (vermicompost tea) has been shown to improve plant health, crop yield, and nutritive quality.

Table 6. Yield per hectare (kg)

Treatment	Replication	Total

	1	2	3		Mean	Rank
1	1368	1980	1962	5310	1770	4
2	1800	2016	2538	6354	2118	3
3	2070	2034	2808	6912	2304	2
4	3078	3510	3456	10044	3348	1
Rep. Total	8316	9540	10764			
Grand Total				28620		
Grand Mean					2385	

Table 6.1. Analysis of Variance on yield per hectare

SV	df	SS	MS	Fc	Prob>F
Replication	2	749088	374544	8.21	0.0192*
Treatment	3	4150332	1383444	30.31	0.0005**
Error	6	273888	273888		
Total	11	5173308	5173308		

CV=8.96% *=significant *-highly significant

Table 6.2. Mean Comparison on yield per hectare

Treatment	Mean Yield	Rank
1	1770c	4
2	2118bc	3
3	2304b	2
4	3348a	1

Means with the same letter are not significantly different at 5% level.

With regards to the net income per hectare and return on investment (ROI), considering that it is directly correlated to the yield, it is therefore imperative that plants having the highest yield (1% vermitea) had significantly the highest net income of PhP152,530.00 per hectare and Return on Investment (ROI) of with 315%, while the plants without vermitea (control) got the lowest with only an income of PhP61950.00 and 140% ROI, respectively.

Table 7. Net Income Per Hectare (Php)

Treatment	Replication			Total	Mean	Rank
	1	2	3			
1	37830	74550	73470	185850	61950	4
2	60800	73760	105080	239640	79880	3
3	76680	74520	120960	272160	90720	2
4	136330	162250	159010	457590	152530	1
Rep. Total	311640	385080	458520			
Grand Total				1155240		
Grand Mean					96270	

Table 8.1. Analysis of Variance on net income per hectare

SV	DF	SS	MS	Fc	Prob>F
Replication	2	2696716800	1348358400	8.21	0.0192*
Treatment	3	13927453800	4642484600	28.25	0.0006^{ns}
Error	6	985996800	164332800		
Total	11	17610167400			

CV=13.32% ns=not significant *-significant

Table 8.2. Mean Comparison on net income per hectare

Treatment	Mean	Rank
T1	61950c	4
T2	79880bc	3
T3	90720b	2
T4	152530a	1

Means with the same letter are not significantly different at 5% level.

As to the occurrence of pests, surprisingly, it could be noted that except for few cutworm larvae during the early vegetative growth of the plants which disappeared after several applications of vermitea, no other pests were observed until it was harvested seventy two days after emergence. Moreover, plants sprayed with vermitea produced healthy plants and no disease of any kind was observed throughout the duration of the study. Again, as cited by Shivsubramanian and Ganeshkumar, 2004, vermitea is a lateral product of vermicomposting process which contains nitrogen, phosphorous and many micronutrients, hormones; etc. Also it contains earthworm enzyme and promote plant growth and yield and increase resistance of plant

to disease and pests. It also contains dissolved nutrient, some organic acids and earthworm mucus. Moreover, Scheuerell and Mahaffee, 2004, in their findings stressed that aside from the nutritional contents, vermitea has ability to decrease plant disease when used as soil drenches or foliar sprays; and vermiteas are viewed as potential alternatives to the use of synthetic chemical fungicides as they provide a means of controlling plant pathogens that are deemed safer for health and the environment as explained by Siddiquiet al., 2008).

Table 9. COST OF PRODUCTION FOR ONE (1) HECTARE SUPERSWEET CORN APPLIED WITH VARRYING LEVELS OF VERMITEA

ITEM/ACTIVITIES	**MD (PhP250/d) MAD (500/d)**	**T_1 (Control)**	**T_2- Vermitea &H_2O (1:300)**	**T_3- Vermitea &H_20 (1:200)**	**T_4- Vermitea &H_20 (1:100)**
OPERATIONAL COST					
Land preparation	(Contract basis from 1st plowing to final harrowing)	6000.00	6000.00	6000.00	6000.00
Furrowing	5 MAD	2500.00	2500.00	2500.00	2500.00
Application of Vermicast	8 MD	2000.00	2000.00	2000.00	2000.00
Planting	6 MD	1500.00	1500.00	1500.00	1500.00
Replanting of missing hills	4 MD	1000.00	1000.00	1000.00	1000.00
Weeding	10 MD	2500.00	2500.00	2500.00	2500.00
Application of Vermitea	10 MD	-0-	2500.00	2500.00	2500.00
8. Care of the crop	10 MD	2500.00	2500.00	2500.00	2500.00
9. Hilling-up	4 MAD	2000.00	2000.00	2000.00	2000.00
. Harvesting	12 MD	3000.00	3000.00	3000.00	3000.00
1. Postharvest activities	10 MD	2500.00	2500.00	2500.00	2500.00
SUB-TOTAL		**19500.00**	**22000.00**	**22000.0**	**22000.00**
INPUTS					
Seeds (20 kg @ P800/kg)		16000.00	16000.00	16000.0	16000.00
Vermicast (400kg @ 10/kg)		4000.00	4000.00	4000.0	4000.00
Vermitea		-0-	450.00	650.00	1300.00

(100/L)			(4.5L)	(6.5L)	(13L)
SUB-TOTAL		**20000.00**	**20450.00**	**20650.0**	**21300.00**
OTHER MATERIALS					
Container (12/pc)		600.00 (50 pcs)	600.00 (50 pcs)	720.00 (60 pcs	900.00 (75 pcs)
Plastic straw		150.00	150.00	150.00	150.00
SUB-TOTAL		**750.00**	**750.00**	**870.00**	**1050.00**
INCIDENTAL EXPENSES					
Meals, snacks, etc.		4000.00	4000.00	4000.00	4000.00
SUB-TOTAL		**4000.00**	**4000.00**	**4000.00**	**4000.00**
TOTAL COST OF PRODUCTION		**44250.00**	**47200.00**	**47520.0**	**48350.0**

Table 10. SUMMARY TABLE ON COST AND RETURN ANALYSIS FOR ONE (1) HECTARE OF SUPERSWEET CORN APPLIED WITH VERMITEA

ITEM	**T R E A T M E N T**			
	T_1 (Control)	**T_2 (1:300-VERMITEA & H_20)**	**T_3 (1:200-VERMITEA & H_20)**	**T_4 (1:100-VERMITEA & H_20)**
OPERATIONAL COST	19500.00	22000.00	22000.0	22000.00
INPUTS	20000.00	20450.00	20650.0	21300.00
OTHER MATERIALS	750.00	750.00	870.00	1050.00
INCIDENTAL EXPENSES	4000.00	4000.00	4000.00	4000.00
TOTAL COST OF PRODUCTION	**44250.00**	**47200.00**	**47520.0**	**48350.0**
PER HECTARE (Kg)	**1770**	**2118**	**2304**	**3348**
PRICE PER KG (PhP)	**60.00**	**60.00**	**60.00**	**60.00**

GROSS INCOME (PhP)	**106200.00**	**127080.00**	**138240.00**	**200880.00**
NET INCOME	**61950.00**	**79880.00**	**90720.00**	**152530.00**
RETURN ON INVESTMENT (%)	**140**	**169**	**190.90**	**315.47**

Conclusion

Based on the results of the study, the following conclusions were made:

Application of optimum level of dilution (1%) of vermitea (1L vermitea:100L water) could be used as an alternative growth enhancers of sweet corn considering that it significantly enhances the vegetative growth of the plants in terms of plant height, number of leaves and diameter of stalk.

In the production aspects, application of the optimum level of dilution (1%) of vermitea (1L vermitea:100L water) significantly increased the diameter and length of dehusked corn ears which resulted to the heaviest weight of yield attained per plot and per hectare, respectively.

Similarly, due to the application of 1% vermitea dilution, higher net income and return on investment were achieved with only a slight difference of PhP4100.00 on the expenses per hectare between the treated and the untreated plants.

Surprisingly, in the pests and diseases occurrence, 1% vermitea dilution could be used as an organic pesticide considering that aside from few cutworms that was noticed during the early vegetative stage of sweet corn which disappeared after several applications, no diseases of any kind was detected and noticed and the plants grow vigorously until it was harvested seventy two days after emergence.

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