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Growth and Yield Performance of the Different Varieties of Pechay (*Brassica chinensis*) as Affected by the Different Organic Fertilizers under MSU-Marawi Condition

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Abstract
Most farmers traditionally use chemical or inorganic fertilizers in their farms because of its availability in the market. However, these types of fertilizers are expensive and develop soil acidity if continuously used. Organic fertilizers are now a promising method for sustainable farming in which most affordable compared to synthetic fertilizers. Organic fertilizers are produced from animal manures, crop residues, organic wastes through earthworm and other farm by-products. These improve the physical, chemical and microbial status of the soil. However, the use of organic fertilizers are not widely adopted by farmers due to low nutrient composition, bulky and require more time and labor for collection, storage, transport and application. Thus, this study aimed to determine the growth and yield performance of the varieties of pechay treated by the different organic fertilizers. Specifically it sought to determine and compare the effects of the different sources of organic fertilizers on the growth and yield of the different varieties of pechay; to determine which of the different sources of organic fertilizers gives the highest yield using the different varieties of pechay; and to determine which of the different treatment combinations (varieties of pechay and sources of fertilizers) gives the highest yield. The organic fertilizers used in the study were F_1 (carabao manure), F_2 (goat manure), and F_3 (vermicast). Twenty five (25) grams per hill as recommended rate was applied basally in each source of organic fertilizer. The experimental design used was a 2x3 factorial experiment in a Randomized Complete Block Design (RCBD). The primary distinguishing feature of the RCBD is the presence of blocks of equal size, each of which contains all the treatments. It is composed of six (6) treatment combinations; two (2) varieties of pechay as factor A and three (3) different organic fertilizers as factor B and replicated three (3) times. The result of the study revealed that the highest yield was obtained in the treatment T_3 (V_1F_3 -Black Behi x vermicast) that differed significantly from the treatment T_4 (V_2F_1 -Haridigma x carabao manure).

Keywords: growth, pechay, fertilizers, organic, farmers

Introduction

Intensive agriculture through the use of modern technologies and innovative schemes has been the answer to increase food production for the growing population. However, this approach has brought in some negative effects to human health and the environment. Hence, alternative means have been explored to address both the need for food and environmental conservation.

One such means is sustainable agriculture through organic farming. Advocates of sustainable agriculture both local and abroad believe that organic agriculture is the remedy to the world's problem of environmental degradation (PCARRD 2008).

Organic materials when added to the soil have numerous beneficial effects, which include increased soil fertility, balanced supply of nutrients, and build-up of organic matter (OM). However, these effects are strongly influenced by the nature of the organic materials, their nutrient content, and the process of the decomposition in the soil. There is a diverse array of organic materials, which can be processed and composted for application in the farm. Most of these are called wastes but some are by-products that can be put to good use by simple processes or treatment. These include plant residues, animal manures, green manures, agro-industrial wastes, and garbage. Such materials are abundant in the Philippine farms and urban areas.

PCARRD (2008) emphasized that organic materials are known to improve rhizosphere ecosystem, suppress soil-borne phytopathogens, and promote root growth. Plants treated with farmyard manure have been found to have better root development during the early growing stage. It is believed that among the factors affecting the root growth, rhizosphere micro flora, root growth regulators, and behaviour of fungi in the rhizosphere may be of particular importance because of their high saprophytic/parasitic activities.

Purpose of the Study

The general objective of this study was to determine the growth and yield performance of the varieties of peachy as affected by the different organic fertilizers. Specifically it sought to (a) determine and compare the effects of the different sources of organic fertilizers on the growth and yield of the different varieties of pechay (b) determine which of the different sources of organic fertilizers gives the highest yield using the different varieties of pechay; and (c) determine which of the different treatment combinations (varieties of pechay and sources of fertilizers) gives the highest yield.

Materials and Method

Experimental Design

The experimental design used was a two-factor experiment in a Randomized Complete Block Design (RCBD). It consisted of six (6) treatment combinations; two (2) varieties of pechay and three (3) different sources of organic fertilizers and replicated three (3) times. The treatments compared are as follows:

Factor A (Varieties of Pechay)
- V_1 (Black Behi)
- V_2 (Haridigma)

Factor B (Sources of Organic Fertilizers)
- F_1 (carabao manure)
- F_2 (goat manure)
- F_3 (vermicast)

Table 1 Treatment combinations used are shown in the following matrix:

Pechay Variety	Source of Organic Fertilizer		
	F_1	F_2	F_3
V_1	V_1F_1	V_1F_2	V_1F_3
V_2	V_2F_1	V_2F_2	V_2F_3

The treatments are:

T_1 (V_1F_1 -Black Behi x carabao manure)
T_2 (V_1F_2 -Black Behi x goat manure)
T_3 (V_1F_3 -Black Behi x vermicast)
T_4 (V_2F_1 -Haridigma x carabao manure)
T_5 (V_2F_2 -Haridigma x goat manure)
T_6 (V_2F_3 -Haridigma x vermicast)

Randomization and Layout

The experimental area of 59.5 square meters was divided into three (3) blocks, which correspond to the number of replications. Then each block measuring one meter (1m) by two meters (2m) was divided into six (6) experimental plots for the six (6) treatments. The distance between plots was 0.5 meter and between block was 0.5 meter. The randomization was done by drawing lots for all the three (3) replications. The layout of the experimental area is shown below.

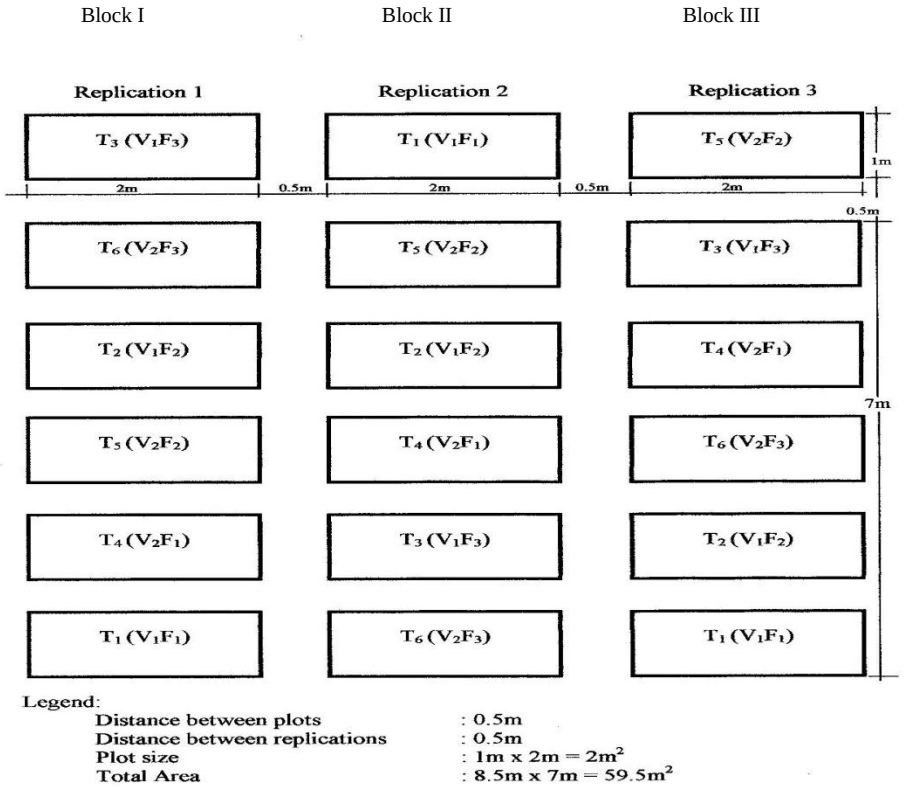

Figure 1. Randomized and Layout of the Experiment (2x3) Factorial Experiment in Randomized Complete Block Design (RCBD)

Data Gathering

Ten (10) randomly selected plants at the center of each plot were measured as data plants. Growth parameters such as plant's height in centimeter were measured from the base to the tip of the longest leaf as well as plants leaf length. The initial and the final heights of the plants and were measured at 23 and 45 days after emergence (DAE). In terms of yield, weight of plants in gram was measures. Ten (10) data plants were taken at 45 days after emergence (DAE) in every plot.

Data Analysis

Analysis of Variance (ANOVA) in 2 by 3 (2x3) factor-experiment in a Randomized Complete Block Design (RCBD) was used as statistical tool in interpreting and analyzing the collected

numerical data. Level of significance was determined at 5% and 1% levels. Significant differences of treatment means were determined using Duncan's Multiple Range Test (DMRT).

Results and Discussion

There are two data that were gathered from the experimental plants which are statistically analyzed. These are plants' height at 45 days after emergence and the yield per plant per hill at 45 days after emergence. The gathered raw data are presented in Tables 1 and 2 while the statistical Tables are presented in 1a and 2a for the analysis of variance, Tables 1b and 2b for DMRT for treatment combinations; Tables 1c and 2c for varieties and Tables 1d and 2d for fertilizers. The treatment combinations are as follows: (V_1F_1 -Black Behi x carabao manure) T_1, (V_1F_2 -Black Behi x goat manure)T_2, (V_1F_3 -Black Behi x vermicast) T_3, (V_2F_1 – Haridigma x carabao manure) T_4, (V_2F_2 - Haridigma x goat manure) T_5 and (V_2F_3 - Haridigma x vermicast) T_6. The sources of organic fertilizers are: F_1 (carabao manure); F_2 (goat manure); and F_3 (vermicast). The varieties used are $_{V1}$ (Black Behi) and V2 (Haridigma).

Average Plants' Height (cm) at 45 DAE

Plants' heights at 45 DAE were obtained and data are shown in Table 3. It can be seen from the table that Black Behi (V_1) fertilized with vermicast (F_3) shows the tallest plants with mean plant height of 25.19 cm. The next taller plant is noted from V_2 (Haridigma) fertilized with F_2 (goat manure) with mean height of 24.82 cm.

On the average, when the two pechay varieties are compared, Black Behi (V_1) is relatively taller than Haridigma (V_2) with mean values of 22.85- and 22,53-cm, respectively. Similarly, when the effects of the three different sources of fertilizers are compared, vermicast (F_3) produce the tallest plant height, followed by plants fertilized with goat manure (F_2) and the shortest plant is seen in plants applied with carabao manure (F_1) with mean values of 25.01-, 23.89- and 19.19-cm, respectively.

Statistical analysis of the data shown in Table 3a indicates that the effects of the different treatment combinations (T) and the different sources of fertilizers (F) show highly significant mean plant height differences at 45 days after emergence while the interactions of the three different sources of organic fertilizer (VxF) and varieties (V) do not reveal significant mean plant height differences.

To compare the effects of treatment combinations (T) and fertilizers (F), DMRT were computed and the results are shown in Tables 3b and 3c, respectively. It can be noted that T_1 (V_1F_1-Black Behi x carabao manure) and T_4 (V_2F_1-Haridigma x carabao manure) do not differ significantly in terms of their effects on plant height at 45 DAE but they both differ significantly from the effects of the rest of the treatment combinations, the latter also do not differ significantly. The Black Behi (V_1) fertilized with vermicast (F_3) produces the tallest plant height that differ significantly from the V_1 Black Behi (V_1) fertilized with carabao manure (F_1). As to the effects of different sources of organic fertilizers, carabao manure (F_1) reveals the shortest plant height at 45 DAE that differ significantly from the effects of F_2 (goat manure) and vermicast (F_3), the latter produces the tallest plant.

Table 1. Average Plants' Height (cm) at 45 Days After Emergence (DAE) of the Different Varieties of Pechay as Affected by the Different Organic Fertilizers, Replicated Three Times.

Treatment Combination (Organic Fertilizer)	Average Plants' Height (cm)			Treatment Total	Treatment Mean
	R_1	R_2	R_3		
	V_1				
T_1 (F_1)	19.28	20.57	17.94	57.79	19.26
T_2 (F_2)	25.09	23.85	23.40	72.34	24.11
T_3 (F_3)	28.25	23.60	23.71	75.56	25.19
	V_2				
T_4 (F_1)	19.30	18.30	19.75	57.35	19.12
T_5 (F_2)	23.82	23.56	23.60	70.98	23.66
T_6 (F_3)	26.56	24.70	23.20	74.46	24.82
Rep. Total (R)	142.30	134.58	131.60		136.20
Grand Total (G)				408.48	
Grand Mean					22.69

Table 1a. ANOVA of Table 1 (Average Plants' Height (cm) at 45 Days After Emergence (DAE) of the Different Varieties of Pechay as Affected by the Different Organic Fertilizers, Replicated Three Times)

Source Of Variation	Degree of Freedom	Sum of Squares	Mean Square	Computed F	Tabular F	
					5%	1%
Replication	2	10.165	5.083	3.233^{ns}	4.10	7.56
Treatment	5	114.743	22.949	14.598^{**}	3.33	5.64
Variety (V)	(1)	0.467	0.467	0.297^{ns}	4.96	10.04
Fertilizer (F)	(2)	114.201	57.101	36.323^{**}	4.10	7.56
(VxF)	(2)	0.075	0.038	0.024^{ns}	4.10	7.56
Error	10	15.716	1.572			
Total	17	140.623				

cv = 5.53%
*** = highly significant*
ns = not significant

Table 1b. DMRT Table on Treatments of Table 3 (Average Plants' Height (cm) at 45 Days After Emergence of the Different Varieties of Pechay as Affected by the Different Organic Fertilizers, Replicated Three Times.)

Treatment Combination	Mean Plants' Leaf in cm[a]	DMRT[b]
T_1 (V_1F_1-Black Behi x carabao manure)	19.26	b
T_2 (V_1F_2-Black Behi x goat manure)	24.11	a
T_3 (V_1F_3-Black Behi x vermicast)	5.19	a
T_4 (V_2F_1-Haridigma x carabao manure)	19.12	b
T_5 (V_2F_2-Haridigma x goat manure)	23.66	a
T_6 (V_2F_3-Haridigma x vermicast)	74.46	a

[a]Average of three replications
[b] = Any two means having a common letter are not significantly different at 5% level of significance.

Table 1c. DMRT Table on Fertilizer of Table 1 (Average Plants' Height (cm) at 45 Days After Emergence (DAE) of the Different Varieties of Pechay as Affected by the Different Organic Fertilizers, Replicated Three Times.)

Source of Fertilizer	Mean Plants' Leaf in cm[a]	DMRT[b]
F_1 (carabao manure)	6.05	b
F_2 (goat manure)	8.95	a
F_3 (vermicast)	9.32	a

[a] *Average of three replications*

[b] = *any two means having a common letter are not significantly different at 5% level of significance.*

Average Plants' Weight in Gram per Plant per Hill at 45 DAE

The yields obtained from the experiment are shown in Table 5. As indicated in Table 5, the highest yield is obtained from Black Behi (V_1) fertilized with vermicast (F_3) with mean yield of 159.93 grams per plant per hill. The next higher yield is taken from Haridigma (V_2) fertilized also by vermicast (F_3) with mean yield of 107.40 grams per plant per hill. On the average, Black Behi (V_1) produces higher yield than Haridigma (V_2) with mean values of 118.07- and 107.40-grams, respectively. Similarly, the fertilizer that gives the highest yield is vermicast (F_3) while the lowest yield is found in carabao manure (F_1) with mean yields of 154.83- and 66-grams per plant respectively. The yield obtained from plant fertilized with goat manure (F_2) is 117.37 grams per plant.

Analysis of variance as shown in Table 5a indicates that the treatment combinations (T), varieties (V), and fertilizers (F) as sources of variation produce effects that are all highly significantly different from each other in terms of the yield. To compare these effects, DMRT were computed and results are presented in Table 5b, 5c, and 5d, respectively.

From Table 5b, the highest yield is found in plant treated with T_3 (V_1F_3 -Black Behi x vermicast) that differed significantly from the plant treated with T_4 (V_2F_1 - Haridigma x carabao manure). The yield obtain from the rest of the treatment combinations did not differ significantly, namely: T_1 (V_1F_1 -Black Behi x carabao manure), T_2 (V_1F_2 -Black Behi x Goat manure), T_5 (V_2F_2 - Haridigma x goat manure) and T_6 (V_2F_3 - Haridigma x vermicast).

Similarly, Table 5c shows no significant mean yield differences between the two pechay varieties used in the experiment, though numerically Haridigma variety (V_2) produces higher yield than Black Behi (V_2) variety.

Further, from Table 5d, it is shown that specific test using DMRT indicates no significant fertilizer mean differences which mean that the effects of the different sources of organic fertilizers do not statistically differ. This implies that the three sources of organic fertilizers may produce yield at different ranks as observed in this experiment, meaning carabao manure or goat manure may give higher yield than the vermicast.

Table 2. Average Plants' Weight (in gram per plant per hill) at 45 Days After Emergence (DAE) of the Different Varieties of Pechay as Affected by the Different Organic Fertilizers, Replicated Three Times

Treatment Combination (Organic Fertilizer)	Average Plants' Weight (gram)			Treatment Total	Treatment Mean
	R_1	R_2	R_3		
	V_1				
T_1 (F_1)	171.80	61	32	264.80	88.27
T_2 (F_2)	113.80	118.40	85.80	318	106.00
T_3 (F_3)	217.40	117.20	145.20	479.80	159.93
	V_2				
T_4 (F_1)	37.60	44.40	49.20	131.20	43.73
T_5 (F_2)	106.20	136.60	143.40	386.20	128.73
T_6 (F_3)	160.60	135.20	151.40	447.20	149.73
Rep. Total (R)	807.40	612.80	607		675.73
Grand Total (G)				2027.20	
Grand Mean					112.62

Table 2a. ANOVA of Table 2 (Average Plants' Yield in Gram per Plant per Hill at 45 Days After Emergence (DAE) of the Different Varieties of Pechay as Affected by the Different Organic Fertilizers, Replicated Three Times).

Source of Variation	Degree of Freedom	Sum of Squares	Mean Square	Computed F	Tabular F	
					5%	1%
Replication	2	6454.351	3227.176	1.582^{ns}	4.10	7.56
Treatment	5	23909.764	4781.953	4.032^{*}	3.33	5.64
Variety (V)	(1)	1600.333	1600.333	0.393^{*}	4.96	10.04
Fertilizer (F)	(2)	18435.524	9217.762	8.648^{**}	4.10	7.56
(VxF)	(2)	3873.907	1936.953	1.237^{ns}	4.10	7.56
Error	10	14457.08	1445.708			
Total	17	44821.191				

cv = 32.87% *** = highly significant*

* = significant* *ns = not significant*

Table 2b. DMRT Table on Treatments of Table 2 (Average Plants' Yield in Gram per Plant per Hill at 45 Days After Emergence of the Different Varieties of Pechay as Affected by the Different Organic Fertilizers, Replicated Three Times).

Treatment	Mean Plants' Leaf in cm[a]	DMRT[b]
T_1 (V_1F_1-Black Behi x carabao manure)	88.27	ab
T_2 (V_1F_2-Black Behi x goat manure)	106.00	ab
T_3 (V_1F_3-Black Behi x vermicast)	159.93	a
T_4 (V_2F_1-Haridigma x carabao manure)	43.73	b
T_5 (V_2F_2-Haridigma x goat manure)	128.73	ab
T_6 (V_2F_3-Haridigma x vermicast)	149.73	ab

[a] *Average of three replications*

[b] *= Any two means having a common letter are not significantly different at 5% level of significance.*

Table 2c. DMRT Table on Variety of Table 2 (Average Plants' Yield in Gram per Plant per Hill at 45 Days After Emergence of the Different Varieties of Pechay as Affected by the Different Organic Fertilizers, Replicated Three Times.)

Treatment	Mean Plants' Leaf in cm[a]	DMRT[b]
V_1 (Black Behi)	8.06	a
V_2 (Haridigma)	8.14	a

[a] *Average of three replications*
[b] = *Any two means having a common letter are not significantly different at 5% level of significance.*

Table 2d. DMRT Table on Fertilizer of Table 2 (Average Plants' Yield in Gram per Plant per Hill at 45 Days After Emergence of the Different Varieties of Pechay as Affected by the Different Organic Fertilizers, Replicated Three Times).

Treatment	Mean Plant's Leaf in cm[a]	DMRT[b]
F_1 (carabao manure)	6.05	a
F_2 (goat manure)	8.95	a
F_3 (vermicast)	9.32	a

[a] *Average of three replications*
[b] = *Any two means having a common letter are not significantly different at 5% level of significance.*

Generally plants' height at 45 DAE, Black Behi (V_1) fertilized with vermicast (F_3) shows the tallest plants with mean plant height of 25.19 cm followed by Haridigma (V_2) fertilized with goat manure (F_2) with mean height of 24.82 cm. On the average, Black Behi (V_1) plant is relatively taller than Haridigma (V_2) with mean values of 22.85- and 22, 53-cm, respectively. Vermicast (F_3) produces the tallest plant height, followed by plants fertilized by goat manure (F_2) and the shortest plant is seen in plants applied with carabao manure (F_1) with mean values of 25.01-, 23.89- and 19.19-cm, respectively.

On the other hand, plants' yield in gram per plant per hill at 45 DAE showed that the highest yield is obtained from Black Behi (V_1) fertilized with vermicast (F_3) with mean yield of 159.93 grams per plant per hill followed by Haridigma (V_2) fertilized also by vermicast (F_3) with mean yield of 149.73 grams per plant per hill. On the average, Black Behi (V_1) produces higher yield than Haridigma (V_2) with mean values of 118.07- and 107.40-grams, respectively. Similarly, the fertilizer that gives the highest yield is vermicast (F_3) while the lowest yield is found in carabao manure (F_1) with mean yields of 154.83- and 66-grams per plant. The yield obtained from plant fertilized with goat manure (F_2) is 117.37 grams per plant.

Conclusions and Recommendations

The effects of the different treatment combinations (T) and the different organic fertilizers (F) are highly significant in terms of plant height differences at 45 days after emergence; while the interactions of the three different sources of organic fertilizers (VxF) and varieties (V) do not reveal significant mean plant height differences. T_1 (V_1F_1 - Black Behi x carabao manure) and T_4 (V_2F_1 - Haridigma x carabao manure) do not differ significantly in terms of their effects on plant height at 45 DAE but they both differ significantly from the effects of the rest of the treatment combinations, the latter also do not differ significantly. Black Behi (V_1) variety that is fertilized with vermicast (F_3) with the treatment combination of (V_1F_3 –Black Behi x vermicast) produces the tallest plant height that differ significantly from the Black Behi (V_1) fertilized with carabao manure (F_1) with the treatment combination of (V_1F_1 -Black Behi x carabao manure). Carabao manure (F_1) reveals the shortest plant height that differ significantly from the effects of goat manure (F_2) and vermicast (F_3), the latter produces the tallest plant.

The Treatment combinations (T), varieties (V), and fertilizers (F) as sources of variation produce effects that are all highly significantly different from each other in terms of the yield. The highest yield is found in plant treated with T_3 (V_1F_3 -Black Behi x vermicast) that differs significantly from the plant treated with T_4 (V_2F_1 -Haridigma x carabao manure). The yield obtained from the rest of the treatment combinations did not differ significantly, namely: T_1 (V_1F_1 -Black Behi x carabao manure), T_2 (V_1F_2 -Black Behi x goat manure), T_5 (V_2F_2 - Haridigma x goat manure) and T_6 (V_2F_3 - Haridigma x vermicast). There is no significant fertilizer mean difference between goat manure (F_2) and vermicast (F_3) but both F_2 and F_3 differ significantly from carabao manure (F_1). Also there is no significant mean yield difference between the two pechay varieties used in the experiment. Thus, the study recommended that vermicast should be used for fertilizing pechay; any of the variety of pechay used is recommended for production; treatment combination is also recommended is (V_1F_3 -Black Behi x vermicast) T_3; and similar study is recommended using other vegetable crops.

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