On-Farm Evaluation of Chinese Kale (*Brassica oleracia* Bailey) Grown with Organic Fertilizers in Kasibu, Nueva Vizcaya

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ABSTRACT

On-farm evaluation for Chinese kale adaptability, productivity and quality was done by conducting a field experiment involving variety and organic fertilizer inputs as interventions in Kasibu, Nueva Vizcaya from September to December 2013.

The growth and yield performance of Kailaan and Gai Lohn were similar.

Results indicated the superiority of organic over that of inorganic fertilizer. Chicken manure (CM), vermicompost (VC) and processed chicken manure (PCM) enhanced the growth and consequently, the yield of Chinese kale.

In terms of quality, the color of both varieties were similarly rated as "like very much" and in terms of taste, both were "like moderately". Kailaan and Gai Lohn were rated as "not bitter".

Based on the findings of the study, Kailaan and Gai Lohn are suitable varieties of Chinese kale for planting in Kasibu, Nueva Vizcaya. For high yield and good quality Chinese kale, organic fertilizers such as CM, VC, and PCM should be applied instead of inorganic fertilizer.

INTRODUCTION

Chinese Kale (*Brassica oleracea* L. var. *alboglabra* Bailey) is also known as Chinese broccoli, flowering kale, Kailan or Gai Lan. It is widely cultivated in Southeast Asia and one of the popular Brassica greens in Southeast Asian countries because of its tolerance to heat and humidity of the tropics. It is an exceptional source of chlorophyll, calcium, iron, and vitamin A, hence, it offers a number of health benefits (Larkcom, 1991).

Vegetables are an important part of the Filipino diet. They are relatively cheaper sources of vitamins, minerals, protein and fiber compared to meat and fish. Various vegetables are grown in the country but Chinese kale is not yet known to majority of Filipino vegetable farmers. The crop needs to be introduced to the country, especially in Nueva Vizcaya, for the people to take advantage of its nutrient value, and health benefits as well as its potential as source of income for small farmers.

Soil management practices have recently changed dramatically including an increased use of synthetic fertilizers and pesticides to help increase crop yields. However, some studies have suggested that excessive use of agrochemicals may actually increase pest problems in the long run. Overall, these results propose a hypothesis that higher synthetic fertilizer inputs may lead to higher levels of herbivore damage to crops. On the other hand, less use of inorganic fertilizer and pesticides would control health and environmental hazards as well as lessen the negative impact on impending climate change considering that inorganic fertilizer is

associated with the production of green house gases.

In the Philippines, Republic Act No. 10068, known as the "Organic Agriculture Act of 2010", was signed into law on April 6, 2010. It aims to promote, propagate, develop further and implement the practice of organic agriculture in the Philippines. This is one of the priority thrusts of the present administration of the municipality of Kasibu, Nueva Vizcaya. Kasibu is one of the major vegetable producers contributing a combined substantial income for the province of Nueva Vizcaya.

Generally, the study was conducted to generate information on the effects of organic fertilizers to introduced Chinese kale varieties such as Kailaan and Gai Lohn which would serve as a tool in the development of appropriate organic production technology specific for these crops.

Specifically, this study aimed to: 1) characterize the growth, yield and quality of Kailaan and Gai Lohn varieties grown under Kasibu, Nueva Vizcaya conditions; 2) evaluate the effects of various organic fertilizers on the growth, yield and quality of Kailaan and Gai Lohn varieties; and 3) determine the best combination of variety and organic fertilizer that will give the highest yield and good quality.

MATERIALS AND METHODS

Experimental Design and Treatments

The experiment was laid out in a 2 x 5 Factorial in Randomized Complete Block Design (RCBD) with three replications. The different treatments are as follows:

Factor A (Variety):
A1 - Kailaan
A2- Gai Lohn

Factor B (Organic Fertilizer Input):
B1 – Chicken manure (CM)
B2– Vermicompost (VC)
B3 – Processed Chicken Manure (PCM)
B4 – NVSU-BioOrganic
B5 – Inorganic fertilizer (120-30-30 NPK kg/ha) - control

Crop Establishment and Cultural Management

A 1m x 3m plot was prepared as seedbed for each variety. A total of 3 kg-composted swine manure was incorporated into each plot. Seeds were sown on September 14, 2013 and started to germinate four days after sowing. Seedlings were raised for 30 days. Blanket application of effective microorganism-activated solution (EMAS) as foliar at the rate of 2 tbsp per liter of water was done weekly during the seedling stage.

Seedlings were transplanted at one seedling per hill with a planting distance of 25cm x 20cm on October 15, 2013. Replanting of missing hills was done three days after transplanting (DAT).

Fertilizer inputs were applied according to recommended fertilizer treatments. The different organic fertilizers such as processed chicken manure, vermicompost and chicken manure were applied two weeks before planting at the rate of 5.4 tons ha^{-1} or 648 g per plot. NVSU BioOrganic was applied based on manufacturer's recommendation. The inorganic fertilizer which served as the control treatment was applied in three splits *i. e.*, basal at 30-30-30 kg ha^{-1} NPK. First and second side dressings were done at 14 and 21 DAT, respectively. The source of nitrogen fertilizer material was Urea at 45-0-0 kg ha^{-1} NPK.

Plants were irrigated when there was no rain to maintain adequate moisture in the soil. Partially decomposed rice straw was used as mulch at 1-2 inches thick to keep the ground cool by maintaining soil moisture which is favorable for kale growth (AVRDC, 2008).

Blanket spraying of organic pesticide was done using liquefied smoke at the rate of 5 tbsp per liter of water to control diamond back moth (DBM). Spraying was done at 15, 21, and 28 days after sowing (DAS), and 8 and 15 DAT.

Hand weeding was done once in both experimental sites.

Harvesting was undertaken on December 1, 2013 at 47 DAT. Whole plant harvesting was adopted in the study which was used for gathering of pertinent data.

Measurement and Analyses

Data Gathered. The data gathered for the two experiments were: plant height (cm), number of leaves per plant, leaf length (cm), leaf width (cm), stem width (cm), root length (cm), root weight (g), biological yield (g), weight per plant (g), and weight of marketable plants per plot (g).

Computed yield was calculated by converting yield per plot data into yield in tons ha^{-1}.

Soil Physico-Chemical Properties. Random soil sampling was done from each experimental area before and after the experiment. These were air-dried and sieved and brought to the Regional Soils Laboratory, Tuguegarao City for pH, organic matter (%), available P (ppm) and exchangeable K (ppm) analyses. Soil texture was also determined.

Quality Evaluation. Two leaves were taken from each sample plant then thoroughly washed and chopped at two inches length. These were blanched in boiling water for several seconds then washed with cold water. Next batches of samples were blanched in the same boiling water. Samples per plot were blanched separately, thus, there were 30 samples for quality evaluation. Ten respondents evaluated the samples according to their preference and acceptability in terms of color, taste and bitterness. The respondents were provided with score cards for their ratings. The 9-point hedonic rating scale for acceptability was used for the quality evaluation on color and taste (Munoz and King, 2007) with 1 being dislike extremely and 9 being like extremely. The 5-point rating scale was used for bitterness.

Statistical Analysis. All gathered data were statistically analyzed except for quality parameters that used means and averages. Based on significance of treatment as described by ANOVA, mean treatment differences were tested using the Duncan's Multiple Range Test (DMRT). The Statistical Analysis System (SAS) program was used for ANOVA and DMRT tests.

RESULTS AND DISCUSSIONS

Plant Growth and Horticultural Characteristics

The summary data on growth and horticultural characteristics of two Chinese kale varieties as affected by organic fertilizers grown under Kasibu conditions are presented in Table 1.

Plant height (cm). The recorded height of Kailaan was 49.90 cm while Gai Lohn was 50.14 cm. The obtained difference in height between varieties was not significant.

Organic fertilizers significantly influenced the height of plants. The tallest, with height of 52.58, cm were applied with processed chicken manure (PCM) followed by those applied with vermicompost (VC) and chicken manure (CM) with combined average height of 50.08 cm. The shortest plants at an average height of 48.68 cm were applied with NVSU BioOrganic and with Inorganic fertilizer.

Number of leaves per plant. The average number of leaves obtained due to the different treatments was 8.47. No significant differences were obtained between varieties and among the organic fertilizer inputs.

Leaf length (cm). Results showed no significant variations in leaf length between varieties with average length of 36.27 cm. However, significant variations were indicated among organic fertilizer treatments. Plants applied with PCM, VC and CM had comparable leaf lengths averaging to 37.05 cm which was significantly longer than those under NVSU BioOrganic and inorganic fertilizer (control) with combined average of 34.58 cm.

Table 1. Summary data on growth and other horticultural characteristics of two Kale varieties as affected by organic fertilizers, Kasibu, Nueva Vizcaya

Treatment	Plant Height (cm)	Leaf Number (No.)	Leaf Length (cm)	Leaf Width (cm)	Stem Width (cm)	Root Length (cm)	Root Weight (g)	Biological Yield (g)
Variety (A)								
A1= Kailaan	49.90	8.53	36.57	20.21	1.83	12.75	14.20	234.9
A2= Gai Lohn	50.14	8.40	35.96	20.31	2.49	13.11	14.28	231.47
Fertilizer Input (B)								
B1= Chicken Manure	49.98b	8.50	37.67a	21.20a	2.24	13.69	15.25a	250.52a
B2= Vermicompost	50.18b	8.67	36.72ab	20.89a	2.43	12.22	14.72a	257.85a
B3= Processed CM	52.58a	8.33	37.77a	20.71a	2.13	13.24	15.53a	243.02ab
B4 = NVSU BioOrganic	48.00c	8.33	34.80b	19.27b	2.09	12.26	14.05a	222.33b
B5= Inorganic (NPK)	49.35bc	8.50	34.37b	19.25b	1.93	13.23	11.66b	192.20c
CV%	**3.06**	**4.11**	**5.90**	**5.02**	**15.32**	**11.89**	**9.84**	**8.89**

**Means within a column followed by the same letter (s) are not significantly different at 5% level by DMRT*

Leaf width (cm). The two varieties did not significantly vary in terms of leaf width with obtained average value of 20.26 cm.The leaf width however, varied significantly among organic fertilizer treatments. Plants applied with CM, VC, and PCM gave comparable and wider leaves than NVSU BioOrganic and the control.

Stem width (cm). Kailaan and Gai Lohn had comparable stem width that averaged 2.16 cm. Likewise, there were no significant variations on stem width due to organic fertilizer treatments.

Root length (cm). Root length of Kailaan and Gai Lohn was 12.75 cm and 13.11 cm, respectively. This difference was not significant. Results also indicate no significant variations due to organic fertilizer inputs.

Root weight (g). Root weight of Kailaan and Gai Lohn were comparable averaging 14.24 g. Root weight as influenced by organic fertilizers ranged from 11.66 g to 15.53 g. The obtained differences on root weight due to organic fertilizers were significant. All organic fertilizers used in the study gave comparable results which were superior over that inorganic fertilizers.

Biological yield (g). There were no significant differences between varieties with regard to biological yield. The average value for this parameter was 233.19 g.

Organic fertilizers significantly influenced the biological yield of Chinese kale. The highest biological yield was exhibited by plants applied with CM, VC and PCM averaging 250.46 g. This was followed by NVSU BioOrganic with a mean of 222.33 g which was comparable with PCM. The lightest biological yield was obtained in plants applied with inorganic fertilizers.

Yield and Yield Components

The summary data on yield and yield components of two Chinese kale varieties as affected by organic fertilizers grown under Kasibu conditions are presented in Table 2.

Weight per plant (g). Kailaan weighed 221.70 g while Gai Lohn was 217.18 g. The obtained difference due to variety was not significant.

Organic fertilizers had significant bearing on the weight per plant. CM and VC gave the heaviest weight averaging 239.20 g. This was followed by PCM which gave a

value of 227.48 g. This was further followed by NVSU BioOrganic that gave a mean weight of 208.28 g. Inorganic fertilizer was the least in terms of its influence on plant weight at 180.54 g.

Weight of marketable plants per plot (kg). There were no significant variations on the weight of marketable plants per plot between the two varieties. The insignificant variations in the yield of the varieties could be attributed to their comparable performance in terms of growth and all other evaluated parameters.

When subjected to organic fertilizers, the plants produced yield that varied from 4.51 kg to 6.17 kg per plot. These observed variations were significant. The greatest marketable yield per plot was obtained from plants that were applied with CM, VC and PCM averaging 5.95 kg. This was followed by plants applied with NVSU BioOrganic with an average value of 5.33 kg. The least was exhibited by those applied with inorganic fertilizers with an average of 4.51 kg. The significant variations in yield per plot due to application of organic fertilizers could be attributed to differences on the influence of organic fertilizers on growth and yield components of Chinese kale. As observed, plant height, leaf length, leaf width, root length, root weight, biological yield and weight per plant were greatest with CM, VC and PCM hence, producing the greatest yield on a per plot basis with organic fertilizers. Among the organic fertilizers tested, NVSU BioOrganic contributed the least in enhancing growth and yield of Chinese Kale.

Chinese kale regardless of variety significantly performed better in growth and consequently in yield when applied with organic than inorganic fertilizer. Similar result was obtained in the study of Masarirambi, *et al.* (2012) on the effects of chicken manure on growth, yield and quality of lettuce wherein plants supplied with inorganic fertilizer were the shortest. The better growth and yield performance of Chinese kale plants when applied with organic fertilizers such as chicken manure, processed chicken manure and vermicompost may be due to their capacity in correcting imbalances in the soil pH to make it suitable for plant growth. As per analysis, the OM content of these materials were relatively high *i. e.*, 26%, 29.10% and 20.00% for C, VC and PCM, respectively. Organic matter stimulates the activities of microorganisms,

Table 2. Yield of two Kale varieties as affected by organic fertilizers, Kasibu, Nueva Vizcaya

Treatment	Weight per plant (g)	Weight of marketable plants per plot (kg)	Computed yield (tons ha^{-1})
Variety (A)			
A1= Kailaan	220.70	5.62	46.86
A2= Gai Lohn	217.18	5.45	45.42
Fertilizer Input (B)			
B1= Chicken Manure (CM)	235.27ab	5.98a	49.86a
B2= Vermicompost	243.13a	6.17a	51.39a
B3= Processed CM	227.48bc	5.69ab	47.43ab
B4 = NVSU BioOrganic	208.28c	5.33b	44.44b
B5= Inorganic (NPK)	180.54d	4.51c	37.57 c
CV%	**8.86**	**9.05**	**9.05**

**Means within a column followed by the same letter (s) are not significantly different at 5% level by DMRT*

like bacteria in the soil. It is one of the building blocks for fertile soil rich in humus. Although NVSU BioOrganic fertilizer had high OM, it contained more microorganisms that might have completed with the plants on soil nutrients. Soil acidity might have rendered some soil nutrients unavailable for plant use. Moreover, the inferior response of Chinese kale to inorganic fertilizers may be explained also via the moderately acidic conditions of Kasibu soils where the two varieties seemed to exhibit sensitivity.

Computed yield. Kailaan yielded 46.14 tons ha^{-1} while Gai Lohn was 45.42 tons ha^{-1}. This yield difference between the two varieties was not significant indicating similar yield performance under Kasibu conditions.

Chinese kale plants yielded an average of 49.56 tons ha^{-1} due to application of either CM, VC or PCM. This combined average yield of the three organic fertilizers was significantly higher than yield obtained due to NVSU BioOrganic and inorganic fertilizer. There was a significant increase by 11.52% brought about by CM, VC or PCM over that of NVSU BioOrganic, and an 11.96 % increase in yield over that of inorganic fertilizers.

Quality Parameters

Mean scores of the sensory panels for color, taste and bitterness are listed in Table 3.

Leaf Color. The mean acceptability rating for the two varieties were the same at 7.59 which indicated that Kailaan and Gai Lohn were "like very much" in terms of leaf color. The mean rating given to leaf color due to application of organic fertilizers alone or the interaction between variety and organic fertilizer varied from 7.50 to 7.68. These results indicated that regardless of treatments, leaf color remained "like very much".

Taste. The acceptability rating for taste of Chinese kale due to different treatments ranged from 7.17 to 7.68. Results indicated that both varieties had taste that were "like moderately". All plants under the different fertilizer treatments had similar acceptability rating. Regardless of variety and fertilizer treatment, the taste of the plants remained as "like moderately".

Bitterness. The mean rating for bitterness due to the different treatments varied from 1.20 to 1.27. These results indicate that Chinese kale is adjudged as "not bitter".

Pests and Diseases

Diamond back moth (DBM) was observed during seedling stage up to seventeen days after transplanting (DAT). There was no

Table 3. Summary data on the quality of two Kale varieties as affected by organic fertilizers, Kasibu, Nueva Vizcaya

Treatment	Color		Taste		Bitterness	
	Rating	Description	Rating	Description	Rating	Description
Factor A (Variety)						
A1= Kailaan	7.59	Like very much	7.23	Like moderately	1.21	Not bitter
A2= Gai Lohn	7.59	Like very much	7.21	Like moderately	1.25	Not bitter
Factor B (Fertilizer)						
B1= Chicken Manure	7.67	Like very much	7.23	Like moderately	1.23	Not bitter
B2= Vermicompost	7.50	Like very much	7.23	Like moderately	1.22	Not bitter
B3= Processed CM	7.53	Like very much	7.18	Like moderately	1.22	Not bitter
B4 = NVSU BioOrganic	7.57	Like very much	7.25	Like moderately	1.22	Not bitter
B5= Inorganic (NPK)	7.68	Like very much	7.68	Like moderately	1.25	Not bitter

incidence of disease. This result might be due to the application of EMAS which was similar to the findings of Winget and Gold (2007) in their study on the "Effects of Effective Microorganism on the Growth of Brassica Rapa", that EM foliar spray could significantly reduce the incidence of plant pests and diseases.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The growth and yield performance of Kailaan and Gai Lohn were comparable.

The growth and yield of the two varieties were significantly influenced by fertilizer inputs. It was found that the influence of organic fertilizer is superior to inorganic fertilizer. Five tons ha^{-1} of chicken manure (CM) or vermicompost (VC) or processed chicken manure (PCM) enhanced the growth and consequently the yield of Chinese kale.

Recommendations

Based on the results and conclusion drawn from the research, the following recommendations can be made:

1. Kailaan and Gai Lohn should be grown in Kasibu, Nueva Vizcaya using chicken manure or vermicompost or processed chicken manure as fertilizer at the rate of 5 tons ha^{-1} for favorable growth, high yield and good quality;
2. Further studies on different and higher levels of organic fertilizers using additional varieties of Chinese kale should be carried out;
3. Similar studies on different sites especially in the lowlands of Nueva Vizcaya should be conducted; and
4. Additional studies involving liming as well as combination of organic and inorganic fertilizers as interventions should be carried out.

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