THE EFFECT OF VARIOUS FERTILIZER TREATMENTS ON THE YIELD OF CABBAGE (*Brassica oleracea capitata* Linn)

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Cabbage (*Brassica oleracea capitata* Linn.) is one of the cole crops that belong to the cruciferae or mustard family. As a cole crop, it thrives best in relatively cool and and moist climate. It is a semi-temperate crop. It requires an optimum monthly average temperature ranging from 10 to 18 degrees C. The maximum requirement should not exceed 24 degrees C (Knott, 1965).

Cabbage is a well-liked vegetable by all Filipinos, especially by the Maranaos. It is commonly preferred fresh, alone or in combination with other foods, rather than canned. It is prepared either raw or boiled and it has a very good eating quality. It is also nutritious. For every 100 grams of edible portion, cabbage contains 1.7 gm. protein, 5.3 gm. carbohydrate, 75.0 I.U. vitamin A, 0.05 mg. thiamine, 0.05 mg. riboflavin, 0.03 mg. niacin, and 62.0 mg. ascorbic acid (Knott and Deanon, 1964).

Green head is more nutritious than the white one because it has more vitamin A content. Cabbage then could be a very good source of much needed nutrients for the Filipinos.

Among the vegetables raised at the College of Agriculture farm, cabbage commands a better price. The demand for cabbage in the Campus and in Marawi City is remarkably good inspite of the fact that the market price is high. Retail price of cabbage in the Campus and Marawi markets is P2.50 per kilo while wholesale price is P1.80 per kilo. Based on the report of PCARR (1975), cabbage production rate in Baguio and in Los Banos, Laguna, is 15-20 tons per ha. for low-yielding varieties. At Marawi City wholesale price, a hectare of cabbage grosses about P36,000.00 in four months. This amount is much higher than crop pro-

duction yield of either rice or corn.

Interviews made by the Researchers from Extension agents of the Bureau of Agricultural Extension revealed that there is no largescale cabbage production enterprise in Lanao del Sur inspite of the fact that the climate of the area is very suitable to cabbage growing. Cabbage farming in the area is limited to backyard gardens. The leading municipalities engaged in cabbage farming are Lumbatan, Saguiaran, Kapai, and Maguing. However, the total area devoted to cabbage production in these municipalities is just a little more than two hectares. In Marawi City, it is only Mindanao State University and Dansalan College that are engaged in cabbage production. About half of a hectare is devoted to cabbage farming on the campus and another one half hectare in Dansalan College.

To satisfy demands of cabbage in the market, Marawi retailers get additional supply from Misamis Oriental, Bukidnon, and Cebu. Because of the distance, cabbage supplies would pass several middlemen before reaching the Marawi market. This accounts for the high price of cabbage here. Cabbage is not within the reach of all housewives. There is then a need to encourage cabbage farming here in Lanao del Sur to meet high demands. With enough supply, price will go down.

It is at this point that this research was conducted. To ascertain its cultural requirements in the area would give an initial boost for the Maranaos to start cabbage growing. Cultural requirements like fertilization of cabbage vary from one place to another. Hit-and-miss fertilization, therefore, could be avoided and proper capitalization could be ascertained. Specifically, the research was conducted to find out the best fertilizer treatments for the most profitable yields of cabbage in Marawi City, in two cropping seasons.

A number of related researches had been conducted. However, there is no published material on cabbage fertilization in Lanao del Sur and Marawi City areas.

The latest fertilizer recommendations for cabbage were that of the Philippine Council for Agricultural Research Resources (1975). It recommended a wide range of fertilizer treatments for cabbage. These are as follow (in combination):

90-240 kilos/ha. Nitrogen (N)

30- 60 kilos/ha. Phosphoric acid (P_2O_5)
30- 60 kilos/ha. Potassium oxide (K_2O)

Work and Carew (1955) had recommended 84.6 to 141.7 kg/ha each of Nitrogen, Phosphoric acid, and Potassium oxide for late crop in U.S. These rates should be applied in combination.

Van Nguyen (1968), in his undergraduate thesis, had recommended 135 kg/ha N on planting an an additional of another 135 kg/ha N after 30 days. In another study, Deanon and Knott (1967) had recommended 500-1000 kg/ha of 12-24-12 complete fertilizer if applied few days before planting or 500-700 kg/ha of 12-24-12 if applied during planting time. De la Cruz and Bautista (1970) had also recommended the rate of 700-1000 kg/ha of 12-24-12 complete fertilizer applied during planting time.

The Bureau of Plant Industry as reported by P. Ortez Ramos (1972) had recommended 596-1004 kg/ha Nitrogen, Phosphorus, and Potassium oxide in combination applied during transplanting time. While in another study, Malixi and Creencia (1978) recommended 600-800 kg/ha of 14-14-14 fertilizer for best yield of cabbage.

Objectives and Methods

The specific objectives of this study were:

a) to ascertain the fertilizer requirements of cabbage at Marawi City and Lanao del Sur, during wet and dry seasons, and b) to determine the cost of cabbage production in relation to the amount of fertilizer used at Marawi City and Lanao del Sur areas, in two cropping seasons.

The ultimate objectives were:

a) to formulate a basis of fertilizer recommendations for cabbage suitable for Marawi City and Lanao del Sur areas, b) to gather definite data to prove that cabbage growing in Lanao del sur and Marawi City is profitable, and c) to give a humble share to the National effort in food production programs initiated by the government.

The experiment was conducted on one of the lots in CAMSU Farm previously planted to cabbage. The wet season crop was planted August 16, 1977 and harvested December 15, 1977, a total of 122 days. The dry season crop was planted January 17, 1978 and harvested April 29, 1978, a total of 103 days.

One small can of certified seeds of cabbage variety KK was secured from Iligan City. One half of the seeds was planted during the wet season cropping and the other half was properly preserved and used during the dry cropping season.

Experimental design used was Randomized Complete Block Design (RCBD). The table below shows the planting lay-out:

Table A. Planting Layout.

A	B	C	C	—
O	P	PK	K	
E	F	G	H	
N	NP	NPK	NK	
H_1	G_1	F_1	E_1	
NK	NPK	NP	N	
D_1	C_1	B_1	A_1	
K	PK	P	O	

Legends:

O — Control, no fertilization
N — Nitrogen fertilization
P — Phosphorus fertilization
K — Potassium fertilization
NP — Nitrogen + Phosphorus fertilization
NK — Nitrogen + Potassium fertilization
PK — Potassium + Phosphorus fertilization
NPK — Complete fertilization

Each kind of fertilizer had 4 levels. There were 8 plots in a block and each plot had 4 rows with 10 plants each. The 4 levels of fertilizer were assigned at random to the 4 rows in a plot. The control plot had also 4 rows with 10 plants per row. All in all, there were 58 treatments tested in the two replications.

The same lay-out of the wet season cropping was used during the dry season cropping.

The following are the rates of fertilizer treatment per block in kg/ha:

		N P K
Block A and A_1	—	0 0 0-(control)
Block B and B_1	—	0-30-0
		0-40-0
		0-50-0
		0-60-0
Block C and C_1	—	0-30-30
		0-40-40
		0-50-50
		0-60-60
Block D and D_1	—	0--0-30
		0-0-40
		0-0-50
		0-0-60
		0-0-50
		0-0-60
Block E and E_1	—	90-0-0
		140-0-0
		190-0-0
		240-0-0

Block F and F_1 — 90-30-0
140-40-0
190-50-0
240-60-0

Block G and G_1 — 90-30-30
140-40-40
150-50-50
240-60-60

Block H and H_1 — 90-0-30
140-0-40
180-0-50
240-0-60

The data collected were the weight of cabbage head per treatment in two cropping seasons and also the number of days from planting to harvesting in the two cropping seasons.

The cultural practices described here were followed exactly in the two cropping seasons unless so indicated otherwise.

The 1m x 1m seedbed was prepared. It was sterilized by burning dried cogon grass on it. It was allowed to cool, watered, and certified seeds of cabbage variety KK were sown. Seeds germinated within five days.

At fifteenth day after sowing, seedlings were pricked to 5 cm x 5 cm distance in two 1m x 4m pricking beds. Solution of ammonium sulfate was applied 5 days after pricking. Seedlings stayed in the pricking beds for 20 days and then transplanted to a well prepared experimental lot.

The experimental lot was plowed once by a tractor-drawn disc plow. Then, it was rotivated once and afterward farrowed by a three-row farrower to a distance of .75 m. between farrows. Dried trashes were removed manually while the farrows were pulverized.

One day before transplanting, holes were made on the ridge at a distance of .5 m. Then, 300 gm. of cattle manure was applied per hole.

This was properly mixed with the soil.

Transplanting was completed in two days time. Seedlings were balled and planted in prepared holes. Transplanted plants were watered immediately. Newly transplanted seedlings were not covered during the wet season but were covered during the dry season planting.

All fertilizers were applied once 7 days after transplanting in ring method.

A pest and disease control program was carried out starting when seeds germinated until crops were harvested. Three insecticides were sprayed one after the other at intervals of 5-7 days. The insecticides used were Vegetox, Hostathion, and Dygun at rates recommended by their respective manufacturers.

The disease control program used vitagram blue, and copper fungicide, at intervals of 7 days during seedling and pricking stages and at intervals of 20 days when plants were already in the experimental lot.

Weeding was done manually at monthly intervals and when necessary.

Five heads out of 10 plants per treatment were randomly selected and weighed right in the field. Based from the weight of 5 heads, production per area was computed. Data collected were tabulated and analyzed.

Results and Discussion

During the wet cropping season, the best yield was taken from 140-40-0 fertilization with an average of 29.06 t/ha. This was followed by 140-0-40 with an average of 27.87 t/ha and by 140-0-0 with 24.53 t/ha.

PCARR (1975) reported an average 20-30 t/ha cabbage yield in Baguio and in Los Baños. The yield of 29.06 t/ha is above average compared to yield data in the two places mentioned. The table below is a summary of the highest average yield of cabbage at various rates of fertilization during wet cropping season.

Table B. Highest Average Yield of Cabbage in t/ha at Various Rates of Fertilization during Wet Cropping Season

Rates in Kg/ha	Average Yield in t/ha
140-0-0	24.53
0-40-0	23.33
0-0-30	13.87
140-40-0	29.06
140-0-40	27.60
0-40-40	21.87
90-30-30	23.87

During the dry cropping season, the best yield was obtained from 90-30-0 fertilization with an average yield of 25.20 t/ha. This was followed by 90-30-30 fertilization with an average of 24.83 t/ha and by 90-0-0 fertilization with a yield of 24.67 t/ha. Compared to yields reported by PCARR, it is within the average yield obtained in Baguio and in Los Banos. The table below is a summary of highest average yield of cabbage at various rates of fertilization during dry cropping season.

Table C. Highest Average Yield of Cabbage in t/ha at Various Rates of Fertilization During Dry Cropping Season

Rates in Kg/ha	Average Yield in t/ha
90-0-0	24.67
0-60-0	24.26
0-0-60	24.33
90-30-0	25.20
140-0-40	21.73
0-60-60	22.93
90-30-30	24.83

From the above tables, it could be pointed out that the top three yields in both cropping seasons came from fertilization with nitrogen alone or with nitrogen combined with the two other macroelements. This emphasizes the importance of nitrogen fertilizer in the growth of leafy vegetables.

It was also found out that it took 122 days for wet season crop to mature and 103 days for dry season crop to be harvested. Comparing the two cropping seasons, wet season crop yield was higher by 4 t/ha than dry season crops.

Basing from the 29.06 t/ha average yield of wet season crop, a hectare of cabbage will gross about P52,428.00 at Marawi City wholesale price at P1.80 per kilo, in four months time.

The following were the inputs computed on a per hectare basis:

A. Personal Services —	
a. Salary of 3 laborers for 4 months at P300.00 per month	P3,600.00
b. Farm Preparation Expenses	600.00
	P4,200.00
B. Supplies and Materials —	
a. 3 sacks ammonium sulfate, 50 kgm, at P70/sack	P210.00
b. 2 bot. Hostathion, 1 lit/bot., at P70/bottle	140.00
c. 1 sack Solophos	80.00
d. 2 bot. Dygun, 1 lit/bot., at P50/bottle	P100.00
e. 10 boxes Vegetox, ½ kilo cap, at P20/bottle	200.00
f. 10 boxes Vitagran Blue, ½ kilo cap., at P24.00 each	240.00
g. 1 can certified seeds of Cabbage, var. KK	150.00
	P1,220.00

C. Equipment	
a. 1 knapsack sprayer, 18 gal.	P500.00
b. 3 pcs. sprinklers, metal, at P40.00 each	120.00
c. 3 pcs. garden hoes, at P35.00 each	105.00
d. 3 pcs. hand trowel, at P10.00 each	30.00
	P 755.00
D. Miscellaneous	P500.00

Summary of Expenses:

A. Personal Services	P4,200.00
B. Supplies and Materials	1,120.00
C. Equipment	755.00
D. Miscellaneous	500.00
GRAND TOTAL	P6,757.00

With the total expenses of P6,575.00 the net profit that could be realized would be P45,853.00 in four months during wet season. Dry season profit would be a little lower by about P7,200.00 in less than four months.

This shows that cabbage farming is much more profitable than either corn or rice.

CONCLUSIONS AND RECOMMENDATIONS

The highest yield of cabbage during wet season was obtained from 140-40–0 fertilization while the highest yield of cabbage during dry season was obtained from 90-30-0 fertilization.

It was also found out that it took longer to mature cabbage during wet season than during dry season. It took 19 days longer to harvest cabbage during wet season.

It was also found out that Marawi City is suitable to cabbage farming during both wet and dry seasons.

Under Marawi City conditions, a hectare of cabbage grossed about P52,428.00 during wet season and P45,360.00 during dry season.

The following are recommended:

1. Fertilization rate of 140 kg/ha of ammonium sulfate mixed with 40 kg/ha solophos applied 7 days after transplanting be adopted for most profitable yield of cabbage variety KK during the months of June to December.

2. Fertilization rate of 90 kg/ha of ammonium sulfate and 30 kg/ha of solophos applied 7 days after transplanting be adopted for most profitable yield of cabbage variety KK during the months of January and May.

3. It is further recommended that in addition to above-mentioned rates of fertilization, 300 gm. per hill of cattle manure should be applied few days before transplanting.

4. For purposes of cross-checking, it is recommended that a similar study be conducted in cabbage growing Municipalities of Lanao del Sur.

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APPENDIX OF TABLES

Table I. Yield of Cabbage in t/ha under N Fertilization in Two Cropping Seasons.

Fertilizer Levels, kg/ha	Replications DRY I	DRY II	WET III	WET IV	Total	Mean
0-0-0	3.41	5.09	4.53	3.73	16.76	4.19
90-0-0	22.67	26.67	16.93	18.81	85.08	21.27
140-0-0	22.67	20.43	20.53	28.53	92.16	23.04
190-0-0	23.73	22.33	19.49	18.93	84.48	21.12
240-0-0	21.60	17.60	18.53	15.07	72.80	18.20
Total	94.08	92.12	80.01	85.07		
Mean	18.81	18.42	16.00	17.01		

Table II. Analysis of Variance on the Yield of Cabbage under N Fertilization in Two Cropping Seasons.

Sources of Variation	DF	S S	M S	F Value
Treatments	4	942.54	235.63	24.93**
Replications	3	25.24	8.41	
Errors	12	113.44	9.45	
Total	19	1,081.22	56.90	

**highly significant.

Table III. Yield of Cabbage in t/ha under P Fertilization in Two Cropping Seasons.

Fertilizer Levels, kg/ha	Replications DRY I	DRY II	WET III	WET IV	Total	Mean
0-0-0	3.41	5.09	4.53	7.73	16.76	4.19
0-30-0	14.40	20.32	5.54	7.80	48.06	12.01
0-40-0	19.73	19.33	21.87	24.79	85.72	21.43
0-50-0	25.07	16.80	23.00	20.74	85.61	21.40
0-60-0	25.33	23.20	15.08	10.52	74.13	18.53
Total	87.94	84.74	70.02	67.58		
Mean	17.58	16.94	14.00	13.51		

Table IV. Analysis of Variance on the Yield of Cabbage under N Fertilization in Two Cropping Seasons.

Sources of Variation	DF	S S	M S	F Value
Treatments	4	877.04	219.26	9.62**
Replications	3	63.15	21.05	
Errors	12	273.55	22.79	
Total	19	1,213.74	63.88	

Table V. Yield of Cabbage in t/ha under K Fertilization in Two Cropping Seasons.

Fertilizer Levels, kg/ha	Replications DRY I	DRY II	WET III	WET IV	Total	Mean
0-0-0	3.41	5.09	4.53	3.73	16.76	4.19
0-0-30	22.67	8.99	12.66	15.08	59.40	14.85
0-0-40	18.13	14.67	10.66	10.13	53.59	13.39
0-0-50	21.87	15.20	6.53	10.53	54.13	13.53
0-0-60	30.13	16.53	10.66	9.08	66.40	16.60
Total	96.21	60.48	45.04	48.55		
Mean	19.24	12.09	9.00	9.71		

Table VI. Analysis of Variance on the Yield of Cabbage in t/ha under K Fertilization in Two Cropping Seasons.

Sources of Variation	DF	S S	M S	F Value
Treatments	4	373.03	93.25	5.04**
Replications	3	327.97	109.32	
Errors	12	222.04	18.50	
Total	19	923.05	48.58	

**Significant

Table VII. Yield of Cabbage in t/ha under NK Fertilization in Two Cropping Seasons.

Fertilizer Levels, kg/ha	Replications DRY I	DRY II	WET III	WET IV	Total	Mean
0-0-0	3.41	5.09	4.53	3.73	16.76	4.19
90-0-30	18.20	24.74	20.75	26.75	90.44	22.61
140-0-40	23.46	20.00	26.73	28.47	98.66	24.66
190-0-50	24.07	17.53	21.70	25.76	89.06	22.26
240-0-60	18.00	21.74	18.87	16.87	75.48	18.87
Total	87.14	89.10	92.58	101.58		
Mean	15.43	17.82	18.51	20.31		

Table VIII. Analysis of Variance on Yield of Cabbage Under NK Fertilization in Two Cropping Seasons.

Sources of Variation	DF	S S	M S	F Value
Treatments	4	1,095.95	273.98	28.63**
Replications	3	24.54	8.18	
Errors	12	114.88	9.57	
Total	19	1,235.37	65.01	

**highly significant.

Table IX. Yield of Cabbage in t/ha under NP Fertilization in Two Cropping Seasons.

Fertilizer Levels, kg/ha	Replications DRY I	DRY II	WET III	WET IV	Total	Mean
0-0-0	3.41	5.09	4.53	3.73	16.76	4.19
90-30-0	29.87	20.53	24.87	26.63	101.90	25.47
140-40-0	22.67	19.47	29.93	28.20	100.27	25.06
190-50-0	21.87	25.60	25.75	28.11	101.33	25.33
240-60-0	20.80	17.65	25.23	25.43	89.11	22.27
Total	98.62	88.34	110.31	112.10		
Mean	19.72	17.66	22.06	22.42		

Table X. Analysis of Variance on Yield of Cabbage Under NP Fertilization in Two Cropping Seasons.

Sources of Variation	DF	S S	M S	F Value
Treatments	4	1,352.55	338.13	26.89**
Replications	3	73.73	24.57	
Errors	12	150.89	12.57	
Total	19	1,577.17	83.00	

**highly significant.

Table XI. Yield of Cabbage in t/ha under PK Fertilization in Two Cropping Seasons.

Fertilizer Levels, kg/ha	Replications DRY I	DRY II	WET III	WET IV	Total	Mean
0-0-0	3.41	5.09	4.53	3.73	16.76	4.19
0-30-30	21;33	15.47	8.93	7.87	53.60	13.40
0-40-40	22.13	15.20	22.67	21.07	81.07	20.26
0-50-50	24.80	16.53	12.00	12.00	65.33	16.33
0-60-60	26.93	18.93	6.93	6.51	59.30	19.82
Total	98.60	71.22	55.06	51.18		
Mean	19.72	14.24	11.01	10.23		

Table XII. Analysis of Variance on Yield of Cabbage Under PK Fertilization in Two Cropping Seasons.

Sources of Variation	DF	S S	M S	F Value
Treatments	4	567.22	141.80	6.07**
Replications	3	278.59	92.86	
Errors	12	280.51	23.37	
Total	19	1,126.32	59.28	

**highly significant.

Table XIII. Yield of Cabbage in t/ha under NPK Fertilization in Two Cropping Seasons.

Fertilizer Levels, kg/ha	Replications DRY I	DRY II	WET III	WET IV	Total	Mean
0-0-0	3.41	5.09	4.53	3.73	16.16	4.19
90-30-30	23.87	25.79	23.87	23.87	97.40	24.35
140-40-40	21.27	23.27	23.93	21.93	90.40	22.60
190-50-50	22.53	22.53	20.60	22.60	88.26	22.06
240-60-60	24.27	22.93	23.79	22.35	93.34	23.33
Total	95.35	99.61	96.72	94.48		
Mean	19.07	19.92	19.34	18.89		

Table XIV. Analysis of Variance on Yield of Cabbage Under NPK Fertilization in Two Cropping Seasons.

Sources of Variation	DF	S S	M S	F Value
Treatments	4	1,154.52	288.63	317.17**
Replications	3	3.02	1.00	
Errors	12	10.94	0.91	
Total	19	1,168.48	61.49	

**highly significant.

Table XV. Meteorological Data During the Conduct of the Experiment

Month	Monthly rainfall mm	Monthly Ave. Max. Temp., C	Monthly Ave. Min. Temp., C
June, 1977	422.0	26.5	20.7
July, 1977	386.4	26.6	17.5
August, 1977	335.5	26.1	19.0
September, 1977	207.4	26.7	19.2
October, 1977	250.7	27.2	18.1
November, 1977	205.2	26.9	18.3
December, 1977	98.6	25.4	18.1
January, 1978	137.0	25.8	20.3
February, 1978	238.5	24.9	19.9
March, 1978	213.5	24.7	19.2
April, 1978	76.8	27.1	20.3
May, 1978	222.2	27.0	20.2

Source: MSU Agromet Station through the courtesy of Mr. Bagani Macabalang, MSU Agromet In-Charge.