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YIELD OF PECHAY (*Brassica napus L.* var. Black Behi) AS INFLUENCED BY THE APPLICATION OF FULL ON LIQUID FERTILIZER

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YIELD RESPONSE OF PECHAY (*Brassica napus L.* var. Black Behi*)* TO THE APPLICATION OF FULL ON LIQUID FERTILIZER

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Abstract

The efficacy of **Full On Liquid Fertilizer (FOLF)** on the yield of pechay (*Black behi* Var), grown in a nitrogen-deficient silt loam soil was evaluated at Tres De Mayo, Digos City from May to June, 2015. Its influenced on soil properties, the economics of its application and its potential as a substitute or as a supplement to the recommended inorganic fertilizers for the crop was assessed.

The application of the different fertilizer treatments had significantly influenced the growth and yield of pechay specifically in terms of average plant weight and total computed marketable yield, the soil properties and the economic efficiency.

Plants in the unfertilized control (T1) manifested the typical nitrogen deficiency symptoms characterized by severe stunting, small and few leaves with uniform light green color, reddening of the petioles and weight reduction of individual plants. This poor plant growth was improved by the mere addition of FOLF at the recommended dosage (T2) resulting to the significant increase in plant weight by about 159% .

The application of FOLF (T2) alone realized a computed yield 16.2 t/ha which was significantly higher over the unfertilized control (T1) yielding only 6.6 t/ha. The highest computed marketable yield was obtained in plots applied with the full dose of FOLF + 50% of urea (T3) reaching 28.8t/ha. This was comparable with plants applied with 100% of the nitrogenous fertilizer (T5) with yield of 27.8 t/ha indicating that FOLF can replace 50% of the inorganic fertilizer need of the crop.

The application of nitrogen rich urea in a light textured soil had increased soil acidity affirming the environmental concerns brought by its application. The application of FOLF mitigated this condition showing its beneficial effects on soil.

The application of FOLF alone was already a profitable option with BCR more than 1. Combining it with 50% urea substantially increased profitability.

Based on these findings FOLF can be used as a stand-alone fertilizer for organic pechay production. However, for maximum yield and benefits, this could be used to replace 50% of the required inorganic fertilizer.

Keywords: Full On Foliar Fertilizer, pechay growth and yield

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I. RATIONALE:

Foliar fertilization is an important tool for the sustainable and productive management of crops. In recent years, foliar fertilizers, especially organic ones, have proliferated in the agricultural fertilizer market. If use wisely, they may be more environmentally friendly and target-oriented than soil fertilization since nutrients can be directly delivered to plant tissues during critical stages of plant growth (Kanan, 2010). Its importance could not be discounted in the realm of plant nutrition since certain soil conditions, such as pH, excess moisture, or cool temperatures, soil compaction may render a soil-applied nutrient or nutrients unavailable to the plant root.

Johnson *et al*. (2001) suggested that supplying N to peach trees using a combination of soil and foliar N fertilizers leads to optimal plant responses and limited environmental pollution risks. A similar efficacy relationship between foliar and soil K fertilization was demonstrated in rainfed olive trees grown in arid and semi-arid regions (Restrepo-Diaz *et al*., 2009) in order to avoid problems associated with low K root uptake under limited soil moisture conditions. Similarly, a benefit of foliar P nutrition in dry-land cereal crops may occur when soil surface layers become dry thereby reducing the efficacy of surface P applications (Noack *et al*., 2011). Foliar fertilizers can be used to enhance crop quality both in terms of grain protein and Zn content (Cakmak, 2008; Cakmak *et al*., 2010; Erenoglu *et al*., 2002).

An organic nano-based plant nutrient additive in liquid form, **Full On Liquid Fertilizer (FOLF)**, is formulated using an exclusive, proprietary nanotechnology with a guaranteed analysis of 1.0; 0.1 and 0.7 % NPK, respectively (http://growswicth.com). It comes from naturally chelated organic mineral matrix, finest fish hydrolyzed proteins, kelp extracts, amino acids, finest humic acids, enzymes, plant based surfactants and many more. It acts as a biostimulant that enhances nutrient uptake and utilization ensuring fast and strong growth thus better quality of the produce and high yield. It could be applied as soil drench or as foliar spray. It reduces NPK requirements by 50% thus lowering cost and reducing environmental concerns.

Pechay, *Brassica napus* L, is a very popular leafy vegetable in the country that usually responds well to foliar fertilization. Prized for its leaves, proper nutrition and development of the plant must be ensured even in early leaf formation to assure high quality of the produced.

Being an imported fertilizer and a new entrant to the local fertilizer industry, **FOLF** was formally evaluated to establish its efficacy on test crop specifically in pechay for product registration purposes.

II. OBJECTIVES:

The efficacy of **Full On Liquid Fertilizer** on a leafy vegetable, pechay was evaluated. Specifically it determined the effect of **FOLF**, inorganic fertilizers and their combination on the yield of pechay and assessed the potential of **FOLF** as substitute to the inorganic fertilizers for the crop.

III. METHODOLOGY:

A. Description of test product and reference products:

The product tested was **FOLF** with guaranteed analysis of 1.0; 0.1 and 0.7 % NPK. The reference product was urea (46-0-0) to supply the nitrogen need of the crop based on soil analysis which showed very low soil OM content and called for the application of 150 kg of nitrogen per hectare .

B. Experimental Conditions

Test Location, Duration and Test Crop:

This study was conducted from May to July 2015 inclusive of material and land preparation, chemical testing and report writing at Tres De Mayo, Digos City, Davao del Sur. The test crop was pechay (*Brassica napus* L. var Black Behi). The area was flat and with a nitrogen -deficient silty loam soil.

Experimental Design and Treatments:

This study was laid in Randomized Complete Block Design (RCBD) in three replicates with five treatments (see Fig. 1). Treatments were as follows:

T1 – control – no fertilizer

T2 – 100% Recommended Rate of **FOLF**

T3 – 100% Recommended Rate of **FOLF** + 50% of RF

T4 –100% Recommended Rate of **FOLF** + 25% of RF

T5 –100% Recommended Rate of Reference Fertilizer (inorganic fertilizer)

Preparation of Test Materials, Construction of Raised Beds and Planting:

Pechay seeds were thinly sown in the germinating beds. Two weeks after seeding, seedlings were transferred to prepared raised beds or plots each measuring 1 m wide and 10 m long and 30 cm deep. The seedlings were planted 20 cm between rows and 15 cm between hills.

Care and Maintenance of Plants:

All recommended cultural practices for pechay based on good agricultural practices were followed except for fertilizer application that was based on the treatments.

Fertilizer Rates and schedule of application:

Test product: The recommended rate of the test product, **FOLF** at the dilution rate of 4ml/gallon of water was applied depending on crop age starting at transplanting (as soil drench) and every 7 days interval till one week before harvesting. Spraying was always done late in the afternoon to ensure maximum absorption by the plants. To avoid contamination between treatments or plots due to spray drift, during treatment application (i.e. spraying), a laminated plastic sack was used to enclose the plot being sprayed and transferred to the next plot afterward.

Reference products: Based on soil analysis of the trial site, 150 kg/ha of nitrogen fertilizer was needed which was supplied by the reference product, urea (46-0-0). The material was soil applied, basally as drench and as sidedressing. The rate and timing of fertilizer application depended on the growth stage of the crop.

Period	**Full On (ml/gal)**	**Urea (46-0-0) (g/plot)**		
	T2, T3 & T4	T3	T4	T5
At transplanting	4 ml/gal of water as soil drench*	54.50	27.25	109
7 days after transplanting	4 ml/gal of water as foliar spray	-	-	-
10 days after transplanting	-	109	54.50	218
14 days after transplanting	4 ml/gal of water as foliar spray	-	-	-
21 days after transplanting	4 ml/gal of water as foliar spray	-	-	-

Data Collection:

The following data were collected at harvest:

1.) Fresh weight of pechay – The average weight of 20 sample plants were taken after trimming off non- marketable parts

2.) Computed Marketable yield (t/ha) – The total marketable yield was based on the average fresh weight per plot (the weight of all marketable plants from the harvest area-3 inner rows measuring 50 cm x 900 cm) and converted to yield in tons/ha.

3.) Soil Analysis- One composite soil sample (top soil) from the whole area was taken before the trial and one sample (top soil) from each representative treatment after the trial was collected and analyzed for the following: soil texture (before only), NPK, pH and OM content.

4.) Economic Analysis –This was computed using current prices in the locality for labor and other inputs.

Statistical Analysis:

All data were subjected to appropriate Analysis of Variance (ANOVA) and means found to be significant were compared using Duncan's Multiple Range Test (DMRT).

IV. RESULTS AND DISCUSSION

a. Effect of fertilizer application on the fresh weight of each pechay plant.

The application of the different fertilizer treatments had significantly influenced the growth of pechay specifically on the fresh weight of each plant (Table 1). The heaviest plants weighing an average of 165.8g were recorded in plots applied with a combination of 100% **FOLF** + 50% of the reference inorganic (T3). This was comparable with the plants applied with 100% of the reference fertilizer (T5) weighing 165.2g. Plants applied with **FOLF** only weighed 78.8 g which was significantly heavier than the unfertilized control which weighed only 30.4 g. Adding 25% of the rate of urea to **FOLF** increased the weight to 111.17g.

Plants in the unfertilized control (T1) manifested the typical nitrogen deficiency symptoms characterized by severe stunting, small and few leaves with uniform light green color and reddening/purpling of the petioles. On the other hand, the mere addition of **FOLF** at the recommended dosage (T2), significantly increase weight by about 159%. It had bigger and slightly greener leaves than the control although the size and thickness were relatively inferior than those applied with urea either alone or in combination with **FOLF** . It was observed that where **FOLF** was applied, numerous fine roots were observed even on the soil surface and plants were robust.

Table 1. Average plant weight of pechay as influenced by the different fertilizer treatments. (Digos City, Davao del Sur, June 2015).

Treatment	Ave. plant weight (g/plant)	% increase over control
T1-control	30.4d	-
T2-100% of Manufacturer's recommendation for Full On Liquid Fertilizer (FOLF)	78.8c	159
T3- 100% FOLF + 50% Recommended rate of Reference Fertilizer (RRRF)	165.8a	445
T4- 100% FOLF + 25% RRRF	111.2b	266
T5-100% of RR of Reference Fertilizer	165.2a	443
Stat sig	**	
C.V.(%)	14.86	

** Means followed by a common letter are not significantly different at the 1% level, DMRT.

b. Effect of different fertilizers on the computed marketable yield of pechay:

Results of statistical analysis of the total marketable yield of pechay showed significant treatment effects and had almost similar trends as observed on the average fresh weight of plants (Table 2).

It was observed that the highest computed marketable yield was obtained in plots applied with the full dose of **FOLF** + 50% of urea (T3) reaching 28.8t/ha. This yield was comparable with plants applied with 100% of the nitrogenous fertilizer (T5) with yield of 27.8 t/ha. This indicated that **FOLF** can replace 50% of the inorganic fertilizer need of the crop. The unfertilized control yielded 6.6t/ha only. Applying **FOLF** only at the recommended dose increased yield by 145% or 16.2 t/ha. Replacing 75% of the urea requirement with **FOLF** (T4) gave yield of 20.58 t/ha representing 215% increase over the control. These only indicated that despite the small quantities of the nutrients present in the product, this was fully utilized by the plant hence the observed significant yield improvement.

The significant yield improvement over the control by the mere application of **FOLF**, an organic preparation as claimed by the manufacturer, suggest that this would be a stand-alone fertilizer for organic pechay production. However, in order to achieve maximum yield levels, it has to be combined with 50% of the nitrogen requirement of the crop.

The enhanced growth and yield of pechay when **FOLF** was applied either alone or in combination with inorganic fertilizers could be both attributed to the improved mineral nutrition with the presence of other macronutrients like P and K and the efficient uptake and utilization of the applied nutrients through foliar application. Johnson *et al*. (2001) reported that supplying N to peach trees using a combination of soil and foliar N fertilizers leads to optimal plant responses and limited environmental pollution risks. **FOLF** acts as biostimulant that enhances nutrient uptake and utilization ensuring fast and strong growth and better quality of the produce.

Table 2. Computed marketable yield (t/ha) of pechay as influenced by the different fertilizer treatments. (Digos City, Davao del Sur, June 2015)

Treatment	**Computed marketable yield (t/ha)**	**% increase over the control**
T1-control	6.6d	-
T2-100% of Manufacturer's recommendation for Full On Liquid Fertilizer (FOLF)	16.2c	145
T3- 100% FOLF + 50% Recommended rate of Reference Fertilizer (RRRF)	28.8a	336
T4- 100% FOLF + 25% RRRF	20.8b	215
T5-100% of RR of Reference Fertilizer	27.8a	321
Stat sig	**	
C.V.(%)	9.6	

** Means followed by a common letter are not significantly different at the 1% level, DMRT.

c. Effect of different fertilizers on some soil properties:

Changes in the pH of the soil with the addition of fertilizers were observed (Table 3). Where urea was applied, pH became acidic with the highest increase in acidity in plots applied with the highest dose of urea (T5). The pH dropped to 6.4 from the initial pH of 6.8. Reducing urea by 50% resulted to pH of 6.6 while further urea reduction gave a pH of 6.9. However, the soil pH of those applied with urea are still within the ranged favorable to pechay (pH 6.0-6.6) thus no observed yield reduction. Fageria et al (2010) reported the soil pH linearly decreased with the increasing rates of urea or ammonium sulfate application in rice. The unfertilized plot had pH of 6.9.

The observed increasing acidity with urea application simply confirmed the reported environmental concerns associated with its use i.e. soil acidification. The light texture of the soil and the low OM content in the site possibly contributed to these changes also since loose and low OM soil usually had low buffering capacity.

The application of **FOLF** increased pH to neutrality supporting earlier claims of the product developer that the product could reduce environmental concerns i.e. soil acidification.

Table 3. Soil properties of the site before and after the trial (Tres de Mayo, Digos City)

Parameters measured	Soil type	Soil pH	Wilde's OM (%)	P (ppm)	K (ppm)	OM (%)
Initial	Silt loam	6.8	0.9	43	1410	1.23
Post trial:						
T1-control		6.9	0.6	35	1540	0.78
T2-100% of Manufacturer's recommendation for Full On Liquid Fertilizer (FOLF)		7.0	0.5	35	1680	0.76
T3- 100% FOLF + 50% Recommended rate of Reference Fertilizer (RRRF)		6.6	0.6	37	1540	0.87
T4- 100% FOLF + 25% RRRF		6.9	0.5	35	1680	0.81
T5-100% of RR of Reference Fertilizer		6.4	0.5	35	1350	0.76

*Analysis done by the Regional Soils Laboratory of the Dept. of Agriculture, Agdao, Davao City

An economic analysis was done to assess the efficiency of the different treatments (Table 4). It was observed that fertilizer application using **FOLF** or urea alone or in combination in pechay production was really a profitable practice with benefit cost ratio above 1. However, the most profitable fertilizer option aside from the recommended inorganic fertilization (T5) was the application of **FOLF** with 50% urea which gave A BCR of 2.46. It has break -even price of PhP4.02, the next lowest from T5 with PhP3.16. For organic pechay production, the application of pure **FOLF** is already profitable with a BCR of 1.73.

Table 4. Economic analysis for one hectare pechay production using various Full On and Urea fertilizers (Digos City, May-June 2015)

	T1- control	T2- 100% Full On	T3- 100% Full On + 50% Urea	T4- 100% Full On + 25% Urea	T5- 100% Urea
Yield (kg)/ha	6,300	16,200	28,800	20,800	27,800
Price/kg (PhP)	11.00	11.00	11.00	11.00	11.00
Break even yield (kg)	3,395	5,926	8,326	6,890	7,996
Break even price (PhP)	6.98	4.02	3.18	3.64	3.16
Cost of production(PhP)	43,950	65,190	91,595	75,792	87,960
Gross return (PhP)	69,300	178,200	316,800	228,800	305,800
Net return (PhP)	25,350	113,010	225,205	153,007	217,840
Benefit cost ratio	0.58	1.73	2.46	2.02	2.48

V. SUMMARY AND CONCLUSION

The efficacy of **Full On Liquid Fertilizer** on the growth and yield of pechay, *Black behi* Var grown in a nitrogen-deficient silt loam soil was evaluated at Tres De Mayo, Digos City from May to June 2015. Its potential as a substitute or as a supplement to the recommended inorganic fertilizers for the crop was assessed.

The application of the different fertilizer treatments had significantly influenced the growth and yield of pechay specifically in terms of average plant weight and total computed marketable yield, the soil properties and the economic efficiency.

Plants in the unfertilized control (T1) manifested the typical nitrogen deficiency symptoms characterized by severe stunting, small and few leaves with uniform light green color, reddening of the petioles and weight reduction of individual plants. This poor plant growth was improved by the mere addition of FOLF at the recommended dosage (T2) resulting to the significant increase in plant weight by about 159% .

The application of FOLF (T2) alone realized a computed yield 16.2 t/ha which was significantly higher over the unfertilized control (T1) yielding only 6.6 t/ha. The highest computed marketable yield was obtained in plots applied with the full dose of FOLF + 50% of urea (T3) reaching 28.8t/ha. This yield was comparable with plants applied with 100% of the nitrogenous fertilizer (T5) with yield of 27.8 t/ha indicating that FOLF can replace 50% of the inorganic fertilizer need of the crop.

The acidification of urea- applied soils affirmed the environmental concerns caused by its application. The application of FOLF mitigated this condition showing its beneficial effects on soil. The application of FOLF alone like in organic pechay production is already a profitable option with BCR more than 1. Combining it with 50% urea substantially increased profitability.

Based on these findings, FOLF can be used as a stand-alone fertilizer for organic pechay production. However, for maximum yield and benefits, this could be used to replace 50% of the required inorganic fertilizer.

VI. ACKNOWLEDGMENT

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Annex Table 1. Cost and returns analysis for one hectare pechay production using various Full On and Urea (Digos City, May-June 2015)

	Quantity	Unit	Unit Price	T1-control	T2- 100% Full On	T3- 100% Full On + 50% Urea	T4- 100% Full On + 25% Urea	T5- 100% Urea
A. Land Preparation								
1.) Plowing	12	MAD	350	4,200.00	4,200.00	4,200.00	4,200.00	4,200.00
2.) Harrowing	9	MAD	350	3,150.00	3,150.00	3,150.00	3,150.00	3,150.00
3.) Furrowing	4	MAD	350	1,400.00	1,400.00	1,400.00	1,400.00	1,400.00
4.) Plot Construction	20	MD	200	4,000.00	4,000.00	4,000.00	4,000.00	4,000.00
B. Labor Cost								
1.) Seedbed preparation/seed sowing	2.5	MD	200	500.00	500.00	500.00	500.00	500.00
2.) Transplanting	20	MD	200	4,000.00	4,000.00	4,000.00	4,000.00	4,000.00
3.) Fertilization								
a.) basal/drenching	2	MD	200		400.00	400.00	400.00	400.00
b.) sidedress	1	MD	200			200.00	200.00	200.00
c.) foliar spraying (3X)	3	MD	200		600.00	600.00	600.00	
4.) Shading/deshading	5	MD	200	1,000.00	1,000.00	1,000.00	1,000.00	1,000.00
5.) Replanting	3	MD	200	600.00	600.00	600.00	600.00	600.00
6.) Care of the Plants								
(weeding, cultivation, watering)	25	MD	200	5,000.00	5,000.00	5,000.00	5,000.00	5,000.00
7.) Control of pests and disease(3X)	3	MD	200	600.00	600.00	600.00	600.00	600.00
8.) Harvesting, Sorting, Hauling(3 MD/ton)		MD	200	12,600.00	28,800.00	52,200.00	37,800.00	50,400.00
C. Material Cost								
1.) Pechay seeds	2	kg	600	1,200.00	1,200.00	1,200.00	1,200.00	1,200.00
2.) Fertilizer								
a.) Urea	6.6	bags	850			2,805.00	1,402.50	5,610.00
b.) Full On	2	l	2020		4,040.00	4,040.00	4,040.00	
3.) Insecticide								
a.) Decis	2	Liter	1350	2,700.00	2,700.00	2,700.00	2,700.00	2,700.00
D.) Others				3,000.00	3,000.00	3,000.00	3,000.00	3,000.00
TOTAL				**43,950.00**	**65,190.00**	**91,595.00**	**75,792.50**	**87,960.00**

Annex Fig. 1. Transplanting of pechay seedlings (May 2015)

Annex Fig. 2. View of the experimental site (June 2015).

Annex Fig. 3. Pechay plants applied with various fertilizer treatments. Note the purplish petiole of the unfertilized plants (T1).

Annex Fig. 4. Top view of pechay plants applied with various fertilizer treatments.

CERTIFICATION ON THE ADOPTION OF GOOD AGRICULTURAL PRACTICES (GAP)

This is to certify that the study evaluating the efficacy of Full On Liquid Fertilizer applied either alone or in combination with inorganic fertilizers was conducted following Good Agricultural Practices.

Done this 20th day of July 2015 at Davao City, Philippines.

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