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THE EFFICIENCY OF NANOTECH FOLIAR FERTILIZER ON THE GROWTH AND YIELD PERFORMANCE OF PECHAY

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ABSTRACT

This study aimed to verify the efficiency of NANOTECH FOLIAR FERTILIZER on pechay (*Brassica rapa*), particularly on its growth and yield performance. The study was conducted at Children Joy Foundation, INC. Indangan, Davao City, with a duration of 2 months which started from November to December 2022. A Randomized Complete Block Design (RCBD) was used as the experimental design which was composed of six treatments, and replicated three times. The treatments were: (T_1) Control, (T_2) RR of inorganic NPK fertilizer based on soil analysis, (T_3) RR of inorganic NPK + 0.5 rr of NANOTECH FOLIAR FERTILIZER , (T_4) RR of inorganic NPK + rr of NANOTECH FOLIAR FERTILIZER , (T_5) RR of inorganic NPK + 1.5 rr of NANOTECH FOLIAR FERTILIZER, and (T_6) rr of NANOTECH FOLIAR FERTILIZER. Data on growth and yield components were gathered and analyzed using Analysis of Variance (ANOVA) and differences between treatments were compared using Honest Significant Difference (HSD) Test.

Results showed that the growth and yield performance of pechay were significantly affected by ESSEGRO NANOTECH FOLIAR FERTILIZER in terms of root length and pechay yield, but not plant height, leaf length and width and number of leaves. This study indicated that T3 – (RR of inorganic NPK + 0.5 rr of ESSEGRO NANOTECH FOLIAR FERTILIZER) significantly increased pechay yield by 100 % more compared to the control or no application. It was further confirmed that T4 – (RR of inorganic NPK + rr of ESSEGRO NANOTECH FOLIAR FERTILIZER) had the longest root length which was substantially greater than T2 = RR of inorganic NPK fertilizer based on soil analysis. This implies that supplementing pechay with ESSEGRO NANOTECH FOLIAR FERTILIZER improves growth and yield performance.

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Keywords: Pechay, Nanotech, Foliar Fertilizer, Growth, Yield Performance.

INTRODUCTION

Growing vegetables has been a practice for centuries in civilized countries. Vegetables are a very important food commodity. Aside from playing a major role in meeting our vitamin, mineral and protein requirements, they also serve as a reliable source of income for farmers (Chauburg, 1984).

Pechay (Brassica napus L.) belongs to the Brassiceae family and one of the most known vegetables in the Philippines. It is also known as one of the oldest green vegetables in Asia. It therefore plays an important role in the Philippines economy as well as in the nutrition of the filipino people. Pechay is used mainly for its immature, but fully expanded tender leaves

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(http://www.darfu4b.da.gov.ph/pechay.html). About 86.3 percent of the country's total Chinese pechay production came from the Cordillera Administrative Region. Central Visayas came next with 7.0 percent share. Northern Mindanao, Davao Region and the rest of the country had a combined share of 6.7 percent (PSA 2019). The crop is considered the most consumed leafy vegetable in the Philippines and contributes a very good income provider for farmers due to its short duration harvesting. This crop can be harvested 30-45 days after planting, the seedling foundation of this crop strongly affects performance as it contributes to almost half of the duration in cropping (Siemonsma & Piluek 1994). In 2017, the country's total production for broccoli, cabbage, carrots, habitchuelas, Chinese pechay, and white potato registered a combined output of 373,843.8 metric tons, slightly lower by 0.25 percent compared to the production in 2016 with 372,906.7 metric tons (PSA 2019). Hence, a considerate effort to increase vegetable production through efficient fertilization techniques is a wise alternative.

Types and levels of fertilizer applied to crops are very important in crop production and play an important role in cropping systems. Relying on inorganic or chemical fertilizers is a major constraint due to its prohibitive cost though identified as an important factor in meeting the food requirements of a growing population (Kerin and Berova, 2003).

According to Ojeniyi, (2002) there are certain advantages of inorganic fertilizers which makes them a potent candidate to enhance agricultural productivity. There is no need of direct decomposition as the nutrients in mineral fertilizers are relatively high, and the release of these nutrients is quick. Inorganic fertilizers increase the growth rate and plant's overall productivity more rapidly. There are abundant evidences that inorganic fertilizers can improve yield of crop significantly. According to Cooke (1982) fertilizers raise soil fertility so that the yield of crops is independent and no longer be limited by the deficient amounts of plant nutrients. The nutrients in chemical fertilizers are already in inorganic form and so can be immediately used by the plants. It is important to understand that there is no fundamental difference in nutritional quality between organic and inorganic fertilizers.

Nowadays, nanotechnology has been used in many agricultural fields such as production, processing, storing, packaging and transport of agricultural products (Mousavi and Rezai 2011; Ditta 2012). Fertilizer derived from nanotechnology has started to attract attention in agriculture. Nanotechnology can have a profound impact on energy, the economy and environment, by improving fertilizer products (DeRosa et al. 2010). Nanofertilizer can be encapsulated inside nanomaterials, coated with a thin protective polymer film, or delivered as particles or emulsions of nanoscale dimensions (DeRosa et al. 2010).

Essegro Biostimulant is a comprehensive product for agriculture which is made with new-age nanotechnology. Essegro Nanotech Foliar Fertilizer is an exemplary product that fulfills any plant's nutrition needs consisting of essential primary, secondary and micro nutrients with ease. It is a highly effective and eco-friendly formulation consisting of fast absorbing nanometer size particles. Essegro Nanotech Foliar Fertilizer components are seaweed extract, amino acid, humic acid and zinc substances. It contains 100 % natural substances extracted using the ion formula enhancing the efficiency of the nutrient absorption from the soil to the different parts of the plants. It also reduces the recommended fertilizer rate by 50% as the soil gradually restores its fertility through over time application. Essegro Nanotech Foliar Fertilizer enhances the production of starch ad sugar and it rapidly solves the stomatal malfunctions due to the nutrient deficiency.

Foliar feeding is a technique of feeding plants by applying liquid fertilizer directly to their leaves. Plants are able to absorb essential elements through their leaves. The absorption takes place through their stomata and also through their epidermis. It is the application of fertilizers to foliage of the crop as spray solution is known as foliar spray. This method is suitable for application of small quantities of fertilizers, especially micro-nutrients. Major nutrients can also be applied by this method when there is no adequate moisture in top layer of soil. Foliar application is not substitute for soil application, but only a supplement to it. More recently, foliar feeding has been widely used and accepted as an essential part of crop production, especially on horticultural crops. Although not as widespread on agronomic crops, the benefits of foliar feeding have been well documented and increasing efforts have been made to achieve consistent responses (www.marumegh.com).

Previous studies using various fertilizers and foliar supplements have been tested to maximize the growth and yield of various crops (Eroy2015; Eroy 2019;

Fernandez and De Guzman 2021; Magbalot-Fernandez and De Guzman 2019; Magbalot-Fernandez et al. 2020; Magbalot-Fernandez and Montifalcon 2019; Montifalcon and Fernandez 2017;Fernandez and Andigan 2017; Fernandez and Sabay 2016; Fernandez and Caballes2016; Fernandez and Quilab-Tud 2016; Fernandez and Miñoza 2015; Fernandez and Lumbo 2015; Fernandez and Tipay 2013; Fernandez and De Guzman 2013).

This study is therefore conducted to determine the efficiency of Essegro Nanotech Foliar Fertilizer on pechay growth and yield performance; to verify the effects of Essegro Nanotech Foliar Fertilizer application on the specific parameters; plant height, leaf width, leaf length, number of leaves, root length and pechay yield; and to determine the best treatment combination that will increase the grow and yield performance of pechay.

MATERIALS AND METHODS

The field experiments were conducted at the experimental area of Children Joy Foundation, INC. Indangan, Davao City for two months which started from November to December 2022. Soil analysis was done to determine the nutrient requirement of the area for pechay. Before the conduct of the experiment, soil samples were collected at random in the area following the standard procedure of the DA Regional Soil Laboratory, Davao City and analyzed for nutrient requirements. The experiment was carried out in Randomized Complete Block Design (RCBD). Field experiment was composed of six (6) treatments replicated three (3) times.

The recommended rate of fertilizer was applied based on the recommendation of soil analysis. Various treatments were based on the Fertilizer and Pesticide Authority Experimental Use Permit Protocol for fertilizer registration. Inorganic fertilizers as urea, ammosul and ammophos were purchased based on the recommendation in bags/ha and the Essegro Nanotech Foliar Fertilizer was applied based on the following treatments: (T_1) Control, (T_2) RR of inorganic NPK fertilizer based on soil analysis, (T_3) RR of inorganic NPK + 0.5 rr of NANOTECH FOLIAR FERTILIZER , (T_4) RR of inorganic NPK + rr of NANOTECH FOLIAR FERTILIZER, (T_5) RR of inorganic NPK + 1.5 rr of NANOTECH FOLIAR FERTILIZER, and (T_6) rr of NANOTECH FOLIAR FERTILIZER. The recommended rate of Essegro Nanotech Foliar Fertilizer was applied as foliar spray from sowing and transplanting up to one week before harvest. One tablespoon (g/mg) of Essegro Nanotech Foliar Fertilizer was dissolved in 20 liters of water and sprayed on pechay based on various treatments. Data on growth and yield components were gathered and analyzed using Analysis of Variance (ANOVA) and differences between treatments were compared using Honest Significant Difference (HSD) Test.

There were 128.4 pechay plants in a 12" x 12" planting distance with a plot size of $12m^2$ per replication for a total area of 216 m^2 with a total of 2,311 pechay plants. Each plot was provided with a 1m alleyway. Plowing and harrowing the soil thoroughly makes it more friable and more porous suited for good quality produce. The field was plowed and harrowed once using animal-drawn implements or tractor. Direct seeding was accomplished through row sowing. Two to three seedlings were transplanted per hill, one-two weeks after planting from the seed box. One seedling per hill was maintained one week after transplanting. To obtain maximum growth and tenderness it must be supplied with adequate moisture. The plants were watered daily whenever necessary using a sprinkler. Hoeing of the weeds may be necessary at an early stage of weeds growth before the plants shade the spaces in between plants. Manual weeding was done weekly whenever necessary. Insecticide and fungicide were applied whenever necessary at recommended dosage and interval. Rotation use of pesticides was done to avoid the development of resistance to pests. The different fertilizer treatments were applied based on soil analysis and manufacturer's recommendation. Basal application of inorganic fertilizers was done one week before planting and side dress application was done two weeks after planting based on the soil analysis. Pechay (pak-choi cultivar) was harvested at maturity, 21 days from transplanting. The pechay was already matured at three weeks after transplanting the 1-2 weeks old seedlings from the seedbed. So, it took 35-40 days for pechay from planting to harvesting. Land preparation took 2-3 weeks which covers two months for pechay production from clearing, land preparation up to harvesting. This was based on Davao Area region climatic conditions and years of experience in pechay production and research. Pechay production guide publications may differ in conditions per region. Harvesting of pechay was done manually using cutting scissors. Dried leaves and damaged parts were trimmed off and washed in cleaning running water. Freshly harvested leaves were weighed and recorded.

DATA GATHERED

All marketable plant parts per plot was weighed using a digital weighing scale and converted to tons/ha yield.

Plant heights of ten pechay sample plants per replication were measured from the base up to the tip of the plants using a ruler. The number of leaves were counted each from the ten sample plants per replication. The longest leaf lengths and widest leaf widths of the ten sample plants per replication were measured using a ruler. The root length of ten samples plants per replication were measured using a ruler.

RESULTS AND DISCUSSION

Root Length (cm)

The root length of pechay as shown in Table 1 was significantly affected by Essegro Nanotech Foliar Fertilizer at 30 days after transplanting (DAT). Results verified that T4 = RR of inorganic NPK + rr of Essegro Nanotech Foliar Fertilizer got the longest root length which is significantly higher than T 2 = RR of inorganic NPK fertilizer based on soil analysis. This suggests that supplementation of essegro nanotech foliar fertilizer enhances the root growth of pechay. It is however statistically the same to the rest of the treatments.

According to recent research (Fernández, V., & Brown, P. H., 2013), foliar fertilization is becoming an increasingly important agricultural technique. There has been a shift in recent years away from using chemical or commercial fertilizers in favor of using organic fertilizers to increase agricultural yields without depleting soil fertility. Fernandez, et al. (2020) reported that T7 - (Conventional Practice + Bio- Forge + Stimulate) significantly increased plant height of banana plantlets by 7 times, width of leaves by 3 times, stem diameter by 6 times, root number by 3 times, fresh weight by 17 times which were comparable with T6- (Bio-Forge + Stimulate), T5- (CP + Stimulate), T4- (CP + Bio-Forge) and T3- (Bio- Forge). The T3 (Bio-Forge) had the highest leaf length increase by 10 times, root length by 100% which is comparable to T5- (CP + Stimulate), T6- (CP + Stimulate) and T7- (CP + Bio-Forge + Stimulate). While T4- (CP + Bio-Forge) had the heaviest dry weight by 28 times which is also comparable to T3 (Bio-Forge), T5 (CP + Stimulate), T6 (Bio-Forge + Stimulate) and T7- (CP + Bio-Forge + Stimulate).

Table 1: Root length (cm) of pechay as influenced by Essegro Nanotech Foliar Fertilizer at 30 days after transplanting (DAT).

Treatments	R1	R2	R3	Root Length (cm)*
T1 = Control	6.90	9.05	8.95	8.3 ab
T2 = RR of inorganic NPK fertilizer based on soil analysis	4.85	4.85	4.40	4.7 b
T3 = RR of inorganic NPK + 0.5 rr of ESSEGRO NANOTECH FOLIAR FERTILIZER	4.20	5.68	9.25	6.4 ab
T4 = RR of inorganic NPK + rr of ESSEGRO NANOTECH FOLIAR FERTILIZER	9.40	6.36	9.60	8.4 a
T5 = RR of inorganic NPK + 1.5 rr of ESSEGRO NANOTECH FOLIAR FERTILIZER	6.30	6.55	7.76	6.9 ab
T6 = rr of ESSEGRO NANOTECH FOLIAR	7.60	6.98	7.60	7.4 ab
CV				12.40%

**- significant*

Means with the same letter are not significantly different at 5% level of probability using HSD.

Number of Leaves

The number of leaves of pechay was not significantly affected by Essegro Nanotech Foliar Fertilizer at 30 days after transplanting (DAT) as shown in Table 2. This indicates that the number of leaves of pechay in all treatments were significantly comparable which ranged from 6.9- 9.0 leaves. The T1= control had the largest number of leaves due to the soil being fertile prior to the study's completion.

Table 2: Number of leaves of pechay as influenced by Essegro Nanotech Foliar Fertilizer at 30 days after transplanting (DAT).

Treatments	R1	R2	R3	No. of Leaves[ns]
T1 = Control	8.6	9.3	9.2	9.0
T2 = RR of inorganic NPK fertilizer based on soil analysis	7.4	7.4	8.7	7.8
T3 = RR of inorganic NPK + 0.5 rr of ESSEGRO NANOTECH FOLIAR FERTILIZER	7.7	9.3	9.4	8.8
T4 = RR of inorganic NPK + rr of ESSEGRO NANOTECH FOLIAR FERTILIZER	7.7	8.3	10.1	8.7
T5 = RR of inorganic NPK + 1.5 rr of ESSEGRO NANOTECH FOLIAR FERTILIZER	7.5	7.4	9.7	8.2
T6 = rr of ESSEGRO NANOTECH FOLIAR	7.8	7.6	5.4	6.9
CV				12.40%

ns - not significant

Leaf Width

Table 4 shows that the leaf width of pechay was not significantly affected by Essegro Nanotech Foliar Fertilizer at 30 days after transplanting (DAT). This indicates that the leaf width of pechay in all treatments were significantly not different which ranged from 7.8 – 9.7 cm. As a result of its fertile soil before the study was conducted, the T1= control got the largest leaf width.

Table 4: Leaf Width (cm) of pechay as influenced by Essegro Nanotech Foliar Fertilizer at 30 days after transplanting (DAT).

Treatments	R1	R2	R3	Leaf Width (cm)ns
T1 = Control	8.62	10.50	8.80	9.3
T2 = RR of inorganic NPK fertilizer based on soil analysis	8.20	8.20	9.50	8.6
T3 = RR of inorganic NPK + 0.5 rr of ESSEGRO NANOTECH FOLIAR FERTILIZER	7.70	8.20	10.85	8.9
T4 = RR of inorganic NPK + rr of ESSEGRO NANOTECH FOLIAR FERTILIZER	10.11	7.64	11.30	9.7
T5 = RR of inorganic NPK + 1.5 rr of ESSEGRO NANOTECH FOLIAR FERTILIZER	8.45	7.50	10.80	8.9
T6 = rr of ESSEGRO NANOTECH FOLIAR	9.00	7.41	6.85	7.8
CV	15.00%			

ns - not significant

Leaf Width

The leaf length of pechay was also not significantly affected by Essegro Nanotech Foliar Fertilizer at 30 days after transplanting (DAT) as indicated in Table 5. This means that the leaf width of pechay in all treatments have significantly the same length which ranged from 6.9- 9.0 cm.

Table 5: Leaf Length (cm) of pechay as influenced by Essegro Nanotech Foliar Fertilizer at 30 days after transplanting (DAT).

Treatments	R1	R2	R3	Leaf Length (cm)ns
T1 = Control	12.86	13.45	11.80	12.7
T2 = RR of inorganic NPK fertilizer based on soil analysis	10.55	10.55	12.00	11.0
T3 = RR of inorganic NPK + 0.5 rr of ESSEGRO NANOTECH FOLIAR FERTILIZER	10.30	11.59	14.90	12.3
T4 = RR of inorganic NPK + rr of ESSEGRO NANOTECH FOLIAR FERTILIZER	12.38	11.27	14.70	12.8
T5 = RR of inorganic NPK + 1.5 rr of ESSEGRO NANOTECH FOLIAR FERTILIZER	11.60	9.70	15.27	12.2
T6 = rr of ESSEGRO NANOTECH FOLIAR	12.25	11.27	10.80	11.4
CV				12.97%

ns – not significant

Plant Height

The pechay height was not significantly affected by Essegro Nanotech Foliar Fertilizer at 30 days after transplanting DAT (Table 6). This shows that the plant height of all pechay in all treatments were the same.

Table 6: Plant Height (cm) of pechay as influenced by Essegro Nanotech Foliar Fertilizer at 30 days after transplanting (DAT).

Treatments	R1	R2	R3	Leaf Length (cm)ns
T1 = Control	24.30	27.55	22.6	24.8
T2 = RR of inorganic NPK fertilizer based on soil analysis	24.00	24.00	23.20	23.7
T3 = RR of inorganic NPK + 0.5 rr of ESSEGRO NANOTECH FOLIAR FERTILIZER	23.00	23.00	25.80	24.0
T4 = RR of inorganic NPK + rr of ESSEGRO NANOTECH FOLIAR FERTILIZER	26.13	22.50	26.10	24.9
T5 = RR of inorganic NPK + 1.5 rr of ESSEGRO NANOTECH FOLIAR FERTILIZER	23.90	19.00	25.90	22.9
T6 = rr of ESSEGRO NANOTECH FOLIAR	23.00	21.68	24.10	22.9
CV				9.01%

ns – not significant

Yield (kg/plot)

The effect of Essegro Nanotech Foliar Fertilizer on the yield of pechay per plot was highly significant (Table 7). T3= RR of inorganic NPK + 0.5 rr of Essegro Nanotech Foliar Fertilizer increased the yield of pechay by 100% more compared to the control or no

application. This implies that only half amount of Essegro Nanotech Foliar Fertilizer with RR inorganic fertilizer is recommended to increase the yield of pechay.

This supports previous study which increased yield in pechay using FOLF (Eroy 2019). The yield was significantly improved by the mere application of Full On Liquid Fertilizer at its recommended dose (T5) resulting to 86.11% additional yield. However, this yield level was further increased when 50% (T4) or full dose of the reference fertilizer (T6) was added.

The recommended rate (rr) of NPK with and without 1.5 rr foliar fertilizer gave the best result on growth and yield of pechay. It increased plant height and length of leaves as much as 45%, width of leaves by 40%, leaf number by 20%, fresh weight up to two times and yield by three times higher (Fernandez and Miñoza 2015).

Stimulate hormones increased plant height of pechay by 37%, length of leaves by 44%, width of leaves by 39%, fresh weight by 2 times, yield by 3 times, and number of leaves (Andigan and Fernandez 2017).

Roshdy, K. A., and Refaai, M. M. (2016), revealed that when compared to the usage of conventional fertilizer, the usage of nano-fertilizer that was put to the soil boosted the production of date palms as well as their growth. Roshdy and Refaai (2016) found out the effect that nano-fertilizers have on the growth of fruit as well as the developmental and phytochemical processes in the date palm fruit.

Table 7: Yield (tons/ha) of pechay as influenced by Essegro Nanotech Foliar Fertilizer at 30 days after transplanting (DAT).

Treatments	R1	R2	R3	Yield (kg/plot)**	Yield (tons/ha)**
T1 = Control	3509.6	3402.0	3509.6	3473.7 b	3.4 b
T2 = RR of inorganic NPK fertilizer based on soil analysis	5296.1	529.1	5517.0	5369.7 b	5.3 b
T3 = RR of inorganic NPK + 0.5 rr of ESSEGRO NANOTECH FOLIAR FERTILIZER	7032.9	7032.9	9745.5	7937.1 a	7.9 a
T4 = RR of inorganic NPK + rr of ESSEGRO NANOTECH FOLIAR FERTILIZER	6285.4	3762.6	6285.4	5444.5 b	5.4 b
T5 = RR of inorganic NPK + 1.5 rr of ESSEGRO NANOTECH FOLIAR FERTILIZER	6023.4	4886.4	4886.4	5265.4 b	5.2 b
T6 = rr of ESSEGRO NANOTECH FOLIAR	3994.9	3839.0	3839.0	3890.9 b	3.8 b
CV					16.38%

**- highly significant
Means with the same letter are not significantly different at 1% level of probability using HSD.

SUMMARY, CONCLUSION AND RECOMMENDATION

The study entitled, " The Efficiency of Nanotech Foliar Fertilizer on the Growth and Yield Performance of Pechay" was conducted at Children Joy Foundation, INC. Indangan, with a duration of 2 months which started from November to December 2022. The objectives of the study were the following: To determine the efficiency of ESSEGRO NANOTECH FOLIAR FERTILIZER on pechay growth and yield performance ; To verify the effects of ESSEGRO NANOTECH FOLIAR FERTILIZER application on the specific parameters; fresh weight, plant height, leaf width, leaf length, number of leaves, root length and pechay yield; and, To determine the best treatment combination that will increase the growth and yield performance of pechay.

A Randomized Complete Block Design (RCBD) was used as the experimental design which was composed of six treatments, and replicated three times. The treatments were: (T_1) Control, (T_2) RR of inorganic NPK

fertilizer based on soil analysis, (T_3) RR of inorganic NPK + 0.5 rr of NANOTECH FOLIAR FERTILIZER, (T_4) RR of inorganic NPK + rr of NANOTECH FOLIAR FERTILIZER, (T_5) RR of inorganic NPK + 1.5 rr of NANOTECH FOLIAR FERTILIZER, and (T_6) rr of NANOTECH FOLIAR FERTILIZER. Data on growth and yield components were gathered and analyzed using Analysis of Variance (ANOVA) and differences between treatments were compared using Honest Significant Difference (HSD) Test.

Based on the results of the study, the growth and yield performance of pechay were significantly affected by ESSEGRO NANOTECH FOLIAR FERTILIZER in terms of root length, and pechay yield. However, the plant height, the leaf length and width and number of leaves did not have significant differences among treatments.

T3 – (RR of inorganic NPK + 0.5 rr of ESSEGRO NANOTECH FOLIAR FERTILIZER) significantly increased pechay yield by 100 % more compared to the control or no application. This study reinforces preceding study that found that applying FOLF enhanced pechay production (Eroy 2019). The production was greatly increased by just applying Full On Liquid Fertilizer at the prescribed dose (T5), resulting in an extra yield of 86.11%. T4 – (RR of inorganic NPK + rr of ESSEGRO NANOTECH FOLIAR FERTILIZER) had the longest root length which was significantly greater than T2 = RR of inorganic NPK fertilizer based on soil analysis. This implies that supplementing pechay with ESSEGRO NANOTECH FOLIAR FERTILIZER improves growth.

ESSEGRO NANOTECH FOLIAR FERTILIZER hence increased the growth and yield performance of pechay (*Brassica rapa*).

The author therefore, recommends the use of T3 - RR of inorganic NPK + 0.5 rr of ESSEGRO NANOTECH FOLIAR FERTILIZER to boost pechay production and to enhance the yield performance of pechay (*Brassica rapa*).

Figure 1: Effect of Essegro Nanotech Foliar Fertilizer on pechay growth.

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