Annales Universitatis Paedagogicae Cracoviensis
Studia Naturae, 6: XX–XX, 2021
ISSN2543-8832
DOI: 10.24917/25438832.6.X

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Bio-Forge promotes growth and yield performance of pechay (*Brassica rapa* L. var. *chinensis* (L.) Hanelt)

Introduction

Pechay *Brassica rapa* L. var. *chinensis* (L.) Hanelt (= *B. chinensis* L.) group cultivars 'Pak Choi', is an erect, biennial herb, cultivated as an annual about 15–30 cm tall in vegetative stage. Ovate leaves are arranged spirally and spreading. The petioles are enlarged and grow upright forming a subcylindrical bundle. Inflorescence is a raceme with pale yellow flowers. Seeds are 1 mm in diameter and are reddish to blackish brown in colour (Gawryś, 2008). Pechay is an important Constituents of Filipino food such as "puchero" and "nilaga". It is a green leafy vegetable rich in calcium and other essential nutrients. Its nutritional values, in 100 g dry mass, are made up of 93.0 g water, 1.7 g protein, 0.2 g fat, 3.1 g carbohydrates, 0.7 g fiber, 0.8 g ash, 2.3 g β-carotene, 53.0 mg vitamin C, 102.0 mg calcium, 46.0 mg phosphorous, 2.6 mg iron, and an energy of 86.0 kJ. Pechay is used mainly for its immature, but fully expanded tender leaves (Knot, Deanon, 1967). The succulent petioles are used as main ingredient for soup and stir-fried dishes. In Chinese cuisine, its green petioles and leaves are also used as garnish (Jim, Tony, 2006; Jimenez et al., 2021).

The Food and Agricultural Organisation (FAD) has identified cabbage as one of the top twenty vegetables and an important source of food globally. The country's Chinese pechay production slightly decreased by 0.95% in 2017. About 86.3% of the country's total *B. chinensis* production come from the Cordillera Administrative Region Central Visayas came next with 7.0% share. Northern Mindanao, Davao Region and the rest of the country had a combined share of 6.7% (*Philippine Statistics Authority*, 2019). Therefore, the causes of this type of changes are sought.

So far studies using various fertilisers and foliar supplements have been tested to maximize the growth and yield of various crops. For examples, for pummmelo plants (*Citrus maxima* Merr.) fertiliser was used of fermented banana peel, nutrition by foliar or soil fertilisation with potassium (Magbalot-Fernandez, De Guzman, 2019; 2021). For pechay (*B. chinensis*) was examined effect of organic foliar fertiliser or the stimulating effect of hormones (Fernandez, Miñoza, 2015; Fernandez, Andigan, 2017). For an abaca (*Musa textilis* Nee) and banana plants (*M. paradisiaca* L.). The effect of hormones and Bio-Forge fertiliser were analysed (Fernandez, Sabay, 2016; Magbalot-Fernandez et al., 2020). For rice (*Oryza* L.) the effect of organic-based foliar fertiliser were checked (Montifalcon, Fernandez, 2017).

Bio-Forge® (Stoller USA) is a fertiliser use as a biological substance of plant growth. It is used to control stress processes caused by excessive ethylene production. Bio-Forge improves the over expression of plant genes in terms of resistance to stress, facilitates nitrogen uptake and growth of the main root increasing its penetration and length, increases respiration and metabolism of the plants reactivating its growth, eliminates the effects of stress and blockage resulting from excess ethylene produced as a result of stress, delays aging plants, helping them stay active, fresh and productive longer. It can be applied for seed treatment, soil, foliar or as a fertiliser to maximize potential benefits. Its active ingredients are 3.0% total nitrogen, 1.25% urea nitrogen, 1.75% ammoniacal nitrogen, 1.0% soluble potash, 1.0% cobalt, 1.0% molybdenum (Stoller, 2021).

In the fight against changing climatic conditions, soil contamination with heavy metals and pesticides, farmers are still looking for innovative solutions in crops. One of them seems to be the use of Bio-Forge as a plant protection agent against environmental stress, and it’s a positive effect on plant morphology and physiology. Therefore, a major aim of this study was to (*1*) to evaluate the effects of Bio-Forge and Bio-Forge in combination with other fertilisers in the elongation growth of *B. chinensis*, (*2*) to determine the economic benefits of using Bio-Forge in pechay yield production, and (*3*) to determine the best treatment combination of fertilisers that will increase the yield of Chinese pechay.

Material and methods

Location and duration of the study

This study was conducted at the research area of University of Southeastern Philippines, Tagum-Mabini Campus, Philippines at 7º28'8''N 125º85'63''E from December 2014 to January 2015 (Fig. 1).

Experimental design

The study was carried out in Randomised Complete Block Design (RCBD). Field experiments were composed of seven treatments replicated three times. There were 64 pechay plants in a 0.25 × 0.25 planting distance with a plot size of 4 m^2 per replication for a total area of 128 m^2 with a total of 1,344 pechay plants. Each plot was provided with a 0.5 m alleyway. The climatic conditions throughout the duration of the study in reference to the PAGASA Agromet station have rainy days and temperatures which were favourable to the growth and development of pechay (Pagasa, 2021).

Fig. 1. The Experimental area at the University of South-eastern Philippines, Tagum-Mab in Campus; A, B – row cultivation, C – leaf width measurements, D – plant height measurements (Photo. M. Agan)

Soil analysis

Soil analysis was done to determine the nutrient need for pechay. Before the conduct of the experiment, soil samples were collected at random in the area. Soil samples were air-dried, pulverised and sieved and were brought to the Department of Agriculture, Regional Soil Laboratory, Davao City for analysis. Based on the result of the soil analysis (Tab. 1), it was recommended to apply 10 bags of 50 kg / ha compost, 2–4 bags of 50 kg / ha ammonium phosphate, 0.90–1.75 bags of 50 kg / ha ammonium sulphate and 2.2–4.4 bags of 50 kg / ha urea.

Tab. 1. Soil analysis and requirement for pechay (*Brassica rapa* L. var. *chinensis* (L.) Hanelt) at the experimental area

	pH soil	Organic matter [%]	[1]P [ppm]	[2]K [ppm]	Nutrient requirement [kg / ha]		
					N	P_2O_3	K_2O
	6.2 – slightly acidic	1.3 – very Low	8 – very low	955 – very high	150	40	0
Standard values	6.1–6.6 5.6–6.0	< 3.44	< 10	> 750			

Note: [1]Olsen methods (Horta, Torrent, 2007), [2]H_2SO_4 Extraction method (Hunter, Pratt, 1957)

Preparation of the field for cultivation

The area was ploughed and harrowed thoroughly. Plot lay-outing and drainage canal were constructed after ploughing and harrowing. Two to three seedlings were planted per hill. One seedling per hill was maintained one week after transplanting. This was done early in the morning or late in the afternoon or as needed to maintain soil moisture. The different fertiliser treatments were applied based on soil analysis and the manufacturer's recommendation. Weeding was done regularly to prevent weeds from competing with nutrients and water with the experimental plants. The plants were sprayed with appropriate pesticides and fungicides such as Dithiane to control the occurrence of insect pests and diseases following the manufacturer's recommendations. Pechay was harvested at maturity, 45 days after sowing.

Tested fertiliser modifications

The experiment investigated the effects of 7 different combinations of fertilisers. T1 – was control group consisted of plots fed with distilled water and precipitation. Group of T2 was consisted of recommended rate (RR) of inorganic NPK fertiliser according to soil analysis (Tab. 1). The test of T3 was available on the fertiliser market – Bio-Forge fertiliser. The T4 group consisted of T2 + S (simulate as a yield enhancer which contained a combination of 3 different phytohormones including cytokinin (0.009% / 1L), gibberellic acid (0.005% / 1L), and indole-3-butyric acid (0.005% / 1L). Treatment of T5 was consisted of T2 + Bio-Forge. The treatment 6 – T6 was S + Bio-Forge and T7 = T2 + T6.

The recommended rate of stimulate was applied at 10 ml / 1 L of water. Bio-Forge (contains micronutrients that stimulate the production of auxin, a hormone generated by the plant to trigger vegetative growth) and other fertilisers were applied at 5 ml / 1 L of water based on manufacturer's recommendation.

Morphometric analysis

The plant height was measured by the ruler from 10 samples of plant per plot. Leaves were taken from the base of the standing plant. Measurements were done at 15 days intervals up to harvesting. The length of the third leaves was measured by the rule from the base of the leaf up to its tip. The width of the leaves was examined from the one leaf in each of the 10 sample plants per plot. The number of the leaves was determined by counting all fully expanded leaves of the plants at the end of experiment. The mean values are presented in the table in the form of [cm] values and in the figures in the percentage values using the inhibition percentage index according to Mominul Islam et al. (2012).

Fresh weight and yield of pechay plants

Fresh weight [g] was determined by weighing 10 sample plants per plot immediately after harvest using an electronic scale (RS PRO, no. 111–3673, China). The yield of pechay [kg / ha] was taken by weighing all the plants from each plot after harvest. It was determined on a hectare basis following the formula: Yield [kg / ha] = plot yield [kg] × 10,000 sq.m. / plot size and expressed in percentage values.

Statistical analysis

Statistical analysis of the different data gathered was analysed through the Analysis of Variance (ANOVA) and the differences among treatments were compared using Honest Significant Difference (HSD). The results were additionally compiled into MS Excel in the form of percentage values. There were three replications per treatment for a total of 21 repetitions and the standard deviation of every replication means were taken.

Results

Plant height

Biometric analysis of pechay plants after 15 days showed no significant differences between the applied fertiliser modifications with the addition of Bio-Forge, compared to the value in the control sample. After 30 days, slight plant growth was observed, however, no statistically significant differences were found. After 45 days of pechay cultivation, clear differences were observed in the elongation growth of the plants compared to the control (T1). Each of the applied fertilisers had a positive effect on the growth of the tested plants.

The highest plants were found in plots where plants were treated with fertilisers in the form of T2 (recommended rate (RR) of inorganic NPK fertiliser according to soil analysis (Tab. 1)) mixtures, T4 (T2 + S (simulate by phytohormones)), T5 (T2 + Bio-forge) and T7 (T2 + T6) (Tab. 2, Fig. 2A, D).

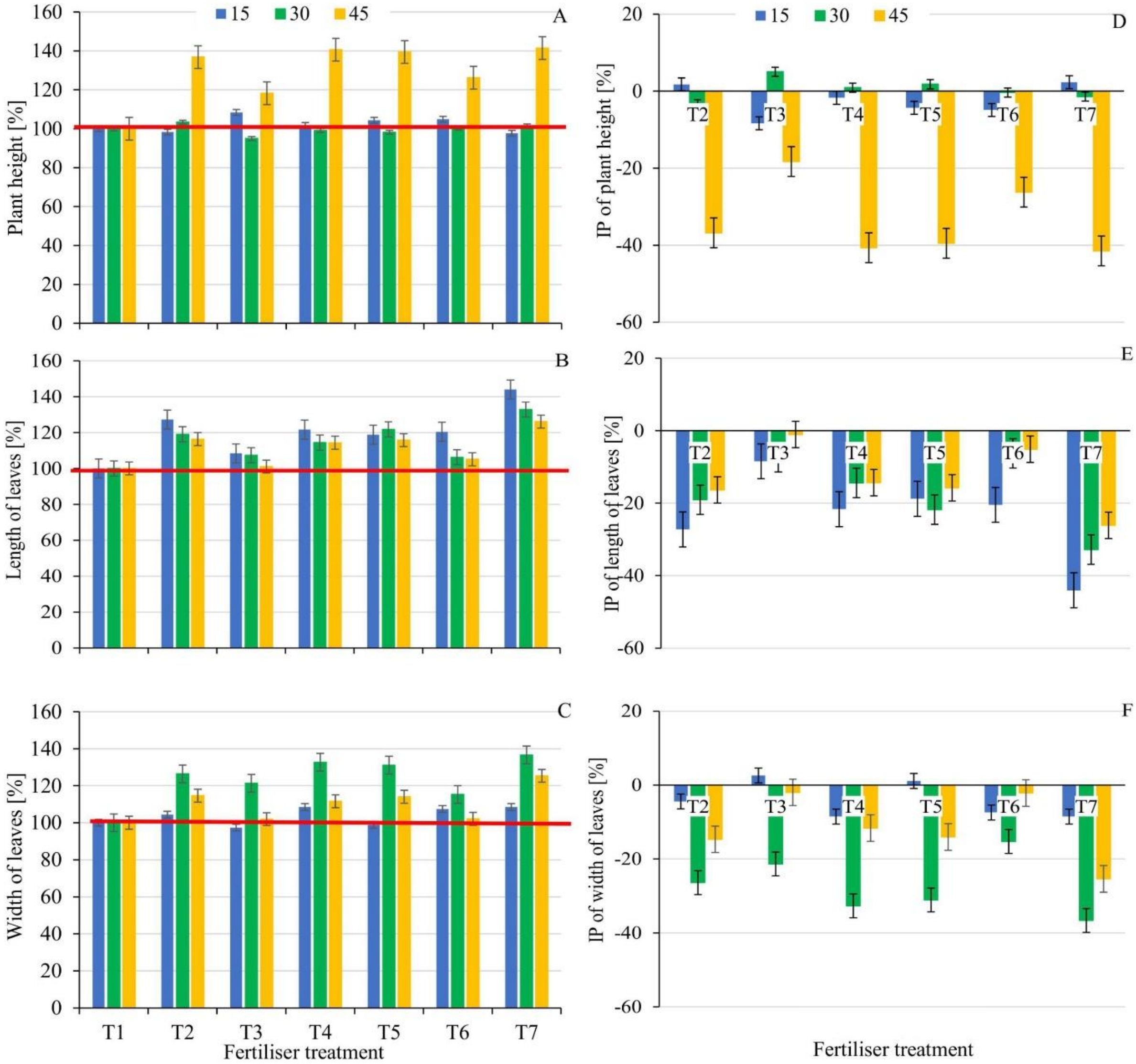

Fig. 2. Plant height, length plant and leaves width of pechay (*Brassica rapa* L. var. *chinensis* (L.) Hanelt) after of application various fertilisers expressed in percentage values; T1 – control; T2 – recommended rate of inorganic fertiliser; T3 – Bio-Forge; T4 – T2 + S (simulate); T5 – T2 + Bio-Forge; T6 – S + Bio-Forge; T7 – T2 + S + Bio-Forge; IP – inhibition percentage expressed as % of control plant, negative values indicate a positive effect of fertilisers, positive values indicate plant growth inhibition; a red line represents 100% (control group), 15, 30, 45 – number of days of pechay cultivation

Length of leaves

The length of the pechay leaves, at each of the three measurement dates, was the highest in the plants treated with the T7 fertiliser. Compared to the control, all fertiliser mixtures had a positive effect on pechay leaf length. The smallest differences in the values of this parameter were found between T1 (control group) and T3 (Bio-Forge fertiliser) (Tab. 2, Fig. 2B, E).

Width of leaves

Results revealed no significant difference was observed at 15 days of application of all T2–T7 fertilisers (Tab. 2). While significant differences in the effect on pechay leaf width were shown in plants after 30 and 45 days of cultivation. Compared to the control and other fertiliser mixtures, the widest leaves of pechay were found in plants treated with T7 fertilisers (Tab. 2, Fig. 2C, F).

Number of leaves

The amount of leaves of *Brassica rapa* L. var. *chinensis* (L.) Hanelt was similar between the plants from the control and those grown on soils with the addition of T3, T4 and T6 fertilisers. In other cases, each fertiliser caused a significant increase in the number of pechay leaves, compared to the number of plants in the control plant (T1) (Fig. 3).

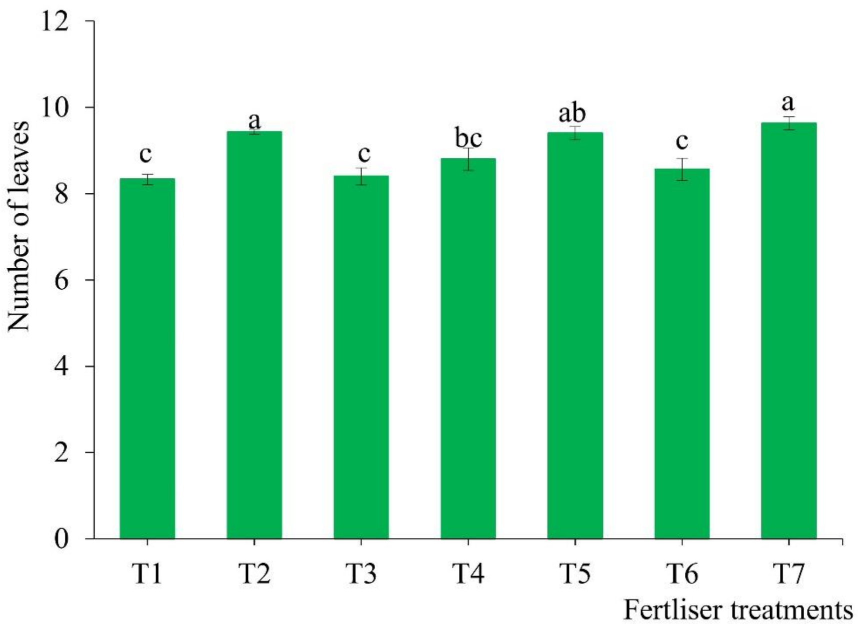

Fig. 3. The amount of leaves of pechay (*Brassica rapa* L. var. *chinensis* (L.) Hanelt) after of application various fertilisers: T1 – control; T2 – recommended rate of inorganic fertiliser; T3 – Bio-Forge; T4 – T2 + S (simulate); T5 – T2 + Bio-Forge; T6 – S + Bio-Forge; T7 – T2 + S + Bio-Forge; means (± SD) with different letters are significantly different at $p < 0.01$ according to the HSD test

Tab. 2. Plant height, length and width of leaves of pechay (*Brassica rapa* L. var. *chinensis* (L.) Hanelt) treated with various fertilisers after 15, 30 and 45 days of planting

Treatments	Plant height [cm]			Length of leaves [cm]			Width of leaves [cm]		
	15 ns	30 ns	45 **	15 **	30 **	45 **	15 ns	30 **	45 **
T_1	3.47 ±0.33	5.59 ±0.32	9.57 c ±0.29	11.97 d ±0.48	13.90 d ±0.56	20.35 c ±0.44	2.70 ±0.42	8.90 e ±0.11	13.16 d ±0.51
T_2	3.41 ±0.48	5.78 ±0.06	13.09 a ±0.36	15.23 b ±0.17	16.55 b ± 1.08	23.68 b ±0.10	2.82 ±0.25	11.25 bc ±0.21	15.09 ab ±0.69
T_3	3.76 ±0.10	5.31 ±0.21	11.32 b ± 0.69	12.98 cd ±0.81	14.92 cd ±0.30	20.57 c ±1.03	2.63 ±0.43	10.80 cd ±0.05	13.42 cd ±0.46
T4	3.53 ±0.06	5.54 ±0.46	13.46 a ± 0.20	14.56 bc ± 0.67	15.90 bc ±0.31	23.27 b ±0.27	2.93 ±0.20	11.81 ab ±0.33	14.69 bc ±0.57
T5	3.62 ±0.23	5.49 ±0.45	13.35 a ± 0.33	14.22 bc ±0.20	16.93 b ±0.80	23.56 b ±0.44	2.67 ±0.06	11.67 ab ±0.27	15.01 b ±0.79
T_6	3.64 ±0.23	5.61 ±0.14	12.08 b ± 0.14	14.42 bc ± 0.70	14.77 cd ± 0.65	21.39 c ±0.92	2.90 ±0.08	10.26 d ±0.27	13.44 cd ±0.54
T_7	3.39 ±0.14	5.67 ±0.03	13.54 a ± 0.27	17.24 a ±0.37	18.46 a ±0.17	25.66 a ±0.14	2.93 ±0.33	12.16 a ±0.23	16.50 a ±0.22
C.V.(%)	3.31	7.66	2.79	4.28	3.16	2.78	10.61	2.08	3.49

Note: T1 – control; T2 – recommended rate of inorganic fertiliser; T3 – Bio-Forge; T4 – T2 + S (simulate); T5 – T2 + Bio-Forge; T6 – S + Bio-forge; T7 – T2 + S + Bio-Forge; C.V. – Coefficient of variance; ns – not significant; ** – highly significant at $p < 0.01$; means (± SD) with different letters in each column are significantly different at $p < 0.01$ according to the HSD test

Fresh weight

The fresh weight of pechay plants grown in soils with the addition of various fertilisers was greater than in the control. Significantly the highest values were recorded in plants treated with fertiliser in compositions T2, T3, T5 and T7. No statistically significant differences in the fresh weight values, compared to the control were found in plants grown on soils with the addition of T3 and T6 fertiliser modifications (Fig. 4).

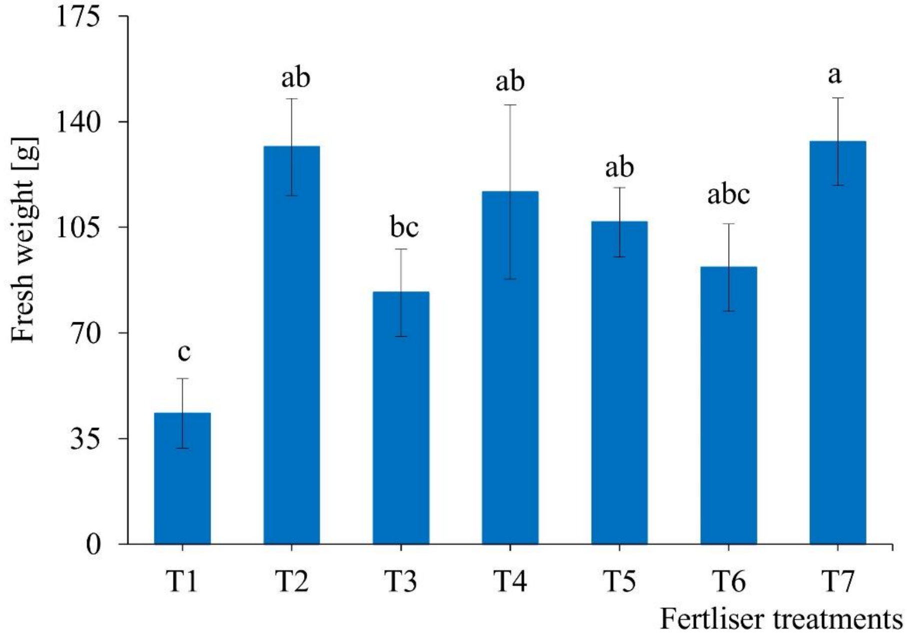

Fig. 4. Fresh weight of pechay (*Brassica rapa* L. var. *chinensis* (L.) Hanelt) after of application various fertilisers: T1 – control; T2 – recommended rate of inorganic fertiliser; T3 – Bio-Forge; T4 – T2 + S (simulate); T5 – T2 + Bio-Forge; T6 – S + Bio-Forge; T7 – T2 + S + Bio-Forge; means (± SD) with different letters are significantly different at $p < 0.01$ according to the HSD test

Yield

Compared to the control, the yield of pechay per plot was the highest in plants treated with fertilisers in the T7 modification (Tab. 3). No statistical differences were observed between control (T1) and T3 and T6 fertilisers. In other cases, each fertiliser had a stimulating effect on the values of this parameter. Similar values and differences were found for the yield per hectare (Tab. 3).

Tab. 3. The yield of pechay (*Brassica rapa* L. var. *chinensis* (L.) Hanelt) after of application various fertilisers

Treatments	Yield / plot [kg / ha]	[%]	Yield / ha [kg / ha]	[%]
T_1	1.83 c ±0.28	100.00	4583.3 c ±721	100.00

T_2	3.50 ab ± 0.50	192.26	8750.0 ab ±1250	190.91
T_3	2.50 bc ±0.66	136.61	6250.0 bc ±1653	136.36
T_4	3.42 ab ±0.38	186.89	8541.7 b ±954	186.37
T_5	3.56 ab ±0.32	194.54	8833.3 ab ±877	192.72
T_6	2.89 bc ±0.16	157.92	7208.3 bc ±401	157.27
T_7	4.50 a ± 0.50	245.90	11458.3 a ± 954	250.00
C.V. (%)	13.22	–	12.75	–

Note: T1 – control; T2 – recommended rate of inorganic fertiliser; T3 – Bio-forge; T4 – T2 + S (simulate); T5 – T2 + Bio-Forge; T6 – S + Bio-Forge; T7 – T2 + S + Bio-Forge; C.V. – Coefficient of variance; ns – not significant; ** – highly significant at $p < 0.01$; means (± SD) with different letters in columns are significantly different at $p < 0.01$ according to the HSD test

Discussion

The fertilisation efficiency depends on many factors. It is related to the quality of the soil (agronomic category, content of humus and nutrients, pH values), the course of the weather during the growing season (amount of precipitation, air temperature) and the type of fertilisers used. Only a regular supply of nutrients is the basis for proper plant growth (Kruczek, 2005). The substances contained in fertilisers improve the absorption of nutrients from the soil, increase resistance to low and high temperatures, strengthen the plants' ability to defend themselves against pests and diseases (Olaniyi, Ojetayo, 2011).

Plants develop properly when grown in fertile and regulated of pH soil. Fertile soil should not only contain a sufficient amount of minerals, but also provide them to the plant in a way that allows stress-free growth and development throughout the growing season. In own research, the content of minerals in the soil was not high, as was the soil pH (Table 1). The acidic reaction of the soil limits the growth and development of plants by adversely affecting the soil structure and the biological activity of its microorganisms. In conditions of low soil pH, humus loses its sticking properties, air-water relations deteriorate and the activity of soil organisms is reduced (Maziarek, Krawczyk, 2015). Therefore, in this study, various combinations of fertilisers were used together with the Bio-Forge fertiliser in order to verify which form had the most beneficial effect on the growth and development of the studied cabbage (*Brassica rapa* L.). Growth parameters monitored at different time intervals confirmed the positive effect of each nutrient mixture. Compared to the control, plants fertilised simultaneously with fertiliser minerals with the addition of plant hormones and Bio-Forge showed the highest values of plant growth, fresh weight, number of developed leaves and, consequently, yield production (Fig. 3, 4; Table 2, 3). The lowest effect of fertiliser mixtures was found after 15 days, compared to the control. With the extension of the treatment time with fertilisers, 30 and 45 days, a significantly positive effect on the growth and development of pechay plants was observed (Fig. 1–4). Most likely, properly selected doses allowed for proper rooting and plant growth, leaf colour and resistance to external factors. The differences in the response of plants to fertilisers depended on the form in which their nutrients were available in the soil (Mozafar et al., 1993). The uptake of certain nutrients depends on the uptake of inorganic nitrogen compounds, as a result of the mutual physiological relationships in the plant's metabolism. The meteorological conditions, mainly thermal ones, have the greatest impact on the effectiveness of fertilisation. They affect the availability of water in the soil and depend on the location of the fertiliser in its layers (Kruczek, Sulewska, 2005).

The use of bio stimulants can be an effective way to reduce the negative impact of environmental stresses on plants and to prevent them (Arif et al., 2006; Ali et al., 2014; Gugała et al., 2017). Bio stimulants increase plant resistance and the effectiveness of traditional soil fertilization (Calvo et al., 2014). They are a component of proteins, the synthesis of which in living organisms requires very large amounts of energy. Providing plants with additional amino acids reduces the energy input necessary for nitrogen absorption. Under unfavourable environmental conditions, plants focus mainly on defence against stress, not on crop production. The effect of bio stimulants on plants is to accelerate and improve the development of leaves and stems and improve their appearance by reducing the deficiency of ingredients. The modern market offers a fairly wide range of products containing amino acids, but not all of them work equally effectively on plants, which is mainly due to their acquisition in the production process (Trawczyński, 2014).

One of the fertilisers available on the market is Bio-Forge, which, as a plant biostimulator, can be one of the many solutions sought in plant cultivation. Its use may increase the efficiency of fertiliser use in the field, along with an increase in plant productivity under abiotic stress conditions (du Jardin, 2015, Colla et al., 2017). Bio-Forge affects the hormonal balance, ensures effective absorption of microelements by plant tissues (Fernandez, Sabay, 2016; Fernandez, Andigan, 2017). It is especially effective when used simultaneously with foliar fertilisers (StollerUSA, 2012). The beneficial effect of Bio-Forge was confirmed by the analyses of pechay growth and development carried out in this experiment. These preliminary studies demonstrated the stimulating effect of this fertiliser not only on plant growth, but also on the yields obtained (Table 3).

In addition to high agricultural production, the main task currently facing agriculture is to protect the environment and natural resources. Proper fertilisation consists in providing plants with nutrients in the right proportions and amounts, enabling them to obtain maximum yields of the desired consumption quality. The unbalanced level of nutrients, as well as the high spatial variability of the content of assimilable nutrients in the soil, prompts the search for new and effective fertilisation technologies that will meet the production, economic and ecological goals.

Conclusion

It was noted in the experiment that [1] the use of Bio-Forge fertiliser had a positive effect on the growth of *Brassica rapa* L. var. *chinensis* (L.) Hanelt. However, the use of Bio-Forge alone has a less stimulating effect than its combination with mineral fertilisers or other stimulants of plant growth and development. [2] Bio-Forge can have a positive effect not only on yield, but also reduce soil contamination. [3] In the studies carried out with the use of various mixtures of fertilisers with the addition of Bio-Forge, the most favourable effect of multi-component fertilisers containing the appropriate proportions of mineral fertilisers, growth stimulants and Bio-Forge was found. This type of fertiliser mixture stimulated plant growth, fresh weight and overall pechay yield to the greatest extent.

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Abstract

The aim of the study was to test the effectiveness of the fertiliser available on the market – Bio-Forge® on the growth and yielding of Chinese cabbage (*Brassica rapa* L. var. *chinensis* (L.) Hanelt). In the experiment, not only the Bio-Forge fertiliser was used, but its action in combination with other fertilisers was tested. T1 – was control group consisted of plots fed with distilled water and precipitation. Group of T2 was consisted of recommended rate (RR) of inorganic NPK fertiliser according to soil analysis used in the experiment. The test of T3 was available on the fertiliser market – Bio-Forge fertiliser. The T4 group consisted of T2 + S (simulate as a yield enhancer which contained a combination of 3 different phytohormones including cytokinin (0.009% / 1L), gibberellic acid (0.005% / 1L), and indole-3-butyric acid (0.005% / 1L). Treatment of T5 was consisted of T2 + Bio-Forge. The treatment 6 – T6 was S + Bio-Forge and T7 = T2 + T6.

Based on the observations, it was found that the Bio-Forge fertiliser alone had a positive effect on the growth and yielding of pechay, but to a lesser extent than in combination with other growth stimulants and mineral fertilisers. Compound fertilisers significantly stimulated plant growth, increased fresh weight and contributed to better yielding.

Key words: Bio-Forge®, *Brassica rapa* var. *chinensis*, growth, yield
Received: [2021.07.05]
Accepted: [2021.10.05]

Bio-Forge wspomaga wzrost i wydajność plonowania kapusty chińskiej (*Brassica rapa* L. var. *chinensi*s (L.) Hanelt)

Streszczenie

Celem pracy było sprawdzenie skuteczności dostępnego na rynku nawozu – Bio-Forge® na wzrost i plonowanie kapusty pekińskiej (*Brassica rapa* L. var. *chinensis* (L.) Hanelt). W doświadczeniu zastosowano nie tylko sam nawóz Bio-Forge, ale zbadano jego działanie w połączeniu z innymi nawozami. T1 – była grupą kontrolną, składającą się z poletek nawadnianych wodą destylowaną i opadami atmosferycznymi. Grupa T2 składała się z poletek podlewanych zalecaną dawką (RR) nieorganicznego nawozu NPK, zgodnie z analizą gleby wykorzystanej w doświadczeniu. Test T3 obejmował dostępny na rynku nawozowym – nawóz Bio-Forge. Grupa T4 składała się z T2 + S (wzmacniacz wydajności, który zawierał kombinację 3 różnych fitohormonów, w tym: cytokininę (0,009% / 1 l), kwas giberelinowy (0,005% / 1 l) i kwas indolo-3-masłowy (0,005% / 1 l). Próba T5 składała się z T2 + Bio-Forge. Próba 6 – T6 to S + Bio-Forge i T7 = T2 + T6.

Na podstawie przeprowadzonych obserwacji stwierdzono, że sam nawóz Bio-Forge wpływał pozytywnie na wzrost i plonowanie kapusty chińskiej, ale w mniejszym stopniu niż w połączeniu z innymi stymulatorami wzrostu oraz nawozami mineralnymi. Nawozy wieloskładnikowe istotnie stymulowały wzrost roślin, przyrost ich świeżej masy, a także przyczyniały się do lepszego plonowania.
Słowa kluczowe: nawóz Bio-Forge®, *Brassica rapa* var. *chinensis*, wzrost, plon

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