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Response of Growth, Yield and Quality of Pakchoy (*Brassica campestrisL.*, Chinensis Group) to Zeolit and Organic Fertilizer Application at Ultisol Jatinangor

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Abstract

This research was aimed to investigate the response of growth, yield and quality of pakchoy plant (Brassica campestris L., Chinensis Group) on zeolit and organic fertilizer application at Ultisol Jatinangor, as well as to find out the dosage of zeolit and organic fertilizer giving the best of growth, yield and quality pakchoy plant result gift zeolit and organic fertilizer at Ultisol Jatinangor. This research was done in May 2010 to June 2010, at green house of Agriculture Faculty, Universitas Padjadjaran, Subdistrict Jatinangor – Regency Sumedang with an altitude of about 700 m above sea level (asl) and soil order is ultisol with the type of climate building on fall of rain including C3 based on Oldeman classification. Experimental design used was Randomized Block Design which consists of ten treatments and three replications. The treatments were as follows: without zeolit and organic fertilizer, 0.75 g/polybag zeolit + 15 g/polybag organic fertilizer, 1.5 g/polybag Zeolit + 15 g/polybag organic fertilizer, 2.25 g/polybag Zeolit + 15 g/polybag organic fertilizer, 0.75 g/polybag Zeolit + 30 g/polybag organic fertilizer, 1.5 g/polybag Zeolit + 30 g/polybag organic fertilizer, 2.25 g/polybag Zeolit + 30 g/ organic fertilizer, 0.75 g/polybag Zeolit + 45 g/polybag organic fertilizer, 1.5 g/polybag Zeolit + 45 g/polybag organic fertilizer, 2.25 g/polybag Zeolit +45 g/polybag organic fertilizer. The research showed that zeolit and organic fertilizer application at Ultisol Jatinangor affected growth and yield . The dosage of 2.25 g/polybag Zeolit + 45 g/polybag organic fertilizer gave the better effect on plant height, leaf wide and yield.

Keywords: pakchoy, zeolit, organic fertilizer, Ultisol, growth, yield, quality

Introduction

Pakchoy is a kind of vegetable crops that require land preparation and intensive maintenance. Difficulties when pakchoy or vegetables grown in the Ultisol soil are bad growth and low production. Barchia Faiz Mohammed (2009) stated that the low productivity of Ultisols soil must be accompanied with a balanced fertilization to get optimum results. It can be seen from the productivity of food crops and vegetables which grown without balanced fertilization on Sitiung ultisol, the growth is not good and productivity is low. The concept of balanced fertilization should be applied based on soil nutrient status and plant nutrient needs.

Ultisols is a kind of soil that forms in humid areas. Ultisol soil has difficulties in terms of physical, chemical, or biological, so this land should not be used for food crops too intensive, in terms it is should not be planted by crops throughout the year, but need to be

interspersed with green manure crops and increasing the cultivation of various types legume plants. To improve Ultisol soil chemical and physical properties which in turn will improve plant productivity, it is necessary to processing soil in a proper way.

The physical properties of Ultisols that are worse can be improved by the addition of organic fertilizers. Organic fertilizers in this study are an organic fertilizer derived from cow manure. The advantages of organic fertilizer is a complete nutrient content, such as macro nutrients (N, P, K) and micro-nutrients like Zn, Cu, Mn, Cl, Mo, Fe,Boron that plants need. In addition, organic fertilizer can increase the content of C-organic in the soil. Organic fertilizer can also react with metal ions to form complex compounds, so that the metal ions poison content can be reduced. The results Rasyda Habli et. al. (2008) stated that the administration of cow manure fertilizer can increase plant height, stover weight (roots, stems and leaves), the amount of fruit, and fruit production in tomato plants.

This research was conducted with the objective of identifying zeolites and organic fertilizer dose that gives the best effect on growth, yield and quality of crops on pakchoy land in Jatinangor.

Material and Methods

The research was conducted at the Greenhouse of Agriculture Faculty, Universitas Padjadjaran, Jatinangor District, Sumedang with altitude 700 m above sea level and type of land is Ultisols with climate types based on rainfall, including C3 classification according to Oldeman. The implementation of the study was held from July to August 2010.

The material used is the seed of the F1 Nauli Pakchoy from PT. East West Seed Indonesia; Ultisols soil taken from Kampung Ciparanje, Cileles Village, Jatinangor District, Sumedang regency, West Java Province; zeolite, organic fertilizer which is cow manure, basal fertilizer which is urea (45% N), SP-36 (30% P_2O_5) and KCl (60% K_2O) and 90 pieces of polybag.The tools were plastic for seeding, the tray for seeding container, scales, buckets, weed retractor, sprinkler or sprayer, termohygrometer, weather cage, digital scales for weighing the weight of the plant, ovens for drying, shovels, scissors, knives, plastic for the harvest , rulers, markers, stationery.

Experimental design used in this experiment was Randomized Block Design which consists of 10 treatments and each repeated 3 times. The treatments were: U0 = Without zeolite and without organic fertilizer, U1 = 0.75 g / polybag zeolite + 15 g / polybag organic fertilize; U2 = 1.5 g / polybag zeolite + 15 g / polybag organic fertilizer; U3 = 2.25 g / polybag zeolite + 15 g / polybag organic fertilizer; U4 = 0.75 g / polybag zeolite + 30 g / polybag organic fertilizer; U5 = 1.5 g / polybag zeolite + 30 g / polybag organic fertilizer; U6 = 2.25 g / polybag zeolite + 30 g / polybag organic fertilizer; U7 = 0.75 g / polybag zeolite + 45 g / polybag organic fertilizer; U8 = 1.5 g / polybag zeolite + 45 g / polybag organic fertilizer; U9 = 2.25 g / polybag zeolite + 45 g / polybag organic fertilizer.

Land used as a planting medium in this experiment is Ultisols soil from Jatinangor. Soil taken as a composite from the topsoil to 20 cm depth, then dried to air dry condition, then crushed and sieved soil with a diameter of 5 mm sieve. Further soil weighed 6 kg per polybag with size 25cm x 30cm. Add zeolites and organic fertilizer adjusted with each treatment and stirred with a flat, then doused with water until field capacity reached 750 ml.

Pakchoy seeds after a minimum two pieces of leaves (14-20 days old) were transferred from seed medium into the polybag nursery that has been in incubated with zeolite and organic fertilizer according to the treatment. Planted seeds that are moved are selected based on the best growth. Plant maintenance activities during the experiment including fertilizing, watering, weeding and pest control. Fertilization using urea with a dose of 0.3 g / polybag, SP-36 with a dose of 0.45 g / polybag and KCl 0.225 g / polybag. SP-36 and all of KCl given at the time of planting, while urea is given twice, half at 3 Weeks After Planting (WAP) and the other half at 5 WAP.

Harvest implementation is when the crop harvest was 7 WAP. The characteristics of crops when ready for pakchoy harvest are large, dark green and shiny. The harvested parts are all part of plants above ground by cutting the base of the stem. Pakchoy that has been harvested were placed in plastic containers and stored in the shade. The results then weighed and washed.

Observations were divided into : height , number of leaves , Leaf area , yield (g / plant) at harvest (7 WAP), dry weight (g / plant) was measured at harvest (7 WAP). The quality of the results at harvest (7 WAP) by sorting to separate the plants which are not markets viable and market viable crop. Crops that worth for the market will be marked by grading (eligible and non eligible market criteria, and the weight percentage of grade A and grade B)

Results and Discussion

Response from giving zeolite and organic fertilizer for the growth of pakchoy in each treatment showed a significantly different effect due to the capacity of zeolites and organic fertilizer to improve soil acidity, increase soil CEC and soil organic C.

This resulted from the content of zeolite which consisting of alkali and alkaline earth bases such as K^+, Na^+, Ca^{2+} and Mg^{2+}, the presence of alkali content in the zeolite can replace the H^+ in the sorption complex, thereby increasing soil pH. Increasing soil pH can affect the value of CEC (Ministry of Agriculture, 2001). Increasing CEC caused by the addition of zeolite make nutrients become available and the plant consumption would be more efficient, thus affecting plant growth.

Provision of organic fertilizer on Ultisol soil can increase soil organic C-. Hanafiah (2005) states that the decomposition of organic fertilizer in the form of CO_2, CO_3^{2-}, HCO_3^-, and C can increase the content of organic C in soil and therefore contributes to plant growth.

Plant height

Data and statistical analysis pakchoy plant height (Table 1) showed no significant different effects at the age of 4 WAP. This is assumed because the plants are adapted to environments of high-temperature greenhouse. According to Poerwowidodo (1993) , the elongation of plant stem will be maximal at low light intensity. Adaptation to high greenhouse temperatures cause the growth of plant height at age 4 WAP will not increased. But at age 5 to 7 WAP, the plants have started to adapt better to the environment. At age 5 WAP, the treatment of U2, U4 and U9 gives a higher yield than other treatments, then at age 6 WAP, the treatment of U6 gives a higher yield than other treatments and at the age of 7 WAP , the treatment of U9 gives a higher yield than other treatments.

Table1. Effect of Zeolite and Organic Fertilizer on Pakchoy Plant Height at 3 WAP–7 WAP

Treatment	3 WAP (cm/plant)		4 WAP (cm/plant)		5 WAP (cm/plant)		6 WAP (cm/plant)		7 WAP (cm/plant)	
U_0	10.54	ab	14.44	a	18.44	cd	20.61	bcd	22.43	abc
U_1	9.11	a	13.53	a	16.11	ab	19.16	ab	21.83	ab
U_2	11.25	b	15.33	a	19.05	d	21.22	bcd	23.10	bcd
U_3	8.94	a	13.08	a	15.53	a	19.50	abc	21.37	a
U_4	10.51	ab	14.88	a	18.83	d	21.26	bcd	23.52	cde
U_5	11.33	b	14.50	a	18.50	cd	21.47	cd	23.42	cde
U_6	10.42	ab	14.55	a	18.33	cd	21.92	d	23.34	cd
U_7	9.88	ab	13.28	a	16.40	abc	20.16	abcd	21.64	a
U_8	11.26	b	14.88	a	18.11	bcd	18.11	a	24.17	de
U_9	11.13	b	14.94	a	20.11	d	20.11	abcd	24.83	e

Note: The figures marked with the same letter in each column which are not significantly different according to Duncan's Multiple Range Test on a real level of 5%.;

WAP : Week After Planting

Organic fertilizers are manure that contains a complete macro nutrients for instance N, P and K, where N nutrients has an active role in plant height increment. At the beginning of the experiment the N content in the soil is in low condition, so the presence of a high content of N in organic manure fertilizers were considered sufficient to supply the nutrients needed for growth of plant height.

Number of leaves

Data and statistical analysis based on pakchoy number of plant's leaves (Table 2) at all observation time showed a significantly different effect. At the age of 3 WAP with U9 treatment gives a higher yield than other treatments. At age 4 and 5 WAP with the treatment of U0, U2, U4, U5, U6, U8 and U9 gives a higher yield than other treatments. U0 providehigher yields as well as in the experiments conducted, U0 still using basic fertilizers (Urea, SP-36, KCl) so that the nutrients available to plants and crops grow well. Treatment of U1, U3, and U7 are not always indicate a higher yield because the slower growth. According to Sitompul and Guritno (1995), when the spacing is short enough (population meeting), it would reduce the opportunity for plants to grow more uniform because the plants that grow more slowly will experience get more pressure quickly fromthe plants that grow faster. Plants that have larger leaves at the beginning of the growth will grow faster, because the ability to fotosintesize higher than plants with smaller leaf area (Gardner *et al.*, 1991). At the age of 6 WAP it is known that the U8 treatment gives a higher results than other treatments. At age 7 WAP it is known that the U8 treatment gives a higher results than other treatments.

On plant growth against the number of leaves, macro nutrients from the cow organic fertilizers that play an active role is the nutrient P. Element of P has a very important function. It is involved in the process of photosynthesis and respiration of plants. To get the increasing number of leaves better, the process of photosynthesis should be made more efficient. This may be done by providing the necessary nutrients in proper portions. At the beginning of the experiment P content in the soil is in a state of very low, so the presence of

high P content of cow manure on organic fertilizers were considered sufficient to supply the P nutrients needed for growth of number of leaves.

Table 2. Effect of Zeolite and organic fertilizer to the Number of Pakchoy Leaves at 3 WAP-7 WAP

Treatment	3 WAP		4 WAP		5 WAP		6 WAP		7 WAP	
U_0	6.44	c	10.00	b	13.55	b	16.00	bcde	18.77	cd
U_1	5.77	a	8.55	a	10.11	a	14.66	a	17.00	a
U_2	6.55	cd	10.44	b	13.77	b	15.33	abcd	19.66	cdef
U_3	5.77	a	8.33	a	10.55	a	14.88	ab	17.22	ab
U_4	6.88	de	10.22	b	13.22	b	16.33	cdef	19.55	cdef
U_5	6.66	cde	9.77	b	13.55	b	16.00	bcde	19.22	cde
U_6	6.44	c	10.22	b	13.22	b	16.66	ef	20.66	ef
U_7	6.11	b	8.33	a	10.88	a	15.11	abc	17.44	bc
U_8	6.77	cde	10.22	b	13.77	b	17.55	f	21.00	f
U_9	7.00	e	10.44	b	14.00	b	16.44	def	20.11	def

Note: The figures marked with the same letter in each column are not significantly different according to Duncan's Multiple range test on a real level 5%;

Leaf area

Data and statistical analysis of organic fertilizers and zeolite influenceson pakchoy plant leaf area (Table 3) shows that the treatment of U2, U5, U6 and U9 gives a higher results than other treatments.

Table 3. Effect of Zeolite and Organic fertilizer on Pakchoy Leaf area, Yield Root Dry Weight and Leaf Dry Weight on 7 WAP.

Treatment	Leaf Area (cm^2/plant)		Yield (g/plant)		Root dry weight (g/plant)	Leaf dry weight (g/plant)
U_0	568.14	ab	58.08	ab	0.18 a	2.38 a
U_1	416.21	a	38.81	a	0.14 a	1.94 a
U_2	909.03	c	70.37	bc	0.19 a	2.29 a
U_3	514.52	a	40.98	a	0.15 a	2.09 a
U_4	827.32	bc	75.76	bc	0.23 a	1.54 a
U_5	928.18	c	73.33	bc	0.21 a	1.57 a
U_6	926.90	c	75.96	bc	0.22 a	2.05 a
U_7	522.18	a	52.90	ab	0.20 a	2.05 a
U_8	840.08	bc	73.87	bc	0.22 a	2.03 a
U_9	1016.28	c	84.12	c	0.24 a	2.44 a

Note: The figures marked with the same letter in each column are not significantly different according to Duncan's Multiple range test on a real level of 5%.;

Nutrients from organic manure fertilizers that contribute actively to the leaf area is nutrient N and K. According to Poerwowidodo (1993), if the supply of N is quite enough, the leaves of the plants will grow and expand the surface which available for photosynthesis. Winarso (2005) claimed that K nutrient deficiency symptoms indicated by the signs of burning leaves

starting from the tip or edge. This shows that the K nutrient-deficient plants has a small leaf area.It can bee seen from U1 treatment which leaves look the smallest.

The treatment of U1, U3, and U7 were experiencing slow growth of etiolation. Etiolation is the movement of the stem to grow towards the light direction. According to Leopold and Kriedeman (1981), the shade will cause the disruption of root growth, leaf and flower buds due to low radiation. Plants that grow in the shade will receive the lower light intensity. Low intensity of sunlight that causes the decrease in the rate of photosynthesis. According to Salisbury and Ross (1995), decreased light intensity causes the rate of photosynthesis decreases. Decrease in the intensity of light causes the rate of photosynthesis is also decreased, which in turn causes small leaf area.

Yield

Data and statistical analysis of the organic fertilizers and zeolite on pakchoy (Table 3) shows that treatment of U9 gives a higher results than other treatments. This is because the nutrients from organic fertilizers which active against the crop is N, P and K. Winarso (2005) claimed that N nutrient contributing to the plant height, P cotribute to the number of leaves and K are closely related to plant metabolism that occur inside the plant. K is a very vital nutrients in the process of photosynthesis. If K deficiency happen, the process of photosynthesis will decrease, but the respiration of plants will increase. It will cause a lot of carbohydrates present in plant tissue used to obtain energy for some activities, therefore the formation of plant parts will be reduced and cause reduced the grwoth or crop production.

According to the results and quality of crops, the use of greenhouse improve crop results and better quality than the open fields. This is because the greenhouses create more conditions for pest and disease attack rates are lower than the open land. The intensity of the attack are larger on the open land because the land is open with no protection, causing the pests easily attack. The intensity of pest attack in the open land is 5.25% per ha (Ferry Firmansyah, 2010) while the intensity of the attack of pests in greenhouses is about 2:19% per ha.

Dry weight of roots and leaves

Measuring the dry weight of roots and leaves is done by measuring the weight of the roots and leaves of the plants that had previously beeen measured in the oven for 48 hours at a temperature of 60^0C. Data and statistical analysis for the dry weight of pakchoy roots and leaves (Table 3) note that the influence of zeolite and organic fertilizers on the dry weight of roots and leaves showed no significantly different effect.

Giving zeolites and organic fertilizers do not provide a significantly different effect on root's dry weight, presumably because the nutrients and water that needed by plants could be taken from the land itself. The availability of water and nutrients are important factors that affect the growth of plant root. Growth of plant roots is affected by the absorption of ions that plants need, so we can get larger root surface area and greater distribution to the expansion of roots (Salisbury and Ross, 1995). In addition, the increase in microclimate temperature around the plants will lead to rapid loss of soil moisture content. The role of soil moisture on growth is through its effect on soil microorganisms that play a role in processing many microorganisms that are more likely absorbed by the soil rooting (Poerwowidodo, 1993).

Dry weight is one parameter which directly reflects the efficiency of physiological processes of interaction with the environment, or in other words the total dry weight of plants is the manifestation of all the processes that occur in plant growth. Pakchoy is a class of C3 plants which have low light compensation point due to high photorespiration. High light intensity which resulted in the air around the plants become taller, so the transpiration is greater than the uptake from the soil that can cause leaf damage directly caused by thermal energy (Dwidjoseputro, 1996).

Dry weight is closely connected with the process of photosynthesis. On leaf vegetable crops, about 10% of the plant body consists of carbohydrates which resulted from the process of photosynthesis. Carbohydrate stored in most plants is starch, which accumulated in chloroplasts, where it carves directly from photosynthesis. The intensity of sunlight that makes the process of photosynthesis is higher resulting in higher carbohydrates. However, the high temperature causes a high carbohydrate us. The respiration process break down carbohydrates into CO2 and water. Therefore, the greenhouse environment does not provide a significantly different effect on the percentage of leaf dry weight.

Percentage weight of the Eligible Market and Non Eligible Market, The weight percentage of grade A and B

Table 4 shows that the weight percentage of the market feasible and not feasible one showed no significantly different effect. In other words, treatment does not give effect to the weight percentage of the market feasible and the market that not feasible. But the environmental greenhouse temperature thought to cause low yield and quality. The experimental results of Fery Firmansyah (2010) states that treatment without shade had no effect on the weight of Eligible Market and Non Eligible Market, but the effect on the percentage of the eligible and non eligible market.

Determination of viable market crops and not worth is done by sorting, separating between worthy and unworthy market. Besides the intensity of pest attack in the greenhouse which is 30% is one of the determinants of doing sorting. The more leaves that are attacked by pests, the more plants into the market are not feasible.

Table 4. Effect of Zeolite and organic fertilizer on the percentage of Eligible Market Weights Yield and Non-Eligible Market, Grade A and Grade B on 7 WAP

Treatment	Weight of Eligible Market Yield (%)	Weight of Non Eligible Market Yield (%)	Grade A (%)	Grade B (%)
U_0	57.48 a	42.52 a	42.31 a	57.69 a
U_1	56.15 a	43.85 a	53.62 a	46.38 a
U_2	79.73 a	20.27 a	45.40 a	54.60 a
U_3	60.85 a	39.15 a	86.86 a	13.14 a
U_4	80.34 a	19.66 a	58.86 a	41.14 a
U_5	80.31 a	19.69 a	83.04 a	16.96 a
U_6	93.58 a	6.42 a	83.07 a	16.93 a
U_7	49.80 a	50.20 a	50.00 a	50.00 a
U_8	79.51 a	20.49 a	75.32 a	24.68 a
U_9	92.22 a	7.78 a	75.60 a	24.40 a

Note: The figures marked with the same letter in each column are not significantly different according to Duncan's Multiple range test on a real level 5%;

After sorting the market feasible crop and the market which is not feasible, we conducted market viable crop grading or classification for the quality of the results by determining the weight of the results that meet the quality criteria of A and B in each treatment. Table 4 shows that the weight percentage of grade A and B showed no significantly different effect. Knowing that the treatment does not give effect to the weight percentage of grade A and B but it will influence the weight percentage of crops which market worth. Weight percentage of the crop that market viable does not show a different effect. Therefore, the weight percentage of grade A and B also showed no noticeable difference.

Conclusion

Based on this research, it can be concluded that the granting of zeolites and organic fertilizer to the soil of Jatinangor Ultisols with a dose of 2.25 g / polybag Zeolite + 45 g / polybag organic fertilizer gives the best effect on plant height, leaf area, and the results of Pakchoy plants while the dose of 1.5 g / polybag Zeolite + 45 g / polybag organic fertilizer gives the best effect on the number of leaves.

References

AVRDC. 1998. Estimate of sample size for leafy vegetable trials in the hot-wet season. Annual Report Asian Vegetable Research and Development Centre 1998. AVRDC Publication: Taiwan.

Barchia Faiz Muhammad. 2009. Balanced Fertilization. http://faizbarchia.blogspot.com/2009/06/pemupukan-berimbang.html (accessed on May 3, 2010).

Department of Agriculture. 2001. Zeolite For Agriculture. Agriculture Information Sheet No. 15 Series: Plants Pangan/PAAPT/2001/djs Agdex: 530. West Java.

Dwijoseputro. 1996. Introduction to Plant Physiology. Scholastic: New York

Ferry Firmansyah. 2010. Effect of Age planting Seeds and Plant Population and Quality of Vegetables On The Pak choi Planted In the Plain Gauze Shade Medium. Department of Agriculture Faculty of Agriculture, Universitas Padjadjaran. (Unpublished).

Foth, D. H. 1995. Basis - the basis of Soil Science. Translation By Endang Purbayanti, Dwi Retno Lukiwati and Rahayuning Trimulastih. Gadjah Mada University Press. Yogyakarta.

Hanum Chairani. 2008. Cultivation Techniques Volume 2 For vocational school. P. 209-219.http://download-book.net/BUDIDAYA-PAK-CHOY-pdf-2.html (accessed on April 28, 2010).

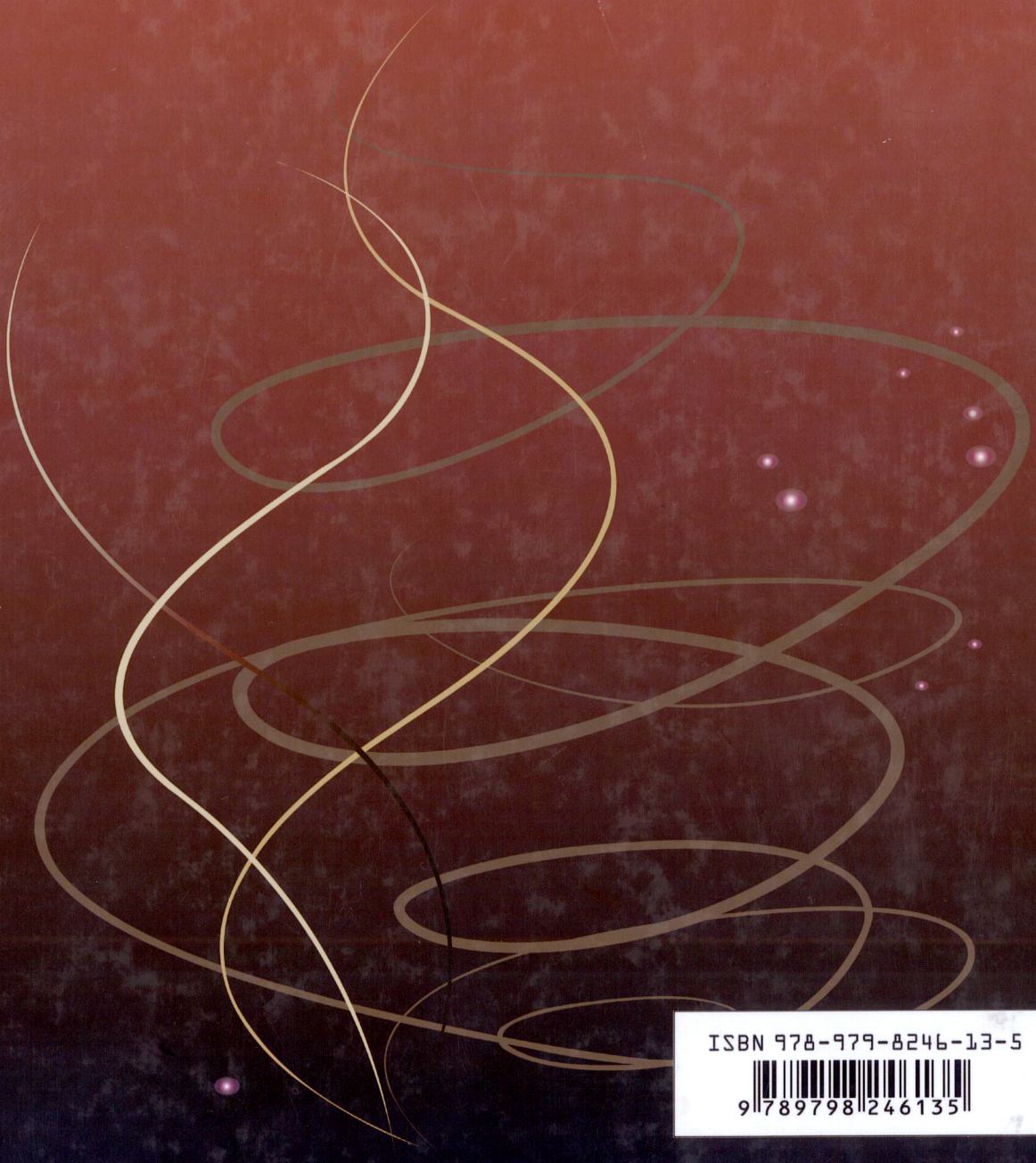
Hidayat, S. E. 1990. Effect of Activation Method of Zeolites on Some Soil Chemical Properties Three Types of Growth and Yield of Soybean (Glycine max (L.) Merr.). Faculty of Agriculture, Universitas Padjadjaran.

Lenny Estiaty. 2006. Effect of Zeolite on Growing Media. Research Center for Geotechnology. Indonesian Institute of Sciences. http://www.geotek.lipi.go.id (accessed April 29, 2010).

Lenny Estiaty. 2008. Natural Zeolite Rocks. Available online at: http://www.toekangkebon.com (accessed May 3, 2010).

Leopold, A.A., P. E. Kriederman. 1981. Plant Growth and Development. Tata-Mc Graw-Hill Pub I. Co. Ltd. New York. 531 p.

Poerwiwidodo, M. 1993. Study of Soil Fertility. Space. Bandung



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