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Chromolaena odorata Compost Affected Soil Chemical and Rice Crop (*Oryza sativa* L.)

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Abstract

The study entitled "*Chromolaena odorata* Compost Affected Soil Chemical and Rice Crop (*Oryza sativa* L.) had been conducted in Padang City, West Sumatra. It was started in February 2015 to May 2015. The study aimed was to examine the mechanism of amendment soil chemical properties and nutrient uptake of rice crop was fertilized By *Chromolaena odorata* Compost. The experiment was conducted by using Randomized Complete Design (RCD) in Split Plot Design with the main plots were three varieties of rice crops namely; Cisokan (V1); Pandan Wangi (V2) and Red Cempo (V3). The subplot consisted three types of fertilizer composition; 5 Mg ha^{-1} Compost *C. odorata* (CCP) +100% Artificial Fertilizer Recommendation (AFR) (F1); 7.5 Mg ha^{-1} CCP+75% AFR (F2); 10 Mg ha^{-1} CCP +50% AFR (F3), with three replications. Data was analysed by using the F test significance level of 5%, and an Honestly Significant Difference test (HSD) α 5%. Parameters include analysis of soil chemical properties, manure, analysis of nutrient uptake and the weight of dry crop biomass. The study indicated there was amendment in soil chemical properties after the application of *C. odorata*, compost achieving optimal fertility for rice crop. Nitrogen and other minerals uptake in rice crop increased due to the increased provision of artificial fertilizers escorted by lowering the dose of *C.odorata* compost. The ability about the nutrient uptake of rice crop is higher in rice Pandan Wangi and causes the higher forage yield than rice Cisokan or Red Cempo.

Keywords: *Chromolaen odorata* compost; Rice cisokan; Pandan wangil; Red Cempo

Introduction

Chromolaena odorata plant or *C. odorata* is known as a shrub. However, its potential as natural forage cannot be utilized by livestock. This is caused by the high polyphenol ingredients that makes animal reluctant to eat it. This potential is ultimately developed to make *C. odorata* as a raw material to be used as compost. It is proved that *C. odorata* contains a quite high N and K, which is 2% higher at the upper forage [1]. These plants are able to thrive even on marginal land and were able to beat the growth and development of the reeds. It is also proved that compost application by using *C. odorata* has a good influence on rice crops grown on land contaminated by mine waste cement [2]. In other writing, it has been reported that the corn plants grow very well on marginal land by compost Kronobio containing *C. odorata* [3].

It is important to know the mechanism of chemical changes in nature and the pattern of nutrient uptake in rice crops which is fertilized by compost *C. odorata*. In other report, stated that compost application by using *C. odorata* can reduce the use of artificial fertilizer on the crop nutrient but it was suspected that nutrient needs of each type of plant will be different and is largely determined by the plant species [4]. Besides, it is important to know the ability of compost *C. odorata* in pressing the need for artificial fertilizer by rice crops with various species.

Rice crop is growing in Indonesia because the crop is the main source provider of food needs in Indonesia. A plant that will produce rice is largely determined by the initial growth of plants which is good and healthy. If plants grow molt, then certainly rice yields will decline, as well as if the plants thrive, then the rice yields will raise. The average rice production in Indonesia in 2013 was around 5.15 tons ha^{-1} and 2015 reached 5.34 tons ha^{-1} [5]. These results still do not meet the needs of rice in Indonesia. Therefore the most important effort is to grow rice crops in conditions of optimum soil fertility. Another issue is that all rice fields in Indonesia, especially in West Sumatra are classified as having a low to moderate fertility. Application of fertilizer which is not maximum will reduce rice yield. Therefore, this study was conducted to determine the mechanism of changes in soil chemical properties and nutrient transport of some types of rice crops by composting *C.odorata* accompanied by the provision of artificial fertilizer.

Materials and Methods

Research was conducted on the Sungai Lareh in Lubuk Minturun Padang from February to May 2015 in Ultisol soil type. The location is in the rice field with 22 m height above sea level. The experiment was conducted by using Randomized Complete Design (RCD) in Split Plot Design with the main plots were three varieties of rice crops namely; Cisokan (V1); Pandan Wangi (V2) and Red Cempo (V3). The sub plot consisted three types of fertilizer composition; 5 Mg ha^{-1} Compost *C. odorata* (CCP)+100% Artificial Fertilizer Recommendation (AFR) (F1); 7.5 Mg ha^{-1} CCP+75% AFR; F3. 10 Mg ha^{-1} CCP+50% AFR (F2), with three replications. Data was analyzed by using the F test significance level of 5%, and an Honestly Significant Difference test (HSD) α 5%, and three replications. Artificial fertilizer recommended was; 100 kg ha^{-1} urea, 50 kg ha^{-1} ZA, 150 kg ha^{-1} SP36 and 100 kg ha^{-1}

KCl. The parameters observed; analysis of soil chemical properties before and after the experiment, the nutrient content of the *C. odorata* compost. Then tabulated soil chemical analysis determined under the provisions of the [6]. Analysis of nutrient transport of N, P, ash material, C/N and the weight of plant dry stover age 45 HST. The plant's analysis was analyzed statistically. Data was analyzed by using the F test significance level of 5%. If the treatment has a real effect, an Honestly Significant Difference (HSD) 5% significance level test was conducted [7].

In implementation stage, water went to the rice field, and paddy soil was processed by using plougher and hand tractor then after one week soil was mashed up into the mud. After one week of siltation, plots for the experiment were created measuring 2 × 4 m and 5 × 25 cm for spacing. The number of test plots by treatment was as many as 27 pieces of the plot. Around the plot, drainage ditches were created in order to control flooding. The location of a seedling is close to the experimental garden by covering the soil with plastic sacks for about 5 cm below the seedling media. Media seedlings are a land of mud and *C. odorata* compost made with a ratio of 1: 10, soil and compost.

Label treatment was installed according to predefined initial plan, which has been randomized. After 2 weeks in the seedling area, then each variety of rice seedlings was planted in locations that have been defined from the beginning. The depth of planting is only 2 cm with an upright plant and root shape of the letter L. *Chromolaena odorata* compost was given when transplanting seedlings into the ground. One week after planting, the rice seedlings were given artificial fertilizer N, P, K based on the treatment. Rice is harvested after 45 days.

Determination of the chemical analysis of soil and plants is conducted according to the instructions [8]. Determination of N-total by the Kjeldahl method, by way of sample digestion, using concentrated H_2SO_4 with selenium catalyst mixture to form $NH_4(SO_4)_2$. NH_4 levels in the extract were determined by distillation. Determination of pH is done by using a pH electrode, with the procedure soil and water ratio of 1: 5.

Measurement of P, K, Ca done by means of a wet ashing. 0.5 g sample is inserted into the tube digest, add 5 ml of nitric acid and 0.5 ml p.a perchlorate acid pa then allowed to stand for one night. Further heated to a temperature of 100°C, for 1.5 h, and then the temperature is increased slowly to be 200°C, with the characteristics formation colour changes to white smoke. The extract was diluted with deionized water. It could then be measured P, K, and Ca. Determination of P using a spectrophotometer, a wavelength of 889 nm, while the measurement of K and Ca using AA Spectrophotometer (WFX-320).

Determination of organic-C as follows; 0.5 g sample put into a 100 ml flask was added 5 ml of 1N K-bichromate, shaken then ditambahkan 7.5 mL of concentrated sulfuric acid. Measurement is by using a spectrophotometer (Genesys 10 uV). Assay of C-organic (%)=ppm curve × ml extract/1000 ml × 100/mg sample × factor correction curve=ppm × 10/500 × factor correction. Determination of ash content is done by using the method of ashing at a temperature of 550-600°C, so organic material into CO_2 and metals into metal oxides. The weight of the missing ingredient is an organic material that can be converted into organic-C levels after multiplied by a factor of 0.58.

Results and Discussion

Chromolaena odorata Compost contains nutrients that are presented in Table 1. In general, nutrient and chemical properties of compost *C. odorata* already comply with the provisions of the Agriculture (2011). The minimum technical requirements C/N of organic fertilizer range from 12-25 [6].

S. No.	Soil chemical properties	Chemical products of bio-organic fertilizer			The minimum technical requirements of solid organic fertilizers*
		Sample 1	Sample 2	Mean	
1	pH	7,58	8,57	8,08	>4–8<
2	N-total (%)	1,44	2,14	1,77	Requirement listed
3	P-total (%)	1,88	2,21	2,06	-
4	P2O5 (%)	nm	nm	4,71	Requirement listed
5	C-organic (%)	11,4	26,65	19,03	>15
6	Ca (%)	1,19	nm	1.19	-
7	K (%)	1,19	1,55	1,37	-
8	K2O (%)	nm	nm	1,65	Requirement listed
9	C/N	7,94	12,48	20,83	Dec-25
Data obtained from the analysis of samples at the soil laboratory in Agricultural Faculty of Andalas University, Padang.					
Note: nm=Not measured; *Based on defined criteria in Technical Guidelines for Chemical Analysis book, Soil, Plant and Fertilizer [6].					

Table 1: Nutrient content of 50% origin *Chromolaena odorata*+50% manure.

The content of organic C is quite high, indicating that the material meets the quality as organic fertilizer. In general, organic fertilizers such as *C. odorata* compost contain N, P, and K which were low compared to artificial fertilizer. It has also been described that *C. odorata* compost has the high content of organic C which can increase the level of soil organic matter [4,9,10]. Increased soil organic matter will improve the soil cation exchange capability, due to increased soil organic colloids. Soil organic colloids can be either humic or other organic compounds. The increasing of organic colloids will extend the area of nutrients absorption in the soil. It can decrease the loss of nutrients due to leaching that takes place in the soil. It has been described that humic acid has a negative surface originating from the dissociation of carboxylate groups and its phenolate [11,12]. The negative charge on the organic colloids is also strongly influenced by soil pH. Nutrients that are bound to complex sorption will be available when the plants need it through a cation exchange mechanism, mass flow, and roots diffusion.

Analysis of soil chemical properties was conducted before and after the provision of fertilizer. The chemical analysis concerns the nature of the soil pH, K-dd (Cmol.kg^{-1}). Amendment in soil chemical properties is presented in Table 2.

Effect of Organic Fertilizer	Pandan Wangi	Ciso-kan	Red Cempo	Pandan Wangi	Ciso-kan	Red Cempo
	pH			K-dd (Cmol.kg^{-1})		
5 t ha^{-1} Chromolaena odorata compost +100% artificial fertilizer (F1)	4,62 a	4,80 a	5,03 m	0,839 h	0,723 h	0,638 h
7,5 t ha^{-1} Chromolaena odorata compost +75% artificial fertilizer (F2)	4,21 va	4,65 a	4,96 a	0,848 h	0,821 h	1,114 vh
10 t ha^{-1} Chromolaena odorata compost +50% artificial fertilizer (F3)	4,60 a	4,64 a	4,82 a	0,930 h	0,819 h	1,326 vh
Preliminary analysis	5,23 a			1,263 vh		
Criteria for soil chemical properties	pH<4,5 (very acid); 4,5-5,5 (acid); 5,6-6,5 (moderate)					
	K-exc; 0,6- 1,0 (high); >1,0 (very high)					

Table 2: Effect of organic and artificial fertilizers to changes in pH and K-dd paddy field at harvest time in three varieties of rice crops.

Table 2 demonstrates that, in general land planted with paddy rice having a pH ranging from very acid to acid. The more doses of *C. odorata* compost, the more acidic the soil. If the soil is not cultivated, the pH is generally higher than the planted one. In general, the content of K-dd is ranging from high to very high.

Treatment also proved that the higher the dose of *C. odorata* compost given, the higher the content of exchangeable Potassium in the soil. It seems that the effect of KCl fertilizer given along with *C. odorata* composts is unclear. This is presumably almost all artificial fertilizers have been absorbed by the plant, fixed by clay minerals, and likely to drift along with irrigation water. It is described that potassium element have the nature of soluble and easily washed away and fixed in the ground [12]. It is also stated that washing in wetlands such as paddy fields, limited potassium available and creates potash fertilizer demand as many as the desired crops [13,14].

P-available and organic C of soil is also influenced by fertilization (Table 3). P-provided in soil generally increased, if the organic manure is given higher, the levels of P-available and the organic C are high significantly.

Effect of organic fertilizer	PW	C	CM	PW	C	CM
	P-available (ppm)			C-organic (%)		
5 t ha^{-1} Chromolaena odorata compost +100% artificial fertilizer (F1)	11,19 m	36,6 vh	8,96 m	3,08 h	2,50 m	4,30 h
7,5 t ha^{-1} Chromolaena odorata compost+75% artificial fertilizer (F2)	8,85 l	10,53 m	16,69 m	3,16 h	3,60 h	4,62 h
10 t ha^{-1} kompos Chromolaena odorata compost+50% artificial fertilizer (F3)	9,29 m	12,38 m	20,62 h	3,90 h	3,70 h	4,80 h
Preliminary analysis	7,18 l			3,70 h		
Criteria of Soil chemical properties	P-available; 4,9-8,8 (low); 9,2-17,5 (moderate); 17,9-26,2 (high); >26,2 (very high); C-organic; 2,01- 3 (moderate); 3,01-5 (high).					
Remarks on table: PW (Pandan Wangi), C (Cisokan) and CM (Red Cempo)						

Table 3: P-available and organic C in soil rice field during harvest rice crops.

The content of P-available in a soil which is not given organic fertilizers and artificial fertilizers are generally low. Meanwhile, P-available in the soil which is given organic fertilizers increased to moderate and high levels even though some are also at low level. Phosphorus element available increased due to organic manure applied to the soil which is able to increase the CEC so that the metals that

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absorb P ions will be fixed by a carboxylate group and a phenolic form organo-metallic complex sorption complex or chelate forming. P-ionic drawn by metal causes the solubility of P increased. Metals that fixes a lot of P-ion in paddy soil is Fe ion. When viewed from the physical characteristics of the fields in the study site, a high content of soluble Fe was found. Therefore it is very important to give the organic fertilizer to the fields, where rice cultivation is done by SRI. P, soluble ionic forms are available in the low acidity such as $H_2PO_4^-$ and HPO_4^{2-}. Both of these ions forms are very easily absorbed by plants [13]. Organic Carbon content of the soil is generally quite high, although the organic matter has not been given. This suggests that naturally paddy soil organic matter is high. This can be caused by the rice fields that are used always mixed waste rice straw when soil tillage. The total soil N content is classified moderate, it is because the element N is a key element needed by the rice plant during its growth phase. When compared with the results of preliminary soil analysis, the application of *C. odorata* compost and artificial fertilizers was able to increase total soil N content. The C/N generally declines in soil that has been planted rice compared to C/N of initial soil. This proves the existence of the rice crop increases the reform process of organic matter in the soil (Table 4).

Effect of Organic Fertilizer	PW	C	RC	PW	C	RC
	N-total (%)			C/N		
5 t ha^{-1} Chromolaena odorata compost +100% artificial fertilizer (F1)	0,24 m	0,21 m	0,34 m	12,32 m	10,00 l	12,65 m
7,5 t ha^{-1} Chromolaena odorata compost+75% artificial fertilizer (F2)	0,26 m	0,23 m	0,46 m	12,15 m	15,65 m	10,11 l
10 t ha^{-1} Chromolaena odorata compost+50% artificial fertilizer (F3)	0,25 m	0,25 m	0,26 m	15,60 h	14,80 h	18,46 h
Preliminary analysis	0,17 l			21,76 h		
Criteria of soil chemical properties	N-total (%); 0,1-0,2 (low); 0,21-0,5 (moderate);					
	C/N; 5-10 (low); 11–15 (moderate); 16-25 (high)					
Remarks on table: PW (Pandan Wangi), C (Cisokan) and RC (Red Cempo)						

Table 4: Levels of N-total and C/N in soil at physiological age.

There are no significant changes in soil because of the application of varied fertilizer. The value of C/N soil generally is also varied so that there is an effect toward the value of C/N soil. The high value of C/N soil indicates that soil contains a lot of organic matter and vice versa. The value of C/N soil is ranging from 12. From C/N initial value it can be seen that land which has been planted has lower C/N value [13]. It indicates that the content of organic matter in the land which has been planted will decrease because of decomposition of organic matter physically, chemically and biologically. Decomposition of organic matter because of the existence of plant tends to happen chemically and biologically. The transportation of N and C/N value of the rice crops which is given *C. odorata* compost and artificial fertilizers are presented in Table 5. The highest N transportation carried by Cisokan rice crops, followed by Pandan Wangi rice, and the lowest is Red Cempo rice. In general, the provision of *C. odorata* compost which is in the lower level along with high level of N causing increased N transport of the crop, except Pandan Wangi rice.

Effect of organic fertilizer application	Cisokan	Pandan Wangi	Red Cempo	Cisokan	Pandan Wangi	Red Cempo
	Kg N ha^{-1}			C/N		
5 t ha^{-1} Chromolaena odorata compost +100% artificial fertilizer (F1)	44,20 a	34,49 b	19,54 a	21,93	31,70	24,49
7,5 t ha^{-1} Chromolaena odorata compost +75% artificial fertilizer (F2)	40,78 b	33,19 b	21,71 a	20,26	29,94	17,35
10 t ha^{-1} Chromolaena odorata compost +50% artificial fertilizer (F3)	39,07 b	52,43 a	16,42 b	21,27	26,61	17,67
Average	41,48 A	39,58 A	19,173 B	21,13 B	29,23 C	19,77 A
Numbers followed by the same small letter in the same column, and numbers followed by the same capital letter in the same line are not different significantly according to HSD test 5% significance level						

Table 5: Effect of organic fertilizer application toward N transport and C/N value of 3 varieties of rice plant which is cut at the time of primordial age.

This shows that the rice crop response more to N from artificial fertilizer than N derived from compost. Nitrogen fertilizer that was given as Urea and ZA and both of the fertilizers are relatively soluble fertilizer and available in a short time. C. odorata compost also contains N, but in addition to its lower level, the element N is slowly released because N fertilizer is still a lot to be in the form of organic compounds. This is also confirmed that the artificial fertilizer N derived from Urea, will be soluble and available for plants at least 2 weeks after application, while ZA fertilizer is seen 1 week later after application to the plants [12].

The C/N value of Red Cempo rice crop is smaller than other types of rice which are Cisokan and Pandan Wangi. This shows that Red Cempo is softer than other rice crops. The drawback makes it easy for Red Cempo to be attacked by disease and pest's disease than other rice. It is proven in the field that beside the Red Cempo is vulnerable to disease. It is also highly favoured by rats. The highest C/N value is possessed by Pandan Wangi rice which is proven to be more resistant to pests and diseases as compared to the two types of rice tested.

Transport of nutrients phosphate and ash are also greatly influenced by the type of rice and fertilizer application. It is presented in Table 6.

Effect organic fertilizer application	Cisokan	Pandan Wangi	Red Cempo	Cisokan	Pandan Wangi	Red Cempo
	kg P ha^{-1}			kg ash material ha^{-1}		
5 t ha^{-1} Chromolaena odorata compost +100% artificial fertilizer (F1)	10,39 a	10,37 b	4,88 a	236,09	304,39 b	103,33 ab
7,5 t ha^{-1} Chromolaena odorata compost +75% artificial fertilizer (F2)	9,59 a	9,48 b	5,17 a	203,23	275,19 c	113,12 a
10 t ha^{-1} Chromolaena odorata compost +50% artificial fertilizer (F3)	11,01 a	14,38 a	5,03 a	213,12	374,50 a	94,s04 c
Mean	10,37	11,34 A	5,09B	217,61	318,40A	103,51C
Numbers followed by the same small letter in the same column, and numbers followed by the same capital letter in the same line are not different significantly according to HSD test 5% significance level						

Table 6: Effect of organic fertilizer toward transport of Phosphate nutrient and ash material from three varieties of rice (kg ha^{-1}) at the initial of primordial age phase.

The highest P nutrient transport is conducted by rice crops Pandan Wangi, followed by rice Cisokan. The lowest transport of P is found in Red Cempo rice. It has ability to carry as many as 50% of the ability of other rice varieties tested. The provision of fertilizer does not affect the transport of P nutrients. This shows that the compost C.odorata or manure and artificial fertilizer SP36 has the same role in providing P nutrients for plants (Table 6). This can happen because SP36 is relatively slow available, so that, the plant can take P elements of both types fertilizer. Pandan Wangi rice absorbed more P element derived from C.odorata compost, because the higher amounts of compost and the lower fertilizers given, the higher the P transport.

The average of Cisokan in transporting P element is as much as 10.37 kg ha^{-1} or the equivalent of 23.75 kg ha^{-1} P_2O_5. If a recommendation is given 150 kg ha^{-1} SP36 or equivalent 54 kg ha^{-1} P_2O_5, then there are 44% of P fertilizer derived from the treatment of F1 absorbed by plants, if the compost C.odorata only given as much as 5 t ha^{-1}. But if the compost C.odorata given as much as 10 Mg ha^{-1} accompanied by a 50% giving artificial fertilizers or the equivalent of 27 kg ha^{-1} P_2O_5, with shuttles P Cisokan rice crops as much as 25.22 kg ha^{-1} P_2O_5. There are 93% of P element derived from the SP36 is absorbed by rice crops. Pandan Wangi rice plant is carrying P as much as 32.93 kg ha^{-1} P_2O_5, then 122% occurred P transportation from all fertilizers applied as well as the remaining 22% transported by P derived from soil and fertilizer.

Similarly, the ash contained in rice crop, ashes of the Red Cempo only 50% of the amount of ash material in Cisokan, and only 30% compared to ash in Pandan Wangi. Ashes contained in the plant material is a reflection of the minerals absorbed by plants through the soil, both of which belong to elements of macro and micro elements, among others; K, Ca, Mg, Fe, Zn, Mn, Cu and some other functional elements.

The ash material content is also not affected by fertilizer application. This suggests that plants can absorb a mineral element, whether from artificial fertilizers or from compost. Artificial fertilizers containing minerals is K fertilizer given in the form of KCl, while compost contains a variety of minerals, macro, and micro. It proves also that KCl fertilizer is relatively slow available, the same is happening in the *C. odorata* compost.

The weight of dry matter forage material Pandan Wangi which is higher than Cisokan and Red Cempo, are presented in Table 7. The highest dry matter forage on Cisokan plants is fertilized 5 Mg ha^{-1} compost *C. odorata*+100% artificial fertilizers, while the highest at the Pandan Wangi by 10 Mg ha^{-1} compost *C. odorata*+50% artificial fertilizers. The higher the transport of nutrients carried out by rice crops, the higher the weight of dry matter forages of rice plant. In general, the highest nutrient transport is carried out by plants Pandan Wangi, so the weight of dry matter forage of Pandan Wangi rice crop is also higher than other rice being tested. Rice Pandan Wangi responds more to fertilizers 10 t ha^{-1} *C. odorata* compost+50% artificial fertilizers, whereas Cisokan rice responds to fertilizer over 5 ha^{-1} *C. odorata* compost+100% artificial fertilizers. This proves that more compost and less artificial fertilizers given is a combination of a better fertilizer for aromatic paddy. For nonaromatic rice varieties such as Cisokan, even better response to the lower dose of organic matter and higher amounts of artificial fertilizers. For rice Red Cempo, response even is among them, it prefers 7.5 Mg ha^{-1} *C. odorata* compost+75% artificial fertilizers.

Effect of organic fertilizer application	Cisokan		Pandan Wangi		Red Cempo	
	g plot^{-1}	Mg ha^{-1}	g plot^{-1}	Mg ha^{-1}	g plot-1	Mg ha^{-1}
5 Mg ha^{-1} Chromolaena odorata compost +100% artificial fertilizer (F1)	946,67	2,037a	1254,22	2,412ab	588,81	1,018
7,5 Mg ha^{-1} Chromolaena odorata compost +75% artificial fertilizer (F2)	854,43	1,743 b	1219,25	2,155 b	445,24	1,034
10 Mg ha^{-1} Chromolaena odorata compost +50% artificial fertilizer (F3)	866,22	1,776 b	1090,67	2,996 a	540,97	0,883
average	889,11	1,852 B	1188.05	2,521A	525	0,978 C
Numbers followed by the same small letter in the same column, and numbers followed by the same capital letter in the same line are not different significantly according to HSD test 5% significance level.						

Table 7: Effect of organic matter on the weight of dry matter forage in three rice varieties that are trimmed when primordial age.

There is a positive correlation between dry forage crops produced on grain production. The higher the rice forage produced, it is assumed that the higher the yield of dry grain will be produced. It is reported that the higher dry matter content of plants, the grain yield of milled rice is also higher [15]. Nutrients transported by the plant will be stored in the dry ingredients before the crop enters the generative growth phase, and then if it has entered the generative phase, then a lot of food products will be moved within the seed component.

Conclusion

The study indicated there was an amendment in soil chemical properties after the application of *C. odorata*, compost achieving optimal fertility for rice crop. Nitrogen and other minerals uptake in rice crop increased due to the increased provision of artificial fertilizers escorted by lowering the dose of *C. odorata* compost. The ability about the nutrient uptake of rice crop is higher in rice Pandan Wangi and causes the higher forage yield than rice Cisokan or Red Cempo.

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