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APPLICATION OF TRICHO-TITHONIA AS COMPOST AND ORGANIC AMELIORANT IN INDUCING GROWTH AND YIELD OF LOCAL-JAMBI VARIETIES OF RED CHILI

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ABSTRACT
The red chili is a superior horticultural product and are currently still a commodity contributing to significant inflation in the Jambi area. The red chili harvest in Jambi Province in 2020 was 10.77 tons ha^{-1}, with national productivity of 12 tons ha^{-1}, while the potential for chili production could exceed 20 tons ha^{-1}. The cause of low chili productivity in Indonesia is the limitation of obtaining superior chili varieties that have stable superior characteristics in different agro-climates, and are less resistant to environmental stress. Environmental stress is the accumulation of the impact of farmers' dependence on intensive and excessive use of inorganic fertilizers and pesticides, which has an impact on high production costs, the phenomenon of pest and other pathogen resurgence, the death of natural enemies, environmental pollution and threats to the safety of the products produced. The research was carried out to overcome the problem of low productivity of chili plants, especially in Jambi Province, consistency in the Application and Development of Environmentally Friendly Technology. The research results showed that the application of Tricho-tithonia 20 tons ha^{-1} and the recommended dose of 50% NPK fertilizer showed the best growth response and results in local-Jambi red chili varieties. The local varieties tested also have good adaptability to agro-climates that are different from the areas of origin of the chili varieties.

KEY WORDS
Capsicum annuum, plant breeding, plant biotechnology, environmentally friendly agriculture.

The red chili commodity (Capsicum annuum L.) is a mainstay product for horticulture, however the productivity of red chilies in various chili development areas in Indonesia is still low. In 2021, national red chili productivity was recorded at 12.10 tons ha^{-1}, while in Jambi Province it was still 9.86 tons ha^{-1}. This productivity achievement is still very low when compared to the potential crop yield which can reach 25 tons ha^{-1} [Syukur, 2012; BPS, 2022]. The causes of low chili productivity in Indonesia are: limited availability of optimal land for the chili extensification program, adaptive superior chili varieties that are still unstable and variations in "Environmental Stress" factors. According to Eliyanti, et al., (2021a). Biotic environmental stress in red chili cultivation is dominated by high attacks by plant pests, while abiotic environmental stress is in the form of decreasing land carrying capacity. The decreasing carrying capacity of land is also an accumulation of farmers' dependence on intensive and excessive use of inorganic fertilizers and pesticides, so that it has a direct impact not only on the high production costs of red chili farming (Wulandari, 2020; Latifa et al., 2021), but it also has an impact on the phenomenon of pest and pathogen resurgence, death of natural enemies, environmental pollution and threats to the safety of the products produced (BPTP, 2009; Directorate General of Horticulture, 2018).

In Indonesia, the available agricultural extensification lands, especially those outside Java, are marginal or sub-optimal lands (around 45.8 million ha or 25% of Indonesia's land area). According to Subandiono et al. (2014) that marginal lands naturally have the potential to become areas for plant extensification, but require the addition of various soil amendments or ameliorants. Currently, soil ameliorant materials which are prioritized for use in relation to the safety of agricultural agroecosystems, are those sourced from organic materials such as: compost, livestock manure, processed agricultural waste products and biological agents from the bacterial group Rhizobium, Mycorrhiza and Trichoderma sp.

The use of Trichocompost in planting media can also replace the use of inorganic fertilizer, while increasing the carrying capacity of sub-optimal land (BPTP, 2009; Hasyim et al., 2015; Eliyanti et al., 2021a; Eliyanti et al., 2022). Nurhayati Research (2019), the addition of 20 tonnes ha^{-1} of compost as an organic ameliorant to Ultisol soil was proven to be effective in increasing the available P content and increasing the Ca-dd value by 25%. Ainiya et al., (2019), the combination of trichocompost (25 tons ha^{-1}) and Lamtoro Liquid Organic Fertilizer (250 ml L^{-1}) can increase the growth and yield of sweet corn. Eliyanti et al.(2021a), the application of Trichokompos 5 - 20 tons ha^{-1} accompanied by spraying 60% Beef Biourin every week on red chili plants, shows higher growth and yield, as well as increasing plant resistance to biotic stress. Another potential organic material that can be explored further is Tithonia diversifolia (tithonia). This plant is a weed with the character of "widely adaptive and highly competitive ecology", has a very fast growth and root distribution system making it difficult to control. On the other hand, the stems and leaves of Tithonia contain many nutrients and active ingredients of flavonoids, alkaloids, terpenoids, saponins and tannins, so that in its use, apart from being an organic fertilizer, it is also effective as a plant biopesticide (Ramirez-Rivera, 2010; Topfik et al., 2010; Batero Londono et al., 2019). Some research results related to the use of tithonia are. The use of Tithonia leaf compost (5–20 tons ha-^{1}) has been proven to be able to induce the growth and yield of various plants (horticultural, food and plantation crops), and is also effective as a biopesticide in controlling pests on food and horticultural crops (Istarofah et al.; Arifiati et al., 2017; Aryani et al.; Yuhardi et al., 2021). Furthermore, the use of 10 tons ha^{-1} Tithonia compost combined with other organic materials (husk charcoal and drum fertilizer) can reduce the use of inorganic fertilizers by up to 50% (Hutomo, 2015; Wicaksono et al., 2018). Then Farni et al. (2022) providing Tithonia compost and sugar cane leaves can improve the carrying capacity of degraded-sandy land.

Various local-Jambi superior varieties have been explored and tested for their resistance to environmental stress in previous research Eliyanti et al. (2021a); Ichwan, et al., 2021), which were used in testing the effectiveness of Tricho-Trithonia. It is hoped that the superiority of the Local-Jambi variety can be "stablely expressed" in different agro-climates using Tricho-Tithonia, so that the results of this test and technology can be used as recommendations for the extensification of red chili plants in various development areas in Jambi Province and other regions.

The research carried out aims to: 1) evaluate further the application of Tricho-Tithonia as compost in reducing the use of synthetic (inorganic) fertilizers, as well as in increasing the growth and stabilization of superior characteristics (high yields) of Local Variety - Jambi chili plants; 2) applying Environmentally Friendly Technology "Tricho-Tithonia" as an organic ameliorant in optimizing the carrying capacity of sub-optimal land; 3) obtaining Local-Jambi Varieties with specific superior characteristics and stability in different agro-climates; 4) completing data on the uniqueness and specific advantages of Local-Jambi Chili Varieties which are expressed stably, through the application and development of Tricho-Tithonia Environmentally Friendly Technology related to the conditions for the release of new superior varieties.

METHODS OF RESEARCH

The research was carried out for 7 (seven) months, at the Teaching and Research Farm, Faculty of Agriculture, Jambi University, at 35 m above sea level. The main research material is local variety red chili seeds - Jambi (variety from the highlands: Kerinci Regency). Tricho-Tithonia Compost, prepared first by making it in the Biotechnology and Plant Breeding Lab, referring to BPTP (2009) and Eliyanti, et al. (2021a). The experiment was designed as a Randomized Block Design, consisting of two factors; factor 1 is Tricho-Tithonia Application (T) which consists of 4 levels; factor 2 is the Inorganic Fertilizer Dosage (P) which consists of 5 levels, The experiment was designed with three (3) repetitions or blocks. In-Organic

Fertilizer (NPK) treatment refers to the POS for Cultivating Red Chili Plants (Balitsa, 2007; BPTP, 2017). Plant growth and yield variables were observed and analyzed referring to the observation methods and procedures (descriptors) of chili plants (International Plant Genetic Resources Institute. 1995; Zulkarnain, 2013).

Environmental Adaptive Variables consist of a) Percentage of sick plants (attacked by pathogens in the field); b) Relative Water Content (RWC in percent) in plant leaves, which is calculated during the generative phase or 2 weeks after the fruit appears. The results of observations of various plant growth and yield variables were tested for variance (ANOVA) and continued with DMRT at 5% level to see the differences that occurred as a result of the treatment.

RESULTS AND DISCUSSION

The research tested the application of Tricho-tithonia as compost and organic ameliorant in inducing the growth and yield of local-Jambi variety chili plants (Loker Variety). The seeding and nursery stages were carried out in the greenhouse of the Faculty of Agriculture, Jambi University.

Details of the ANOVA results for Plant Growth and Yield components can be seen in Table 1.

Table 1 – Details of ANOVA for Plant Growth and Yield Components (P>0.5)

Sources of diversity	PH	MSH	FA	NF
Block/Repeat	*	ns	**	**
Tricho-tithonia	**	**	**	**
NPK Fertilizer	**	**	*	**
Interaction	**	**	**	**

Note: ns: No significant effect (P>0.5).
**: Significant effect (P<0.05). **: Very significant effect (P<0.01).*
PH: Plant Height; MSH: Main Stem Height/Dichotomous; FA: Flowering Age; NF: Number of Fruits per plant.

Furthermore, to see the differences in each level between treatments, it can be seen based on the results of further tests using DMRT level of 5%.

Detailed ANOVA results in Table 1, obtained; the application of Tricho-tithonia and the use of NPK fertilizer as well as interactions at several treatment levels had a very significant on plant height. Next, to find out the average difference, proceed with DMRT at the 5% level (Table 2).

Table 2 – Effect of Tricho-tithonia and NPK fertilizer on plant height (cm) at 12 WAP

Tricho-tithonia (T) (ton ha^{-1})	Inorganic Fertilizer NPK 16:16:16 (P) (% recommended dose)					
	P_1 (0)	P_2 (25)	P_3 (50)	P_4 (75)	P_5 (100)	Single Factor Test (T)
T_1 (0)	73,00 b B	89,00 a A	92,67 b A	78,00 c B	92,67 b A	85,07 b
T_2 (10)	79,00 ab B	81,33 a B	98,00 b A	92,67 ab A	98,00 ab A	89,80 a
T_3 (20)	78,00 ab C	84,67 a C	111,00 a A	98,00 a B	99,00 ab B	94,13 a
T_4 (30)	82,67 a B	82,67 a B	109,00 a A	88,00 b B	103,33 a A	93,13 a
Single Factor Test (P)	78,17A	84,42D	102,67A	89,17C	98,25B	

Note: The same uppercase (capital) letters horizontally (row) and the same lowercase letters vertically (column) indicate that they are not significantly different at 5% DMRT.

From table 2, various applications of Tricho-tithonia provide the same plant height growth response; meanwhile various doses of NPK provide different plant height growth responses at various doses of tricho-tithonia. Application of tricho-tithonia 20 – 30 tons ha^{-1}

with 50% NPK fertilizer provides the best plant height growth response. This is in accordance with previous research that the application of Tithonia Fertilizer can reduce the use of inorganic fertilizer by up to 50% (Hutomo, 2015; Wicaksono and Sumarni, 2018; Eliyanti et al., 2021b).

Detailed ANOVA results in Table 1, obtained; The application of Tricho-tithonia and the use of NPK fertilizer as well as interactions at several treatment levels had a very significant on main stem height (plant dichotomous). Next, to find out the average difference, proceed with DMRT at the 5% level (Table 3).

Table 3 – Effect of Tricho-tithonia and NPK fertilizer on main stem height (cm) at 12 WAP

Tricho-Tithonia (T) (ton ha^{-1})	Inorganic Fertilizer NPK 16:16:16 (P) (% recommended dose)					
	P_1 (0)	P_2 (25)	P_3 (50)	P_4 (75)	P_5 (100)	Single Factor Test (T)
T_1 (0)	25,17 c B	28,93 c A	29,40 c A	28,27 b A	29,23 b A	28,20 d
T_2 (10)	27,40 b C	30,13 bc B	34,73 b A	34,73 a A	34,33 a A	32,27 c
T_3 (20)	29,43 a C	32,70 a B	36,50 a A	36,50 a A	36,23 a A	34,27 a
T_4 (30)	27,53 b C	31,27 ab B	36,20 ab A	35,47 a A	36,10 a A	33,31 b
Single Factor Test (P)	27,38C	30,76B	34,21A	33,74A	33,98A	

Note: The same uppercase (capital) letters horizontally (row) and the same lowercase letters vertically (column) indicate that they are not significantly different at 5% DMRT.

From Table 3, application of Tricho-tithonia 20 tons ha^{-1} at various fertilizer doses and application of fertilizer doses of 50 – 100% at various Tricho-tithonia doses provide the best main stem height growth response. Application of Tricho-tithonia 10 – 20 tons ha^{-1} with fertilizer dose of 50 – 100% provides the best main stem height growth response.

The application of Tricho-tithonia and its interaction with the application of NPK fertilizer at several treatment levels had a very significant on flowering time. Next, to find out the average difference, proceed with DMRT at the 5% level (Table 4). The application of various doses of fertilizer gave the same flowering age response, while the application of Tricho-tithonia 20 tons ha^{-1} gave a faster flowering age response. Application of Tricho-tithonia 10 – 30 tons ha^{-1} with various doses of NPK fertilizer is able to induce faster flower emergence in red chili plants.

Table 4 – Effect of Tricho-tithonia and NPK fertilizer on plant flowering age (DAP)

Tricho-Tithonia (T) (ton ha^{-1})	Inorganic Fertilizer NPK 16:16:16 (P) (% recommended dose)					
	P_1 (0)	P_2 (25)	P_3 (50)	P_4 (75)	P_5 (100)	Single Factor Test (T)
T1 (0)	35,83 a A	32,67 a B	31,83 a B	32,93 a B	32,47 a B	33,15 a
T2 (10)	30,40 b A	29,67 b A	29,67 b A	29,53 b A	29,77 b A	29,81 b
T3 (20)	28,80 c A	29,20 b A	29,00 b A	28,00 c A	28,73 b A	28,75 c
T4 (30)	29,07 bc A	29,93 b A	29,67 b A	29,67 b A	29,93 b A	29,65 b
Single Factor Test (P)	31,03A	30,37AB	30,04B	30,03B	30,23B	

The application of Tricho-tithonia and the use of NPK fertilizer as well as interactions at several treatment levels had a very real influence on the number of fruits per plant. Next, to find out the average difference, proceed with DMRT at the 5% level (Table 5).

From Table 5, the fertilizer application at a dose of 50 - 100% gives a response to the same number of fruit, while application of Tricho-tithonia 20 - 30 tons ha^{-1} gives a response to a higher number of fruit. The use of Tricho-tithonia can not only replace the use of inorganic fertilizer, but also act as an organic ameliorant which can increase the carrying capacity of sub-optimal land. It has been proven that the local Jambi chili plant is able to grow and produce well according to the plant conditions in its area of origin (highlands). This is in accordance with previous research (Farni et al., 2022) the application of Tithonia compost and sugarcane leaves with various compositions to corn plants on marginal (degraded sandy) land; there is an increase in plant growth and improvement in land conditions (increasing soil pH and soil base exchange).

Table 5 – Effect of Tricho-tithonia and NPK fertilizer on the number of fruit per plant

Tricho-Tithonia (T) (ton ha^{-1})	Inorganic Fertilizer NPK 16:16:16 (P) (% recommended dose)					
	P_1 (0)	P_2 (25)	P_3 (50)	P_4 (75)	P_5 (100)	Single Factor Test (T)
T1 (0)	52,83 b C	59,33 b BC	82,13 b A	81,67 c A	75,33 c AB	70,26 b
T2 (10)	65,97 ab C	78,83 a B	98,77 b A	100,67 b A	95,47 b AB	87,94 b
T3 (20)	84,73 a B	91,57 a B	148,53 a A	150,47 a A	145,67 a A	124,19 a
T4 (30)	83,40 a B	88,07 a B	146,47 a A	146,13 a A	144,27 a A	121,67 a
Single Factor Test (P)	71,73B	79,45B	118,98A	119,73A	115,18A	

Observation of disease intensity in the form of "level of plant damage" due to OPT attacks (Plant Pest Organisms) is carried out every week until the completion of the research. Calculated using the Yoon method [7], namely: Ip = n/N x 100%, where Ip = Disease Intensity, n = Number of plants with symptoms or attacked by various pathogens, and N = total plants observed (960 plants).

Figure 1 – Domination of damage to chili plants in the field: a) Thrips attack; b) Infection with various viruses.

Furthermore, the Disease Intensity (Ip) value can be grouped into several Attack Category levels as follows:

Table 6 – Attack Categories Based on Level of Plant Damage

Disease Intensity (Ip)	Attack category
0	Normal
> 0 – 25 %	Light/mild
> 25 – 50 %	Medium
> 50 – 75 %	Heavy
> 75 %	Very heavy

Source: Directorate General of Horticulture, 2018; Technical Guidelines for Horticultural Protection Systems.

The results of observations on the average number of infected plants showed that the disease intensity ranged from 10.16% – 23.20% (Table 7). This figure indicates that the red chili plants in the field experienced pest attacks in the mild category (< 25%). However, plants without tricho-tihonia treatment and inorganic fertilizer experienced an average pest attack in the medium category (31.25%). These results indicate that tricho-tithonia can also act as a biopesticide that protects plants from severe damage due to attacks by plant pests. In accordance with previous research, the stems and leaves of Tithonia contain many nutrients and active ingredients of flavonoids, alkaloids, terpenoids, saponins and tannins, so that its use, apart from being an organic fertilizer, is also effective as a plant biopesticide (Ramirez, et al., 2010; Toufik et al., 2010; Botero, et al., 2019). Next, to see the adaptability of plants to different agro-climates, an analysis of the relative water content (RWC in percent) of plant leaves was carried out, which was calculated during the generative phase or 2 weeks after the fruit appeared (Table 8).

Table 7 – Observation Data on Average Disease Intensity (%) in Plants Aged 12 WAP

Tricho-Tithonia (T) (ton ha^{-1})	Inorganic Fertilizer NPK 16:16:16 (P) (% recommended dose)					
	P_1 (0)	P_2 (25)	P_3 (50)	P_4 (75)	P_5 (100)	Average (%)
T1 (0)	31,25	25,00	23,44	19,53	16,80	23,20
T2 (10)	18,75	21,88	15,63	14,06	13,67	16,80
T3 (20)	12,50	9,38	12,50	13,28	11,72	11,88
T4 (30)	6,25	15,63	10,16	12,14	6,64	10,16
Average	17,19	17,97	15,43	14,75	12,21	

Table 8 – Relative Water Content (RWC in percent) in plant leaves 12 WAP

Tricho-Tithonia (T) (ton ha^{-1})	Inorganic Fertilizer NPK 16:16:16 (P) (% recommended dose)					
	P_1 (0)	P_2 (25)	P_3 (50)	P_4 (75)	P_5 (100)	Average (%)
T1 (0)	66,68	69,29	74,07	73,35	73,74	71,43
T2 (10)	76,06	75,56	78,81	76,81	78,52	77,15
T3 (20)	76,40	77,33	80,59	82,44	80,73	79,50
T4 (30)	85,82	86,67	90,03	91,50	89,91	88,79
Average (%)	76,24	77,21	80,88	81,03	80,72	

Observation of the adaptability of the test varieties to lowland agroclimate showed an average of good adaptability and resistance to agroclimatic changes. This can be seen from the average RWC value which exceeds 65%, even with tricho-tithonia treatment of 30 tons ha^{-1} showing an RWC value of more than 85%. This also indicates that the Loker variety is able to grow and produce optimally in environmental conditions that are different from their original habitat (Highlands >700 m above sea level). The ability of local Jambi chili plants to adapt to marginal environments (Ultisol land) is due to the use of tricho-tithonia as an organic ameliorant which is able to increase the carrying capacity of the land.

The marginal lands (Ultisol, Peat, Tidal land and so on) naturally have potential as areas for plant extensification, but require the addition of various soil amendments or ameliorants that can improve or optimize the carrying capacity of agricultural land (Eliyanti et al., 2021b).

In accordance with the results of previous research, the addition of tricho-tithonia to marginal land can improve soil physical, chemical and biological properties such as increasing soil pH, cation exchange capacity, increasing soil organic matter and increasing the number of soil microbes (Ichwan et al., 2021). Furthermore, the addition of trico-compost to land contaminated with heavy metals has been proven to reduce the poisoning effect of peanut plants on mercury (Hg) by more than 70% (Isrun et al., 2018).

CONCLUSION

The application of various doses of Tricho-tithonia and NPK fertilizer and their interactions can influence the growth and yield of local Jambi varieties of red chili plants, such as the variables Plant Height, Main Stem Height (Dichotomous), Flowering Age and

Number of Fruits per plant. The application of Tricho-tithonia 20 tons ha^{-1} and the recommended dose of 50% NPK fertilizer showed the best growth response and results in local-Jambi red chili varieties.

Adaptability of the tested varieties to lowland agroclimate showed good average ability of adaptability and resistance to agroclimatic changes. This can be seen from the results of observations of the average number of infected plants showing disease intensity ranging from 10.16% – 23.20% or in the mild category (< 25%), as well as an average RWC value that exceeds 65%, even with tricho-tithonia treatment of 30 tons ha^{-1} showed an RWC value of more than 85%.

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REFERENCES

1. Ainiya M, M. Fadil M, & R. Despita. (2019). Increasing the Growth and Yield of Sweet Corn by Utilizing Trichokompos and Lamtoro Leaf POC. Agrotech Res J 3(2): 69-74.
2. Arifiati A, Syekhfani, & Y. Nuraini. (2017). Comparative Effectiveness Test of Paitan Compost Material (Tithonia diversifolia), Ferns (Dryopteris filixmas), and Goat Manure on the N Uptake of Corn Plants in Inceptisol. Journal of Soil and Land Resources. 4(2): 543-552.
3. Aryani D, N. Uswatun, & Hasanudin. (2019). Utilization of Paitan Weed (Tithonia diversifolia) (Hemsley) A. Gray Biomass as Compost Fertilizer to Increase Peanut Yields. JIPI. 21(2): 115-120.
4. Badan Pusat Statistik Jambi. Jambi Central Statistics Agency. (2022). Harvest Area, Production and Productivity of Chili in Jambi 2018 - 2021. Jambi Central Statistics Agency, Jambi.
5. BALITSA. Vegetable Crops Research Institute. (2007). Technical Instructions for Vegetable Plant Cultivation. 135 p.
6. BPTP Sumatera Barat. Agricultural Technology Research Center - West Sumatra. (2017). Cultivating Chilies in Pots/Polybags (/index.php/info-tek/1022-cultivating-chilies-in-pot-polybags.
7. BPTP Jambi. Jambi Agricultural Technology Research Center. (2009). Use of Trichocompost in Vegetable Plants. Jambi Agricultural Technology Research Center, Jambi.
8. Botero Londoño JM, A. Gómez Carabali., M.A.Botero Londoño. (2019). Nutrient absorption in Tithonia diversifolia, Univ. Sci. 24(1):33-48.
9. Directorate General of Horticulture. (2018). Technical Instructions for Horticultural Protection Systems: Application of IPM to Chilies and Shallots. Directorate General of Horticulture, Ministry of Agriculture, Republic of Indonesia, Jakarta. pp. 78 p.
10. Eliyanti E, B. Ichwan, A.P. Lestari, Z. Zulkarnain, Z. (2021a). The Induction of Biotic Stress-Resistance and Increasing Growth and Yield of Chili Pepper (Capsicum annuum L.) Using Cow Bio-Urine and Tricho-Compost. Proceedings of the 3rd Green Development International Conference (GDIC 2020). Advances in Engineering Research. 205: 129-135.
11. Eliyanti E., Z. Zulkarnain, B. Ichwan, H. Setyaji, D. Dwiputri. (2021b). Application of Golden Snail Compost 3-Bio Technology to reduce the use of inorganic fertilizers on red chili plants (Capsicum annuum L.). Scientific Journal of Applied Sciences. 5(2):276-284.
12. Eliyanti E., Z. Zulkarnain, B. Ichwan, T. Novita, & J. Sihotang. (2022). Improving drought tolerance in chili pepper by the application of local microorganisms (LMo). Journal of

Suboptimal Lands: Journal of Suboptimal Lands 11 (1): xx-xx. DOI: 10.36706/JLSO.11.1.2022.566.
13. Farni Y., R. Suntari, & S. Prijono. (2022). Utilization of Tithonia diversifolia and sugarcane leaves to improve soil properties and plant growth on a degraded sandy soil of Malang, East Java. Journal of Degraded and Mining Lands Management 9(2):3227-3236.
14. Hasyim, A., W. Setiawati, & L. Lukman. (2015). Innovation in environmentally friendly pest control technology in chilies: alternative efforts towards a harmonious ecosystem. Agricultural Innovation Development 8: 1-10.
15. Hutomo, I. (2015). The Effect of Tithonia diversifolia Green Manure on the Growth and Yield of Corn Plants (Zea mays L.). Agrotechnology 3(4): 475-481
16. Ichwan B., E. Eliyanti, & Z. Zulkarnain. (2021). Effect of biostimulants and media com positions on growth and yield of Capsicum annuum L. under drought stress conditions. AHS; Adv. Hort. Sci. 35(2): 129137.
17. Istarofah & Z. Salamah. (2017). Growth of Green Mustard Plants (Brassica juncea l.) by Providing Compost Made from Paitan Leaves (Thitonia diversifolia). Bio-site. 3 (1): 39-46.
18. International Plant Genetic Resources Institute. (1995). Descriptors for Capsicum (Capsicum spp.). International Plant Genetic Resources Institute, Rome, Italy.
19. Isrun, M. Basir-Cyio, I. Wahyudi, U. Hasanah, S. Laude, T. Inoue, & T. Kawakami. (2018). Tithonia diversifolia compost for reducing the activity of mercury in soil. J Environ. Sci. Technol., 11: 79-85.
20. Latifa D., F. Tanjung, & D. Yuzaria. (2021). Analysis of Competitiveness and Government Policy for Curly Red Chili Commodities in Kerinci Regency, Jambi Province, Indonesia. Agro Bali: Agricultural Journal. 4(3): 447-458.
21. Nurhayati. (2019). Effect of Ameliorant Application on Ultisol Soil Ca-DD Levels. Innovation Vehicle. 8(2):181 - 183.
22. Ramírez-Rivera U., J. R. Sanginés-García, J. G. Escobedo-Mex, F. Cen-Chuc, J. A. Rivera-Lorca, & P.E. Lara-Lara. (2010). Effect of dietary inclusion of Tithonia diversifolia on feed intake, digestibility and nitrogen balance in tropical sheep. Agroforestry Systems, 80(2), 295-302.
23. Subandiono RE, E. Suryani, & D. Subardja. (2014). Soil Properties on Potential Land for Agricultural Development in Jambi Province and Management Implications. Journal of Soil and Climate. 38 (1): 51 – 62.
24. Syukur, M. (2012). Chili: International Business and Technology Prospects. Agriflo, Jakarta.
25. Taofik M., E. Yulianti, A. Barizi, & E K Hayati. (2010). Isolation and identification of active compounds from water extract of paitan leaves (Tithonia diversifolia) as a botanical insecticide for controlling Eriophyidae mite pests. Alchemy, 2(1): 32-142.
Wicaksono, A. T., & Sumarni, T. (2018). Effect of NPK Fertilizer and Paitan Green Fertilizer (Tithonia diversifolia) on the Growth and Yield of Corn (Zea mays L.) var. P-21. Journal of Crop Production, 6(8): 1620–1626.
26. Wulandari, S.A. (2020). Fluctuations in Red Chili Prices during the Covid 19 Pandemic in Jambi City. MeA Journal (Agribusiness Media), 5(2): 112-120.
27. Yuhardi E, Gusnidar, & S. Yasin. (2021). Effect of Application of Rice Straw Compost + Tithonia Prunings and Rice Husk Biochar on Nitrogen, Phosphorus and Potassium Uptake and Sri Method Rice Production (System of Rice Intensification) in Padang City. Journal of Soil and Land Resources. 8(1):301-308.
28. Zulkarnain. (2013). Tropical Vegetable Cultivation. PT Bumi Aksara, Jakarta.