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Research paper

Study of Various Organic Mulch Sheet Compositions Usage towards The Growth and Yield of Cauliflower (Brassica oleracea Var Botrytis, L.)

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Abstract

The production decrease and the imported commodity increase were due to the low quantity and quality of cauliflower, it was also caused by pre-harvest factors including cultivation technique that mostly used non-biodegradable plastic mulch. Functionally, the seasonal organic mulch was less effective and thus it needed engineering technology in the form of organic mulch sheet. The selection of organic materials (water hyacinth, banana pseudostem and tannery waste) which were used as mulches have met the eco-friendly concept. This research was aimed to study the effect of various organic mulch sheet compositions usage towards the growth and yield of cauliflower. The result showed that the use of organic mulch sheet was significant compared to the treatment without using mulch with the yield increase by 72.18%. However, the results were not significantly different in various compositions and black silver plastic mulch (BSPM) treatments with the growth and yield as the observable variables. The temperature of organic sheet mulch was between 25.10C – 29.10C; the soil temperature was between 25.9oC – 34.6oC; the soil humidity was between 66.1 - 78.2. The intensity of the light received was between 47,844.3 – 52,735 lux, meanwhile the light reflected was between 7,196.79 – 8,451.18 lux.

Keywords: *Micro climate, cauliflower, organic mulch sheet, plastic mulch*

1. Introduction

The decrease of national cauliflower production by 9.77% and the increase of imported commodity by 115% in 2013-2014 were caused by cultivation technique factor named mulching wich generally used non-biodegradable plastic

(Direktorat Jendral Hortikultura, 2014, 2015, Respati et al., 2013, 2015). The inaccurate black silver plastic mulch (BSPM) waste management can pollute the environment because resins may contaminate the soil (Coolong, 2012; Courter, Hopen, & Vandemark, 1970; Kasirajan & Ngouajio, 2012). Moreover, it costs a lot to recycle plastic mulch trash and requires double transportation (Miles et al., 2012).

Organic mulch has been used widely but due to its seasonal availability and less effective function it needs technology engineering in the form of organic mulch. Previous research on the use of paper mulch application (grayish brown and black) shows its effect towards the lettuce fresh weight (Lactuca sativa L. cv. Ithaca) with 1.2 - 3.6 higher compares to the treatment without using mulch (Brault, Stewart, & Jenni, 2002a). The research also shows that organic paper mulch made from water hyacinth, straw and tannery waste significantly affects the tuber diameter, tuber quantity, fresh weight and dry weight of onion compared to the treatment without using mulch and plastic mulch (Iriany, Lestari, & Chanan, 2016).

Paper made from fiber can be proceed from natural cellulosic source such as kenaf, pineapple leaf fibre, banana fibre, coir, paddy straw, sugarcane, water hyacinth and many more (Bhatnagar, Gupta, & Yadav, 2015; Indriyati, Musfiroh, Kusmawanti, Sriwidodo, & Hasanah, 2016; J, Yusoh, & W.S, 2015; Main, Talib, Ibrahim, Rahman, & MOhamed, 2014). These materials include fibre waste as same as materials for this research. Besides, the organic materials used to make mulch (water hyacinth, banana pseudostem and tannery waste) have met the eco-friendly concept. This research was aimed to study the effect of various organic mulch sheet compositions usage towards the growth and the yield of cauliflower (Brassica oleraceavar botrytis, L.).

2. Materials and Methods

This research was conducted in the experimental garden of Faculty of Agriculture and Animal Husbandry, University of Muhammadiyah Malang from December 2015 to April 2016. The tools used in this research consisted of digital scales, knives, blender, stove, pans, gauze, wood, farming tools, caliper, thermo hygrometer, and digital lux meter. Then, the materials were water hyacinth leaf stalk, banana pseudostem, tannery waste, water, black silver plastic mulches (BSPM), cauliflower seeds, goat manure and bioinsecticides.

The simple Group-randomized complete block Design was used in this research. It consisted of 6 mulch compositions treatments, black silver plastic mulch (BSPM) treatments and without using mulch as control ; there were 4 replications and with 6 plant samples for each treatment. The mulch compositions treatments of water hyacinth : banana pseudostem : tannery waste (percentage of the material mass per 1 kg of material) were M1 (30:60:10), M2 (35:55:10), M3 (40:50:10) , M4 (45:45:10), M5 (50:40:10) and M6 (55:35:10). Then, the data were analyzed by using F-test, Honest Significant Difference test (Tukey's HSD) with 5% significance level. The observable variables were plant height (cm), number of leaves (leaf), flower fresh weight (g), flower diameter (cm), and micro-climate (air temperature, soil temperature, soil humidity, intensity of light received and reflected).

3. Discussion and Conclusion

The organic sheet mulch was made of water hyacinth, banana pseuodestem, and tannery waste. It produced a compact and strong structure (Li, Fu, Zhan, Zhan, & Lucia, 2010; Nata, Niawati, & Muizliana, 2013; Sutyasmi, 2012). The high cellulose content in the water hyacinth and banana pseudostem (over than 60%) and low lignin content (lower than 5%) through the delignification process are used to remove the lignin contained in the materials (Li et al., 2010; Ramesh, Ananda, Aswin, Eashwar, & Deepa, 2014; Tumolva, Ortenero, Kubouchi, & City, 2013). Lignin is a reinforcing susbstance that make tree cells wood hard also binding agent between cellulose molecules and it must be eliminated in order to obtain fiber (Chen, 2014; Li et al., 2010). Heating or boiling process was intended to accelerate the softening process of cellulose so that the pulp making became easier also improved the dimensional stability (K, W, Zaidon, F, & A.R, 2012) . Celluloses are reattached to strengthen the structure of the material with the addition of tannery waste containing gelatin from the pulping process (Iriany et al., 2016; Khakalo et al., 2014).

3.1. Plant Height, Number of Leaves, Flower Fresh Weight, and Flower Diameter

Table 1 showed the overall organic mulch treatments with different compositions. The average of plant height and number of leave was not significantly different between all treatment (non mulch, BSPM and organic mulch sheet).Related with previous research, both the paper and polyethylene mulch promoted growth and development of head lettuce as reflected by earlier heading and heavier heads compared with a manually weeded control (Brault et al., 2002a).

Table 1: Mean of Plant Height per Plant (cm), Number of Leaves, fresh flower weight and flower diameter

Treatment	Plant Height (cm)	Number of Leaves	Flower Fresh Weight (g)	Flower Diameter (cm)
A (without mulch)	13,46 a	8,33 a	206.33 a	11.93 a
B (BSPM)	14,13 a	8,89 ab	379.72 b	14.49 b
M1 (30:60:10)	15,10 a	10,53 b	310.67 b	14.74 b
M2 (35:55:10)	14,47 a	9,02 ab	389.96 b	15.34 b
M3 (40:50:10)	15,70 a	9,83 ab	318.44 b	15.02 b
M4 (45:45:10)	14,65 a	9,33 ab	322.11 b	14.79 b
M5 (50:40:10)	14,58 a	8,25 a	396.56 b	14.24 b
M6 (55:35:10)	13,63 a	8,65 ab	393.88 b	14.65 b
HSD 5%	2,81	1,91	91.04	1.29

Notes: • The mean value which was followed by the same letter in the same column showed that the difference was not significant based on Tukey's test with 5% significance level.

• A (without mulch), B (BSPM), M1-M6 organic mulch composition (water hyacinth: banana pseudostem: tannery waste): M1 (30:60:10), M2 (35:55:10), M3 (40:50:10), M4 (45:45:10), M5 (50:40:10) dan M6 (55:35:10).

The composition of the organic mulch sheet treatments gave significant difference in the weight and diameter of the flower compared to treatment A (without mulch) but it was not significantly different compared to treatment B (BSPM) (Table 1). The treatment of organic mulch increased the yield by 72.18% compared to treatment without using mulch. The difference in cabbage yield is not significant whether it applies white plastic mulch or organic sawdust powder mulch (Masarirambi, Mndzebele, Wahome, & Oseni, 2013). That was similar to a research that explained all mulch treatments give better result than the treatment without using mulch, but there is no significant difference in cucumber yield from all types of paper mulches used in the research (Haapala, Palonen, Tamminen, & Ahokas, 2015) also in others paper showed mulch increasing yield in several crop plant (Damayanti, Aini, & Koesriharti, 2013; Darmawan, Nyana, & Gunadi, 2014; Islam, 2013; Law, Rowell, Snyder, & Williams, 2006; Salim, Khan, Sarkar, Hossain, & Hossain, 2008). Mulching affected the microclimate around the plants which could be used to stabilize the temperature and retain the moisture so that the generative development of plants with mulch treatment was better (Ibarra, Flores, & Díaz-Pérez, 2001; Ibarra-Jiménez, Lira-Saldivar, Valdez-Aguilar, & Lozano-Del Río, 2011). The temperature fluctuation during the flower initiation and development phase will decrease the flower quality (Ajithkumar, Karthika, & Rao, 2014).

3.2. Micro Climate of Plant: Air Temperature, Soil Temperature, Soil Humidity and Light Intensity

The air and soil temperature in organic sheet mulch treatment were lower and more stable compared to the treatments without using mulch (Figure 1 and 2). It was consistent with the previous study which mentioned that the soil temperature in organic mulch (straw, sawdust, peat and grass) treatment was 7% lower compared to the treatment without using mulch (Sinkevičienė, Jodaugienė, Pupalienė, & Urbonienė, 2009); as well as the treatment of various types of kraft paper mulch which lowers the soil temperature significantly up to 48% -50% compared to the treatment without using mulch (Haapala et al., 2015). That is due to the application of mulch on the soil surface which can be used to slow the heating and cooling that occur as the result of the solar radiation received and released, so that the soil temperature and humidity will be more stable.

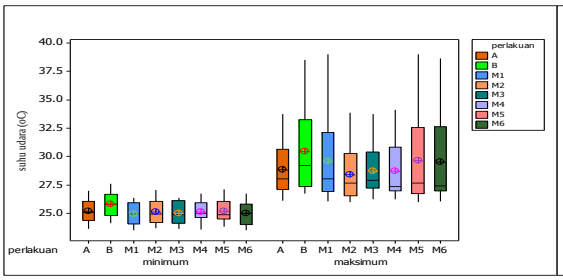

Fig 1: Minimum and Maximum Air Temperature on the 12th – 48th Days After Mulch Application

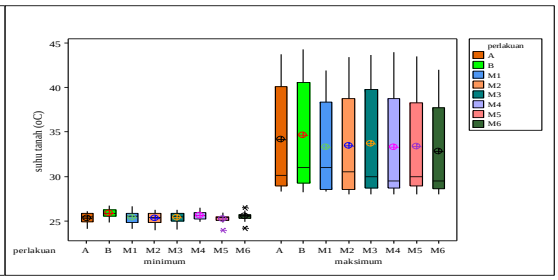

Fig 2: Minimum and Maximum Soil Temperature on 12th-48th Days After Mulch Application

The soil humidity in organic mulch treatment and BSPM was higher and more stable than without using mulch (Figure 3); as mentioned in previous study, the soil humidity in the treatment without using mulch shows a lower value than the treatment of plastic mulch and sawdust by 4.5% (Masarirambi et al., 2013). The intensity of the light received showed similar values in all treatments, while the intensity of the reflected light in BSPM and organic sheet mulch treatments tended to be higher and more stable than without using mulch (Figures 4). The intensity of the reflected light was influenced by the color of the soil surface (mulch treatment). The percentage of the transmitted and the reflected light on the grey paper mulch treatment is 20% and 25% higher compared to the BSPM treatment (Brault, Stewart, & Jenni, 2002b).

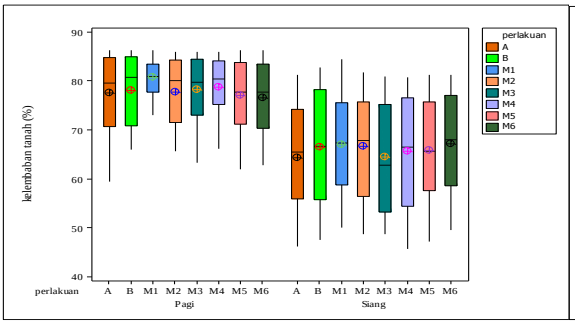

Fig 3: Maximum and Minimum Soil Humidity on 12th - 48th Days After Mulch Application

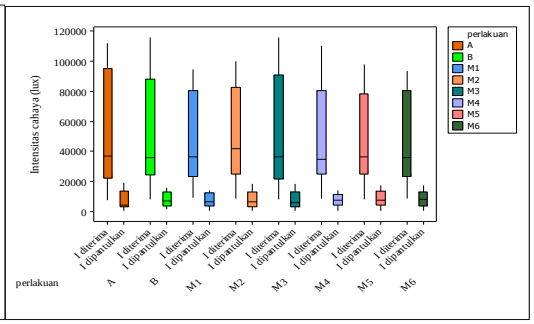

Fig 4: Intensity of the Received and Reflected Light on the 12th – 48th Days After Mulch Application

Table 3: Physical Test of Various O

Treatment	Grammatur (g/m^2)	Absorbsivity (g/m^2)	Water content (%)	Tensile strength (kg/cm^2)	Density (g/cm^3)	Thickness (cm)
M1 (30:60:10)	226.90	1024.56	13.33	0.05	0.26	0.10
M2 (35:55:10)	255.22	1284.94	12.83	0.06	0.23	0.11
M3 (40:50:10)	259.50	1260.06	13.51	0.03	0.20	0.10
M4 (45:45:10)	195.78	1189.44	31.03	0.01	0.20	0.13
M5 (50:40:10)	267.83	1086.22	12.41	0.04	0.24	0.10
M6 (55:35:10)	230.44	868.56	12.78	0.002	0.21	0.09

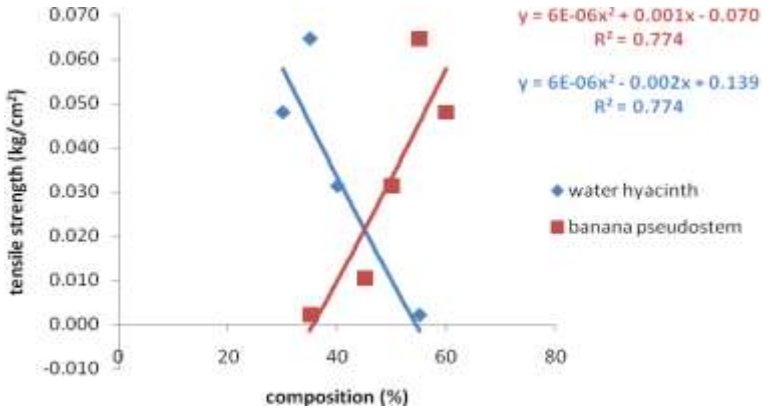

Fig 5: Scatter plot between banana pseudostem and water hyacinth composition towards tensile strength

Physical test of organic mulch sheet showed there was not significant difference between various organic mulch sheet composition. Organic mulch sheet grammatur include duplex carton and heavier than biodegradable paper made before (Indonesia Standarization Institution (BSN), 2008). However, asorsivity of organic mulch sheet higher than previous study that reached 38% (Djojowasito, Ahmad, & Wijaya, 2007). High absorsivity can prevent excess water or flooding on soil surface also reservation soil temperature and humidity. Tensile streght of organic mulch sheet lower than previously (Djojowasito et al., 2007; Faezah, 2015; Iriany et al., 2016; Lee et al., 2003; Lumbanbatu, 2008). Maximum tensile strength reached by combination of 35% water hyacinth and 55% banana pseudostem. Increasing composition of water hyacinth inversely with tensile strength and increasing composition of banana pseudostem tended to increase of tensile strength (fig. 5). The paper layer helps the mulch maintain a tight fit with the ground, helps the mulch resist penetration by

weeds,makes the mulch more opaque (i.e. it blocks the sun from the ground) and it holds moisture (Lee et al., 2003). Density of mulch represent density of fibre composing mulch also inversely with thickness and absorsivity High presipitation due to water content of organic mulch paper increased with the result torn of mulch and weed can penetrated easly.

4. Conclusion

Based on the result of the research, the use of organic sheet mulch was significant compared to the treatment A (without mulch) with 72.18% of yield increase, but it was not significant in various compositions and treatment B (BSPM) towards the growth and the yield as observable variables.

References

[1] Ajithkumar, B., Karthika, V. ., & Rao, V. U. . (2014). Crop weather relationships in C auliflower (Brassica oleracea var . Botrytis L .) in the Central zone of Kerala. Mannuthy, thrissur: Kerala Agricultural University.

[2] Bhatnagar, R., Gupta, G., & Yadav, S. (2015). A Review on Composition and Properties of Banana Fibers. International Journal of Scientific & Engineering Research, 6(5), 143–148. Retrieved from www.ijser.org

[3] Brault, D., Stewart, K. A., & Jenni, S. (2002a). Growth, development, and yield of head lettuce cultivated on paper and polyethylene mulch. HortScience, 37(1), 92–94.

[4] Brault, D., Stewart, K. A., & Jenni, S. (2002b). Optical properties of paper and polyethylene mulches used for weed control in lettuce. HortScience, 37(1), 87–91.

[5] Chen, H. (2014). Chemical Composition and Structure of Natural Lignocellulose. In Biotechnology of Lignocellulose: Theory and Practice (pp. 25–72). Beijing: Chemical Industry Press. https://doi.org/10.1007/978-94-007-6898-7

[6] Coolong, T. (2012). Mulches for Weed Management in Vegetable Production. Weed Control, Dr. Andrew Price (Ed.). Retrieved from http://cdn.intechopen.com/pdfs/29919/InTech-Mulches_for_weed_management_mulches_for_weed_management.pdf

[7] Courter, J. ., Hopen, H. ., & Vandemark, J. . (1970). Mulching Vegetables. The University of Georgia Cooperative Extension.

[8] Damayanti, D. R. R., Aini, N., & Koesriharti. (2013). The Study of Organic Mulch Application on the Growth and Yield of Red Pepper (Capsicum annuum L.). Jurnal Produksi Tanaman, 1(2), 25–32.

[9] Darmawan, I. G. P., Nyana, I. D. N., & Gunadi, I. G. A. (2014). Influence of Plastic Mulch on Crop Chili Pepper (Capsicum frutescens L.) Off Season in the Kerta village. E-Jurnal Argoekoteknologi Tropika, 3(3), 148–157.

[10] Direktorat Jendral Hortikultura. (2014). Statistic of Horticulture Production on 2013. (A. Promosiana, Ed.). Jakarta.

[11] Direktorat Jendral Hortikultura. (2015). Statistic of Horticulture Production on 2014. (H. D. Atmojo, Ed.). Jakarta: Direktorat Jenderal Hortikultura, Kementrian Pertanian.

[12] Djojowasito, G., Ahmad, A. M., & Wijaya, K. (2007). An Evaluation of Sheet Mulch Made from a Combination of Hyacinth (Eichornia crassipes Mart. Solms) and Musa paradisiaca L. Biomass Decomposed with Either Urea or Caustic Soda. Jurnal Teknologi Pertanian, 8(2), 110–118.

[13] Faezah, K. (2015). Reinforcing Mechanical , Water Absorption and Barrier Properties of Poly (Lactic Acid) Composites with Kenaf-Derived Cellulose of Thermally-Grafted Aminosilane. 564 Pertanika J. Trop. Agric. Sci, 38(4), 563–573. Retrieved from http://www.pertanika.upm.edu.my/

[14] Haapala, T., Palonen, P., Tamminen, A., & Ahokas, J. (2015). Effects of different paper mulches on soil temperature and yield of cucumber (Cucumis sativus L .) in the temperate zone. Agricultural and Food Science, 24, 52–58.

[15] Ibarra, L., Flores, J., & Díaz-Pérez, J. C. (2001). Growth and yield of muskmelon in response to plastic mulch and row covers. Scientia Horticulturae, 87(1–2), 139–145. https://doi.org/10.1016/S0304-4238(00)00172-2

[16] Ibarra-Jiménez, L., Lira-Saldivar, R. H., Valdez-Aguilar, L. A., & Lozano-Del Río, J. (2011). Colored Plastic Mulches Affect Soil Temperature and Tuber Production of Potato. Acta Agriculturae Scandinavica, Section B - Plant Soil Science, 61(4), 365–371. https://doi.org/10.1080/09064710.2010.495724

[17] Indonesia Standarization Institution (BSN). SNI 0123:2008 Duplex Cardboard (2008). Indonesia.

[18] Indriyati, W., Musfiroh, I., Kusmawanti, R., Sriwidodo, & Hasanah, A. N. (2016). Characterization of Carboxymethyl Cellulose Sodium (Na-CMC) from Water Hyacinth (Eichhornia crassipes (Mart.) Solms) Cellulose) Growing in Jatinangor and Lembang. IJPST, 3(3), 100–110.

[19] Iriany, A., Lestari, R., & Chanan, M. (2016). Examining Organic Mulch Sheet on The Growth and Yield of Shallot (Allium ascalonicum L .). Malang.

[20] Islam, M. M. (2013). Effect of Organic Manures and Mulching on Growth and Yield of Broccoli. Sher-e-Bangla Agricultural Uniersity.

[21] J, S., Yusoh, M., & W.S, R. (2015). Tensile Strength of Some Natural-Fibre Composites. Pertanika J. Trop. Agric. Sci., 38(4), 575–582.

[22] K, I., W, R., Zaidon, A., F, A., & A.R, N. (2012). The Effects of Crude Oil Boiling Treatment on Physical Properties of Bambusa vulgaris var . Striata (Buluh Gading). Pertanika Journal Science and Technology, 35(4), 823–832. Retrieved from http://www.pertanika.upm.edu.my/

[23] Kasirajan, S., & Ngouajio, M. (2012). Polyethylene and biodegradable mulches for agricultural applications: A review. Agronomy for Sustainable Development, 32(2), 501–529. https://doi.org/10.1007/s13593-011-0068-3

[24] Khakalo, A., Filpponen, I., Johansson, L., Vishtal, A., Lokanathan, A. R., Rojas, O. J., & Laine, J. (2014). Reactive & Functional Polymers Using gelatin protein to facilitate paper thermoformability. Reactive and Functional Polymers, 85, 175–184. https://doi.org/10.1016/j.reactfunctpolym.2014.09.024

[25] Law, D. M., Rowell, A. B., Snyder, J. C., & Williams, M. A. (2006). Weed control efficacy of organic mulches in two organically managed bell pepper production systems. HortTechnology, 16(2), 225–232.

[26] Lee, P. F., Cornelius, E. C., Potnis, P. S., Cleveland, C. S., Knauf, G. H., & Creek, B. (2003). Biodegradable Paper Based Agricultural Substrate. United States. https://doi.org/10.1016/j.(73)

[27] Li, K., Fu, S., Zhan, H., Zhan, Y., & Lucia, L. A. (2010). Analysis of the chemical composition and morphological structure of banana pseudostem. BioResources, 5(2), 576–585. https://doi.org/10.15376/biores.5.2.576-585

[28] Lumbanbatu, K. (2008). Fabrication and Characterization on Papers Made from Hyacinth Pulp. Universitas Sumatera Utara.

[29] Main, N. M., Talib, R. A., Ibrahim, R., Rahman, R. A., & MOhamed, A. Z. (2014). Suitability of Coir Fibers as Pulp and Paper. Agriculture and Agricultural Science Procedia 2, 2, 304–311. https://doi.org/10.1016/j.aaspro.2014.11.043

[30] Masarirambi, M. T., Mndzebele, M. E., Wahome, P. K., & Oseni, T. O. (2013). Effects of White Plastic and Sawdust Mulch on " Savoy " Baby Cabbage (Br assica oleracea var . bullata) Growth , Yield and Soil Moisture Conservation in Summer in Swaziland, 13(2), 261–268. https://doi.org/10.5829/idosi.aejaes.2013.13.02.1813

[31] Miles, C., Wallace, R., Wszelaki, A., Martin, J., Cowan, J., Walters, T., & Inglis, D. (2012). Deterioration of potentially biodegradable alternatives to black plastic mulch in three tomato production regions. HortScience, 47(9), 1270–1277.

[32] Nata, I., Niawati, H., & Muizliana, C. (2013). Utilization of Water Hyacinth (Eichornis crassipes) Cellulose Fiber as Raw Material of Paper Making : Isolation and Characterization. Konversi, 2(2). Retrieved from http://ppjp.unlam.ac.id/journals/index.php/konversi/article/view/75

[33] Ramesh, M., Ananda, T. S., Aswin, U. S., Eashwar, H., & Deepa, C. (2014). Processing and Mechanical Property Evaluation of Banana Fiber Reinforced Polymer Composites. In Procedia Engineering (Vol. 97, pp. 563–572). Elsevier B.V. https://doi.org/10.1016/j.proeng.2014.12.284

[34] Respati, E., Komalasari, W. B., Widyawati, Manurung, M., Sehusman, & Supriyati, Y. (2013). Monthly Bulletin of Macro Indicator of Agricultural Sector. (Sarabella, Ed.). Jakarta: Pusat Data dan Sistem Informasi Pertanian, Kementrian Pertanian.
[35] Respati, E., Komalasari, W. B., Widyawati, Manurung, M., Sehusman, & Supriyati, Y. (2015). Monthly Bulletion of Macro Indicator of Agricultural Sector. (Sarabella, Ed.). Jakarta: Pusat Data dan Sistem Informasi Pertanian, Kementrian Pertanian.
[36] Salim, M. M. ., Khan, A. S. M. M. ., Sarkar, M. A., Hossain, M. A., & Hossain, M. J. (2008). Growth and Yield of Cauliflowers as Influenced by Polyethylene Mulching. Int. J. Sustain. Crop Prod., 3(6), 88–90.
[37] Sinkevičienė, A., Jodaugienė, D., Pupalienė, R., & Urbonienė, M. (2009). The influence of organic mulches on soil properties and crop yield. Agronomy Research, 7(I), 485–491.
[38] Sutyasmi, S. (2012). Recycling of Shaving Waste from Tanning Industry for Art Paper. Majalah Kulit Karet Dan Plastik, 28(2), 113–121. https://doi.org/http://dx.doi.org/10.20543/mkkp.v28i2.114
[39] Tumolva, T., Ortenero, J., Kubouchi, M., & City, Q. (2013). Characterization and Treatment of Water Hyacinth Fibers for NFRP Composites. In International Conference on Composite Materials (pp. 1–11).