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Weed Vegetation around Red Dragon Fruit Plants: *Hylocereus polyrhizus*

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Abstract: Increasing red dragon fruit productivity faces management weed problem. This study aims to investigate the structure and composition of weeds around dragon fruit plants, the presence of each growth form and dominant weed species, the similarity index between weeds of dragon fruit plants and other crops, and the physicochemical conditions at Sabila Farm in Yogyakarta. The total farm area of each crop was divided into 50 square-shaped areas using a gridline, so all of the areas have the same size. The size of these areas was adjusted in accordance with the total area of the studied plants. Subsequently, a 1m x 1m plot was put in each of 15 areas chosen randomly from the 50 areas. The structure and composition of weed vegetation in the dragon fruit farm responded to soil condition, rooting systems and psychochemical condition of dragon fruit plants. The formation of the structure and composition of the weed vegetation could be attributed to a possible reciprocal relation from the interaction patterns between the weeds and the dragon fruit plants. Red dragon fruit's weed vegetation was specific and was influenced by interaction patterns that could be formed between the weed communities and the fruit crops.

Key words: weed, vegetation, red dragon fruit, ecology, ecosystem

1. Introduction

The need for dragon fruit in Indonesia is getting higher, triggering the increasing number of dragon fruit farms. As a relatively new commodity in Indonesia, dragon fruit has been very popular among people because it has a high economic value and rich in health-related benefits.

Although dragon fruit plants have great potential and are being developed in Indonesia. Its domestic production is often constrained. The growth of the farms in Indonesia is not significant enough to increase the production of the fruit in the country. This is because dragon fruit plants are often attacked by pests or diseases. Although various preventive measures have been done to control them, these cannot stop the spread of the diseases and pests. An important factor that causes less effective prevention of these problems is weed control technique that is less suited to soil condition and the structure of floor vegetation. To carry out a proper weed control techniques it is necessary to know in advance the composition and structure of weed vegetation in a dragon fruit farm area [1]. This is in accordance with Winarsih (2007) [2], who states that in addition to pests and diseases, the growth of weeds can cause the emergence of the diseases and pests for fruit crops.

Weeds that are able to live in farm areas are likely to interact with the fruit crops. Therefore, it is certain that each fruit has weed vegetation with different compositions and structures. In this study, srikaya fruit was used as the comparison for dragon fruit. Both fruits were in the same farm, Sabila Farm.

This study aims to investigate the structure and composition of weeds around dragon fruit plants, the presence of each growth form and dominant weed species, the similarity index between weeds of dragon

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fruit plants and other crops, and the physicochemical conditions at Sabila Farm in Yogyakarta.

2. Material and Methods

This research was conducted from August 4 to 18, 2015 at Sabila Farm located on Kaliurang Street km 19.5, Sleman Regency, Special Region of Yogyakarta. Geographically, Sabila Farm is located at the foot of Mount Merapi with an altitude of about 500-550 meters above sea level. Rainfall in the area is between 3000 and 4488 mm per year. The average temperature throughout the year is 26.5°C. The research site is a 5 ha dragon fruit farm with a spacing of 3 m × 3 m or 2.5 m × 2.5 m. Sabila Farm lies on the coordinates of S7O39'12.5532 "E110O25'27.5988". The total farm area of each crop was divided into 50 square-shaped areas using a gridline, so all of the areas have the same size. The size of these areas was adjusted in accordance with the total area of the studied plants. Subsequently, a 1 m × 1 m plot was put in each of 15 areas chosen randomly from the 50 areas. The tools used in this research were the plot (1 m × 1 m), places for dry herbaria, pH meter, soil tester, and lux meter.

A total of 30 plots made of ropes and stakes were placed randomly, but only 15 of them were put in the 15 selected areas. In each plot, weed species were identified, and the members of each species were counted. Unidentified weeds were made herbariums and identified by consulting the book of “A Field Guide: Tropical Plant of Asia” [3]. Subsequently, the data were analyzed to obtain density, relative density, frequency, relative frequency, and important value. Physicochemical parameters of the environment in each plot (sampling spot) including soil moisture, soil acidity, and light intensity were measured using soil tester, pH meter, and lux meter.

After all parameters were obtained, the data were analyzed. These included density, frequency, relative frequency, relative density, importance value, and similarity index between dragon fruit tree weeds and other plant weeds in the farm.

The data for the analyses on the weeds structure are density and frequency. Subsequently, relative density and relative frequency were calculated [4]. The next step was comparing the structure and diversity of weeds around the plants of the red dragon fruit and srikaya fruit by using Sorensen Similarity Index (IS). The following is the formula.

Density of species A : $\frac{\text{Individual calculation of species A}}{\text{Volume of water sample (l)}}$

Relative Density : $\frac{\text{Individual Density of species A}}{\text{Total of community density}} \times 100\%$

Frequency : $\frac{\text{Presence of species A in each sampling spot}}{\text{Total of sampling spots per location}}$

Relative Frequency : $\frac{\text{Individual Frequency of species A}}{\text{Total of community frequency}} \times 100\%$

Important Value : Relative Density + Relative Frequency

(Wetzel and Likens, 1991) [5]

Similarity Index: $\boxed{\mathrm{IS} = \frac{2C}{A+B}}$

The value of Sorensen Similarity Index (IS) is obtained from multiplying C value by 2 or the smallest quantitative value of a species in two compared sites divided by the sum of the total quantitative values of the first plant (A) and the total quantitative value of the second plant (B).

3. Results and Discussion

3.1 The Composition and Structure of Weed Vegetation around Dragon Fruit Plants

Based on the analysis results of weed vegetation in the area of red dragon fruit plant SF 1, there were 1401 individuals, 14 families, 26 genera, and 31 species. In addition, there are 2 families with 9 species of grass category, 7 families with 11 species of herbaceous category, and 9 families with 11 species of shrub category. The dominant family was the *Asteraceae* family consisting of 6 species. Other families with significant number included *Rubiaceae* with 3 species and *Cleomaceae* with 1 species (Table 1).

Table 1 Composition and structure of weed vegetation in dragon fruit garden Sabila farm.

Growthform	Famili	Number of Spesies	relative density (%)	relative frecuency (%)	Important value (%)
Grass					
Poaceae	*Agrotis gigantean*	1	0.07	0.72	0.79
	Axonopus compressus	1	0.07	0.72	0.79
	Cynodon dactylon	1	0.07	0.72	0.79
	Digitaria setigera	1	0.07	0.72	0.79
	Echinochloa colonum	4	0.29	0.72	1.01
	Eleusine indica	3	0.21	1.44	1.65
	Paspalum conjugatum	16	1.14	2.88	4.02
Cyperaceae	*Cyperus kyllingia*	5	0.36	2.16	2.52
	Cyperus rotundus	11	0.79	3.6	4.39
Herbs					
Amaranthaceae	*Amarantus luvidus*	14	1	1.44	2.44
	Amarantus sp.	40	2.86	3.6	6.46
Asteraceae	*Eclipta prostrate*	5	0.36	1.44	1.8
	Crassocephalum crepidiodes	6	0.43	2.88	3.31
	Ageratum conyzoides	135	9.64	5.04	14.68
Rubiaceae	*Borreria repens*	1	0.07	0.72	0.79
	Borreria alata	27	1.93	5.76	7.69
Piperaceae	*Peperomia pellucida*	6	0.43	0.72	1.15
Convolvulaceae	*Dichondra repens*	113	8.07	7.91	15.98
Euphorbiaceae	*Euphorbia hirta*	18	1.28	7.19	8.47
Portulacaceae	*Portulaca oleracea*	13	0.93	0.72	1.65
Shrub					
Oxalidaceae	*Oxalis barrelieri*	3	0.21	1.44	1.65
	Oxalis corniculata	12	0.86	3.6	4.46
Phyllanthaceae	*Phyllantus niruri*	59	4.21	10.07	14.28
	Phyllantus sp.	2	0.14	0.72	0.86
Asteraceae	*Emilia soncifolia*	3	0.21	2.16	2.37
	Galinsoga parviflora	335	23.91	6.47	30.38
	Acmella panicullata	1	0.07	0.72	0.79
Rubiaceae	*Hedyotis corymbosa*	172	0.86	3.6	4.46
Plantaginaceae	*Scopana dulcis*	182	12.99	5.04	18.03
Onagraceae	*Ludwigia hyssopifolia*	1	0.07	0.72	0.79
Cleomaceae	*Cleome rutidosperma*	210	14.99	10.07	25.06

Weed vegetation in the dragon fruit farm was dominated by shrubs and herbs, while grass weeds were relatively fewer. The shrubs were dominant as they have high competitiveness and survival capacity in dry or slightly shaded soil. In addition, their structure is more resistant when living side by side with dragon fruit with a root system that can squeeze the surrounding weeds. Moreover, *Asteraceae* rejects insects, so this plant has great potential to be bio-insecticides and a multipurpose drug [6].

The most common weed species that were found were *Galinsoga parviflora*. This weed is one of the most common members of *Asteraceae* found in fertile land. This plant is able to live in hot areas even with minimum shade. *Galinsoga parviflora* has a strong capability to absorb water, but this species can only thrive on very fertile land but not on dry land.

Therefore, this species can be used as an indicator of soil quality. This plant has the ability to grow faster to compete with other small plants. Its ability to complete his life cycle in a short time can make this plant abundant on a farm land. This species is not harmful to the farm crops. On the other hand, *Galinsoga parviflora* in fact has potential as a plant that has antibacterial and antifungal activity [7]. In addition, the existence of weeds *Amaranthus* sp. and *Galinsoga parviflora* Cav. in the farm invites Arthropod predators that can prey on plant pests [6].

Meanwhile, some grass species such as *Agrotis gigantean*, *Axonopus compressus*, *Cynodon dactylon*, and *Digitaria setigera* had the smallest number with only one plant for each species. This was because grass plants are difficult to grow in the red dragon fruit farm. Grass growth was hampered by the root structure of dragon fruit plants that does not allow the grass to grow. This root structure makes it difficult for the grass' fibrous roots to function well. Furthermore, the root structure of dragon fruit plants makes the soil texture relatively harder.

In addition, weeds that can cause considerable losses, such as *Axonopus compressus*, *Boreria* sp., *Cynodon dactylon*, *Cyperus* sp., *Echinochloa colonum*, *Eleusine indica*, and *Paspalum conjugatum*, were also found. These weed species have considerable negative effect on farm crops because in addition to being the ancestors of pests and diseases, their population growth will absorb many of the nutrients contained in the soil. Furthermore, the researchers also found some weeds that are not too dangerous for the dragon fruit plants, but they still have to be controlled. These weeds were *Ageratum conyzoides*, *Cyrtococcum* sp., and *Digitaria* sp.

The results of data analysis on weed vegetation structure in area Sabila Farm 1 (SF 1) at the dragon fruit farm, Sabila Farm, are shown in Table 1 that present important value of each weed. For grass weeds, the highest important value (4.38%) belonged to *Cyperus rotundus*. In addition, *Paspalum conjugatum* had an important value of 4.02%. These show that *Cyperus rotundus* and *Paspalum conjugatum* were the most dominant among other types of grasses. For herbaceous weeds, the highest important value (15.98%) belonged to *Dichondra repens* followed by *Ageratum conyzoides* with an important value of 14.67%. For shrub weeds, the highest important value (30.39%) belonged to *Galinsoga parviflora*. It is an annual herb found in most temperate and subtropical regions of the world as a weed of many crops and waste land. *Galinsoga parviflora* is highly competitive and quickly spreads and becomes dominant in a field. A study by Rai and Tripathi (1984) [8] indicated that at higher altitude, that weed was more successful as indicated by its higher population density, longer life of its first and second cohorts and greater biomass production in crop fields. Seedling recruitment and survivorship of cohorts were significantly influenced by mode of cultivation, crop type and altitude. The growth of the weed was affected by altitude and crop type as indicated by its poor performance in radish field at lower altitude than at higher altitude [9]. *G. parviflora* can be invasive species which invade agricultural and other disturbed areas in most temperate and subtropical regions of the world [10]. In addition, there are several species of shrub weeds that had high important values, among which are *Cleome rutidosperma* (25.06%), *Hedyotes corymbosa* (20.19%), and *Scoparia dulcis* (18.03%) (Table 1). This proved that shrub weeds were very dominant in area SF1. This was because shrub weeds had relatively stronger roots than grass and herb weeds. Root system became very important for them to grow on the dragon fruit farm because the root structure of dragon fruit plants was strong and could reach a relatively wide area around the plants, so it can suppress weed populations with weak root systems. Red Dragon Fruit have an extensive root system. That condition makes other plants around the red dragon fruit stressed [11]. In addition, Sabila Farm (SF 1) is placed in Merapi mountain area. Generally, Mountain clusters that inhabit the newly arable land are characterized by the highest disturbance level, soil compactness level, total natural species, and total shrubs, but the lowest number of weeds and species diversity and evenness [12].

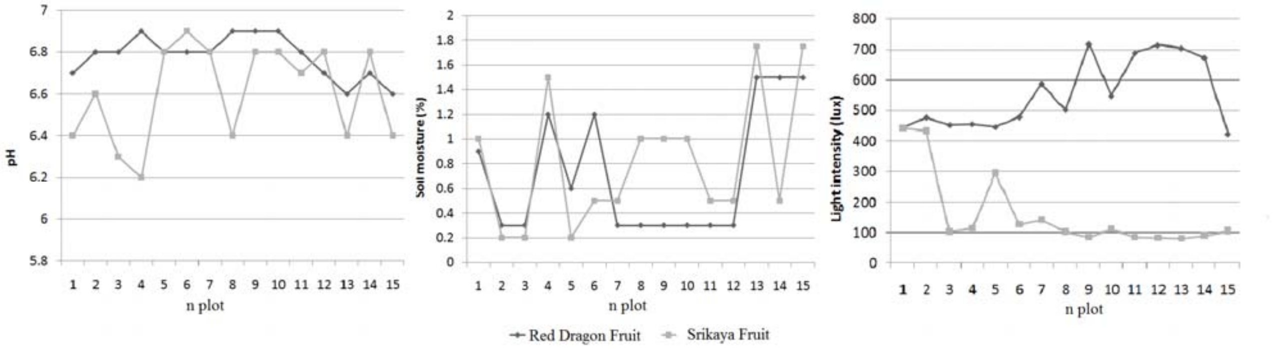

Fig. 1 Environmental condition in red dragon fruit area and Srikaya fruit area: (a) soil pH, (b) soil moisture, and (c) light intensity.

3.2 Similarity Index and Physicochemical Condition

Sorensen similarity index was obtained through the comparison between weed vegetation around the dragon fruit plants and srikaya fruit trees. Weeds around srikaya trees were selected in the calculation of the similarity index because srikaya trees had a different structure as they had a relatively larger shade than that of dragon fruit plants. In srikaya farms weeds that relatively enjoy sun exposure respond to this condition.

The result of the calculation of the similarity index was 36.41%, so it can be said that the structure of weed vegetation in the dragon fruit farm and the srikaya farm was very different. The similarity index in both vegetations is said to be equal if the similarity value of the two vegetations is > 60%. This difference was influenced by interaction patterns that could be formed between the weed communities and the fruit crops. That result also is significantly influenced by two species, that is *Galinsoga parviflora* which is not invented in srikaya area but became the most dominant species in red dragon fruit's weed vegetation, and *Emilia sonchifolia* which is not invented in red dragon fruit area but the most dominant species in srikaya's weed vegetation. In the other hand, srikaya's weed vegetation is dominated by herb species, but red dragon fruit's weed vegetation is dominated by shrub species. It can be influenced by canopy cover of main plant and root system of main plant. The dragon fruit canopy is narrower than srikaya canopy. It makes light intensity in the dragon fruit area higher than srikaya area, so that herb can grow as good as in srikaya area.

From the measurement of abiotic environmental factors, the researchers obtained information about environmental factors comprising soil pH, light intensity, and soil moisture. The soil pH was between 6.6 and 6.7. This shows that soil tended to have a neutral pH, so that any plant including weeds can grow well (Fig. 1). The measured light intensity was between 400 and 720 lux. This shows that the light intensity was high enough although some of the sun light was blocked by the red dragon fruit plants. Such a light intensity would allow many species of weeds to grow well (Table 2). In addition, the measured soil moisture was not more than 1.5%, and the average of soil moisture level in each plot was 0.7%. This soil moisture was quite low, so that the growth of some

Table 2 Number of weed individual and weed species around dragon fruit and Srikaya fruit plants.

Parameter	Dragon Fruit Area	Srikaya Fruit Area
Number of individual	1401	1159
Grass	43	62
Herbs	378	585
Shrub	980	512
Number of spesies	31	27
Grass	9	6
Herbs	11	10
Shrub	11	11

weed species was inhibited, especially weeds belonging to herbaceous species that require a lot of water supply. In the other hand, soil moisture relate with soil compactness. Soil compactness variable showed correlations with species richness and the cover values of the species. Moreover, soil compactness is related to high clay and organic matter content which exhibited significant differences between mountain and lowland farms [12].

4. Conclusion

The structure and composition of weed vegetation in the dragon fruit farm responded to soil condition, rooting systems and psychochemical condition of dragon fruit plants. The formation of the structure and composition of the weed vegetation could be attributed to a possible reciprocal relation from the interaction patterns between the weeds and the dragon fruit plants. The dominant shrub weeds around the dragon fruit plants were related to their ability to endure being squeezed by the dragon fruit roots and thrive on soil with low moisture. This interaction pattern did not always have a negative impact as it can correlate with the increase in productivity of dragon fruit plants.

References

[1] Perdana Elsa Olivia and Chairul dan Zuhri Syam, Analisis Vegetasi Gulma Pada Tanaman Buah Naga Merah (Hylocereus polyrhizus, L.) di Kecamatan Batang Anai, Kabupaten Padang Pariaman, Sumatera Barat, *Jurnal Biologi Universitas Andalas (J. Bio. UA.)* 2 (2013) (4) 242-248.

[2] S. Winarsih, *Mengenal dan Membudidayakan Buah Naga*, Aneka Ilmu. Jakarta, 2007.

[3] D. H. Engel and S. Phummai, *A Field Guide: Tropical Plant of Asia*, Timber Press, Inc. Portland, USA, 2000.

[4] G. M. Barbour, J. K. Burk and W. D. Pitts, *Terrestrial Plant Ecology*, The Benyamin Cummings Publishing Company Inc., Los Angeles, USA, 1987.

[5] R. G. Wetzel and G. E. Likens, *Limnological Analysis* (2nd ed.), Springer, Verlag, New York, 1991.

[6] R. Armadiah, Ketertarikan Arthropoda Predator Pada Tumbuhan Gulma di Lahan Pertanian Brokoli (Brassica oleracea var. Botrytis L.) Desa Sumber Brantas Kecamatan Bumiaji Kota Batu, thesis, Jurusan Biologi, FMIPA, Universitas Negeri Malang, 2014.

[7] J. Namukobe, J. M. Kasenene, B. T. Kiremire, R. Byamukama, M. Kamatenesi-Mugisha, S. Krief, V. Dumontet and J. D. Kabasa, Traditional plants used for medicinal purposes by local communities around the Northern sector of Kibale National Park, Uganda, *Journal of Ethnopharmacology* 136 (2010) 236-245.

[8] J. P. N. Rai and R. S. Tripathi, Effect of herbivory by the slug, Mariaella dussumieri and certain insects on growth and competitive success for two sympatric annual weeds, *Agriculture Ecosystems and Environment* 13 (1985) 125-137.

[9] D. Kagima, Bibliography & biology outline of galinsoga spp, 2000, available online at: http:// www.agron.iastate.edu/~weeds/weedbiollibrary/517stude nt pages/2000/Galinsogad.htm.

[10] D. F. Waterhouse, The major arthropod pests and weeds of agriculture in South-East Asia, Canberra, Australia: Australian Centre for International Agricultural Research, 1993.

[11] D. Henkel-Johnson, S. Ellen Macdonald, E. W. Bork and B. R. Thomas, Influence of weed composition, abudance, and spatial proximity on growth in young hybrid poplar plantations, *Forest Ecology and Management* 362 (2016) 55-68.

[12] M. A. El-Sheikh, Weed vegetation ecology of arable land in Salalah, Southern Oman, *Saudi Journal of Biological Sciences* 20 (2013) 291-304.