

Morphological Characteristics and Biomass Production *Brassica rapa* var. Marco During the Dry Season

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Abstract. This study aimed to determine morphological, adaptability, and biomass production of *Brassica rapa* var. Marco planted in Karang Malang, Yogyakarta, Indonesia during the dry season. The seeds used were the introduced feed plants *Brassica rapa* var. Pillar from Crop Mark Seed Company New Zealand. The seeds were spread in 1 m² plots. Each plant had 3 replicates at the end of rainy season (March) and defoliation in September. The variables observed in this study were plant growth and plant morphology. Also, biomass production, dry matter (DM), and organic matter (OM) content of each plant were statistically analyzed by independent sample t-test. Biomass production was taken from the first and second defoliation (first regrowth). The plant morphology showed that the plants could develop well. The plant growth showed that dry matter production of *Brassica rapa* var. Pillar was 1.15 tonnes/ha/year. The first and second defoliation of *Brassica rapa* var. Marco produced 1.61 tonnes/ha (DM 9.89% and OM 79.99) and 2.47 tones/ha (DM 9.17% and OM 84.82%), respectively, indicating significant difference. It can be concluded that the varieties of *Brassica rapa* var. Marco can thrive when planted during the dry season in Yogyakarta.

Keywords: *Brassica rapa* var. Pillar, *Brassica rapa* var. Marco, adaptability, morphology, production

Abstrak. Penelitian ini bertujuan untuk mengetahui morfologi, daya adaptasi, dan produksi biomassa *Brassica rapa* var. Marco ditanam di Karang Malang, Yogyakarta, Indonesia selama musim kemarau. Benih yang digunakan adalah tanaman pakan introduksi yaitu *Brassica rapa* var. Pillar dari Crop Mark Seed Company Selandia Baru. Penanaman dilakukan pada petak seluas 1 m² dengan cara menebar benih. Setiap tanaman dilakukan 3 kali ulangan ditanam pada akhir musim hujan (Maret) dan pemotongan pada bulan September. Variabel yang diamati dalam penelitian ini adalah pertumbuhan tanaman dan morfologi tanaman. Juga, produksi biomassa, bahan kering (BK), dan kandungan bahan organik (BO) dari masing-masing tanaman dianalisis secara statistik dengan uji-test sampel independen. Produksi biomassa diambil dari produksi pemotongan pertama dan kedua (*regrowth* pertama). Morfologi tumbuhan menunjukkan bahwa tumbuhan dapat berkembang dengan baik. Pertumbuhan tanaman menunjukkan produksi bahan kering *Brassica rapa* var. Pillar 1.15 ton/ha/tahun. Pemotongan pertama *Brassica rapa* var. Marco menghasilkan 1.61 ton/ha (BK 9,89% dan BO 79,99%) Pemotongan kedua menghasilkan 2,47 ton/ha (BK 9,17% dan BO 84,82%). Hasil penelitian menunjukkan bahwa pemotongan pertama *Brassica* berbeda nyata dengan produksi Pemotongan kedua. Dapat disimpulkan bahwa *Brassica rapa* var. Marco bisa tumbuh subur bila ditanam di musim kemarau di Yogyakarta.

Kata kunci: *Brassica rapa* var. pillar, *Brassica rapa* var. Marco, daya adaptasi, morfologi, produksi

Introduction

Plant introduction is one way to improve forage crop quality in an area. *Brassica rapa* as fodder is also cultivated as feed in temperate regions. *Brassica rapa* variety which is widely developed in Indonesia is the vegetable type, namely *Brassica rapa* var. Parachinensis commonly referred to as mustard greens or bok choy or choy sum because the climate is suitable for plant development. *Brassica rapa* var. Parachinensis or bok choy comes from China which has been cultivated since 2.500 years ago (Zhao et al., 2005).

Brassica family belongs to several species used as animal feed since ancient times (Ayres and Clements, 2002). *Brassica* is generally sown in spring and late summer to provide high-quality feed in summer and autumn when the grass quality is often low, or in autumn and winter when quality pasture is limited. Seed production, dry matter, and yield index are higher in *Brassica* (El-Sherbeny et al., 2012). *Brassica* is a useful high of quality feed for livestock that is approaching maturity or for breeding ewe sheep (Collins et al., 2017). The potentials for nutritional attributes of forage

Brassica influence animal performance (Westwood, 2012). The highly competitive canopy properties of *Brassica* can help control weeds and increase the next perennial forage seeding in the pastoral renovation program. *Brassica* also functions as a temporary substitute for small trunked plants such as Alfalfa and other similar plants.

This study uses the varieties of *Brassica rapa* var. Marco that belongs to the *rape* type. *Brassica* from rape group is very effective in suppressing weed growth in pasture land (Judson et al., 2013). In addition to grow rapidly, this plant can also decompose quickly after being defoliated. It is very good at reducing soil surface compaction, functioning as a ground cover plant in winter, and capturing nitrogen from the soil around the plant roots. *Rape* is a type of short season *Brassica* and grows for 60 to 90 days in the planting season.

Brassica is a forage that has a high crude protein and mineral content. The nutrient content does not experience significant changes in each phase of its growth. Therefore, this plant can be used at any time without concerns about the nutrient content. This plant can also grow when the perennial plant has low productivity (Jung et al., 1984). *Brassica* can produce 5 to 12 tonnes/ha dry matter after 90 days of planting. High yields depend on adequate moisture and nutrient intake for plants. After defoliation, a minimum of 15 to 20 cm at the base of the *rape* must remain intact for the plant to regrow (Collins et al., 2017).

This study aimed to determine the growth ability and adaptability of *Brassica rapa* var. Marco or rape in Indonesia, which came from New Zealand.

Materials and Methods

The material used in this research was the seeds of *Brassica rapa* var. Marco (rape) from the Crop Mark Seed Company, New Zealand. Before used, the land was roundup first. The land

was plowed and then watered. Grass seeds to be spread, with a predetermined amount from New Zealand, which was 2 grams/m² seed of *Brassica rapa* var. Marco. The seeds planting method used was by spreading. Seeds that had been weighed, spread in plots with a size of 2 x 2 m, repeated 3 times, so that there were 3 plots observed in the first and second defoliation.

Plant height, stem diameter, width, and leaf length were measured before cutting. Plant height was measured from the stem above the ground to the heighest part of the plant. Plant length was straightened so that the maximum length of the plant was known. The number of leaves was calculated by counting all the leave in the plant. Biomass production was calculated based on fresh production and dry matter weight. While fresh production was determined by weighing the converted plant crown in tonnes/ha, dry matter production was calculated by converting plant weight (top) in tonnes/ha and multiplying it by dry matter content. Dry matter and organic matter were analyzed using proximate method (AOAC, 2005). Morphological data and research results were presented in descriptive form.

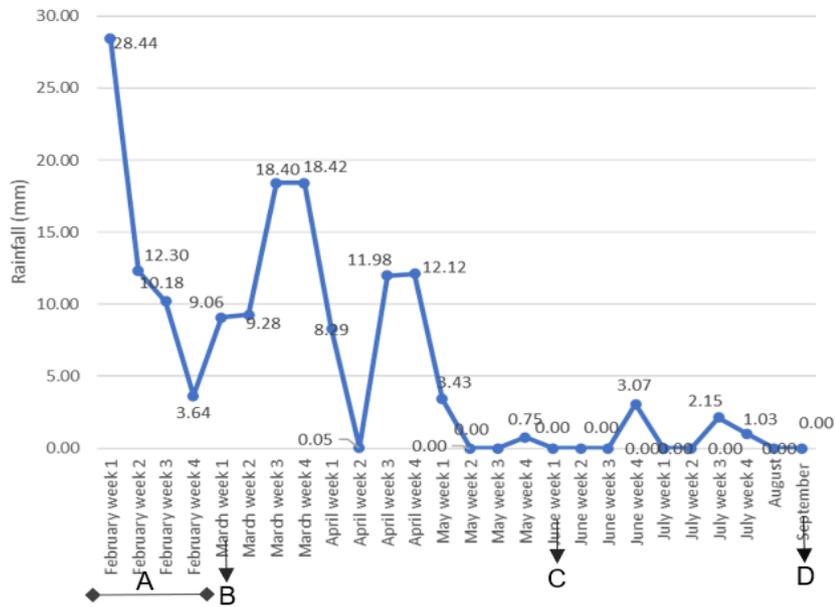
The data observed in this study were plant height, plant length, number of leaves, and biomass production. The first and second defoliation were analyzed using statistical analysis of independent sample t-test.

Results and Discussion

Rainfall data at the research site in Karang Malang, Yogyakarta during the study can be seen in Figure 1. The data was obtained from the Meteorology, Climatology, and Geophysics Agency as secondary data to determine the climatic conditions at the study site. Based on these data, it was known that the rainfall in the study area ranges from 0 mm to 28.44 mm.

In New Zealand, Rape is better to sow in early spring to late summer between September and February.

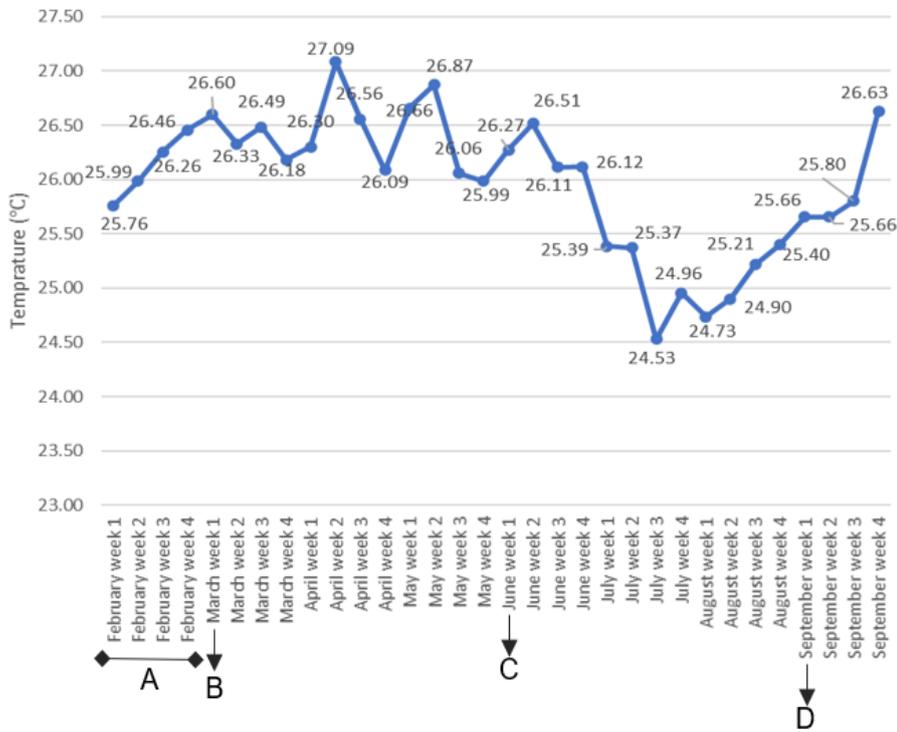
Rainfall



- A: Land Preparation
- B: Planting of *Brasscia rappa*
- C: 1st defoliation
- D: 2nd defoliation

Figure 1. Graph of rainfall in Yogyakarta in February – September 2019

Temperature



- A: Land Preparation
- B: Planting of *Brasscia rappa*
- C: 1st defoliation
- D: 2nd defoliation

Figure 2. Temperature graph in Yogyakarta from March to September 2019

Crop Mark Seed planted Rape in Canterbury from 2011 to 2013 with a production of 8.96 tonnes DM/ha (Seed, 2015). The average rainfall in the area is approximately 96.88 mm (Macara, 2014). In Yogyakarta, Rape was planted when the rainfall reached 18.42 mm in March 2019. The plants were cut when there was no rainfall or 0 mm. Rainfall in Yogyakarta was lower than rainfall in New Zealand at the time of the study. However, in this study, we watered the plant to control sufficient amount of hydration for the plant.

In New Zealand, Rape produces better when sown in early spring to late summer. Crop Mark Seed planted rape in Canterbury from 2011 to 2013 with a production of 8.96 tons DM/ha (Seed, 2015). The temperature in the area ranges from 10°C to 18°C (Macara, 2014). In Malaysia with tropical climate 25°C poduce the growth at 50 plants/m² size achieved in less than 30 days at low temperature growth (Maludin, 2020). Planting rape in Yogyakarta was carried out when the highest average temperature reached 27.09°C and the lowest was 24.3°C. The temperature in Yogyakarta is very different from that in New Zealand which is lower.

Based on the plant observations for 35 days, the plants had the same morphological characteristics as the plants growing in their natural habitat. The plant had broad leaves with an average plant height of 26.6 cm and an average plant length of 29.3 cm. Brassica can be used for grazing when the plant height has reached 30 cm. Rape has the good regrowth

ability that it can be used for grazing several times. Based on observations for 35 days after sowing, plant growth data were obtained in Table 1.

Brassica rapa var. Marco has a fairly good growth, characterized by a plant height that is almost the same as the plant height grown by the Crop Mark Seed Company in Ohaupo, New Zealand. Brassica cutting age is around 50 to 90 days with a minimum plant height of 30 cm. Turnip planted in Yogyakarta reached a height of 27.78 cm at the age of 35 days. Cutting of Brassica rapa var. Marco was done by pruning the plant 5 cm from the soil surface, so the remaining parts of the plant can grow back. Incorrect management can also result in plants producing more stems than leaves. While the leaves are easier to digest and very beneficial for livestock, the stems have low digestibility and palatability.

The second defoliation on Brassica was done in the 60 days after the first defoliation. The second defoliation was carried out when the plant height reached 38.90 cm and the average number of leaves per plant was 11. Brassica production can be optimized by rotational grazing management. The exact distance between the first grazing with the next grazing was 60 days, to have the optimum production of Brassica rappa var. Marco. Plant height after grazing or cutting also should not be less than 5 cm to make sure there was still the first leaf remaining on the plant.

Table 1. Average growth of *Brassica rapa* var. Marco in a few weeks of observation

Week	Plant height (cm)	Plant length (cm)	Number of leaves
I	3.13	3.87	1
II	6.01	8.90	1
III	14.75	19.89	4
IV	20.75	28.92	6
V	27.78	39.85	8

Table 2. Biomass production of *Brassica rapa* var. Marco at first defoliation (90 days) and second defoliation (60 days).

Parameters	First defoliation	Second defoliation (regrowth 1)
Biomass production (tonnes/ha)	1.61±0.25 ^a	2.47±0.10 ^b
Dry matter content (%)	9.89 ± 0.11 ^a	9.17±0.15 ^b
Organic matter content (%)	79.99 ± 0.43 ^a	84.32 ± 0.64 ^b

Note: ^{a,b} different superscripts on the same line show a significant difference (P<0.05)

The analysis result in Table 2 shows that the production of biomass, DM, and OM content between the first defoliation was significantly different (P<0.05) with the second defoliation. The difference was due to the increase in biomass production *Brassica rapa* var. Marco because of the defoliating effect. Defoliation promotes secondary shoot development but suppresses primary shoot development (Judson et al., 2013). *Brassica rapa* var. Marco is more sensitive to the frequency of defoliation than to the intensity of defoliation. Biomass production of *Brassica rapa* var. Marco averaged 0.192 tonnes of DM/ha in the first defoliation with a DM content of 9.89% and OM content of 79.99%. If it is estimated that in 1 year this plant is cut 6 times with a defoliation age of 60 days, then the production will be 1,156 tonnes DM/ha/year.

The production of *Brassica* with a defoliation age of 50 days yields 5 tonnes of DM/ha/year (Seed, 2015). Based on this research, it was known that the production of *Brassica* plants in Yogyakarta, Indonesia was slightly higher than the production of *Brassica* in New Zealand. This was influenced by several factors, including climatic factors and soil factors. The soil in Yogyakarta has a higher pH than the optimal soil pH for growth *Brassica*. Soil pH affects plant growth in two ways, namely the direct effect of hydrogen ions and the indirect effect on the availability of certain nutrients and affects the availability of N and P (El-Sherbeny et al., 2012). It is well established that N improves plant growth and yield. Nitrogen many have essential compounds, such as amino acid, nucleic acids to plant growth regulators (Munasik et al., 2012; Siddiqui et al., 2012). Climate also affects plant

growth and productivity, because it is related to the biological reactions that take place in plants (Purbajanti et al., 2009).

Conclusions

Based on the results of the study, it can be concluded that *Brassica rapa* var. Marco can be developed as animal feed in Indonesia. The plant has good growth, with a total biomass production of second defoliation is 2.47 tonnes/ha However, special attention is needed, especially when in planting at the end of the rainy season and cutting in the dry season.

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