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RESEARCH PAPER

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Evaluation of intercropping of sweet corn and leguminous cover crops at various doses of nitrogen on production and land equivalence ratio

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Abstract

The study was aimed to determine and evaluate the effect of different levels of nitrogen fertilizer doses and planting patterns on chlorophyll content, sweet corn yield, leguminous cover crop (LCC) yield and land equivalent ratio (LER). A factorial randomized block design with 2 factors and 3 replications was used throughout the experiment. The first factor was the dose of nitrogen consisting of 4 doses, namely 0, 50, 100 and 150 kg nitrogen ha^{-1}. The second factor was planting pattern, consisted of 3 planting pattern i.e. sole cropping sweet corn, intercropping sweet corn-*Centrocema pubescens* and intercropping sweet corn- *Pueraria phaseloides*. In addition, monoculture planting of *C. pubescens* and *P. phaseloides* was also established to calculate LER. The results showed that increasing the dose of nitrogen had an impact on increasing the chlorophyll content and fresh cob yield of sweet corn. The fresh forage yield of *P. phaseloides* was significantly higher than that of *C. pubescens*. The LER value of sweet corn-LCC intercropping was more than 1, which means that intercropping was more profitable than sweet corn planted as a monoculture. Based on the results, it may be concluded that the highest sweet corn ear production can be achieved with application of 50-100 kg N ha^{-1} and to obtain highest LCC forage production may be done by intercropping sweet corn-*P. phaseloides*.

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Introduction

Low farmer income is one of the main problems in the agricultural sector in Indonesia. Around 72.2% of farmers in Indonesia are small-scale farmers with characteristics of managed land area of less than 2 ha or the number of livestock raised is less than or equal to 2 animal units (AU) and a maximum income of IDR 18,800,000.00 (about US$1,200) per year (Central Bureau of Statistics, 2022). One AU is equivalent to one adult cow ready for slaughter with a body weight of 350 kg (Utomo, 2020).

Intercropping of food crops with forage legumes can be applied by small-scale farmers to increase their income. The advantage of it was that farmers obtain additional green forage without having to replace their main source of income (Mayberry *et al.*, 2021). Intercropping sweet corn-legume cover crops is one example of intercropping horticulture crops-forage legumes that may be tried by farmers. Intercropping sweet corn with LCC produces sweet corn cobs, sweet corn straw and LCC greens. Sweet corn cobs are the main source of income for farmers while sweet corn straw and LCC greens may be used as animal feed.

Types of forage legumes that may be cultivated by farmers include *C. pubescens* and *P. phaseloides* because both forage legumes are tolerant to shade (Teitzel and Peng, 1997; Halim, 1997) and their seeds are easily obtained by farmers. Planting LCC may reduce the use of nitrogen fertilizers because LCC have ability to fix atmospheric nitrogen through mutualistic symbiosis with Rhizobium and LCC may also reduce the loss of nutrients from the soil.

The recommended fertilization of sweet corn is 150 kg N/ha, 75 kg P_2O_5/ha and 50 kg K_2O/ha (Pangaribuan *et al.,* 2017). It was found that plant production in the low nitrogen fertilizer treatment (nitrogen fertilizer application 2/3 of the recommended dose) was not significantly different from nitrogen fertilization in the recommended dose treatment in the corn-legume intercropping system (Tan *et al.,* 2020; Zhang *et al.,* 2022). Corn-legume intercropping with low nitrogen fertilizer dose treatment resulted in significantly higher total grain production compared to the normal dose nitrogen fertilization treatment and without nitrogen fertilization (Chen *et al.,* 2017).

Previous studies have focused more on reducing the use of nitrogen fertilizers in corn-legume intercropping and no research has been found on reducing nitrogen doses in sweet corn-legume intercropping. Research on the effect of nitrogen doses of the sweet corn-LCC intercropping system needs to be conducted to determine the effect of nitrogen doses on the performance of both plants in the intercropping system. Nitrogen fertilization in the cereal-legume intercropping system was given to the cereal rows because the application of nitrogen fertilizer to the legume rows may reduce nitrogen fixation in legumes (Maitra *et al.,* 2021). Therefore, this study used various nitrogen dose treatments in the sweet corn-LCC intercropping system.

Based on previous studies, the performance of *C. pubescens* and *P. phaseloides* differs in intercropping systems with enset, cassava and oil palm. The production of *C. pubescens* was significantly higher than *P. phaseoloides* in the intercropping system with enset (*Ensete ventricosum* (Welw.) Cheesman) (Yemataw *et al.,* 2018). Meanwhile, different results were obtained in the production of *P. phaseoloides* was significantly higher than *C. pubescens* in the intercropping system with cassava (Suwarto, 2021). The production of *P. phaseloides* was significantly higher than *C. pubescens* at the age of 12 weeks after planting (WAP) (Yuniarti *et al.,* 2018). Therefore, research is needed to obtain information on the performance of *C. pubescens* and *P. phaseloides* in the intercropping system with sweet corn.

Materials and methods

Site description and experimental design

Field experiment was carried out from September to December 2023 at research field, Tembalang Campus, Diponegoro University, Semarang, Central Java, Indonesia. The experimental site is located at 7°2'42" - 7°3'27" South and 110°25'55" - 110°26'55" East with an altitude of 216 meters above sea level, average daily temperature of 30 – 32°C, average daily humidity of 65% rainfall of 12 - 184.5 mm/month (Central Bureau of Statistics, 2021). Soil properties and chlorophyll content analysis was conducted at Ecology and Plant Production Laboratory, Department of Agriculture, Faculty of Animal and Agricultural Sciences, Diponegoro University, Semarang, Central Java, Indonesia. Soil properties of research farm and climate properties throughout the experiment were shown at Table 1 and 2, respectively.

Table 1. Soil properties

Soil properties	Method	Value	Criteria*
pH	1:5 H_2O	6,39	Slightly acidic soil
Total Nitrogen (%)	Kjeldahl	0,13	Low
Potential P_2O_5 (mg/100g)	HCl 25%	89,71	Very high
Available P_2O_5 (ppm)	Olsen	124	Very high
Potential K_2O (mg/100g)	HCl 25%)	24,55	Moderate
C-organic (%)	Walkley and Black	1,64	Low
C/N		12,62	Moderate

*Standard Testing Center for Soil and Fertilizer Instrument, Ministry of Agriculture, Republic Indonesia (2023).

Table 2. Air temperature, air humidity, precipitation from september – december 2023

Month	Temperature (°C)			Average air humidity (%)	Precipitation (mm)
	Min.	Max.	Average		
September	23,58	36,09	29,27	66,43	5,00
October	25,25	36,72	30,74	65,07	17,9
November	25,55	34,95	30,79	70,20	216,80
December	25,56	33,40	30,15	72,48	253,80

Source: Central Java Agency of Meteorological, Climatological and Geophysical, 2023.

Factorial randomized block design with 2 factors and 3 replications was used throughout the experiment. The first factor was the dose of nitrogen consisting of 4 doses, namely 0, 50, 100 and 150 kg nitrogen ha^{-1}. The second factor was planting pattern, consisted of 3 planting pattern i.e. sole cropping sweet corn, intercropping sweet corn-*Centrocema pubescens* and intercropping sweet corn- *Pueraria phaseloides*. In addition, monoculture planting of *C. pubescens* and *P. phaseloides* was also established to calculate LER.

The experimental field was cleared, plowed, harrowed, and divided into 42 plots, namely 12 plots for single planting of sweet corn, 6 plots for single planting of LCC, and 24 plots for interplanting of sweet corn-LCC. Each plot was 4.8 m² (2 m × 2.4 m) with a distance between plots of 0.5 m.

Row spacing (RS) was 0.8 m and plant-to-plant distance (PPS) was 0.2 m for sweet corn in single and intercropping systems. The RS and PPS for LCC were 0.2 m both in single and intercropping systems. The distance between LCC and sweet corn was 0.3 m in the intercropping system. The LCC was planted first on September the 15, 2023 and sweet corn was planted 30 days later on October 15, 2023. Before planting, LCC seeds were soaked in a mixture of 2 parts boiled water (±100°C) and 1 part of normal temperature water (±28°C) for 2 hours. After planting, LCC seeds were inoculated with Legin containing *Rhizobium* Spp. for *C. pubescens* and *P. phaseoloides* at a dose of 25 g legin kg^{-1} seed. No treatment was given to sweet corn seeds. The number of seeds sown was 5 seeds/planting hole for LCC and 2 seeds/planting hole for sweet corn. Plants were thinned, respectively, at 3 weeks after planting for LCC and 2 weeks after planting for sweet corn.

Inorganic fertilizers used in the experiment were urea (46% N), turrima phosphate (24% P_2O_5) and KCl (60% K_2O). Inorganic fertilizers were given at the time of planting LCC, while for sweet corn were applied twice, each two-thirds of the dose at the age of 1 week after planting (WAP) and one-third of the dose at the age of 4 WAP. The dose of inorganic fertilizer of LCC was 40 kg P_2O_5 ha^{-1} and 50 kg K_2O ha^{-1} which was equivalent to 166.67 kg phosphate ha^{-1} and 83.33 kg KCl ha^{-1} (Almeida *et al.,* 2019). The doses of P_2O_5 and K_2O for sweet corn were 75 and 50 kg ha^{-1}, respectively (Pangaribuan *et al.*, 2017), equivalent to 312.50 kg phosphate ha^{-1} and 83.33 kg KCl ha^{-1}.

The plants were watered every day only in September to October because of low precipitation (rainfall). The LCC forage was harvested 12 WAP by cutting the stems approximately 5 cm from the ground. Sweet corn cobs and straw were harvested at 70 days after sowing. Sweet corn cobs were harvested by take the cobs from the plant and sweet corn straw were harvested by cutting the stems approximately 5 cm from the ground.

Data collections and analysis

Total chlorophyll contents

Analysis of total chlorophyll of sweet corn and LCC were carried out respectively at flowering (54 DAP) and at 77 DAP. Fresh leaves were taken as a composite, the third leaf from the tip of the shoot was used as a sample for total chlorophyll analysis of sweet corn and LCC. Fresh leaves were weighed about 0.25 g, crushed with a mortar and 80% acetone was added little by little to facilitate leaf crushing. The final volume of acetone used was 25 ml for each sample. The crushed samples were filtered with filter paper. Absorbance was observed at wavelengths of 645 and 663 nm using a spectrophotometer. Chlorophyll a, b and total chlorophyll were estimated using the following formula (Arnon, 1949; Ahmed *et al.*, 2020) as follows.

$$\text{Chlorophyll a (mg/g)} = \frac{(12.7 \times A660 + 2.69 \times A645) \times V}{1000 \times W}$$

$$\text{Chlorophyll b (mg/g)} = \frac{(22.9 \times A645 + 4.68 \times A660) \times V}{1000 \times W}$$

Total chlorophyll (mg/g) = chlorophyll a + chlorophyll b

Here:

A660 = absorbance at 660 nm

A645 = absorbance at 645 nm

W = the weight of leaves sample (mg)

V = extract final volume (ml)

Sweet corn and LCC Yield

Fresh sweet corn cob yield (ton/ha), fresh sweet corn straw yield (ton ha^{-1}), and LCC forage yield were obtained by converting fresh cob yield, fresh straw yield and fresh forage yield of LCC per plot (area of each plot 4.8 m^{-2}) to ton ha^{-1}.

Land equivalent ratio (LER)

Land equivalent ratio (LER) was estimated using equations of Mead and Willey (1980):

$LER = LER_a + LER_b = (Y_{ab}/Y_{aa}) + (Y_{ba}/Y_{bb})$

Here:

LER_a = LER of sweet corn,

LER_b = LER of LCC,

Y_{ab} = sweet corn yield (fresh cobs + fresh straw) in intercropping,

Y_{aa} = sweet corn yield in solecropping,

Y_{ba} = LCC yield in intercropping and

Y_{bb} = LCC yield in solecropping.

Statistical analysis

The data were analyzed statistically using analysis of variance (ANOVA) with R Studio 4.3.1 and the treatments that showed a significant effect on the observed parameters, it was further tested by using the Duncan Multiple's Range Test (DMRT) at a significance level of 5%.

Results

Total chlorophyll content of sweet corn

Based on ANOVA, it was shown that the total chlorophyll content of sweet corn was significantly affected by nitrogen dose treatment. There was no effect of planting pattern and interaction of sweet corn nitrogen dose with planting pattern on the total chlorophyll of sweet corn. Based on DMRT results, the total chlorophyll content at different nitrogen levels, 50, 100 and 150 kg N ha^{-1}, was significantly higher than that of sweet corn without nitrogen, 0 kg N ha^{-1} (Table 3). Similar to the previous studies, the chlorophyll content of ordinary corn in the control (0 kg N ha^{-1}) was significantly lower than the nitrogen treatment. This finding was in accordance with the results found previously by Ullah *et al.* (2015), Wu *et al.* (2019), Muhammad *et al.* (2022), Lu *et al.* (2023); and Suntari *et al.* (2023). There was no significant difference in the total chlorophyll content of sweet corn between the treatments of 50, 100 and 150 kg N ha^{-1} (Table 3.).

Table 3. Total chlorophyll content and yield of sweet corn

Nitrogen dose (kg ha-1)	Planting pattern			Average
	Sole cropping Sweet corn	Intercropping sweet corn-*C. pubescens*	Intercropping sweet corn-*P. phaseloides*	
Total chlorophyll (mg g-1)				
0	2.29±0.43	2.24±0,27	2.18±0.52	2.24±0.37^{b}
50	2.48±0.30	2.27±0.11	2.90±0.28	2.55±0.35^{a}
100	2.70±0.57	2.49±0.31	2.70±0.23	2.63±0.36^{a}
150	2.93±0.15	2.63±0.15	2.70±0.10	2.75±0.18^{a}
Average	2.60±0.42	2.41±0.25	2.62±0.39	
Fresh cobs yield (ton ha-1)				
0	5.41±3.07	3.87±1.02	3.73±1.67	4.34±1.99^{b}
50	5.10±2.47	5.69±2.49	5.61±1.75	5.47±1.98^{ab}
100	6.48±2.50	6.88±2.92	5.72±1.02	6.36±2.06^{a}
150	6.53±2.53	5.39±1.13	6.73±0.69	6.22±1.56^{a}
Average	5.88±2.36	5.46±2.09	5.45±1.62	
Fresh straw yield (ton ha-1)				
0	8.80±3.79	7.33±1.42	8.50±2.48	8.21±2.47
50	10.13±3.77	11.67±3.28	10.36±2.63	10.72±2.91
100	11.18±4.79	9.20±1.43	9.28±1.70	9.88±2.81
150	10.73±0.92	8.43±1.87	10.49±0.94	9.88±1.59
Average	10.21±3.23	9.16±2.47	9.66±1.95	

[a, b] different superscript in the same column show significant differences

Table 4. Total cholorophyl and yield of LCC

Nitrogen doses (kg ha-1)	Planting pattern (Intercropping)		Average
	Sweet corn-*C. pubescens*	Sweet corn-*P. phaseloides*	
Total chlorophyll (mg g-1)			
0	3.38±0.23	2.64±0.21	3.01±0.45
50	3.43±0.48	2.59±0.45	3.01±0.62
100	3.18±0.45	3.00±0.28	3.09±0.23
150	3.57±0.17	2.62±0.23	3.10±0.55
Average	3.39±0.29^{a}	2.71±0.31^{b}	
Fresh FORAGE YIELD (ton ha-1)			
0	3.17±0.65	6.86±3.16	5.02±2.87
50	3.76±1.04	7.10±4.13	5.43±3.26
100	3.99±0.74	8.26±2.27	6.13±2.78
150	4.40±0.90	5.95±2.13	7.04±1.69
Average	3.83±0.86^{b}	7.04±2.72^{a}	

[a, b] different superscript in the same row show significant differences

Table 5. Land equivalent ratio (LER)

Nitrogen doses (kg ha-1)	Planting pattern (Intercropping)		Average
	Sweet corn-*C. pubescens*	Sweet corn-*P. phaseloides*	
	LER		
0	1.33±0.38	1.71±0.22	1.52±0.35
50	1.84±0.93	1.78±0.70	1.81±0.74
100	1.51±0.28	1.69±0.33	1.60±0.29
150	1.40±0.14	1.57±0.20	1.48±0.18
Average	1.52±0.49	1.69±0.36	

Sweet corn yield

Based on ANOVA, the yield of fresh sweet corn cobs was significantly affected by the nitrogen dose treatment. The yield increased with increasing nitrogen dose. This finding was in accordance with the results obtained in previous studies on sweet corn plants (Turk and Alagoz, 2018; Gao *et al.*, 2020; Sunuwar *et al.*, 2023). There was no effect of planting pattern and interaction nitrogen dose with planting pattern on the yield of fresh sweet corn cobs. Fresh sweet corn straw was not significantly affected by nitrogen dose, planting pattern, and interaction of nitrogen dose with planting pattern. Based on DMRT, Yield of fresh sweet corn cobs in the treatment of 0 kg N ha^{-1} not significantly different from the treatment of 50 kg N ha^{-1}, but significantly different from the treatment of 100 dan 150 kg N ha^{-1} (Table 3.) There was no significant difference in the yield of fresh sweet corn cobs between the treatments of 50, 100 and 150 kg N ha^{-1} based on DMRT (Table 3).

Total chlorophyll content and yield of legume cover crops

Based on ANOVA, total chlorophyll and fresh forage yield of LCC was significantly affected by planting pattern. There was no effect of nitrogen dose and interaction of nitrogen dose with planting pattern on the total chlorophyll and fresh forage yield of LCC. Based on DMRT, total chlorophyll of intercropping sweet corn-*C. pubescens* was significantly higher than intercropping sweetcorn-*P. phaseloides* (Table 4). In contrast to total chlorophyll, fresh forage yield of intercropping sweet corn-*P. phaseloides* was significantly higher than intercropping sweet corn-*C. pubescens* (Table 4).

Land equivalent ratio

The LER was not significantly affected by nitrogen dose, planting pattern and interaction between nitrogen dose and planting pattern (Table 5).

Discussion

Sweet corn

Nitrogen implementation increases the availability of nitrogen in the soil, so that more nitrogen may be absorbed by plants. Soil microbes convert urea into nitrate (NO_3^-) and ammonium (NH_4^+) (Witte, 2011). Nitrate and ammonium were form of nitrogen that may be absorbed by plants. Nitrate absorbed by the roots was reduced to ammonium, and then ammonium was catalyzed by the GS/GOGAT cycle to glutamine and transported to the shoots via the xylem (Liu *et al.*, 2022). Nitrogen that reaches the plant shoots was stored in the form of protein, metabolized or translocated to leaves, roots, fruits, and developing seeds via the phloem (de Bang *et al.*, 2020). Glutamine was the main amino donor for the biosynthesis of amino acids, proteins, chlorophyll, nucleic acids, and other nitrogen-containing compounds (Nunes-Nesi *et al.*, 2010). Based on DMRT, Chlorophyll content was higher in sweet corn given nitrogen (50, 100 and 150 kg N ha^{-1}) than in sweet corn not given nitrogen (0 kg N ha^{-1}). This is may due to the fact that nitrogen application increasing the availability of nitrogen in the soil, nitrogen uptake, and glutamine synthesis which may be used by sweet corn to form chlorophyll.

The highest average total chlorophyll content of sweet corn in this study was achieved in the 150 kg N ha^{-1} treatment, which was 2.75 mg g^{-1}. The findings are in accordance with previous research by Pangaribuan *et al.* (2020), where the highest total chlorophyll content of sweet corn of 2.78 mg g^{-1} was obtained in the treatment of 15 tons ha^{-1} of chicken manure, 300 kg of urea ha^{-1} equivalent to 138 kg N ha^{-1} and 116.5 kg KCl ha^{-1}. Meanwhile, the same results were also found in the study of Susanti *et al.* (2023) which was 2.34 - 2.76 in 25 sweet corn genotypes with fertilization of 10 tons ha^{-1} of manure, 300 kg NPK ha^{-1} equivalent to 48 kg N ha^{-1}, 2 tons of dolomite and 150 kg urea equivalent to 69 kg N ha^{-1}.

Chlorophyll plays a role in influencing the photosynthetic capacity of plants including corn. Chlorophyll content was highly correlated (R = 0.75) with the photosynthetic capacity of corn (Wang *et al.*, 2021), according to previous research by Wu *et al.* (2019). Chlorophyll content and photosynthetic rate in corn given nitrogen were significantly higher than those not given nitrogen. The high correlation between chlorophyll and plant photosynthetic capacity was because chlorophyll plays an important role in the light reaction of photosynthesis. Chlorophyll contributes to the absorption, transport and conversion of light energy (Mu and Chen, 2021). The light absorbed by chlorophyll a and b was the violet, blue and red wavelengths (Qiu *et al.*, 2019). Higher photosynthesis means more glucose was produced by plants that may be used for plant growth or translocated to the generative parts of the plant.

During the generative phase, nitrogen mainly in the form of amino acids was remobilized from the leaves for use in fruit and seed development (Xu *et al.*, 2012; De Bang *et al.*, 2020). About 65-90% of the nitrogen in corn seeds comes from nitrogen storage during the vegetative phase (Padhan *et al.*, 2021). Stronger translocation of C and N from the source (vegetative organs) to the storage (corn kernels) and a balanced C/N ratio of the kernels are required to obtain higher corn yields (Ren *et al.*, 2022).

Based on DMRT, Yield of fresh sweet corn cobs in the treatment of 100 and 150 kg N ha^{-1} was not significantly different from the treatment of 50 kg N ha^{-1}, but significantly higher from the treatment of 0 kg N ha^{-1}. This is may be due to the fact that nitrogen application increases nitrogen storage during the vegetative phase, increasing chlorophyll content and photosynthetic capacity of sweet corn. This correlates with the greater amount of carbohydrates (C) and nitrogen (N) that may be translocated to the corn cob for the development and filling of sweet corn kernels. The greater amount of carbohydrates (C) and nitrogen (N) that may be translocated to cobs resulted in higher fresh cobs yield in the 100 and 150 kg N ha^{-1} treatment compared to 0 kg N ha^{-1}. Higher fresh cob yields were obtained in the 100 kg N ha^{-1} treatment, which was 6.36 tons ha^{-1}.

This result was lower than the results of the study by Pangaribuan *et al.* (2017) in the nitrogen fertilization treatment of 0, 75 and 150 kg N ha^{-1}, respectively, of 10.49, 12.53 and 14.18 tons ha^{-1}. The difference in sweet corn production was due to differences in the cultivars used and the influence of climate. Sweet corn cv. Bimmo was used in this study, while the Jambore hybrid sweet corn used by Pangaribuan *et al.* (2017). The productivity of 23 sweet corn cultivars in Indonesia based on research by Gunawan *et al.* (2022) is 4.37-14.87 tons ha^{-1} with the production of sweet corn cv. Bimmo of 8.11 tons ha^{-1}. The lower fresh cob yield in the study by Gunawan *et al.* (2022) was caused by the air temperature of Semarang City was being higher than 30^{o}C which was less suitable for sweet corn cultivation. According to Dhaliwal and Williams (2022), sweet corn yields decreased when cultivated in land or environments with air temperatures higher than 30^{o}C.

Legume cover crops

Based on DMRT, the total chlorophyll content in Intercropping sweet corn-*C. pubescens* was higher than that of Intercropping sweet corn-*P. phaseloides*, presumably due to differences in plant species. In contrast to total chlorophyll content of LCC, the fresh forage yield of intercropping sweet corn-*P. phaseloides* was higher than that of Intercropping sweet corn -*C. pubescens*. Higher forage yield of sweet corn-*P. phaseloides* intercropped than sweet corn-*C. pubescens* intercropped due to higher forage yield of *P. phaseloides* than *C. pubescens* similar to the results of Agung *et al.* (2015) in a single cropping system and Suwarto (2021) in an intercropping system with cassava. There was no significant effect of nitrogen dose on forage yield because LCC was able to meet its own nitrogen needs through symbiosis with rhizobium.

Legumes provide carbon and hosts for rhizobium while rhizobium provides ammonia for legumes (Lindstrom and Mousavi, 2019). The interaction between legumes and rhizobium is a mutually beneficial interaction known as mutualistic symbiosis.

Significantly higher forage yield *P. phaseloides* due to faster growth rate of *P. phaseloides* compared to *C. pubescens*. This was in accordance with Sarjono *et al.* (2019) who stated that the growth rate of *P. phaseloides* faster than that compared to *C. pubescens*. It was indicated via the percentage of land covered by *P. phaseloides* significantly higher than *C. pubescens* in 4 and 8 WAP. It was reported that growth rate of *P. phaseloides* significantly higher than *C. pubescens* based on dry matter weight gain. The better growth and yield in *P. phaseloides* compared to *C. pubescens* due to differences in root characteristic (Suwarto, 2021). The average growth of *P. phaseloides* root was significantly higher than *C. pubescens* (Sarjono *et al.*, 2018). Higher average root growth means more water and nutrients from soil may be taken up by plant to support growth and development and produce higher yield.

Land equivalent ratio

Sweet corn-LCC intercropping was more profitable than single planting of sweet corn because the LER value of sweet corn-LCC intercropping was greater than 1, meaning that intercropping was more profitable than single planting, while LER less than 1 means that single planting was more profitable than intercropping for both types of crops (Hamzei and Sayedi, 2015; Sundari *et al*., 2019; Nawar *et al*., 2020; Khanal *et al*., 2021). The LER value also shows the area of land needed for monoculture planting to obtain the same or equivalent results as planting in an intercropping system (Khanal *et al*., 2021; Li *et al*., 2023). This means that to obtain equivalent results in sweet corn monoculture planting with sweet corn-*C. pubescens* and sweet corn-*P. phaseloides* intercropping, it is necessary to increase the area of sweet corn monoculture planting by 52 and 69%, respectively.

Conclusion

Based on the research results, it may be concluded that to obtain the highest sweet corn yield, a Nitrogen dose of 50-100 kg ha^{-1} may be recommended for sweet corn-LCC intercropping cultivation. Meanwhile, to gain the highest yield of fresh forage, it may be done by intercropping sweet corn-*P. phaseloides*.

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