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# Improving dwarf Napier grass production through the suppression of weeds by intercropping of *Asystasia gangetica*

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**Abstract** The effect of sole Dwarf Napier grass (T1), sole *Asystasia gangetica* (T2) and intercropping Dwarf Napier grass with *A. gangetica* (T3) on weed suppression, growth, yield indices and nutritive value were evaluated. The results showed that T3 treatment presented with the highest trend for biomass yield and leaf stem ratio. Whereas, T3 treatment resulted in lower trend for weed yield than T1 and T2 treatments. There were no significant (p>0.05) differences on dry matter (DM), crude protein (CP) and ether extract (EE) contents in plant tissues among the treatments. However, T3 treatment showed the highest trend for DM, CP and EE contents. The T3 treatment resulted significantly (p<0.05) in lower crude fibre content than those of T1 and T2 treatments. In conclusion, the intercropping of dwarf Napier grass and *A. gangetica* (T3 treatment) showed increasing trend for biomass yield, nutritive value, while produced less weed yield. The outcome of this study contributed to a better cultural weed management strategy that may increase yield and nutritive value while reduced the impact of weeds.

**Keywords:** *Asyastasia gangetica*, Biomass yield, Dwarf Napier grass, Leaf stem ratio, Nutritive value

## Introduction

For profitable livestock production, major portion of diet should be supplied with roughages instead of full feeding of concentrate, since ruminants can convert fibrous materials to valuable food (e.g., meat, milk). Subsequently, these valuable foods will ensure the food security for human population. Roughages include all types of fibrous plant materials. For example, there are many tropical and sub-tropical forage grasses in Malaysia such as Napier grass (*Pennisetum purpureum),* Guinea grass (*Panicum maximum*) and setaria (*Setaria sphacelata*). Among tropical and subtropical forage grasses, Napier

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grass is a very popular grass that has been used to feed the livestock and it is the most important forage crop in agriculture and farming including dairy and feedlot production system (Halim *et al*., 2013). The desirable characteristics of Napier grass had made it as a popular forage because of its palatable leafy shoots, high biomass yield, drought tolerance, ease to propagate and high-water use efficiency.

Napier grass has two varieties: tall and dwarf. Tall varieties of Napier grass produce higher biomass yield and lower nutritive value than dwarf varieties. The nutritive quality of dwarf Napier grass is higher (crude protein 12% and acid detergent fibre <37%) than other tall varieties (crude protein 10% and acid detergent fibre >37%), mainly because of the higher leaf-to-stem ratio (Halim *et al*., 2013). Dwarf Napier grass is also able to generate rapidly after repeated cutting (Negawo *et al*., 2017). Dwarf Napier grass can grow in areas with annual rainfall between 750 and 2500 mm (Negawo *et al*., 2017). However, farmers, who are producing Napier grass, are facing serious problem with controlling weeds. Thus, farmers must use pesticides to control the weeds. However, the use of pesticide can possibly cause a negative impact on the environment, and it is costly and not eco-friendly. Due to aggressive growth of the weeds in Napier grass production, farmers give up and abandon their land. Therefore, control practices to manage the weed should be implemented in order to create wealth in yield production. Some researches were previously done to solve these problems by intercropping the legume and grass in a plot. Rahman *et al*. (2015) proved that the intercrop of grass and legumes produced a high yield crop production due to excellent soil fertility through nitrogen fixation by the legumes. In another study, the feeding of sole Napier grass had resulted in slow replenishment of the ruminant body weight than mixed Napier grass with other plants (Manaye *et al*., 2009). Intercropping the plants is also the best application to control the weed population (Olasantan *et al.*, 1994). Thus, the possibility to control the weed can be done by intercrop.

*Asystasia gangetica* is one of the weeds that may be used to intercrop with dwarf Napier grass to control other weeds and produce a high yield of crop. The reason for using this plant to conduct the intercrop application lies on its ability to supply rich nutrient, be made as a hay and be grown easily. It can grow under the shade and containes a high nutritive value in protein, fibre, and minerals. It is used as a forage and can be given as fresh forsge or hay to the livestock (Adetula, 2004; Nordin *et al*., 2022).

Both plants, dwarf Napier grass and *Asystasia gangetica*, are high in nutritive value which is essential to the livestock production. They can be harvested as hay which is a very suitable and acceptable type of feed for animal’s consumption, and made as a complete feed because of its sufficient nutrient content. Thus, the feeding of concentrate supplement can be reduced and save farmer's expenditure from purchasing the concentrate supplement and pesticides. The intercrop of the *Asystasia gangetica* and dwarf Napier grass can help to control weed and supply sufficient nutrients to livestock due to its high nutritive value. Plants intercrop also reduce the usage of pesticides indirectly. Limited information on agronomic characters and nutrient composition of Napier grass-*Asyastasia gangetica* intercropped plants is available.

Therefore, in order to improve Napier grass production, this study aimed to investigate the effects of intercropping on agronomic characteristics and nutritive values of dwarf Napier grass and *Asystasia gangetica*.

## Materials and methods

### *Study site and plant materials*

Rooted tillers of dwarf Napier grass and *Asystasia gangetica* were grown at Kampung Sungai Tendong, Pasir Mas, Kelantan, Malaysia for about 2 months (from June until August 2020). Rooted tillers of dwarf Napier grass were collected from local farmer at Pasir Pekan, Pasir Mas, Kelantan, Malaysia, while *Asystasia gangetica* was collected from an area in Kampung Sungai Tendong.

### *Experimental design*

There were three treatments in this experiement, namely, sole Dwarf Napier grass (T1), sole *Asystasia gangetica* (T2) and intercrop Dwarf Napier grass with *Asystasia gangetica* (T3) with 3 replications for each treatment. Fodder was cultivated in nine plots having homogenous soil characteristics and each plot size was 2 m × 2 m. All plots were arranged in a completely randomized design. For T1 treatment, dwarf Napier grass was planted at a spacing of 0.5 m × 0.5 m and the plot was separated by 1.0 m path. For T2 treatment, *Asystasia gangetica* was planted at a spacing of 0.2 m × 0.2 m. For T3 treatment, the dwarf Napier grass was planted as T1, while *Asystasia gangetica* was planted between the row spacing of dwarf Napier grass.

Before planting, goat manure was applied to the plot at the rate of 1.0 kg per $m^2$ as a basal fertiliser. During planting, NPK fertiliser was applied to the plot at the rate of 5.56 g per $m^2$. After planting, water was given to the plant for the first five days and during the hot days if necessary.

### *Parameters studied and sample preparation*

Agronomic parameters were measured including tiller number per plant, survivability, plant height, leaf length, leaf width and stem circumference. All plants were harvested with 5 cm above the ground after 2 months of planting. Yield and leaf stem ratio were measured. The fresh samples were weighed and dried using an oven at 70 ℃ for 48 hours for the determination of dry matter (DM) and chemical analysis.

### *Chemical analysis*

Dried samples were ground using a blender, passed using a 1 mm sieve and preserved in zipper bag for chemical analysis. These samples were analysed for nitrogen (N), ether extract (EE) and crude fibre (CF) contents following the method of AOAC (2000). Crude protein content was calculated as N × 6.25.

### *Statistical analysis*

The data were subjected to analysis of variance to determine the effect of intercropping on agronomic characters and nutrient composition in plant tissue by using the general linear model procedure of SPSS (ver. 23.0) and the differences between the means were determined by the least significant difference at $p<0.05$.

## Results

### *Agronomic characteristics*

There were no significant ($p>0.05$) differences on tiller number, survivability, plant height, leaf length, leaf width and stem circumference of dwarf Napier grass over 2 months period of cultivation between the sole Napier grass and intercrop Napier grass (Table 1). However, the intercrop Napier grass showed the higher trend for the values of tiller number (14.18 vs. 9.94), plant height (72.87 vs. 70.20 cm) and leaf length (54.00 vs. 52.15 cm) compared to the sole Napier grass, respectively.

**Table 1.** Effect of intercropping on agronomic parameters in Napier grass

| **Parameter** | **Treatment** | | ***Level of significance*** |
|---|---|---|---|
| | **Sole Napier grass** | **Intercrop Napier grass** | |
| Tiller number (No.)/plot | 9.94 ±4.16 | 14.18 ±0.31 | 0.153 |
| Survivability (%) | 61.33 ±20.53 | 57.33 ±16.65 | 0.806 |
| Plant height (cm) | 70.20 ±5.29 | 72.87 ±4.11 | 0.529 |
| Leaf length (cm) | 52.15 ±3.42 | 54.00 ±1.46 | 0.439 |
| Leaf width (cm) | 1.97 ±0.17 | 1.94 ±0.95 | 0.799 |
| Stem circumference (cm) | 6.67 ±0.22 | 6.67 ±0.15 | 0.968 |

The effect of intercrop on leaf stem ratio for Napier grass production is presented in Figure 1. The leaf stem ratio of dwarf Napier grass for the treatments of sole Napier grass and intercrop Napier grass were 0.7 and 1.2, respectively. The mean value for stem in sole Napier grass was higher (0.2) than the value (0.15) of intercrop Napier grass. However, the mean value for leaf was observed in opposite trend. Intercrop Napier grass showed higher trend (0.18) than the value (0.14) of sole Napier grass. Both the values of leaf and stem for the treatments of sole Napier grass and intercrop Napier grass did not have any significant (p>0.05) difference, but the intercrop Napier grass showed the highest trend for leaf stem ratio in this study.

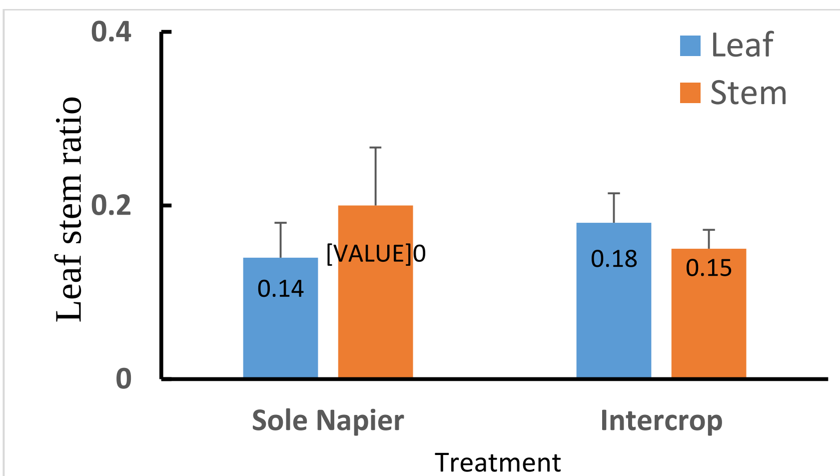


**Figure 1.** Effect of intercropping on leaf stem ratio in dwarf Napier grass. Vertical bars represent standard deviation (SD) of the mean

It was observed that the DM yields of sole Napier grass, sole *Asystasia*, intercrop Napier grass, intercrop *Asystasia gangetica* and weeds were 4.45, 0.73, 5.20, 0.70 and 5.84 ton/ha, respectively, and were unaffected (p>0.05) by intercropping (Table 2). However, the T3 treatment showed the highest trend for the DM yield of Napier grass and the lowest trend for the total DM yield of weeds.

**Table 2.** Effect of intercropping on dry matter yield (ton/ha) of Napier grass, *Asystasia gangetica* and weeds

| **Parameter** | **Treatment** | | | ***Level of significance*** |
|---|---|---|---|---|
| | **T1 (sole Napier grass)** | **T2 (sole *Asystasia*)** | **T3 (Intercrop*)** | |
| Napier grass | 4.45 ±2.14 | - | 5.20 ±1.01 | 0.612 |
| *Asystasia* | - | 0.73 ±0.08 | 0.70 ±0.10 | 0.677 |
| Napier grass plus *Asystasia* | - | - | 5.89 ±0.95 | - |
| Weeds | 7.70 ±1.32 | 7.88 ±1.68 | 5.84 ±2.75 | 0.439 |
| Total dry matter yield | 12.15 ±2.75 | 8.61 ±1.74 | 11.74 ±2.81 | 0.242 |

*Napier grass plus *Asystasa gangetica*.

### *Chemical composition*

The effect of intercropping on DM, CP, EE and CF contents in Napier grass and *A. gangetica* is shown in Table 3. There were no significant ($p>0.05$) differences on chemical composition (except CF content) observed among the treatments. However, the intercrop Napier grass (T3 treatment) showed numerically higher trend for the values of DM, CP and EE than the values for sole Napier grass (T1 treatment). Similarly, intercrop *A. gangetica* (Treatment 3) showed the higher trend for the numerical values of DM, CP and EE contents than the values for sole *A. gangetica* (Treatment 2). Napier grass and *A. gangetica* in the intercrop contained significantly ($p<0.05$) lower CF content (37.61% and 31.11%) compared to sole Napier grass (44.24%) and sole *A. gangetica* (36.41%), respectively.

**Table 3.** Effect of intercropping on proximate composition in Napier grass and *Asystasia gangetica*

| **Parameters** | **Sole Napier grass (T1)** | **Sole *Asystasia gangetica* (T2)** | **Intercrop** | | **p-value** |
|---|---|---|---|---|---|
| | | | ***A. gangetica* (T3)** | **Napier grass (T3)** | |
| DM | 12.93 ±0.61 | 14.80 ±1.39 | 15.60 ±1.74 | 13.33 ±1.62 | 0.148 |
| CP | 12.80 ±1.31 | 15.75 ±6.15 | 17.29 ±1.86 | 15.73 ±3.53 | 0.545 |
| EE | 1.15 ±0.38 | 0.77 ±0.29 | 1.40 ±1.05 | 2.13 ±1.41 | 0.376 |
| CF | 44.24 ±0.90$^{a}$ | 36.41 ±4.77$^{b}$ | 31.11 ±2.73$^{c}$ | 37.61 ±1.62$^{ab}$ | 0.004 |

DM, dry matter; CP, crude protein; EE, ether extract; CF, crude fibre. $^{abc}$means with different superscripts in a row differ significantly ($p<0.05$). T1, sole Napier grass; T2, sole *Asystasia gangetica*; T3, Intercrop.

## Discussion

### *Agronomic characteristics*

Jensen *et al*. (2020) reported that legumes in intercrop help to improve N fixation and increase the N intake of fodder that contribute to growth. As for the survivability, however, the T1 treatment in this study showed the highest trend. This may be due to climatic variability, soil condition and different shades at each location which lead to different amount of moisture, nutrient and sunlight received by Napier grass. Each location with climatic variability can give an effect on DM yields of Napier grass (Menbere *et al*., 2015).

The amount of leaf and stem of dwarf Napier grass in T1 and T3 treatments of this study resulted differently. It is important as leaf is more nutritious as a livestock feed than stem. The greater number of leaves per plant is a desirable attribute in producing forage for livestock feeding. The quality of pasture and animal performance depends on the leaf fraction of the plant (Wangchuk *et al*., 2015).

The yields of sole Napier, sole *Asystasia*, intercrop Napier, intercrop *Asystasia* and weeds in this study were 4.45, 0.73, 5.20, 0.70 and 5.84 ton/ha, respectively, and were unaffected by intercropping. These data suggest that the intercropped dwarf Napier grass with *A. gangetica* (T3) better competed for growth factors against dwarf Napier grass (T1) during the period when dwarf Napier grass and *A. gangetica* overlapped. However, the T3 treatment showed the highest trend for the yield of Napier grass. Intercropping legumes and fodder could produce a higher yield due to the improvement of soil fertility through N fixation, decay of root nodules and mineralization of shed leaves that contribute to the increased N in soil (Rahman *et al*., 2015).

The T3 treatment showed the lowest trend for the total yield of weeds, which is in line with the findings of Bilalis *et al*. (2009) who stated that intercrop legumes with fodder resulted in a higher soil canopy cover that could avoid the light interception to the seeds of the weed. Developing a soil cover suppresses the weed. This study proved that intercrop could reduce the yield of weeds without implementing pesticides in the plot. The yield of the Napier grass and *A. gangetica* was associated with optimum rainfall from June (140 mm) to August (190 mm). During the planting of Napier grass and *A. gangetica*, experimental area had experienced a hot and humid weather.

### *Chemical composition*

The intercrop Napier grass (T3) showed numerically higher trend for the values of DM, CP and EE than the values for sole Napier grass (T1). Similarly, intercrop *A. gangetica* (T3) showed numerically higher values of DM, CP and EE contents than the values for sole *A. gangetica* (T2). This could be attributed to the effect of intercropping legumes and fodder that helps to improve the nutritive value in both plants. The Napier grass and *A. gangetica* in intercrop contained significantly ($p<0.05$) lower CF content (37.61% and 31.11%, respectively) compared to the sole Napier grass (44.24%) and sole *A. gangetica* (36.41). This result suggests that intercropping is beneficial for livestock production, because the energy content of the feed containing high CF content is low since some of the CF is considered indigestible. Riaz *et al*. (2014) reported that diets containing high fibre is negatively correlated with digestibility coefficients in ruminants. It is known that the low CF content in diet can ease the feed utilisation by ruminant microorganisms, which in turn enhances higher fermentation rates and increases digestibility.

Crude protein is a prudential nutrient needed for the livestock growth and production. Njoka-Njiru *et al*. (2006) stated that legumes help to improve CP in Napier grass and reduce fibre content as the N in the soil is high. It is well known that the CP content is usually higher in short varieties of Napier grass than tall varieties. Halim *et al*. (2013) reported that Australian dwarf Napier grass contained 12.08% CP while tall varieties contained 11% CP. Intercrop Napier grass and *Asystasia* can provide a high amount of fat in a pasture and contribute high energy to the livestock since there was a trend of increased EE content in T3 treatment.

Dry matter yield of Napier grass in this study increased by 17% when grown with *Asystasia gangetica* compared to sole Napier grass. This result is in agreement with those of Njoka-Njiru *et al.* (2006) who reported that intercropping legumes with Napier grass produced higher total yield than sole grass. Mureithi *et al.* (1995) also showed a beneficial effect to Napier grass when grown together with Leucaena. Other workers who have reported higher forage DM yield from grass/legume mixtures than pure stand grass includes; Tudsri and Kaewkunya (2002) in Thailand and Berdahl *et al*. (2001).

In conclusion, intercropping of dwarf Napier grass with *A. gangetica* resulted in increasing trend of tiller number, plant height, leaf length, yield, nutritive value and weed suppression, despite of finding non-significant effect on observed parameters (except CF content) among treatments. It should be noted that non-significant results found in this study may be owing to the high standard deviation between replications. The weed suppression in intercropped showed a positive result as the weed yield in DM was lower trend than in sole dwarf Napier grass and sole *A. gangetica*. Intercropping of legumes and fodder helps to provide a greater canopy to the soil which retards photosynthesis of the weeds as light cannot reach the soil. Intercropping of legumes and fodder is highly recommended to be conducted as it gives benefit for future agriculture production and environment as it is an economical and eco-friendly cultivation.

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