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Increased Growth of Kume Grass (*S. plumosum*) and *B. pertusa* Through the Introduction of Various Types of Herbaceous Leguminosae

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ABSTRACT

This study aims to determine the interaction between age and leguminous to the growth of grass *S. plumosum* (Sp) and *B. pertusa* (Bp). Both types of grass are planted in 18 plots measuring 2x2m^2 with a distance of 60 cm between plots. The study was conducted using a completely random design of factorial patterns with two factors. The first-factor plant typically consists of 6 levels, namely Co, Clitoria ternatea (Ct), Pueraria phasoloides (Pp), Centrocema pubescent (Cp), Desmodium incanum (Di), and Alysicarpus vaginalis (Av). The age of cutting as a second factor consists of 3 levels, namely 40, 60, and 80 days and repeated three times. Variables measured were the number of spouts, the height of the plant, and the number of leaves. Data analysis was carried out using the SPSS software package version 25. The level of significance adopted was P<0.05. The results showed that there was an interaction (P<0.05) towards the height and number of SP leaves, while in the number of saves Sp Bp, high and the number of Bp leaves, there was no interaction (P>0.05).

Key words: leguminous, *S. plumosum, B. pertusa*

INTRODUCTION

Grazing fields are the primary source of ruminant animal feed in dryland areas, including East Nusa Tenggara Province. This area is one of the centers of cattle production and contributes more than 60,000 beef cattle to meet national meat needs. Of the cattle population of 1.1 million, 94% were grazed or tied up in existing grazing fields. Nevertheless, natural grazing fields have been heavily degraded due to free grazing, which has stimulated overgrazing for years (Riwukore et al., 2020).

Reintroducing grass species is a common strategy against grazing fields that have undergone degradation to increase vegetation diversity. In the selection of local grass species in grazing fields that have been degraded. It is necessary to consider the combination of various species that not only have high productivity and quality but have different growth patterns. Namely between the combination of grass species with early shooting growth patterns or moderate with species that have a period of slow flowering and fertilization. The combination will further guarantee a higher forage availability for a more extended period in the dry season. The results of Jelantik *et al.* (2019) explained that *B. pertusa* has a shooting growth at the beginning of the rainy season recorded the number of clumps *B. pertusa* increased from 1 to 12.9 in the 6th week after rain. The introduction of suitable species is the one that has a slow growth pattern and survives at the beginning of the dry season. *S. plumosum* has a growth pattern as expected. In addition, this grass species has high growth potential and relatively high forage quality in vegetative periods. The study results concluded that the combination of *S. plumosum* and *B. pertusa* can be used as a primary species of pasture prime dryland development.

There have been many studies introducing herbaceous leguminous to various types of grasslands. Still, until now, there is no information about the herbaceous leguminous species that are best suited for an introduction to the combination of *S. plumosum* and *B. pertusa*. In mixed land, things that need to be considered are the compatibility or compatibility between grasses and legumes planted together so that the two do not suppress the growth of each other. The match between grass and legume species depends on the morphological nature of both. This study aims to determine the interaction between age and leguminous types to the morphology of grass growth *S. plumosum* and *B. pertusa*.

MATERIALS AND METHODS

The experiment was conducted during the rainy season from December 2020 to June 2021 at the land of inceptisol in Penfui (10° 05'LS dan 123° 52' BT at an altitude of 10 dpl), Kupang Regency, East Nusa Tenggara Province (NTT), Indonesia. The type of soil found in the area is deep (50-60 cm) of vertisol with an average pH of 7.7. The soil's parent material comes from the sea; it is essentially dominated by calcium carbonate.

Stages of Research and Trial Design

This research began with creating a map measuring 2x2m^2 in as many as 18 plots with a distance between fields of 60 cm. The plot is then randomized for treatment placement. Then preparations were made to take saplings *Sorghum plumosum* (SP) and *Bothriochloa pertusa* (BP) and Leguminosae *C. ternatea*, *A. vaginalis*, *C. Pubescens*, *D. incanum*, and *P. phasoloides*. Grass sap runs and Leguminosae are taken in the surrounding area.

The implementation phase begins after the equalization of plants that have previously been planted at a distance of 40 cm and legume—no watering and fertilizing. Meanwhile, weeding against weeds is done every two weeks. The study was conducted using a completely random design of factorial patterns with two factors. The factor I plant typically consists of 6 levels, namely Co, Clitoria ternatea (Ct), Pueraria phasoloides (Pp), Centrocema pubescent (Cp), Desmodium incanum (Di), and Alysicarpus vaginalis (Av). As a factor II, the age of cutting consists of 3 levels, namely 40, 60, and 80 days, repeated three times.

Sampling and Measurement

Measurement and harvesting of forages are done on days 40, 60, and 80 after homogenization. Morphological measurements of both types of grass were calculated on five randomly selected samples in 1 x1 m for each plot. Measurements of plant height were taken from ground level to the most extended/highest leaf shoots on each experiment plot. The number of sprouts in this study is a new plant that grows above ground level in each plot of the experiment, and the number of leaves, while the number of leaves is calculated, is still green on each field of the investigation.

Data Analysis

All data analysis is done using the SPSS software package version 25. The level of significance adopted is $P<0.05$.

RESULTS AND DISCUSSION

Number of Saves

The mixed farming system in this study can have competitive and synergistic effects between the two types of grass and herbaceous legumes.

Table 1. Morphological measurements of *S. plumosum* and *B. pertusa* grass

Introduction	Age	number of SP spouts	SP plant height (cm)	Sp leaves	number of BP spouts	BP plant height (cm)	BP leaves
AV	40	19.4	67.52	5.8	19	83.9	16.7
	60	17.93	110.44	6.8	21.6	101.98	28.57
	80	14.4	144.58	9.1	21.2	110.19	34.93
CO	40	21.2	69.97	5.2	14.67	59.57	12.67
	60	21.8	117.67	7	16.67	90.26	14.9
	80	20.73	174.39	11.97	15.87	99.95	23.1
CP	40	23.4	71.14	5.47	19.13	86.47	16.67
	60	21.2	113.86	7.13	16.6	99.5	18.37
	80	19.53	164.78	10.4	13.8	99.2	21.57
CT	40	14.07	69.37	5.5	17.4	77.04	12.57
	60	14.47	102.53	8.07	20.13	96.68	23.57
	80	13.87	140.64	10.8	18.67	84.21	33.4
DA	40	13.67	62.97	7.4	13.13	60.55	30.6
	60	13.13	151.25	12	15.87	88.86	53.2
	80	12.27	155.29	13.4	15.08	103.78	54.23
PP	40	11.73	81.39	5.77	11.67	74.48	10.8
	60	13.67	109.41	7.6	10.4	96.92	18.6
	80	14.6	146.56	14.4	12.33	109.02	37.7
SEM		2.35	7.714	0.668	2.08	6.382	4.11
P	Treatment	<0.001	0.032	0	<0.001	0.022	<0.001
	Age	0.572	<0.001	<0.001	0.676	<0.001	<0.001
	Legume X Age	0.951	0.01	0.004	0.795	0.182	0.128

Competitive effects can occur when plants utilize nutrients, space, and time simultaneously while synergistic/complementary products will happen when plant species use nutrients, sunlight, habitat, and water in different ways.

The results of this study are presented in table 1. This study showed an interaction between treatment and age in the high parameters of the *S. plumosum* (SP) plant, the number of SP leaves. While in the parameters of the number of SP spouts, the number of *B. pertusa* spouts (BP), the height of BP, and the number of BP leave, there is no interaction between the factor ($P<0.05$) treatment and age.

Table 2. Morphological measurements of the growth of different types of leguminous

Introduction	Age	Height (cm)	No. Leaves	Leaf length (cm)	Leaf wide (cm)	No. branch
AV	40	38.280	160.733	3.540	2.492	12.333
	60	58.640	233.067	3.267	2.120	16.467
	80	72.480	320.600	3.180	2.080	24.600
CP	40	29.099	21.622	5.208	2.703	7.633
	60	56.787	36.067	5.333	3.193	13.600
	80	75.119	47.056	5.434	2.907	18.367
CT	40	41.854	63.048	4.140	2.242	14.781
	60	69.627	116.933	4.207	2.620	29.467
	80	89.993	150.600	3.953	2.540	34.867
DA	40	39.127	178.733	5.293	3.713	57.533
	60	79.113	250.867	5.180	3.553	156.400
	80	98.880	291.600	4.920	3.260	200.667
PP	40	80.960	78.600	6.587	5.280	29.667
	60	134.840	98.800	6.720	5.433	46.067
	80	199.100	151.267	6.307	4.753	75.667

The number of saves or clumps indicates the growth and development of plants before the generative phase. The number of spouts can estimate the production rate of forage weight produced. Saves are defined as young individuals who emerge from the soil's surface in a clump of plants. There was no interaction between plant type and age ($P>0.05$) factors in the number of capfuls of *S. plumosum* and *B. pertusa*. So that the data is displayed separately according to age factors and types of leguminous (Table 3). Judging from the leguminous type factor, the highest number of sap runs achieved by *S. plumosum* is found in treatment without legumes and C. pubescent. Meanwhile, *B. pertussis* gets the highest number of samples in treatments grown along with A. vaginalis. The difference in the number of spouts of both types of grass in legume type treatment can be due to the influence of the characteristics of legume growth (table 2) planted together.

Table 3. Effect of treatment of parameters

Variable	Introduction						SEM	P
	CO	AV	CP	CT	DA	PP		
SP Spouts	21.244c	17.244b	21.378c	14.133ab	13.022a	13.333ab	1.357	0.001
BP Spouts	15.733bc	20.600d	16.511bc	18.733cd	14.694ab	11.467a	1.201	0.001
BP height (cm)	83,263a	98,688c	95,055bc	85,976ab	84,398ab	93,473abc	3,685	0,022
No. leaf BP	16,889a	26,733b	18,867a	23,178ab	46,011c	22,367ab	2,373	0,001

The increase in the number of *S. plumosum* spouts in the study was due to the association between *S. plumosum* and *C. pubescens* not giving rise to competition for the growth of *S. plumosum* saves. The unprocessable growth of *C. pubescens* at the 40-80-day age indicates the high legume, branch growth, and lower leaf dimensions of other legumes in this study, indicating the absence of competition for sample growth of *S. plumosum*.

The association between *S. plumosum* and *C. pubescens* causes grass to get higher irradiation levels than other legumes. There is a negative relationship between shade and the number of spouts. This is because the low light in the shade causes the decreased photosynthetic activity of plants. The photosynthesis results are still used or utilized in grasses for the high growth of plants so that up to defoliation, the results of this assimilation are not enough to form sap saves. The intensity of light affects the fulfillment of plant assimilation results so that it affects the formation of sap saves. Wijaya et al. (2018) reported the number of odot grass saves given shade and without shade consecutively 3 to 22 saves. The same results were also reported by Sukarji *et al.* (2012), where there was an increase in the number of *Stenotaphrum* grass samples in *Cv. Vanuatu* from 45 samples to 88 samples with treatment without shade. Nonetheless, Sawen (2012) reported increased seaweed spouts *Pennisetum purpureum* and *Panicum maximum* with a light intensity rate of 60-100%.

The highest increase in the number of samples of *B. pertusa* ($P<0.05$) in this study is found in the mixing of *A. vaginalis* plants. The compatibility of *B. pertusa* and *A. vaginalis* due to the characteristics of these two plants does not compete with each other in utilizing nutrients or light.

Table 4. Effect of age on parameters

Variable	Age (days)			SEM	P
	40	60	80		
SP Spout	17.244	17.033	15.9	0.959	0.572
BP Spout	15.833	16.878	16.158	0.849	0.676
BPHeight (cm)	73.669a	95.698b	101.059b	2.605	0.001
No. leaf BP	16,667a	26,200b	34,156c	1,678	0.001

The results showed no difference in the number of spouts of *S. plumosum* and *B. pertusa* to the age of cutting ($P>0.05$). Seseray et al. (2012) obtained similar results, who reported no increase in elephant grass saves at a defoliation age of 20-60 days. In his explanation, elephant grass did not experience an increase in the number of spouts due to lack of care, so the growth of the rooting system was not optimal and resulted in the slower formation of children. However, in this study, the absence of an increase ($P>0.05$) in the number of samples of these two types of grass when viewed from the age factor caused by *B. pertusa* has entered the sexual period (40-80 days). An increase in the number of spouts occurs during the vegetative period. Vegetative growth leads to the formation or development of leaves, roots, stems, and branching (vegetative organs as sources and sinks). When it reaches the adult/generative phase, growth is entirely or mainly directed at flowering and fertilization so that the growth of leaves, roots, and branching begins to stop or decrease.

Plant Height

Plant height is an illustration of the growth rate. The height of SP plants obtained in this study ranged from 60-to 180 cm. This result was higher than the Kamlasi et al. report (2014), which got the height of *S. plumosum* grass that grows naturally at 42-84 days 31.53-114 cm. However, it is lower than the report by Keraf et al. (2015), who reported the height of SP at the same age range from 145-181.75 cm with the administration of N fertilizer.

Measurements of SP plant height showed an interaction ($P<0.05$) between treatment and age. The exchange of age and leguminous treatment is listed in graph 1. The increase in the height of the *S. plumosum* plant combined with *D. incanum* increased significantly compared to other legumes. The increase in the size of the *S. plumosum* plant planted together with *D. incanum* at 40-60 days of age is more significant than other legumes. The increase in the size of SP crops in this research is in line with the report by Armecin et al. (2005), where the planting of *desmodium sp* soil cover plants. It can increase the length of the stems of the Manila banana plant (Musa textilis) to 248.21 cm and the size of the leaves to 199.59 cm compared to other types of legumes.

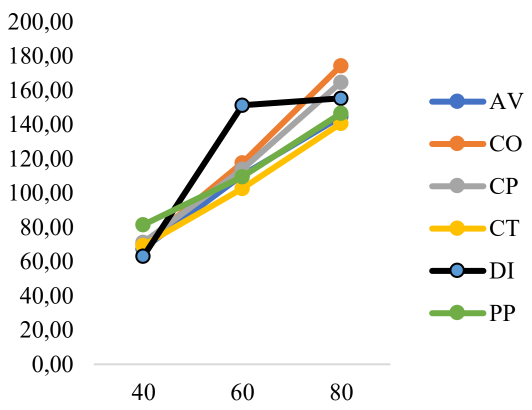
Increased leaf dimension size, multiplication of branches, and several leaves on legumes *D. incanum* successfully create shade. The existing shade has impacted grass and soil—the shadow caused by the spread of leguminous causes the mining intensity of light. Low light intensity during plant development will cause symptoms of etiolation caused by the activity of the hormone auxin. The header of plants exposed to the growing light will be slow because the machine's work is inhibited by light, while in the header part of the plant that is not exposed to light, the growth is very fast because the work of the machine is not inhibited. This condition makes the header (apical) part of the plant experience the most active growth so that the plant grows looking for light to perform more optimal photosynthesis. The same thing was obtained by Sawen (2012), where there was a significant increase in the height of elephant grass along with shade with an average of 141.87 cm. In addition, a shadow against the soil results in a suitable environment for microorganisms that convert organic nitrogen into inorganic forms ready to be absorbed by surrounding plants.

At the age of 80 days, the height of the SP plant reaches its peak at the treatment without legumes which is 174 cm. Although various studies reported the positive effects of planting grasses and legumes together, this study produced a high SP at the age of 80 days highest buried without legumes. This phenomenon can be explained because the grass growth rate at the beginning grows slowly and increases rapidly during the generative phase up to 98 days after planting (Kamlasi et al., 2014).

In contrast to the height of *S. plumosum* that there is an interaction between age and the type of Leguminosae, the size of grass *B. pertusa* is not found an interaction (P<0.05), so the data is displayed according to treatment and age factors (table 3). The height of BP grass, when viewed from legume type treatment factors and age, has increased (P<0.05). The highest plant height of *B. pertusa* was achieved in legumes *A. vaginalis, C. pubescent*, and *P. phialides,* and the lowest increase in the no legume combination. This research gives the impression that there is an increase in growth if this grass is planted along with legumes. This proves a positive impact due to being produced along with legumes. The supply of N by leguminous plants to non-leguminous plants leads to increased growth and production of nonleguminose plants. The results of this study are in line with the results of Budiasa et al. (2019) research that reported that the monocultural-grown Paspalum atratum grass has a relatively lower height of 38 vs. 47 cm compared to those planted mixed with *Centrocema*.

However, various reports do not get a positive response, including *Glass* et al. (2017), which reported no increase in *Pennisetum purpureum* cv grass height. *Mott* (89-93cm) planted monoculture or planted together with *Centro* and *kalopo* legumes, Saifullah et al. (2019) get the growth of *Panicum grass maximum cv* planted along with legum *Alysicarpus vaginalis* does not increase (117-125cm).

Graph 1. height of grass Sp by age and



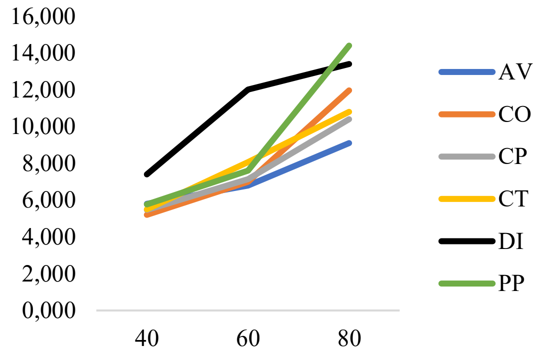
introduction of legumes

BP growth is significant at 40-60 days of age, while at 60-80, there is no increase in growth (Graph 1). This can be due to the growth pattern of *B. pertusa,* which increases sharply at the beginning of the growth period but slows down at the age of older plants. The initial growth rate of the plant takes place very quickly, including in terms of increasing the amount of dry and high plant material; the plant is in the vegetative phase, then the growth will slow down when entering the next phase, namely the generative phase. The rate of high development of plants after reaching the peak point will decrease with age because gradually, plants experience a decrease in the rate of photosynthesis. The photosynthesis results will be transported to a growing network of issues; the less photosynthetic results are transported, the slower they will grow and eventually stop growing. Therefore, the plant slows down at a high growth rate and is eventually constant.

Number of Leaves

There was an interaction between treatment and the age of the number of *S.*

plumosum leaves in the study (P<0.05). The number of leaves seen on the graph of 4.3 SP leaves introduced with *D. incanum* at 40-60 increases significantly and more slowly at 60-80 days of age. Meanwhile, at the age of 60-80 days, the number of *S. plumosum* leaves experienced the highest increase in the treatment of *P. phasaloides* compared to other types of legumes.



Graph 2. number of Sp leaves by age and legume introduction.

The number of *S. plumosum* leaves in this study is listed in table 1. A sharp increase in the age of 40-60 days is achieved by introducing *D. incanum,* while at the age of 60-80, *P. phasaloides.* The ability of the *D. incanum* legume to form shade has impacted soil ecosystems to convert the process of mineralization of organic N into better inorganic N in its early days of growth (40-60 days). Similarly, Hardy and Gibson (1977) reported were *Desmodium sp*. Able to patch 122 kg N / ha/year in the early stages of growth and decrease to 99 kg N / ha/year at an older age. Meanwhile, the ability to increase *P. phasaloides* at an early age and slow down after entering the flowering period causes a high accumulation of litter that positively impacts the grass planted together, thus increasing nitrogen transfer. Nitrogen transfer (N) is the movement of N from legume plants to non-legume plants that are generally grasses. The term is also used to describe the beneficial effect of the N residue of dead legume plants (Ofori and Stern, 1987). Over roots and nodules contain most of the transferable N, and the leaves of old leguminous plants then fall can undergo decomposition and are the source of N for the soil and surrounding plants.

As a result of the strengthening of grass *B. pertusa*, there is no interaction between treatment and age. However, the treatment and age of each of these factors get increased results due to legume introduction and increased generation of cutting. The increase in the number of BP leaves in this study was combined with legum *D. adscendens*. The number of leaves can be caused because legum *D. adscendens* provide good shade for soil ecosystems. Existing dye increases the improvement of microbial ecosystems in the soil. Improvement of soil ecosystems can spur increased forage production. Good soil management is achieved by providing suitable habitat for soil microorganisms. Increased soil carbon and nitrogen stores with legume mix systems also increase the number of microorganisms in the soil. Furthermore, due to the acquisition of nitrogen as diatomic N by legumes, the pH of the soil becomes lower, which encourages microbial activity. On grass-legume lifts, sunlight is used more efficiently because the light passing through tall plants is captured by low-growing plants leading to higher net photosynthesis (Liu et al., 2016).

CONCLUSION

This study showed an interaction between the age factor and leguminous introduction (P<0.05) to plant height and the number of S. plumosum leaves. The introduction of legum D. incanum increases the number of leaves and the size of the S. plumosum plant at 40-60 days compared to other legumes.

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