Conference Paper

Productivity of Hamil Cultivar (Panicum maximum cv Hamil) in Dry Acid Soil

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Abstract.
The limiting factor in acid dry land is root poisoning by Al^{3+}. Hamill cultivar (*Panicum maximum* cv Hamil) is a plant that is commonly used by farmer, where the production of the dry matter is not much different from elephant grass. This study aimed to evaluate the productivity of hamil cultivars on acid soil. The research was conducted in the greenhouse of the Research Institute of Animal Production in Ciawi. The research used a completely randomized design with 10 replications, the treatment included 2 types of soil: acid soil (pH 4.5 Al^{3+} 2.7 cmol kg^{-1}) and non-acid soil (pH 7, Al^{3+} + 2.7cmol kg^{-1}). Plants were planted using pols in pots measuring 40 cm x 30 cm. The variables observed were morphological characters, generative phase, forage production and seed production. The results showed that almost all morphological characters on acid soils were lower ($P < 0.05$). The fresh and dry weight of forage at the first and second harvests in non-acid soils was 50% higher ($P < 0.05$). The booting and flowering age was faster ($P < 0.05$) in non-acid. Seed production on non-acid soils was higher ($P < 0.05$). The reduced productivity of the Hamill necessitated a solution that is tolerant of acid dry land.

Keywords: Hamil cultivar, acid soil, seed production.

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1. Introduction

Hamil cultivar Benggala grass was from Queensland Australia, this cultivar was named Hamil because the seed was selected from Mr. Jack Hamil grass station, although there is no originally source that indicate where this seed came before [1]. This grass has height 2.4-3.0 m, stronger and rougher than comersial cultivar. The Leaves are blue-green, broad, flat, long and pointed. The inflorescence is a large open panicle with lower branches tending to be whorled. The spikelets 3.0-3.5 mm long, glabrous, and flushed with purple, are 2-flowered; the upper floret fertile [2]. Most of local benggala grass found in Indonesia is mostly Hamil cultivar. Production of this cultivar in Indonesia is 503.3 g DM (dry matter) $clump^{-1}$ [3] or 149.42 ton ha^{-1} $year^{-1}$ fresh weight and 31.4

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ton ha^{-1} $year^{-1}$ DM, this production was sufficient for livestock need as much as 14,4 AU [4].

Forage cultivation was usualy directed at suboptimal land, including cultivar Hamil. Dry acid land is one of the suboptimal lands that has potential for Hamil cultivar development. The area of acid dry lands in Indonesia is 108.78 milion ha, and the potential area for agricultural is 62.65 milion ha [5]. Beside that, livestock development was also concentrated in this land. Therefore, cultivating forage in suboptimal land, including acid dry land was expected to increase livestock farming in this area. However, cultivation in acid dry land has a limiting factor, the dominant factor being the Al^{3+} toxicity [6]. Aluminum toxicity distrubs the plant availability and utilization of essential nutrients such as phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), molybdenum (Mo) and boron (B) [7]. Aluminum can also inhibit root growth, which can cause disturbances in nutrient and water absorption [8].

Cultivation of Hamill cultivar on acid dry land should pay attention to Aluminum toxicity in this plant. Therefore this research was aimed at studying the productivity and morphological characters of Hamil cultivars on acid soil.

2. Materials and Methods

The research was conducted in the RIAP greenhouse for 10 month, using a completely randomized design with ten replications. Two type soil were used as treatment, the first type is acid dry soil (pH 4.5, P_2O_5 68 ppm, Al^{3+}2.70 cmol kg^{-1}) from the oil palm plantation area of the Sei Putih-North Sumatra and the second type is non-acid soils (pH 7.10, P_2O_5 464 ppm, Al^{3+} 0.00 cmol kg^{-1}) from the Ciawi Balitnak. The Benggala grass cultivar used was the Hamil cultivar from the Balitnak collection. Planting material using pols, and grown in pots with a diameter of 40 cm and a height of 30 cm. Plant cultivation followed the standard procedure [9]. Before planting, the seeds were sown in polybags, after the plants were one month old, then transferred to pots. The basic fertilizers applied were 100 kg ha^{-1} urea, 100 kg ha^{-1} TSP and 100 kg ha^{-1} KCl and given only once at one-month-old.

The parameters observed were leaf length and width, internode length, stem and node diameter, plant height, number of tillers, fresh and dry weight, flag leaf length and width. The observed characters during the generative phase were boot age, age at first flowering, age at flowering, panicle length, number of spikelets, seed weight, precentage of pithy and empty seed. The observations in this phase were taken from an average of 3 panicles/clumps. All parameters observed were conducted after three months of pruning. The forages were harvested at the age of 40 days after pruning, and was made two times. Data were analyzed using the SAS 9.4 program. If there are differences, it will be followed by the LSD test.

3. Result and Discussion

The Result showed that type of soil was affected to productivity Hamil cultivar ($P<0.05$). The forage fresh and dry weight in first and second harvest of acid soil decreases when compared to it's weight on non-acid soil (Table 1), penurunan bobot segar dan kering rata-rata lebih dari 50%. (It's weight decrease average more 50%). Soil type also affected the number of tillers and height of Hamill cultivars ($P<0.05$), the number of tillers and height of Hamil cultivar in acid soils were lower when compared to non-acid soils (Table 1). The decrease in productivity and the number of tillers is thought to have the effect of Al on acidic soil which causes root growth to be inhibited, inefficient in absorbing nutrients and water, making the plant more susceptible to various forms of stress [10]. Aluminum toxicity can greatly reduce yield and crop quality in case of sensitive plants [11]. Plant height is also affected by soil type, the height of the hamill cultivar in acid soils was lower than in non-acid soils, the lower plant height in the Hamill cultivar is thought to be due to the influence of Al which results in inhibition of plant growth. [12]. Aluminum toxicity can affect many physiological processes in the plant like inhibition of root elongation, decreased biomass, deposition of callose and lignin in root tips, disruption of the functions of the plasma membrane and cell wall, generation of excess reactive oxygen species (ROS) such as H2O2 and O2 [13].

Table 1: The Productivity of Hamil cultivar on acid and non acid soil

Parameter	Soil type	
	acid	non-acid
Fresh weight 1st harvest (g clump^{-1})	26.26^{b}	101.33^{a}
Dry weight 1st harvest (g/clump^{-1})	7.51^{b}	35.57^{a}
Fresh weight 1st harvest (g/clump^{-1})	34.35^{b}	175.89^{a}
Dry weight 1st harvest (g/clump^{-1})	9.94^{b}	41.66^{a}
Tiller number	7.9^{b}	12.3^{a}
Plant height	86.9^{b}	116.9^{a}

[a] the numbers followed by different superscrifts on the same row indicate significant differences ($P<0.05$)

Most of the morphological characters observed were influenced by soil type (P <0.05). Except for the width and length of the leaves, the other characters observed in acid soils were lower than the other characters on non-acid soils (Table 2). The internode length of hamill cultivars in acid soils was lower than that of non-acid soils. The internode length had a positive correlation with plant height [14]. Therefore, the height of Hamil cultivar on acid soil lower than height on non-acid soil (Table 1). Besides internode length, other characteristics that are influenced by soil type are the length and width of the flag leaf (Table 2). Flag leaves was positive corelation with seed production, the results of research that has been conducted on rice show that there is a positive correlation between flag leaves and seed weight in rice. Cutting flag leaves when panicles appear will result in a decrease in the weight of 100 seeds, reduce panicle length and branches, and reduce rice production [15]. Flag leaves also affect wheat seed germination [16].

Table 2: The morphology carachter of Hamil cultivar on acid and non acid soil.

Parameter	Soil type	
	acid	non-acid
Leaf width (cm)	1.87[a]	1.70[a]
Leaf length (cm)	66.6[a]	68.7[a]
Stem diameter (mm)	0.79[b]	1.34[a]
Node diameter (mm)	0.57[b]	0.78[a]
Internode length (cm)	31.20[b]	61.80[a]
Flag leaf length (cm)	15.60[b]	29.30[a]
Flag leaf width (cm) Root fresh weight (g clump^{-1}) Root dry weight (g clump^{-1}) Root length (cm)	1.06[b] 4.56[b] 2.01[b] 39.8[b]	1.66[a] 64.13[a] 20.49[a] 46.1[a]

[a] the numbers followed by different superscrifts on the same row indicate significant differences (P <0.05)

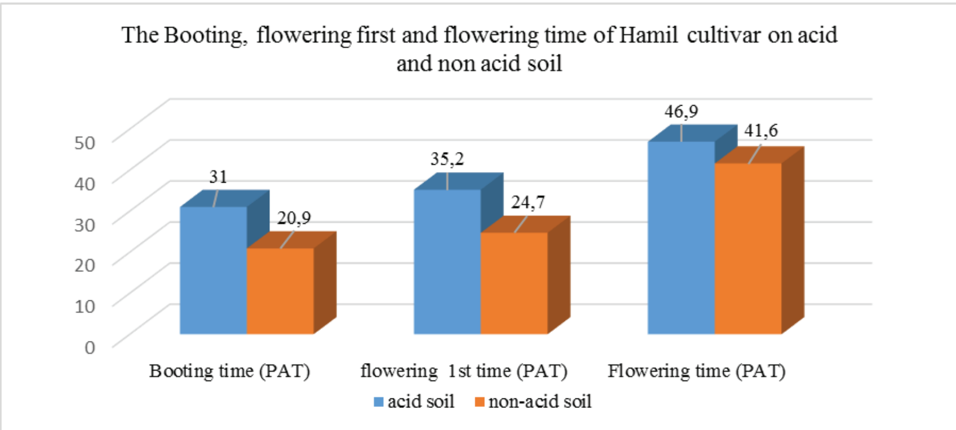

Figure 1: The Booting, flowering first and flowering time of Hamil cultivar on acid and non acid soil.

The part of the plant that is directly affected by aluminum is the root [17]. Previous research has examined the relationship between Al toxicity and inhibition of root growth in plants [18]. Therefore, inhibition of plant roots is a characteristic feature for selecting plants that are tolerant of Al stress [17]. Inhibition of root growth due to Al toxicity also occurs in *Brachiaria grass* [19]. Inhibition of root growth in this cultivar indicated that the hamill cultivar was sensitive to Al stress (Table 2). Extensive root damage due to exposure to Al will inhibit the absorption of water and minerals by plants so that it will affect their growth and productivity [20]. Therefore, there was a decrease in Hamill cultivar production due to inhibition of growth at the roots (Table 1).

The variables measured in the generative phase were boonting age, first flower and flowering. The results showed that the booting age, early flowering and flowering of Hamill cultivars in acid soils were longer than non-acid soils ($P<0.05$). Boot age, first flowering and flowering of the Hamill cultivar in acid soils was 10 days longer (Figure 1). Booting to flowering time is longer in acid soils because Al^{3+} affects photosynthesis, hormones, nutrient absorption, cell wall formation, plasma membranes and signal transduction pathways [7], therefore, inhibit the generative phase in Hamil cultivars on acid soils.

The seed weight and the percentage of pithy seeds of the Hamill cultivar on acid soils were lower than non-acid soils (Figure 2 & 3). The decline in seed production due to the influence of Al^{3+} also occurred in rice [21]. Seed weight and pithy seed decrease in seeds is also associated with disruption of metabolism in plants. Beside, there is a relationship between flag leaves and seed production [15]. The results showed that the flag leaf of the Hamil cultivars on acid soils was lower than the cultivars on non-acid soils (Table 1), so that the seed production is lower.

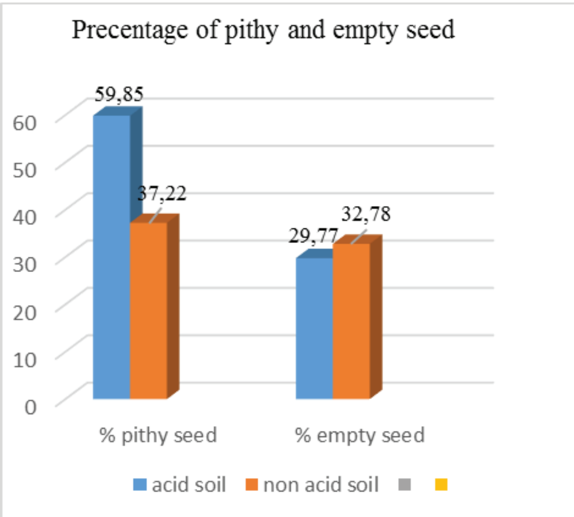

Figure 2: Precentage of pithy and empty seed Hamil cultivar on acid and non acid soil.

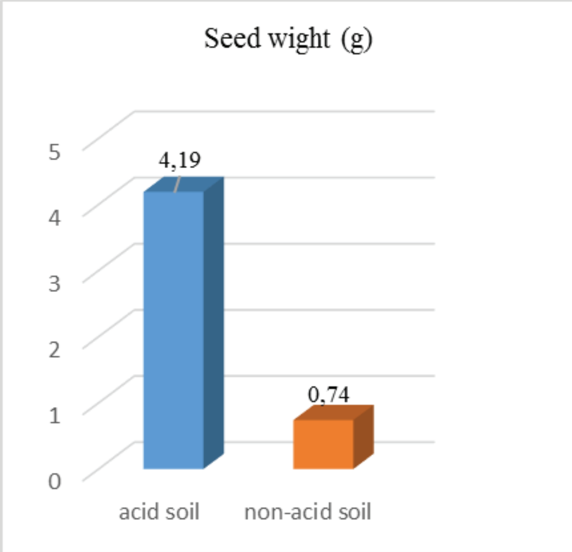

Figure 3: Seed weight of Hamil cultivar on acid and non acid soil.

4. Conclusion

Hamill cultivar productivity on acid soils has decreased significantly. This decrease was also indicated by a decrease in morphological characters, especially root growth. This shows that this cultivar was sensitive to acid soils in this study. It is suggested to assemble an acid-tolerant Hamill cultivar through forage plant breeding.

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