EFFECTS OF TEMPERATURE AND DEFOLIATION FREQUENCY ON DRY MATTER PRODUCTION AND NUTRITIVE VALUE OF *IMPERATA CYLINDRICA*

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ABSTRACT

An experiment was conducted to determine the effects of temperature and defoliation frequency on dry matter production and nutritive value of *Imperata cylindrica*. The plants were grown in Phytotron room under the temperature of 15, 20, 25 and 30°C and defoliated at 60 and 90 days (two times) and 90 days (one time) after transplanting to the pots. Plant parts responded differently to increasing of temperature. Shoot dry weight increased as increasing temperature up to 30°C, but total dry yield declined at 30°C. The decrease in total dry weight at 30°C largely due to detrimental effect of high temperature on rhizome and root growth. One time defoliation also increased total dry yield, shoot dry weight but reduced dry weight of rhizome and roots, although were not significant. Although favorable effects of high temperature on total dry weight and shoot dry yield was found, however, increasing of temperature and one time defoliation reduced crude protein content and digestibility in *Imperata* grass.

(Key words: *Imperata cylindrica*, Dry weight, Nutritive value)

Buletin Peternakan 30 (4): 168 - 173, 2006

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PENGARUH TEMPERATUR DAN FREKUENSI DEFOLIASI TERHADAP PRODUKSI BAHAN KERING DAN NILAI GIZI ALANG-ALANG (*IMPERATA CYLINDRICA*)

INTISARI

Suatu penelitian telah dilakukan untuk menentukan pengaruh temperatur dan frekuensi defoliasi terhadap produksi bahan kering dan nilai gizi pada *Imperata cylindrica*. Tanaman ditumbuhkan di dalam kamar Phytotron pada temperatur 15, 20, 25 dan 30°C dan didefoliasi 60 dan 90 hari (dua kali) dan 90 hari setelah (satu kali) setelah ditanam di dalam pot. Bagian-bagian tanaman berespon secara berbeda terhadap kenaikan temperatur. Berat kering pucuk meningkat dengan kenaikan temperatur sampai 30°C tetapi berat kering total menurun pada 30°C. Penurunan berat kering total pada 30°C kebanyakan disebabkan karena akibat buruk temperatur tinggi terhadap berat kering rizoma dan akar. Satu kali defoliasi juga meningkatkan berat kering total dan shoot tetapi menurunkan inbangan pucuk dengan rizoma dan akar, walaupun tidak nyata. Walaupun diperoleh hasil yang menguntungkan dari temperatur tinggi terhadap berat kering, akan tetapi kenaikan temperatur dan satu kali defoliasi menurunkan kadar protein dan daya cerna pada rumput *Imperata*.

(Kata kunci: *Imperata cylindrica*, Berat kering, Nilai gizi)

Introduction

Imperata cylindrica (L.) Beauv) is an ubiquitous plant with wide biological adaptation. Although the largest area of *Imperata* vegetation is found in tropical countries, the plant also has been spreading to temperate region of the world such as the slopes of Vesuvius in Italy, Florida, Alabama and Mississippi in the United States of America (Patterson *et al.*,1980) and Hokkaido in Japan (Osada, 1989).

The total area of *Imperata* grassland in the world has been estimated about 500 million hectares, about 200 million of which are in South East asia (Falvey, 1981). The large areas of *Imperata* grassland, either as dominant or minor component of grazingland in Indonesia were found in Sumatera, Kalimantan and Sulawesi. The areas are continuously incresing, with an annual increse of 0.15 million hectares, mostly as results of slash and burn agriculture (Soerjani, 1970).

Distribution of tribe Andropogoneae in which genera *Imperata* belongs is found to be closely related to temperature, and to a lesser extent rainfall. The maximum concentration of this tribe in in the Indo-Malaysian zone (Jones, 1985). Competitive ability and the successful of introduction od one species into new area is also determined by temperature (Steiner, 2001).

Many grass and legume species are adapted to a broad range of temperatures in the tropics and sub tropics but grow more luxuriantly within an optimum range of temperatures. Temperature is not only influenced the growth rate of plants but also affecting morphology, dry matter partitioning and nutritive value.

Although *Imperata* has been reported has a wide range of adaptation to temperature and management practices, however, the effects temperature and defoliation frequency on dry matter yield, distribution of materials within the plant and nutritive value has been rarely investigated. This experiment was conducted to determine the effects of temperature and defoliation frequency on dry matter yield and nutritive value in *Imperata* grass.

Materials and Methods

The rhizomes of *Imperata* with leaves and rhizomes attached which previously had been grown for one month in growth cabinet were transplanted into plastic pots filled with 3.5 litres of light clay soil, at the rate of one plant per pot. All pots then were placed in Phytotron room under 17 hours and 70% relative humidity.

The experimental design was a split plot design with four levels temperature (15, 20, 25 and 30°C) as main plot and two cutting frequencies (60 and 90 days after transplanting into the pots) as sub plot treatment. During the experiment, all pots were watered as needed and hand weeded periodically.

Four months after transplanting, plants were unearthed, separated into plant parts and then oven dried at 70°C for 24 days. Data were taken on tiller number, total dry yield, dry yields of shoot, rhizome and root, crude protein content and digestibility.

Crude protein content was determined with C-N Corder (MT-500 type, Yanagimoto Co, Japan). Digestibility measurement used was the method of Goto and Minson (1977).

Results and Discussion

The productivity and nutritive value of *Imperata* as influenced by temperature and cutting frequency was shown in table 1.

Table 1. Effect of Temperature and Cutting Frequency on Tiller Number, Dry Yields of Shoot, Rhizome and Root, Crude Protein Content and Digestibility

Treatment	Tiller Number (/pot)	Total Dry Wt (g/pot)	Shoot Dry Wt (/pot)	Rhizome + Root Dry Wt (/pot)	Shoot-(rhizome-root ratio)	Crude Protein (%)	Digestibility (%)
Temperature							
15°C	3.75^{a}	1.76^{a}	0.80^{a}	0.96^{ab}	0.83^{a}	20.64^{c}	68.81^{c}
20°C	6.75^{ab}	3.21^{b}	1.63^{b}	1.57^{b}	1.04^{a}	16.75^{b}	52.63^{b}
25°C	8.5^{b}	4.31^{c}	2.68^{c}	1.63^{b}	1.64^{a}	13.55^{a}	44.58^{a}
30°C	7.13^{b}	3.25^{b}	2.84^{c}	0.41^{a}	6.93^{b}	11.99^{a}	41.56^{a}
Cutting frequency							
One time	7.06^{a}	3.36^{a}	2.26^{a}	1.10^{a}	2.05^{a}	15.52^{a}	60.72^{a}
Two times	6.00^{a}	2.90^{a}	1.71^{a}	1.18^{a}	1.45^{a}	16.04^{a}	63.67^{a}

^{abc} Different superscripts in the same column of each treatment indicate a significant difference (P<0.05).

Shoot dry weight and shoot-(rhizomes + roots) ratio, increased linearly ($P<0.01$) with increasing temperature up to 30°C, but tiller number and total dry yield increased ($P<0.05$) up to 25°C and at 30°C, they were declined. Crude protein and digestibility increased ($P<0.01$) as decreasing of temperature and two times of defoliation increased crude protein content and digestibility although not significant. The was no significant interaction between temperature and defoliation frequency (Table 1).

The high dry weight of shoot up to 30°C indicates that the high potential for dry matter production of shoot at high temperature. This finding was in agreement with Patterson *et a*l. (1980) who reported an increase in shoot dry weight with increasing temperature in *Imperata* up to day/night temperature of 27/17°C.

The increased shoot growth with increasing temperature probably due to physiological characteristic of *Imperata* that need a high temperature for growth. Like other tropical grasses, *Imperata* has a high optimum temperature for dry matter accumulation. Jones (1985) reviewed some works and noted that the optimum mean daily temperature for C4 grasses is about 30-35°C and the growth is severely reduced above 40°C and below 20°C. This helps to explain why *Imperata* grass mostly found in tropical areas.

Although high temperature enchances photosynthetic fixation of carbon by leaves, it also raises the rate of respiration (Jones, 1985). The decline in total yield at 30°C largely due to decrease of rhizome and root yield at higher temperature. This result indicates that at high temperature, the rate of respiration was higher than the rate of photosynthesis and relatively more dry matter was partitioned to aerial plant parts. This was in agreement with McWilliam (1978) who stated that the optimum for the growth of roots tends to be lower than for shoot growth.

High temperature tends to increase tillering in grasses (McWilliam, 1978). However, Langer (1973) who review some works noted the increase of tillering as decreasing temperature. In this experiment, the number of tiller increased as temperature increased up to 25°C and at 30°C declined. It has been known that growth of buds to form tiller is largely depend on availability of adequate resources carbohydrates, determined by relative rates of photosynthesis and respiration. Rates of photosynthesis and respiration were not measured in this experiment, however, it is strongly suggested that at 30°C, due to high rate of respiration, unfavorable balance of carbohydrates was occurred and reduced the potential of plant to form new tiller.

Crude protein contents of *Imperata* followed a trend which was, in general, the reserve of shoot dry weight. Maximum crude protein content was obtained when the grass grown in temperature of 15°C. The lower crude protein content a increasing temperature also had been reported in other plant species (Kallebach *et al*, 2002; Monjardino *et al*., 2005) This was due to dilution of tissue nitrogen by greater dry matter accumulation, not by reducing uptake (Jones, 1985). In general, crude protein content of *Imperata* in the tropics is very low, however, in northern Thailand, owing to lower temperature, *Imperata* pastures can maintain their nitrogen level above critical level for livestock for a total of about 20 weeks (Falvey *et al*.,1979).

Digestibility of *Imperata* decreased as increasing temperature. The decreasing of digestibility as increasing temperature has been reported elsewhere (Jones, 1985; Newman *et al*., 2005). A decrease in digestibility by 7.7% for bermudagrass and 12.9% for bahiagrass occurred when temperature increased when temperature increased from 26 to 35°C (Henderson and Robinson, 1982). The more advanced plant maturity as resulted from increasing temperature in undoubtedly responsible for some of the decrease of digestibility. High temperature accelerates growth, flowering and maturation and in so doing they increase lignification and decrease digestibility (Pearson and Ison, 1987). Cell wall content increases with increasing temperature; the increase is largely in the less digestible fraction of cell wall (Moir *et al.*,1977).

Table 1 also shows that total dry yield and shoot yield of plants imposed to two times defoliation were lower than one time defoliation, although statistically the difference were not significant. The decline in dry yield as affected by two times of cutting might be caused by reducing rate of photosynthesis and carbohydrate reserve contents as already reviewed (Younger, 1982). This result indicates that under condition of this experiment, the dry yield of *Imperata* can be increased by increasing interval between defoliation. However, it should be realized that the increase of defoliation interval decreased crude protein content and digestibility.

Conclusion

Although *Imperata* needs a high temperature for optimum growth, but plant parts differed in their reaction to increased temperature. At 30°C more dry matter partitioned to aerial plant parts, resulting in thje lowest shoot (rhizome + root) ratio. Although more dry matter available for animal feed at 30°C, but quality of grass declined. Fortunately, crude protein and digestibility in this experiment appear still can fulfil the needs of livestock grazing in *Imperata* pastures.

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