The Effects of Restricting Nitrogen, Phosphorus, and Potassium Fertilizers on Erianthus (*Erianthus arundinaceus*) Growth and Nutrient Contents

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Introduction

Low inputs and sustainability are the major concerns in bioenergy crop production (Reijnders 2006). *Erianthus* spp. is a relative of sugarcane and is a perennial crop with high dry matter production (Matsuo *et al.* 2003). It is expected to become a cellulosic bioenergy crop. However, its fertilizer requirements are still unknown because erianthus has a highly developed root system (Matsuo *et al.* 2003), and appears to absorb nutrients from the subsoil layer, which is hardly used by other crops. Therefore, it is necessary to experimentally restrict fertilizer application and maintain the rhizosphere to clarify the fertilizer requirements.

In this study, we grew *Erianthus* (*Erianthus arundinaceus*) in pots and restricted nitrogen (N), phosphorus (P), and potassium (K) fertilizer application to evaluate the fertilizer requirements.

Materials and Methods

The *Erianthus* (*Erianthus arundinaceus*) breeding line JES1 was used in this experiment. We prepared pots containing 10 kg of soil with nutrient content as shown in Table 1. *Erianthus* seedlings at the 8-leaf stage were transplanted into each pot on July 30, 2012 and were grown in field conditions until October 29, 2012. The experimental design was set up by using 4 different fertilizer treatments: NPK, NP-K, NK-P, and PK-N. In the NPK treatment nitrogen, phosphorus, and potassium fertilizers were applied, whereas in the NP-K treatment, only nitrogen and phosphorous fertilizers were applied. Similarly, in the NK-P treatment, only nitrogen and potassium fertilizers were applied and in the PK-N treatment, only phosphorous and potassium fertilizers were applied. Each treatment was replicated 5 times. Pots were fertilized with reagent grade ammonium sulfate (4.72 g/pot), calcium dihydrogenphosphate (3.55 g/pot), and potassium chloride (1.58 g/pot) were applied every 2 weeks immediately after transplanting. We harvested *Erianthus* on October 29 and measured the plant length, tiller number, leaf age, leaf weight, stem and stem sheath weights, litter weight, and nutrient content.

Results and Discussion

Erianthus responded differently to all the fertilizer treatments (Fig. 1). The NK-P and PK-N treatments resulted in significant reductions in all the measured parameters, especially in the total shoot dry weight (Table 2). By contrast, the NP-K treatment resulted in significantly reduced

Table 1. Soil nutrient content used for this experiment.

pH	CEC (me/100 g)	Nitrate nitrogen (mg/100 g)	Available Phosphate (mg/100 g)	Exchangeable potassium (mg/100 g)	Exchangeable calcium (mg/100 g)	Exchangeable Magnesium (mg/100 g)	Humus (%)
6.1	7.6	0.2	1.4	24.1	134	29.1	2.1

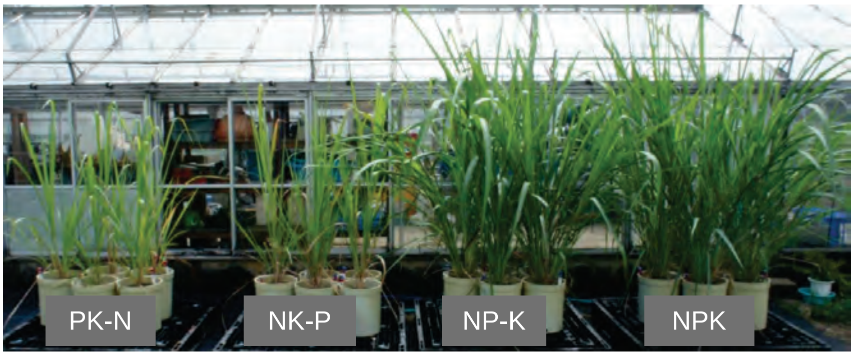

Figure 1. The effect of fertilizer restriction on *Erianthus* growth (46 days after transplanting).

Table 2. The effects of fertilizer restriction on plant length, tiller number, leaf age, shoot dry weight

Treatment	Plant length (cm)	Tiller number	Leaf age	Leaf weight (g/plant)	Stem and stem sheath (g/plant)	Litter (g/plant)	Total shoot dry weight (g/plant)
NPK	240a	18.0a	22.8a	169a	217a	38a	423a
NP-K	225a	12.4b	24.2a	157a	162a	22b	340a
NK-P	161b	6.6c	18.6b	12b	11b	14bc	37b
PK-N	144b	9.8bc	19.6b	24b	19b	6c	48b

Different letters in the same column show significant differences at $P<0.05$ by Tukey's multiple-hoc test.

Table 3. The effects of fertilizer restriction on *Erianthus* nutrient contents.

Treatment	Uptake of nutrients (g/plant)			Nutrient concentration (%)		
	N	P	K	N	P	K
NPK	4.21a	0.59a	3.72a	1.01a	0.14a	0.89a
NP-K	3.96a	0.59a	1.22b	1.19ab	0.17a	0.36b
NK-P	0.47b	0.01b	0.30c	1.29b	0.03b	0.80a
PK-N	0.44b	0.07b	0.69c	0.94a	0.15a	1.45c

Different letters in the same column show significant differences at $P<0.05$ by Tukey's multiple-hoc test.

numbers of *Erianthus* tillers, and tended to result in reduced total shoot dry weight, but the reductions were lower than that observed during NK-P and PK-N treatments (Table 2). The amount by which the plant nutrient concentrate-ions were reduced depended on the fertilizer treatment. NK-P and NP-K treatments had significantly lower nitrogen, phosphorous, and potassium contents, but the NP-K treatment only had significantly low potassium concentration (Table 3). These differences were reflected in the degree of suppression in *Erianthus* growth. Further, low potassium content was observed in the NP-K treatment, and low phosphorus was observed in the NK-P treatment (Table 3). However, the nitrogen content in *Erianthus* grown under the PK-N treatment remained at the same level as that in the NPK treatment (Table 3).

The above results indicate that *Erianthus* growth requires a nitrogen content of more than about 1%. The results suggest that nitrogen and phosphorus deficiency limits the growth of *Erianthus* more severely than potassium deficiency. These results showed that in this soil *Erianthus* requires additional nitrogen, phosphorus, and potassium for high growth rates, but that the response to phosphorus and nitrogen is greater than that for potassium.

Conclusion

In this study, we investigated the fertilizer requirements of *Erianthus* (*Erianthus arundinaceus*). Nitrogen and phosphorus were the first limiting nutrients. Potassium restriction also reduced the number of tillers and tended to reduce the total shoot dry weight. These results showed that in this soil *Erianthus* requires additional nitrogen, phosphorus, and potassium for its growth, but that the response to phosphorus and nitrogen are greater than for potassium.

Acknowledgements

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