EFFECTS OF NITROGEN ON THE GROWTH OF *HYPARRHENIA DIPLANDRA*

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ABSTRACT

The nitrogen effects on *Hyparrhenia diplandra* were studied. Plants were grown on nutrient solutions of variable concentrations in nitrogen. The supplied nitrogen increased tillering, leaf production, lamina area, total dry matter accumulation and total nitrogen accumulation in lamina. A detailed examination showed that the effect on tillering was the main cause of the differences observed in dry weights between different treatments. The nitrogen supply elongated significantly the lamina and nitrogen deficiency increased its thickness; but this was not enough to compensate the loss of weight in lower nitrogen treatment. The lamina area as well as nitrogen accumulation in the lamina showed a positive correlation with shoot dry matter, r>0.8 and with root dry matter r>0.6.

KEYWORDS

Forage grass, nitrogen, morphogenesis, growth, correlations.

INTRODUCTION

Hyparrhenia diplandra is a tropical perennial grass that presents a double interest in savannas it covers in the Congo. Its roots that grew into deeper soil allow fragile soils to resist erosion. As natural forage grass, it is the cause of pastoral activities that were encouraged about 1950s (Trochain and Koechlin, 1958), but which failed for lack of a rational management. Interdisciplinary studies have been initiated in order to understand how to manage these savannas in a better way. Botanical and ecological studies had been undertaken (Mackany, 1976) but little is known about ecophysiological aspects of the main useful species. This study was conducted to examine the effects of different levels of nitrogen on the growth of *Hyparrhenia diplandra*.

MATERIAL AND METHODS

Seedlings of *Hyparrhenia diplandra* were collected from natural population at stage 4 to 5 leaves. The roots were washed from soil, then the plants were transferred to 1.5 l pots containing nutrient solutions. Two nitrate concentrations were used: 15 10^{-3} mol./l as high nitrogen treatment (HNT) and 1.5 10^{-3} mol./l as low nitrogen treatment (LNT). Plants were kept in a greenhouse. The nutrient solutions were exchanged once weekly, then twice weekly and finally thrice weekly according to the plant development in HNT. Between two nutrient changes, the loss of water by transpiration was compensated for by distilled water.

4 to 7 plants per treatment were harvested on days 30, 41 60 79 and 102 after transplanting. The following measurements were made: number of leaves and tillers, lamina area and dry matter of different plant parts. The dry weights were recorded after drying at 80°C and lamina area was estimated by the product length lamina x median lamina width x 0.905 (de Parcevaux, 1970). The total nitrogen content in lamina was determined by Kjeldahl analysis.

RESULTS AND DISCUSSION

Tables 1 and 2 summarise the evolution of plant growth parameters. All along the experiment, on average 18 tillers per plant were produced in HNT against 7 in LNT. At the same time, the leaves produced in HNT were 2.5 times more than those in LNT.

The number of live leaves per plant was also greater in HNT than in LNT. Unlike the number of live leaves per plant, the number of live leaves per tiller showed no dependence on the nitrogen concentrations and values. Between 5 and 3.37 live leaves per tiller were comparable to those found for other grasses (Langer, 1957; Robson, 1973).

Thus, the marked effect of additional nitrogen on the plant development was the increase in tillering as previously recorded (Ryle, 1970; Wilman *et al*., 1977; Robson and Deacon, 1978).

The lamina area per plant, as well as live leaves per plant, increased in both treatments. Whereas nitrogen did not affect the number of live leaves per tiller, lamina area per tiller showed a rise in HNT from 60 days after transplanting. The values obtained for mean area per leaf were more or less the same in both treatments until 41 days after transplanting. Afterwards differences occurred to the detriment of the LNT. After promoting tillering, nitrogen secondly stimulated leaf size. (Ryle, 1970; Wilman *et al*., 1976).

This last effect of nitrogen agreed with the variation of lamina dry weights. Nitrogen enrichment increased significantly lamina dry weights 58%, 74% and 78% respectively at 60, 79 and 102 days after transplanting. For the dry matter of other plant parts, the trend in response to the nitrogen supply was not similar to that of lamina dry matter.

Values of shoot (lamina + sheaths + stems) dry weights presented significant differences between both treatments throughout the experiment and the enhancement at HNT varied from 26%, 30 days after transplantation, to 57% at the end of the experiment.

Root dry weights increased in both treatments. Nevertheless differences in root dry matter accumulation varied irregularly between the treatments.

As to total dry matter accumulation, it followed shoot dry matter accumulation. The enhancement in favour of HNT varied from 38% to 48% at respectively 30 and 102 days after transplanting.

This analysis shows that leaves (lamina + sheaths) dry matter contributed for 72% and 64% in total dry matter respectively in HNT and LNT at 30 days after transplanting. At the end this fraction decreased to 35% in LNT but persisted to 64% in LNT. Nitrogen supply decreased root to shoot growth (Troughton, 1977; Lawlor *et al*., 1988). The stimulated effect of nitrogen on total dry matter is the result of an increase in leaf dry matter accumulation, mainly in lamina dry matter. Nevertheless, specific lamina mass was 22% to 59% lower at HNT. This showed that nitrogen deficiency increased the thickness of lamina. The effect of HNT in the increase of lamina dry mass was due to the increase of lamina size, particularly lamina length and consequently due to the increase of lamina area. Nitrogen influences via lamina area the partition of dry matter between shoot and root parts. Relationships were observed between lamina area and shoot dry matter on the one hand with a correlation coefficient r= 0.91, and between lamina area and root dry matter on the other hand with r= 0.78.

Nitrogen accumulation in lamina rose rapidly in HNT but showed no noticeable increase in LNT. Nitrogen supply enhanced nitrogen accumulation from 34% to 80% respectively at 30 and 102 days after transplanting. Lamina nitrogen, as well as lamina area, correlated with shoot dry matter (r= 0.89) and root dry matter (r= 0.67). A link appeared between nitrogen lamina and lamina area, in fact between nitrogen lamina and photosynthesis, to regulate dry matter distribution between plant parts.

The results obtained in this study are not different from those encountered in the literature. Laboratory results can differ from those in natural conditions but before confronting them by undertaking field experiments, it would be interesting to observe in laboratory the behaviour of carbohydrate components which play an important role on the regrowth of the perennial grasses.

REFERENCES

Langer, R. H. M. 1957. Growth and nutrition of timothy (Phleum pratense). II. Growth of the plant in relation to tiller development. Ann. Appl. Biol. 45 **(3):** 528-541.

Lawlor, D. W., F. A. Boyle, A. J. Keys, A. C. Kendall and A. T. Young. 1988. Nitrate nutrition and temperature effects on wheat: a sythesis of plant growth and nitrogen uptake in relation to metabolic and physiological processes. J. Exp. Bot. 39 **(200):** 329-343.

Mackany, L. 1976. Végétation des Plateaux téké (Congo). Collection Travaux de l'Université de Brazzaville.

Parcevaux, S. de et J. Catsky. 1970. Méthodes et techniques de mesure des surfaces foliaires. Pages 493-499 *in* Techniques d'étude des facteurs physiques de la biosphère, I.N.R.A., Paris.

Robson, M. J. 1973. The growth and development of simulated swards of perennial ryegrass. I. Leaf growth and dry weight change as related to the ceiling yield of a seedling sward. Ann. Bot. **37:** 487-500.

Robson, M. J. and M. J. Deacon. 1978. Nitrogen deficiency in small closed communities of S24 ryegrass. II. Changes in the weight and chemical composition of single leaves during their growth and death. Ann. Bot. **42:** 1199-1213.

Ryle, G. J. A. 1970. Effects of two levels of applied nitrogen on the growth of S37 cocksfoot in small simulated swards in a controlled environment. J. Brit. Grassld Soc. **25:** 20-29.

Trochain J.-L. et J. Koechlin. 1958. Les pâturages naturels du Sud de l'A.E.F. Bull. I.E.C. Nouv. série, **15-16:** 59-83.

Troughton, A. 1977. Relationship between the root and shoot systems of grasses. Pages 39-51 in J. K. Marshall, ed. The below ground ecosystem: a synthesis of plant-associated processes. Rge Sc. Dpt. Science series no. 26, Colorado State University, Fort Collins, Colorado.

Wilman D., D. Droushiotis, Mary N. Mzamane and J. S. Shim. 1977. The effect of interval between harvest and nitrogen application on initiation, emergence and longevity of tillers and dimensions and weights of leaves and stems in Lolium. J. Agric. Sci. **89:** 65-79.

Table 1
Effect of N on tiller and leaf number and lamina area

Days after transpl.	Nitrogen treat.	Number of tillers	Number of leaves total	leaves living	leaves living/tiller	Leaf area (dm2) plant	tiller	per leaf
30	1.5	2a	15a	10a	5	1.89a	0.94	0.18
	15	3a	18a	14a	4.66	2.12a	0.70	0.15
41	1.5	3.25	22	13	4	2.98	0.91	0.22
	15	6.25	35	26	4.16	5.42	0.86	0.20
60	1.5	6.33	43.67	22.67	3.58	4.61	0.72	0.20
	15	13.33	73.33	52.33	3.92	16.21	1.21	0.30
79	1.5	8.33	56.00	27.33	3.28	5.61	0.67	0.20
	15	17.00	96.33	67.00	3.94	32.76	1.92	0.48
102	1.5	9.33	61.00	29.00	3.10	6.74	0.72	0.23
	15	21.00	134.67	82.00	3.90	42.87	2.04	0.52

Numbers followed by the same letter in a column were not significantly different (P=0.05) to Newman and Keuls test.

Table 2
Effect of nitrogen on biomass allocation characteristics and nitrogen accumulation in lamina

Days after transpl.	Nitrogen treat.	Mean dry matter weights (g)/plant Lamina	Sheaths	Shoots	Roots	Total	Lamina specific mass	Lamina nitrogen (mg)
30	1.5	1.17a	0.29	1.56	0.47	2.03	0.61	1.36
	15	1.04a	0.87	2.13	0.83	2.96	0.49	2.18
41	1.5	1.48a	0.61	2.25	1.26a	3.51	0.49	2.15
	15	1.93a	1.48	3.68	1.50a	5.18	0.35	4.50
60	1.5	2.10	0.95	3.34	2.63a	5.97	0.45	1.32
	15	5.05	4.26	9.85	3.54a	13.39	0.31	8.80
79	1.5	3.01	1.10	8.77	4.63	13.40	0.53	1.38
	15	11.72	8.53	23.74	6.56	30.30	0.35	13.90
102	1.5	5.51	1.14	12.82	6.15a	18.97	0.81	1.57
	15	14.46	9.34	29.55	7.34a	36.89	0.33	17.60

Numbers followed by the same letter in a column were not significantly different (P=0.05) to Newman and Keuls test.