NITROGEN IN STUBBLE AS A LIMITING FACTOR OF REGROWTH AND YIELD OF ORCHARDGRASS AFTER CUTTING

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ABSTRACT
Two field trials were carried out to reexamine the role of total nonstructural carbohydrates (TNC) and nitrogen (N) of the stubble in regrowth of orchardgrass (*Dactylis Glomerata* L.) during 10 days after cutting and the yield of next cutting. The regrowth and the yield were independent of TNC content in the stubble. They increased with N content in the stubble derived from the different rate of previous N application. When the TNC content in the stubble at the time of cutting was more than about 18% (dry matter basis), the regrowth even in a darkroom was not affected by the TNC content. From these results we concluded that N in the stubble at the time of cutting played a more important role in the regrowth after cutting and the yield of orchardgrass than TNC in the stubble.

KEYWORDS
Orchardgrass, regrowth, stubble, total nonstructural carbohydrates, nitrogen, dry matter yield

INTRODUCTION

It has been emphasized for a long time that reserve carbohydrates in stubble play a pre-eminent role in the rate of regrowth of grasses following cutting. However there are also many works that question this role of carbohydrates. Some papers (Sullivan and Sprague, 1953; Mckee *et al*., 1967; Kumai and Sanada, 1973) reported that the regrowth of grass was affected not only by the carbohydrates but also by N in the stubble. Kumai and Sanada (1973) therefore stressed that optimal content of carbohydrate and nitrogen in the stubble could ensure good regrowth of orchardgrass. In general, however, there is a negative correlation between carbohydrate and N content in the stubble. Hence it is difficult to maintain the optimal content of carbohydrate and N for good regrowth.

This paper describes the results of field studies to reexamine the role of TNC and N of the stubble in the regrowth of orchardgrass after cutting and the yield of next cutting.

MATERIALS AND METHODS

Two field trials were conducted on an orchardgrass (*Dactylis Glomerata* L. cv. Okamidori) sward cut three times a year for hay or silage in 1995. Trial 1 was carried out to clarify the effect of differences in N and TNC content of the stubble at the time of first cutting, which were derived from different rates of N application (0, 30, 60 and 90 kg ha^{-1}) at early spring, on regrowth of the grass during 10 days after first cutting and yield of second cutting. In trial 2, all plots received 60 kg N ha^{-1} in early spring and treatments of fertilizer N application was done after first cutting. The treatment levels of the N application were the same as those in trial 1. We determined the effect of the differences in N and TNC content of the stubble at the time of second cutting on the regrowth of the grass and yield of third cutting. We described the removed part of the grass above cutting height (5cm) as herbage in this report.

In both trials small samples (30cm X 30cm, 15cm depth) were dug out with soil from each plot at the time of each cutting. They were placed in a darkroom for 10 days under suitable water supply in order to investigate the regrowth of the grass in the absence of light.

Treatment plots in both trials were arranged in 3 randomized blocks. Twenty kg P_2O_5 ha^{-1} and 70 kg K_2O ha^{-1} were applied to all plots at early spring and after each cutting. TNC in stubble was analyzed by the method of Smith *et al*. (1964). Plant tissue N content was determined by the Kjeldahl method after digestion with H_2SO_4 and H_2O_2.

RESULTS AND DISCUSSION

Trial 1. We show some of the results obtained from this trial in Table 1. The dry matter (DM) yield of first cutting increased with the rate of N applied at early spring, while there was a slight difference in the DM weight of the stubble at the time of first cutting among the treatments. The N content in the stubble also increased with the rate of N applied and TNC content in the stubble clearly decreased with the rate.

The DM weight of herbage at 10 days after first cutting was more in the plots receiving previous N than that in the plot receiving no N, although there were little differences in the DM of herbage among the plots receiving N. The DM weight of the stubble at 10 days after first cutting increased with the rate of N applied. Therefore total DM (DM weight of herbage + DM weight of the stubble) also increased with the N content in the stubble at the time of cutting, but it decreased with increased TNC content. The DM yield of the second cutting was also related to the N content in the stubble at the time of first cutting, although the same rate of 60 kg N ha-1 was applied on all treatment plots after first cutting. These results show that the regrowth of the grass during 10 days after first cutting and the yield of second cutting are dependent on the N content in the stubble at the time of the first cutting.

The regrowth of the grass placed in a darkroom for 10 days after first cutting was less than that in the field. The DM weight of herbage in the darkroom was related to the TNC content in the stubble at the time of cutting. Therefore it appeared that the regrowth of the grass in the absence of light was limited by the TNC content in stubble at that time. In this case, the maximum TNC was 16.6% (DM basis).

Trial 2. As shown in Table 2, this trial showed similar trends to trial 1. The DM weight of herbage at 10 days after second cutting and the DM yield of third cutting increased with the N content in the stubble at the time of second cutting. These DM weight decreased with increase in the TNC content in the stubble at that cutting. In particular, even in the darkroom, the DM weight of herbage was not dependent on the TNC content in the stubble at the time of second cutting. In this case, the minimum content of TNC in the stubble was 18.5% (DM basis) and it was more than the maximum content of TNC in trial 1. It appeared that this difference in the accumulation of TNC in the stubble between trial 1 and trial 2 resulted in the different response of the regrowth in the darkroom.

CONCLUSION

From the results of trial 1 and 2, we can point out that N in the stubble at the time of cutting plays a more important role in the regrowth after cutting and the yield of orchardgrass growing from spring to autumn than TNC in the stubble.

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Table 1
Effect of N and TNC in the stubble at the time of first cutting on the regrowth during 10 days after the cutting and yield of second cutting.

N applied after first cutting (kg ha^{-1})	First cutting				Regrowth at field			Regrowth at darkroom			Yield of second cutting (kg DM ha^{-1})
	Yield (kg DM ha^{-1})	Stubble (kg DM ha^{-1})	Content (%) in stubble		Herbage (kg DM ha^{-1})	Stubble (kg DM ha^{-1})	Total (kg DM ha^{-1})	Herbage (kg DM ha^{-1})	Stubble (kg DM ha^{-1})	Total (kg DM ha^{-1})	
			N	TNC							
0	4910	472	0.80	16.6	217	402	619	73	420	493	4620
30	5450	500	0.95	13.9	257	448	705	65	401	466	4970
60	6160	555	1.20	10.9	307	475	782	45	383	428	5280
90	6720	500	1.46	10.6	311	523	834	47	315	362	5320

Table 2
Effect of N and TNC in the stubble at the time of second cutting on the regrowth during 10 days after the cutting and yield of third cutting.

N applied after first cutting (kg ha^{-1})	Second cutting				Regrowth at field			Regrowth at darkroom			Yield of third cutting (kg DM ha^{-1})
	Yield (kg DM ha^{-1})	Stubble (kg DM ha^{-1})	Content (%) in stubble		Herbage (kg DM ha^{-1})	Stubble (kg DM ha^{-1})	Total (kg DM ha^{-1})	Herbage (kg DM ha^{-1})	Stubble (kg DM ha^{-1})	Total (kg DM ha^{-1})	
			N	TNC							
0	3440	613	0.98	25.8	273	621	894	143	464	607	4340
30	4560	630	1.05	23.1	297	683	980	176	421	597	4320
60	4920	810	1.36	19.2	428	866	1294	238	380	618	4720
90	5360	711	1.87	18.5	401	847	1248	274	450	724	4780