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Evaluation of Slow Release Nitrogen Fertilisers for Tall Cabbage Grown in Autumn

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Tall cabbage (*Brassica oleracea*, var. *costata*, cv. Penca de Mirandela) is very popular in Portugal. It forms part of the traditional Christmas Eve dinner every year. The nurseries are prepared in the middle of summer and the young plants transplanted late in August. The highest growth rates of this vegetable as well as the highest demands for nitrogen (N) occur in October and early November, a typical rainy period where there is a high risk of nitrate leaching. Therefore, the use of slow release N fertilisers may be a viable option as a sound N fertilization strategy for this production system. The objectives of the research were to examine the effect on crop yield of three materials that delay N availability to plants and also to monitor when N becomes available to the crop. Results of a pot experiment are presented where tall cabbage was grown in the autumn as a main crop and Italian ryegrass (*Lolium multiflorum* L.) was sown in spring in-order to evaluate the residual effect of fertilisers.

Methodology

Young plants of tall cabbage were planted on 21 August 2007 in pots with 15 kg of screened (6 mm mesh) and air dried soil mixed with the respective fertilisers. The fertiliser treatments were: Urea, applied at rates of 1.47 g/pot (Urea1/2) and 2.94 g/pot (Urea1); Floranid Permanent 16-7-15 (slow-release, IBDU/Isodur fertiliser); Basacote plus 9M 16-8-12 (controlled-release fertiliser, copolymer ethylene acrilic); and Entec 26 (stabilized-fertiliser, DMPP as nitrification inhibitor), applied all at rates of 2.94 g/pot. A zero N control was also included. Phosphorus and potassium rates were balanced by using singular-granular superphosphate and potassium chloride. Five replicates per treatments were provided. The plants were irrigated with distilled water and the pots protected from rain to avoid nitrate leaching. The plants were cut at the ground level on 14 Dec 2007. Thereafter the soil was kept moist to stimulate microbial activity. On 4 Apr 2008, 1 g/pot of seed of Italian ryegrass was sown to recover the residual N released from December. Italian ryegrass was cut on 17 May 2008. Collected data at harvest of tall cabbage included above-ground plant dry matter (DM), tissue N concentration (TNC) and petiole nitrate concentration (PNO_3C). Nitrogen uptake and apparent N recovery (ANR) were estimated from collected data. Dry matter yield and tissue N concentration were also recorded from Italian ryegrass. Nitrogen released from soil and fertilisers was monitored by recovering the NO_3^- in 1x2 cm strips of an anion exchange membrane (AEM) inserted directly into the soil and kept there for a week. Soil NO_3^- concentrations were determined on 29 Sep 2007, 24 Oct 07, 5 Dec 07 and 4 Apr 2008. N concentration in tissues was determined in a Kjeltec Autoanalyser 1030. Nitrate concentration in extracts, prepared from petioles and from AEM, was determined by UV-Vis. spectrophotometry.

Results

The dry matter yields of tall cabbage differed significantly among treatments. Maximum (82.9 g/pot) and minimum (32.8 g/pot) values were recorded in Urea1 and Control treatments, respectively (Table 1). TNC and PNO_3C differed also among treatments. However, Entec and Floranid yielded similar results than Urea1. Values of N uptake and ANR were also very similar among Entec, Floranid and Urea1. Tall cabbage plants recovered 80 to 90% of N applied as Urea, Entec and Floranid, whereas the ANR from Basacote was only 32.9%. Soil nitrate concentration 31 days after fertiliser application was higher in Floranid and Urea1 treatments (Fig. 1). The results of Entec and Urea1/2 were similar and the result of Basacote significantly higher than the Control. Nitrogen uptake from Italian ryegrass was significantly higher for Basacote (0.47 g/pot) than for any of the other treatments (Table 1). Floranid,

Entec and Urea1 showed similar N uptake values. Nitrogen uptake from Urea1/2 was not significantly different than N uptake from Control. Total ANR for both the crops were in the range of 85.7 and 95.7% from Urea, Floranid and Entec. Total ANR from Basacote was 41.6%. Nitrate concentration in AEM extracts 220 days after planting was higher in Floranid, Basacote and Urea1 treatments (Fig. 1).

Table 1. Crop performance, N nutritional indices and N recovered as a function of fertiliser treatment

	Tall cabbage					I. ryegrass	Both crops
Fertiliser treatment	DM yield (g/pot)	TNC (g kg^{-1})	PNO_3C (g kg^{-1})	N uptake (g/pot)	ANR[1] (%)	N uptake (g/pot)	ANR[1] (%)
Control	32.8 b	19.7 c	22.9 b	0.64 c	---	0.21 d	---
Urea1/2	62.5 ab	29.3 bc	47.0 b	1.83 b	81.4	0.29 cd	85.7
Urea1	82.9 a	40.0 ab	107.0 a	3.21 a	87.2	0.36 bc	92.3
Entec	68.5 a	47.0 a	111.8 a	3.18 a	86.2	0.34 bc	90.8
Basacote	66.5 a	24.5 c	36.7 b	1.61 bc	32.9	0.47 a	41.6
Floranid	78.5 a	42.1 a	102.7 a	3.29 a	90.0	0.36 b	95.1

[1](N uptake, from fertiliser treatments – N uptake, from control) / (N applied as fertiliser) x 100

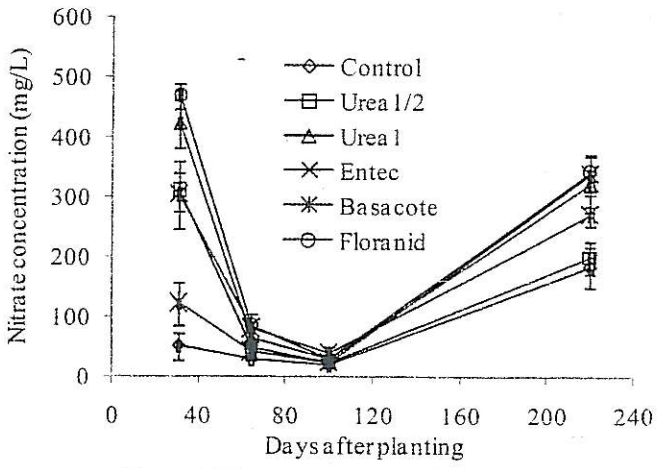

Figure 1. Nitrate concentration in AEM extracts

Conclusions

Basacote showed a marked slow release pattern. According to the marketing specifications of the product it is intended to release nutrients over 9 months. In this experiment 9M after fertiliser application only 41.6% of N was recovered by the crops. Basacote continued to actively release N 220d after planting. On 4 Apr NO_3^- concentration in AEM extracts from Basacote was 339 mg/L.

Floranid yielded similar NO_3^- concentration in AEM extracts as Urea1 at 31d after fertiliser application. Nitrogen of urea is available to plants after hydrolysis to NH_4^+ and nitrification to NO_3^-. In moist and warm soils these processes occur in a few weeks (Rodrigues, 2004). The N in Floranid is 2.1% NO_3^-, 7.9% NH_4^+ and 6.0% IBDU. Nitrogen released from IBDU is mainly affected by soil moisture and temperature (Trenkel, 1997). Thus, the apparent rapid hydrolysis of IBDU would be due to the favourable conditions in terms of soil moisture and temperature. Entec contains 7.5% N-NO_3^- and 18.5% N-NH_4^+ and also 0.8% DMPP. Nitrate concentration in AEM extracts 31d after planting was lower in Entec than in Urea1 and Floranid. It seems that DMPP effectively delayed NH_4^+ nitrification. Further studies under field conditions that allow for N (urea, NO_3^-, ...) leaching are needed to clarify the potential of Entec and Floranid for use in the autumn growing cycle of tall cabbage. Even not considering the high cost of Basacote plus 9M, it was clear that it would not be advisable to use it in a crop of a growing cycle of 4 months.

References

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