Comparison of single high rate and multiple low rate zinc fertiliser applications to increase available soil zinc supplies.

C. W. Dowling[1] and D. W. Lester[1]

[1] Incitec Fertilizers, Toowoomba, Qld.

ABSTRACT

Zinc (Zn) is a commonly applied nutrient in many alkaline vertosol soils of the north-eastern Australian grain belt (1). Two Zn fertiliser application strategies were compared for their impact on soil Zn availability of a grey vertosol. These strategies were a single application of 10 kg/ha of Zn as zinc sulfate monohydrate (ZSM) (35% Zn) in 1996 or 4 applications of 1.25kg/ha or 2.5 kg/ha Zn as Incitec Granulock ST-Z (10 %N, 19.5 % P, 2.5% Zn) between 1996 and 1999. Soil samples were collected at the commencement of the experiment, after the first application and post-harvest from the fourth crop. Samples were analysed for DTPA extractable Zn. The percentage of soil extractable Zn available from applied Zn after 4 cereal crops was about 12 % for the single application of 10 kg/ha Zn as ZSM, 22% for multiple applications of 1.25 kg/ha Zn and 20 % for 2.5 kg/ha Zn as STZ. It would appear that provided there is no compromise in crop productivity, a multiple low rate strategy of Zn fertiliser addition may be more effective in building available soil Zn concentration than a single higher rate.

KEY WORDS

Band, broadcast, vertosol, zinc sulfate

INTRODUCTION

Change in soil management from to minimal disturbance tillage systems has reduced the opportunity to apply Zn fertiliser using traditional methods such as broadcast and incorporated, and soil banded in narrow rows (3). This change saw the commercial release of a range of new fertiliser products and application methods including incorporation of Zn in and onto phosphate fertiliser products.

This study was conducted to determine how rapidly soil Zn would accumulate from multiple application of the “new” products compared to the earlier practice of a single large application.

MATERIALS AND METHODS

The experiment was conducted in a grey vertosol soil in the Tulloona district of north-western NSW with pH ($CaCl_2$) 7.2, CEC 44 meq/100g, OC % 0.8 and Zn (DTPA) 0.8 mg/kg. Zinc fertiliser treatments consisted of application of 10 kg/ha Zn (30 kg/ha of ZSM) banded into the soil at 22.5cm spacing once only in 1996 or applications of 1.25 or 2.5 kg/ha Zn as Granulock ST-Z (STZ) placed in the seed-furrow in of each of 4 cereal crops. Phosphorus (P) was applied to the nil Zn control plots and ZSM treatments at 10 kg/ha or 20 kg/ha P as triple superphosphate (20.7 % P) in each crop to match P input from STZ.

After harvest of the fourth crop, each plot was sampled to determine the residual effect of fertilisation on soil Zn concentration. To ensure residual fertiliser bands were equally represented, soil was extract from an area 75 mm wide, 100 mm deep and across all fertiliser bands, perpendicular to the line of application at 3 locations in each plot. There were 3 replicates of each treatment. Samples from the 3 locations in each plot were bulked, homogenised and a sub-sample taken for analysis. Soil Zn (DTPA) concentration was determined using the extraction procedure 12A1 of Rayment and Higginson (2).

RESULTS AND DISCUSSION

Soil Zn concentration remained at 0.3 mg/kg in the nil Zn fertiliser treatments from the establishment of the experiment till sampling after the fourth crop and was unaffected by rate of P fertiliser applied (Table 1). Generally, grain yield and therefore zinc removal has not significantly increased with added P.

Where Zn was added the soil Zn concentration significantly ($P<0.05$) increased the concentration from the single application of ZSM being similar to that of 4 applications of 1.25 kg/ha. Addition of 2.5 kg/ha annually produced the highest soil zinc concentration even though the total amount added was the same as the initial application as ZSM.

Table 1. Soil residual Zn concentration from a single application of ZSM (1996) and 4 applications of STZ (1996-99).

Treatment	0 Zn: 0 P	0 Zn: 10 P	0 Zn: 20 P	ZSM 10 Zn: 10 P	ZSM 10 Zn: 20 P	STZ 1.25 Zn : 10 P	STZ 2.5 Zn: 20 P
Zn (mg/kg) l.s.d 5 % =0.6	0.3	0.3	0.3	1.5	1.6	1.4	2.3

The lack of change in soil Zn after 4 crops (estimated total removal of 700g/ha Zn) suggests the soil has an ability to buffer against removal.

Chemical reactions between applied Zn and soil, and to a lesser extent crop removal, have reduced available Zn from single 10 kg/ha Zn as ZSM to a similar concentration from 4 applications of 1.25 kg/ha Zn. This suggests that providing the crop response to the individual at-sowing band application of Zn is not significantly less than the single high rate application, it may be more efficient to apply smaller Zn rates at-sowing. After subtracting the background extractable Zn concentration from the treatment effects, and assuming a soil bulk density of 1 for the top 10 cm of soil profile, the percentage of soil extractable Zn available from applied Zn is about 12 % for the single application of ZSM, 22% for multiple applications of 1.25 kg/ha Zn and 20 % for 2.5 kg/ha Zn as STZ. Given the much higher apparent availability of the multiple application, there would appear to be a very steep decline in Zn availability with time in these soils.

It is hypothesised that the low level of soil mixing of application bands under the zero-till cropping management may have reduced chemical reactions with the soil less where multiple low rates were applied in each crop compared to where a single high rate was applied and bands disturbed by all subsequent tillage operations.

CONCLUSION

Provided there is no compromise in crop productivity, a multiple low rate strategy of Zn fertiliser addition may be more effective in building available soil Zn concentration than a single higher rate applied infrequently.

REFERENCES

1. Dalal, R. C. and Probert, M. E. 1997. In *Sustainable Crop Production in the Sub-tropics - an Australian perspective*. Eds. A. L. Clarke and P. B. Wylie. (Department of Primary Industries, Queensland).

2. Rayment, G. E. and Higginson, F. R. 1992. Australian Laboratory Handbook of Soil and Water Chemical Methods. (Inkarta Press, Melbourne).

3. McIntyre, G. and Mills, B. 1998. Summer Crop Management Notes. Summer 1998/99. (Department of Primary Industries, Queensland)