Increasing efficiency of water run fertilization

P.E. Bacon[a] and J.A. Thompson[b]

[a]Agricultural Research Centre, Yanco. N.S.W. 2703.
[b]Agricultural Research Station, Leeton. N.S.W. 2705.

Fertilizer addition to irrigation water is a common practice in trickle-irrigated orchards and, in recent years, this fertilization method has created interest for furrow-irrigated crops in southern N.S.W. In the experiment reported below the fertilizer type and time of addition within an irrigation period were used to manipulate the distribution and uptake of nitrogen by a furrow-irrigated maize crop.

Methods

The experiments were carried out on a duplex red-brown earth (Dr 2.22) soil. A maize crop (XL45 at 90,000 plants ha^{-1}) was sown in hills 0.75 m apart and 100 m long. There were eight treatments.

Table 1. Treatments used in the experiment.

Fertilizer application method		Fertilizer
Added in first 2 hours of 3 six-hour irrigations		Urea
Added in last 2 hours of 3 six-hour irrigations	×	
Added continuously during 3 six-hour irrigations		Aqua ammonia
Basal fertilization of 120 kg N ha^{-1} as urea		
[illegible]		

Nitrogen was applied as either urea or aqua ammonia at 40 kg N ha^{-1} in each of 3 irrigations between 2 weeks after emergence and tasselling.

Results and Discussion

All fertilizer treatments (mean 2.81 t ha^{-1}), except late ammonia (1.12 t ha-1), significantly increased grain yield (control n.81 t ha^{-1}, $LSD_{5\%}$ = 0.97 t ha-1). Urea-fertilized plots had greater yield (mean of irrigation treatments 3.2 t ha^{-1}) than ammonia-fertilized plots (1.78 t ha^{-1}), while application early in the irrigation resulted in higher yield (3.19 t ha^{-1}) than that obtained from plots on which fertilizer was applied continuously (2.45 t ha^{-1}). Plots receiving fertilizer solution in the last 2 hours gave poorest production (1.77 t ha-1). There was no significant difference between basal (4.87 t ha^{-1}) or early urea treated plots (4.19 t ha^{-1}). Yield component analysis showed that, though grain weight had some influence on yield (range 0.158 to 0.202 g grain-^{1}), the major contributor to the differences was the number of grains per cob (range 83 to 395).

Urea was, as expected, a superior fertilizer to ammonia. This was so for several reasons. Firstly, ammonia can be lost directly to the atmosphere by volatilization as the ammonia solution moves down the furrow. Secondly, while ammonia can move relatively unhindered through the soil, it is very rapidly exchanged on to clay surfaces once it forms the ammonium ion. The ratio of NH3:NH_4^+ is dependent and equilibrium is almost instantaneous. The pH of the fertilizer solution 10 mm above the soil surface on the late-ammonia plots was 9.75 (ratio NH_3:NH_4 approximately 2:1), while 10 mm below the surface the pH was 5.5 (ratio NH_3:NH_4 1:5500). Thus virtually all the ammonia was exchanged on to clay surfaces near the soil-water interface and above the root zone. By contrast, the urea molecules moved through the profile at the same speed as the infiltrating solution until hydrolysis to ammonia. This resulted in deeper penetration of urea into the soil below the furrow and into the hills. Urea hydrolysis took place within 2-3 hours of irrigation, and the infiltration rate fell rapidly soon after flooding. Thus movement of urea solution after the initial wetting period in the continuous and late urea treatments would be very slow and a high proportion would be hydrolyzed to ammonia in the region above the root zone.

This experiment demonstrated that urea was superior to ammonia when applied into irrigation water and that greatest benefit from this fertilization technique occurred when the fertilizer was added in the initial period of irrigation.