Effect of management technique on soil and ^{15}N fertilizer use by wheat

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Over 100,000 ha of rice is now grown in southern N.S.W. After rice harvest the land was normally left fallow for 12-16 months prior to wheat sowing, but there is now increasing interest in planting wheat within 2-3 months of harvest. Agronomic studies indicated that both land and fertilizer management techniques influenced crop yield. This study was undertaken to determine if crop yield response was related to plant use of soil and fertilizer N.

Methods

A factorial experiment was set out within a large wheat field from which the rice crop had just been harvested. The ^{15}N label as 100 kg N ha^{-1} 5% enriched $^{15}NH4$ $^{15}NO_3$ powder was applied to the soil surface within 15cm I.D. cylinders driven 30cm into the soil. There were four replicates of each treatment shown in Table I. The wheat crop was harvested at maturity and grain weight and percent ^{15}N enrichment determined.

Table 1. Treatments used in the factorial ^{15}N wheat experiment.

Preparation Technique	N kg ha^{-1} Previous Rice Crop		Fertilization Time
Incorporate stubble 10 weeks before wheat sowing	0		Sowing
Incorporate stubble at wheat sowing			Tillering
Burn stubble, direct-drill	X	X	
Burn then cultivate			
Retain stubble, direct-drill	100		½ Sow + ½ Till

Results and Discussion

Land preparation techniques significantly influenced uptake of soil and fertilizer N. Grain from the two direct-drill treatments had an average of 24.6 kg N ha^{-1} from soil and 15.8 kg N ha^{-1} from fertilizer. These figures were significantly higher than the 15.5 and 8.2 kg N ha^{-1} respectively found in wheat grain produced on cultivated plots. Cultivation would increase breakdown of root and shoot residue leading to both immobilization of applied N and mineralization of soil N. The net effect was that cultivation reduced total N uptake by 43%. Grain yield from the two direct drill treatments were very similar (mean 2.0 t + 0.08 ha^{-1}) and were significantly higher than any of those obtained from three untreated treatments (mean 1.1 t ha^{-1}, range + .2 t ha^{-1} LSD 5% = 0.5 t ha^{-1}). The importance of both soil and fertilizer N uptake to grain yield is obvious from the highly significant correlation between soil N and yield (r^2 - .97) and fertilizer N and yield (r^2 = .91).

Increasing the amount of N applied to the previous crop and consequently increasing the quantity of residue significantly increased the proportion of total N uptake derived from fertilizer on crops where residue was incorporated at sowing. Stubble level had no effect on the other land management treatments. This result suggests that stubble incorporation at sowing reduced soil N mineralization as well as immobilising applied N. An average of 38% of N came from the fertilizer with the percentage increasing with delayed application from 35 to 43% LSD 51=4.3%). It is likely that much of the fertilizer applied at sowing was immobilized during early crop growth. Delaying N application until tillering increased fertilizer recovery, but this appeared to occur at the expense of soil N uptake.

This experiment demonstrated the value of ^{15}N tracer in improving understanding crop response to variation in management. It also demonstrated that management strategies influence the relative importance of soil and fertilizer N sources.