Chapter 5

DISCUSSION

5.1 Nodulation and nitrogen fixation under SSC

In this study, SSC influenced the onset, persistence and level of nitrogen fixation in both SJ5 and NW1 soybean variety (Figure 15). A similar observation was made by Troedson et al (1986) who measured nitrogen fixation with the acetylene reduction assay.

The positive response of SSC to nitrogen fixation was related to low plant nitrogen concentration which stimulated early and increased nodulation. The following sequence of events may be considered to have occurred:

(1) The raising of the water table led to a decrease in available soil nitrogen as a result of denitrification (Nathanson et al, 1984). In addition, the death of plant roots below water-level resulted in a decreased root surface for the plant to absorb soil nitrogen and other nutrients. Plants under SSC developed the symptoms of chlorosis.

(2) A subsequent stimulation of growth of roots occurs in the upper soil layer in SSC, and this ultimately leads to a greater proliferation of roots than under CI. Higher root:shoot ratios in SSC than that in CI has been found by other studies (Troedson et al, 1986 and Nathanson et al, 1984).

(3) An external source of nitrogen for plant growth is limited under SSC. The initial period of plant nitrogen deficiency that stimulated root growth resulted in enhanced nodulation. This would agree with a general hypothesis that nodulation and nitrogen fixation is stimulated by a high C:N ratio in the plant (Wilson, 1940), and the earlier SSC observations on nodulation reported by Nathanson et al (1984) and Troedson et al (1986).

(4) Because of the enhanced nodulation, and presumably continued limited access to soil nitrogen by roots in SSC, more active nitrogen fixation resulted.

5.2 Contribution of nitrogen fixation under SSC

If soybean is to contribute positively towards the sustainability of a cropping system, the amount of nitrogen fixed from the atmosphere must exceed that removed in the harvested seed. Other reports on the amount of nitrogen fixed by soybean range from 0 to 60% of plant total nitrogen (Weber, 1966; Bergersen et al, 1985, 1989; Herridge et al, 1990 and Widjang et al, 1990). About 60-80% of crop nitrogen is commonly removed in seed. In this experiment, 56-79% of crop nitrogen was fixed and 63-70% was removed in SSC treatments while 38-61% was fixed and 59-78% was removed in seed in CI. Consequently, the use of SSC improved final nitrogen balance.

An application of fertilizer at 50 kg N/ha not only had an economic cost to production, but negatively affected the amount of nitrogen fixed and lead to a depletion of the soil nitrogen pool.

5.3 Soybean yield in SSC

The positive response of soybean dry matter accumulation and yield in SSC treatment was expected in light of other studies (Nathanson et al, 1984 and Troedson et al, 1989). But the present experiment showed no dry matter and yield response to SSC. This may reflect environmental conditions under which the experiment was conducted. Firstly, the soybean was grown in the rainy season. The rainfall during experimentation (Fig 2) may have decreased the SSC effect on soybean biomass production and yield. Other studies have been undertaken in the dry season (Hunter et al, 1980; Nathanson et al, 1984; Hartley, 1988 and Troedson et al, 1989). Secondly, the selected varieties, SJ5 and NW1, may be independent of water treatment. The great variations of genotypes response to SSC reported elsewhere (Hartley, 1988) may have been important in the present study. Soil type may be a further reason for a lack of yield response. The soil of this experiment was a sandy loam, while most other studies on the SSC method have been conducted in heavy soils in Australia or in Thailand (Troedson et al, 1986; Nathanson et al, 1984; Hunter et al, 1980 and Chinchat et al, 1987).

5.4 Trade offs, further studies

The effect of SSC in decreasing plant nitrogen during the early stages of growth implies that SSC has caused a certain amount of lost in mineral nitrogen in the soil due to denitrification with the raising of water table (Watanabe et al, 1981 and Wetselaar et al, 1977). With this particular effect of SSC, the benefit on enhanced nitrogen fixation was achieved with the expense of the lost in mineral nitrogen from the soil.

Further studies will be necessary to determine the trade-offs between effects of SSC on the lost of mineral soil nitrogen through denitrification and gain through the enhancement of nitrogen fixation, in order that the net effects of SSC on nitrogen balance after soybean, and hence its potential contribution towards sustainability of cropping systems can be defined.