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# Weed Management Options on the Dynamics of Nitrogen Fractions in the Rhizosphere Soil of Rice Hybrids

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**Abstract : Field experiments were conducted at Agricultural college and Research Institute, Coimbatore to study the impact of weed management options on the nitrogen dynamics in the rhizosphere soil of two rice hybrids CORH2 and ADTRHI during 2001-02. Manual hand weeding was tested against conoweeding in which weeds were incorporated insitu in the field. Conoweeding set a favourable impact on the nitrogen fractions of the rhizosphere soil owing to the aeration of the soil rendered by the mechanical weeder due to soil stirring resulting in greater mobility of nitrogen in the rhizosphere region.**

***Key words : Rice hybrids, hand weeding, conoweeding, ammoniacal nitrogen, nitrate nitrogen, nitrogen fractions***

## Introduction

The domesticated grass "rice" has been the companion of humankind for more than 8000 years providing staple food to 2.5 billion people, which may escalate to 4.6 billion by the year 2050. In India, its acreage spreads over an area of about 44.9 million hectares constituting 34% of the area under food crops and 42% under cereals with a total production of 89.47 million tonnes and productivity of 1990 kg ha$^{-1}$ (India, 2002).

Rice production is plagued by several constraints of which weeds inflict heavy losses. An yield reduction of 50 to 60 per cent or even complete crop failure is recorded due to weed infestation (Govindarasu *et al.*, 1998). In the recent past weed control is effected more by chemical means supplemented by hand weeding. Increasing demand for labour and escalating cost of agrochemicals together with phytotoxicity effects pose the farming community to think of mechanical measures, which will help the rice production to free itself from the scourge of weed menace with limited labour. Mechanical weeding can be done by unskilled labour and is generally economical, nonpolluting without residual problems and is relatively safe to the operator. Nutrient drain by weeds in rice ecosystem is exorbitant to the extent of 37.6 kg N, 7.6 kg $P_2O_5$ and 26.0 kg $K_2O$ per hectare per season (Balasubramanian *et al.*, 1996). The trend of continuous cultivation without adequate concern on compensating this export of nutrients out of farms needs to be mitigated. The technology in which weed control is accomplished through incorporation of weeds insitu aided by mechanical means may help in effective recycling of the depleted nutrients together with aeration of the root zone. Thus mechanical weed control offers wider scope in irrigated rice culture. However problems are encountered in incorporation of weeds like *Cynodon* and sedges with underground stolons and rhizomes which result in faster regeneration. The aim of the present investigation was to study the dynamics of nitrogen fractions *viz*., ammoniacal nitrogen ($NH_4$ - N) and nitrate nitrogen ($NO_3$ -N) in the rhizosphere soil as effected by weed management options.

## Materials and methods

Two field experiments were conducted in the Agricultural College and Research Institute,

**Table 1.** Soil characteristics of the experimental site

| S.No. | Parameters | Wet season | Dry season |
|---|---|---|---|
| 1. | pH | 8.3 | 8.2 |
| 2. | Electrical conductivity ($dSm^{-1}$) | 0.54 | 0.59 |
| 3. | Cation exchange capacity (Cmol (p+) $kg^{-1}$) | 18.0 | 17.3 |
| 4. | Total N (g $kg^{-1}$) | 0.83 | 0.83 |
| 5. | Total P (g $kg^{-1}$) | 0.5 | 0.5 |
| 6. | Total K (g $kg^{-1}$) | 3.5 | 3.5 |
| 7. | Organic carbon (g $kg^{-1}$) | 5.1 | 6.6 |
| 8. | $KMn0_4$-N (kg $ha^{-1}$) | 232 | 190 |
| 9. | $NH_4$-N (ppm) | 38.5 | 32.0 |
| 10. | $NO_3$-N (ppm) | 35.2 | 34.0 |
| 11. | Olsen P (kg $ha^{-1}$) | 32 | 30 |
| 12. | $NH_4$oAc-K (kg $ha^{-1}$) | 740 | 730 |
| 13. | Textural class | Clay loam | |
| 14. | Soil series | Noyyal | |
| 15. | Taxonomic class | Vertic Ustochrept | |

Coimbatore with two rice hybrids CORH2 (125 days duration) and ADTRHI (115 days duration) during samba 2001 (wet season) and summer 2002 (dry season) respectively. The experiments were laid out in strip plot design with four replications. The soil characteristics of the experimental site is depicted in Table 1. The treatments included two methods under each of the four factors studied *viz*., planting, irrigation, weeding and nutrition.

$P_1$: Transplanting 24 days old conventional nursery seedlings at 20 x 20 cm spacing

$P_2$: Transplanting 10 - 12 days old dapog nursery seedlings at 20 x 20 cm spacing during wet season and direct seeding during dry season

$I_1$: Irrigating the field to 5 cm one day after the disappearance of ponded water.

$I_2$: Irrigating the field to 2 cm after the development of hairline cracks

$W_1$: Manual hand weeding twice as per the farmers' practice (weeds removed).

$W_2$: Weeding by conoweeder at 10 days interval upto maximum vegetative period (weeds buried)

$N_1$: Recommended level of N, P, K and Zn without the addition of green manures

$N_2$: Recommended level of N, P, K and Zn with the addition of green manures @ 6.25 t $ha^{-1}$.

The rhizosphere soil sampling was done by wiping out the soil adhering to the roots. The soil was analysed for $NH_4$-N and $NO_3$-N using standard procedure (Bremner and Keeney, 1966). The soil samples were collected at the important physiological growth stages viz., active tillering (AT), panicle initiation (PI), fifty percent flowering (FF), grain filling (GF) and harvest (HT) stages. The entire dose of $P_2O_5$ (60 kg $ha^{-1}$) was applied as single super phosphate at the time of transplanting (TP) during both the seasons. $K_2O$ and N were applied respectively as muriate of potash and urea in split doses. Nitrogen @ 150 kg $ha^{-1}$ was applied as 60 kg $ha^{-1}$ - basal and remaining 90 kg $ha^{-1}$ in

**Table 2.** Exchangeable $NH_4$-N (ppm) and $NO_3$-N (ppm) in rhizosphere soil at various growth stages of CORH2 as influenced by weed management options.

| S.No. | Treatments | Active Tillering | | Panicle Initiation | | 50% Flowering | | Grain Filling | | Harvest | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $NH_4$-N | $NO_3$-N | $NH_4$-N | $NO_3$-N | $NH_4$-N | $NO_3$-N | $NH_4$-N | $NO_3$-N | $NH_4$-N | $NO_3$-N |
| 1. | $P_1I_1W_1N_1$ | 46.3 | 46.7 | 41.0 | 44.3 | 53.0 | 39.7 | 37.3 | 32.7 | 19.3 | 18.7 |
| 2. | $P_1I_1W_1N_2$ | 52.3 | 42.0 | 41.7 | 44.3 | 46.3 | 37.3 | 40.3 | 30.3 | 17.0 | 18.7 |
| 3. | $P_1I_1W_2N_1$ | 49.7 | 39.7 | 39.0 | 49.0 | 55.7 | 53.7 | 33.3 | 39.7 | 17.7 | 18.7 |
| 4. | $P_1I_1W_2N_2$ | 52.3 | 39.7 | 44.3 | 46.7 | 61.7 | 53.7 | 44.3 | 46.7 | 16.8 | 16.3 |
| 5. | $P_1I_2W_1N_1$ | 60.7 | 44.3 | 38.3 | 39.7 | 59.7 | 51.3 | 32.7 | 32.7 | 19.5 | 18.7 |
| 6. | $P_1I_2W_1N_2$ | 59.3 | 42.7 | 48.7 | 39.7 | 60.0 | 39.7 | 35.0 | 39.7 | 17.8 | 18.7 |
| 7. | $P_1I_2W_2N_1$ | 52.3 | 40.7 | 44.7 | 51.3 | 57.7 | 51.3 | 35.3 | 32.7 | 17.5 | 16.3 |
| 8. | $P_1I_2W_2N_2$ | 59.3 | 41.0 | 51.7 | 49.0 | 61.7 | 51.3 | 39.7 | 35.0 | 19.7 | 21.0 |
| 9. | $P_2I_1W_1N_1$ | 49.3 | 53.7 | 47.0 | 40.7 | 46.7 | 32.7 | 46.7 | 46.7 | 22.8 | 16.3 |
| 10. | $P_2I_1W_1N_2$ | 56.7 | 52.0 | 48.0 | 56.0 | 47.6 | 51.3 | 46.7 | 37.3 | 22.8 | 18.7 |
| 11. | $P_2I_1W_2N_1$ | 49.3 | 53.7 | 51.7 | 53.7 | 56.7 | 53.7 | 39.7 | 46.7 | 17.0 | 16.3 |
| 12. | $P_2I_1W_2N_2$ | 58.7 | 46.7 | 56.7 | 53.7 | 51.7 | 46.7 | 39.7 | 44.7 | 17.8 | 18.7 |
| 13. | $P_2I_2W_1N_1$ | 42.3 | 53.7 | 49.7 | 49.0 | 46.3 | 39.7 | 44.3 | 32.7 | 19.5 | 18.7 |
| 14. | $P_2I_2W_1N_2$ | 47.0 | 53.7 | 44.7 | 53.7 | 50.7 | 53.7 | 46.7 | 35.0 | 19.7 | 23.3 |
| 15. | $P_2I_2W_2N_1$ | 49.3 | 51.3 | 44.7 | 56.0 | 43.7 | 56.0 | 32.7 | 39.7 | 20.0 | 18.7 |
| 16. | $P_2I_2W_2N_2$ | 49.7 | 44.3 | 51.7 | 51.3 | 50.7 | 53.7 | 35,0 | 32.7 | 21.0 | 25.7 |
| | Mean | 52.2 | 46.6 | 46.5 | 48.6 | 53.1 | 47.8 | 39.3 | 37.8 | 19.1 | 19.0 |
| | CD (5%) | NS | NS | 5.7 | NS | NS | NS | NS | NS | NS | NS |
| | $W_1$ | 51.8 | 48.6 | 44.9 | 45.9 | 51.3 | 43.2 | 41.2 | 35.9 | 19.8 | 19.0 |
| | $W_2$ | 52.6 | 44.6 | 48.0 | 51.3 | 54.9 | 52.5 | 37.5 | 39.7 | 18.4 | 19.0 |
| | CD (5%) | NS | 2.78 | 3.13 | 3.02 | 3.46 | 2.83 | NS | NS | 0.97 | NS |

three equal splits at 20, 40 and 60 days after transplanting. Potassium @ 60 kg ha$^{-1}$ was applied as 30 kg ha$^{-1}$ - basal and remaining in two equal splits at 20 and 40 days after transplanting.

## Results and Discussion

The combined effect of all the four factors of production had imparted no significant influence on $NO_3$ - N content at all the growth stages studied during both the seasons. A similar trend was observed for $NH_4$ N also except at panicle initiation stage during wet season (CORH2) and grain filling stage during dry season (ADTRH I ).

At panicle initiation stage during wet season, green manuring practice along with inorganics ($N_2$) established a significantly higher $NH_4$ - N content, very distinctly under conoweeding practice, irrespective of the age of the seedlings and irrigation strategies adopted. Whereas younger seedlings combined with water saving irrigation significantly decreased the $NH_4$ - N, under green manuring practice ($N_2$) This may be attributed to the cause that the enhanced oxidising power of the roots of

**Table 2.** Exchangeable $NH_4$-N (ppm) and $NO_3$-N (ppm) in rhizosphere soil at various growth stages of ADTRH1 as influenced by weed management options.

| S.No. | Treatments | Active Tillering | | Panicle Initiation | | 50% Flowering | | Grain Filling | | Harvest | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $NH_4$-N | $NO_3$-N | $NH_4$-N | $NO_3$-N | $NH_4$-N | $NO_3$-N | $NH_4$-N | $NO_3$-N | $NH_4$-N | $NO_3$-N |
| 1. | $P_1I_1W_1N_1$ | 42.0 | 46.7 | 53.7 | 53.7 | 46.7 | 39.7 | 49.0 | 39.7 | 32.7 | 35.0 |
| 2. | $P_1I_1W_1N_2$ | 46.7 | 42.0 | 58.3 | 42.0 | 46.7 | 44.3 | 46.7 | 44.3 | 39.7 | 35.0 |
| 3. | $P_1I_1W_2N_1$ | 46.7 | 46.7 | 42.0 | 51.3 | 39.7 | 39.7 | 49.0 | 44.3 | 32.7 | 32.7 |
| 4. | $P_1I_1W_2N_2$ | 51.3 | 42.0 | 53.7 | 44.3 | 42.0 | 37.3 | 58.3 | 53.7 | 37.3 | 30.3 |
| 5. | $P_1I_2W_1N_1$ | 44.3 | 51.3 | 42.0 | 60.7 | 46.7 | 42.0 | 63.0 | 49.0 | 32.7 | 39.7 |
| 6. | $P_1I_2W_1N_2$ | 58.3 | 46.7 | 53.7 | 49.0 | 46.7 | 49.0 | 46.7 | 46.7 | 44.3 | 30.3 |
| 7. | $P_1I_2W_2N_1$ | 46.7 | 39.7 | 56.0 | 39.7 | 42.0 | 42.0 | 42.0 | 51.3 | 28.0 | 35.0 |
| 8. | $P_1I_2W_2N_2$ | 53.7 | 49.0 | 58.3 | 42.0 | 49.0 | 39.7 | 60.7 | 49.0 | 39.7 | 35.0 |
| 9. | $P_2I_1W_1N_1$ | 46.7 | 44.3 | 51.3 | 44.3 | 42.0 | 46.7 | 51.3 | 42.0 | 35.0 | 30.3 |
| 10. | $P_2I_1W_1N_2$ | 46.7 | 49.0 | 46.7 | 42.0 | 51.3 | 46.7 | 46.7 | 44.3 | 28.0 | 30.3 |
| 11. | $P_2I_1W_2N_1$ | 42.0 | 44.3 | 56.0 | 49.0 | 51.3 | 44.3 | 58.3 | 46.7 | 44.3 | 35.0 |
| 12. | $P_2I_1W_2N_2$ | 56.0 | 53.7 | 63.0 | 46.7 | 58.3 | 37.3 | 58.3 | 51.3 | 35.0 | 42.0 |
| 13. | $P_2I_2W_1N_1$ | 46.7 | 49.0 | 60.7 | 51.3 | 39.7 | 42.0 | 49.0 | 58.3 | 32.7 | 42.0 |
| 14. | $P_2I_2W_1N_2$ | 53.7 | 42.0 | 63.0 | 46.7 | 44.3 | 42.0 | 51.3 | 53.7 | 32.7 | 35.0 |
| 15. | $P_2I_2W_2N_1$ | 44.3 | 49.0 | 51.3 | 44.2 | 37.3 | 44.3 | 58.3 | 46.7 | 42.0 | 39.7 |
| 16. | $P_2I_2W_2N_2$ | 56.0 | 51.3 | 60.7 | 53.7 | 42.0 | 44.3 | 60.7 | 53.7 | 44.3 | 32.7 |
| | Mean | 48.9 | 46.8 | 54.4 | 47.5 | 45.4 | 42.6 | 53.2 | 48.4 | 36.3 | 35.0 |
| | CD(5%) | NS | NS | NS | NS | NS | NS | 8.97 | NS | NS | NS |
| | $W_1$ | 48.1 | 46.4 | 53.7 | 48.7 | 45.5 | 44.0 | 50.8 | 47.3 | 34.7 | 34.7 |
| | $W_2$ | 49.6 | 47.0 | 55.1 | 46.4 | 45.2 | 41.1 | 55.7 | 49.6 | 37.9 | 35.3 |
| | CD(5%) | NS | NS | NS | NS | NS | NS | NS | 2.14 | 2.44 | NS |

younger seedlings coupled with aerated moisture regime would have favoured the nitrification process resulting in considerable reduction of $NH_4$-N in the rhizosphere region. Also conoweeding practice established itself in recording an improved ammoniacal and nitrate nitrogen contents at early growth stages only (Table 2).

In the dry season the ammoniacal nitrogen content over different crop growth stages varied between 28.0 ppm at harvest and 63.0 ppm at panicle initiation and grain filling stages. The content was found to sway over different growth stages with the maximum content (54.4 ppm) recorded at panicle initiation stage. The variation due to the combination of the four factors of study occurred only at grain filling stage. Addition of green manures ($N_2$) resulted in reduced $NH_4$-N content under manual weeding, whereas, conoweeding practice reversed the trend. The impact of conoweeding in increasing the ammoniacal and nitrate nitrogen content of the rhizosphere soils were evident only at harvest (37.9 ppm) and grain filling stages respectively (49.6 ppm), while at the rest of the stages conoweeding had not set a notable impact on the nitrogen fractions of the rhizosphere soil (Table 3).

Nutrient drain by weeds is accounted to the extent of 48.79 kg N, 43.68 kg $P_2O_5$ and 67.37 kg $K_2O$ per hectare (Madhu and Nanjappa, 1996). In the present experiment approximately 30 kg N, 10 kg $P_2O_5$ and 17 kg $K_2O$ were removed per hectare by the weeds. Export of these nutrients out of the farm by manual hand weeding is counteracted by the mechanical weed control, which resulted in recycling of the depleted nutrients to the soil together with aeration effect. During wet season, conoweeding could markedly increase the status of nitrogen fractions in the soil. Release of nutrients from the decomposing weeds could have augmented the nutrient pool of the rhizosphere soil and hence for the increased status of the nitrogen fractions.

Biological nitrogen fixation was reported to be higher under mechanical weed control owing to the aeration provided by churning up the surface soil to remove weeds (Magdoff and Bouldin, 1970). Further aeration process might have favoured the oxidation of $NH_4$+ to $NO_3^-$ form and thereby accounted for higher nitrate nitrogen content Weed incorporation offers twin benefits as labour saving and nutrient mineralisation effected by aeration due to conoweeding. In the era of increasing labour scarcity and exploding pollution effects, weed management strategy could be reoriented towards mechanical means for satisfactory fertility and monetary benefits.

## References

Balasubramanian, R. Veerabadran, V., Mark Devasagayam, M., Krishnasamy, S. and Jayapaul, P. (1996). Influence of herbicides on weed management in lowland rice. *Pestology,* **12** : 18-20.

Bremmer, J.M. and Keeney, D.R. (1966). Determination and isotope - ratio analysis of different forms of nitrogen in soils : 3. Exchangeable ammonium, nitrate and nitrite by extraction - distillation methods - *Soil Sci. Soc. Am. Proc.* **30 :** 577 - 582.

Govindarasu, R., Rammohan, J., Ramamoorthy, N. and Mohamed Hanifa, A. (1998) Direct seeding a best substitute for transplanted rice cultivation in future. *Kissan World,* **(25) 11:** 20-21.

India, (2002). A Reference Annual. *Publications Division, Ministry of information and broadcasting, Govt. of India.*

Madhu, M. and Nanjappa, H.V. (1996). Crop weed competition for nutrients in puddle seeded rice. *Indian J. Weed Sci.,* **28(1 and 2) :** 4-7.

Magdoff, F.R. and Bouldin, D.R. (1970). Nitrogen fixation in submerged soil - sand - energy material media and the aerobic - anaerobic interface. *Pl. Soil,* **33** : 49 - 61.

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