Madras Agric. J., 85(5,6): 273 - 278 May, June 1998
https://doi.org/10.29321/MAJ.10.A00737

FORMS AND MAGNITUDE OF LEACHING LOSS OF NITROGEN IN WETLAND RICE SOILS OF CAUVERY DELTA

V. VELU and K.M. RAMANATHAN

Department of Soil Science and Agricultural Chemistry
Agricultural College and Research Institute
Tamil Nadu Agricultural University
Coimbatore 641 003

ABSTRACT

The forms and magnitude of leaching loss of N under different sources and levels of N in the three major wetland rice soils of Cauvery delta were studied. Light textured Madukkur series registered higher leaching loss of N under all N sources, than the heavy textured Kalalthur and Padugai series soils. Out of the total leaching loss, about 11 per cent was in the form of NH_2-N, 77 per cent as NO_3-N. Among the N sources tried, application of USG recorded the highest leaching loss of N irrespective of the soil studied. Use of coated fertilizers as well as ammonium chloride was found very much effective in reducing the leaching loss of N in the light textured Madukkur series compared to their performance in heavy textured soils.

KEY WORDS : Leaching loss, N forms, N sources, soils

The nitrogenous fertilizers when applied to soil undergo several transformations such as ammonification, nitrification and denitrification depending upon the soil conditions, type of fertilizer used and its method of application etc., during which the losses of applied N occur in different ways. One among the various pathways of N losses in wetland rice soils is the leaching loss of N. Presence of standing water under lowland conditions during the growing period of rice crop might cause substantial leaching loss of nitrogent due to downward percolation of water influenced by soil type and land preparation (Owens, 1960 ; Sanchez, 1973 ; Reddy *et al.*, 1980). Further, the leaching loss may be in the form of either NH_2-N, NH_4-N or NO_3-N depending upon the source of N used and the transformation reactions that are taking place in the soil. With a view to elucidate information on the forms and magnitude of the leaching loss of N in the major rice growing soils of Cauvery delta, the rice bowl of Tamil Nadu, a pot culture experiment was conducted using different sources and levels of N, the results of which are presented in this paper.

MATERIALS AND METHODS

A pot culture experiment was conducted with three major rice growing soil series of Cauvery detal zone of Tamil Nadu and different sources and levels of applied N as given below :

Soils : i. Madukkur series (Mdk)
ii. Kalathur series (Klt)
iii. Padugai series (Pdg)

Sources of N : i. Prilled urea (PU)
ii. Ammonium chloride (AC)
iii. Neem cake coated urea (NCU)
iv. Coal tar coated urea (CTU)
v. Lac coated urea (LCU)
vi. Urea supergranule (USG)

Levels of N : 0, 0.46, 0.92 and 1.38 g N pot^{-1} (equvalent to 0, 51, 102 and 153 kg N ha^{-1})

Treatment combinations : 19 (with single control) in each soil series, replicated twice in factorial randomised block design.

The properties of the soils used in the pot culture study are presented in Table 1. Twenty kg. of air dried, powdered soils were filled in convergent type, inside wax coated cement pots with dimensions 30 x 30 cm in the upper side and 25 x 25 cm at the bottom, with depth of 30 cm. The bottom of the cement pot was provided with a single hole (1 cm dia) in which a glass tube of 5 cm length was fixed with cement paste. The outlet of the glass tube was attached with a rubber tube of 8 cm. length at the end of which a screw cock was provided. Polythene containers of 500 ml capacity

Table 1. Characteristics of the soils used in the study

Characteristics	Madukkur series	Kalathur series	Padugai series
Taxonomical class	Udic Haplustalf	Entic Chromustert	Typic Ustifluvent
Textural class	Sandy loam	Sandy loam	Sandy clay laom
Apparent sp. gravity ($Mg\ m^{-3}$)	1.45	1.26	1.18
Max. water holding capacity (%)	22.6	31.5	33.2
Total pore space (%)	41.2	50.7	51.6
Hydraulic conductivity ($cm\ hr^{-1}$)	5.47	3.95	3.66
pH (1 : 2)	7.2	7.3	7.0
EC (dSm^{-1})	0.28	0.19	0.25
Organic carbon (%)	0.66	0.70	0.78
Exch. NH_4-N (ppm)	23.8	28.0	26.6
Exch. NO_3-N (ppm)	0.56	0.63	0.70
Cation exch. capacity cmol (P^+) kg^{-1})	10.8	28.6	30.5

were fixed below the outlet tube for the collection of leachate samples.

The soil in the pots were puddled repeatedly and allowed to settle for one week with standing water of 5 cm. At planting, recommended quantity of P_2O_5 and K_2O in the form of super phosphate and muriate of potash respectively were added and mixed well with the soil. Nitrogen was applied by surface incorporation in three splits viz., 50% at planting, 25% at tillering and 25% at pancile initiation for the N sources other than USG, while in USG, it was point placed at 8 - 10 cm soil depth using 0.5 and 1 g size granules at the centre of the four kills in two splits viz., 50% at planting and 50% at panicle initiation. About 5 cm of standing water was maintained throughout the crop growth period.

Leachate samples were collected in the polythene bottles attached at the bottom of the pots, daily at the rate of 500 ml per day from each pot for 10 days at each time of fertilizer application, by suitably adjusting the screw cock. The samples were transferred to narrow mouth polythene bottles containing few drops of 50 ppm phenyl mercuric acetate (PMA) solution and taken for analysis. The samples were analysed for urea-N (NH_2-N) by colorimetry, ammonium-N (NH_4-N) by steam distillation with ignited MgO and nitrate-N (NO_3 - N) by colorimetry using chromotropic acid. From the contents of the different forms of N and the volume of leachate collected, the quantum of leaching loss of N was worked out. The total loss of N for the 10 days period during the respective phases of observation under different sources and levels of N in the three soils was statistically analysed and the results are presented and discussed hereunder.

RESULTS AND DISCUSSION

Leaching loss of Urea-N

The urea nitrogen (NH_2-N) content of the leachate ranged from 0.09 to 9.66 ppm in Madukkur series and 0.99 and 5.44 ppm in Kalathur and Padugai series under different sources and levels of N tried. The mean value of NH_2-N content was the highest (2.22 ppm) on the very next day of basal application as well as top dressings of N in Madukkur series whereas it was on the second or third day after fertilization (DAF) in the case of the other soils (Fig. 1). Relatively a higher NH_2-N content was observed in the leachate from the basal applied fertilizers over the top dressings.

The NH_2-N was detected in the leachate upto 5-8 DAF depending on the N source used during basal dressing as well as first top dressing, in all the three soils studied. At second top dressing NH_2-N was found in the leachate upto 4-5 DAF under all the soils and sources of N tried. The overall mean loss of NH_2-N was the highest in Madukkur series (6.66 mg N pot^{-1}), followed by Kalathur (3.34 mg N pot^{-1}) and Padugai series (2.43 mg pot^{-1}) (Table 3). This was so under all sources and levels of N tried.

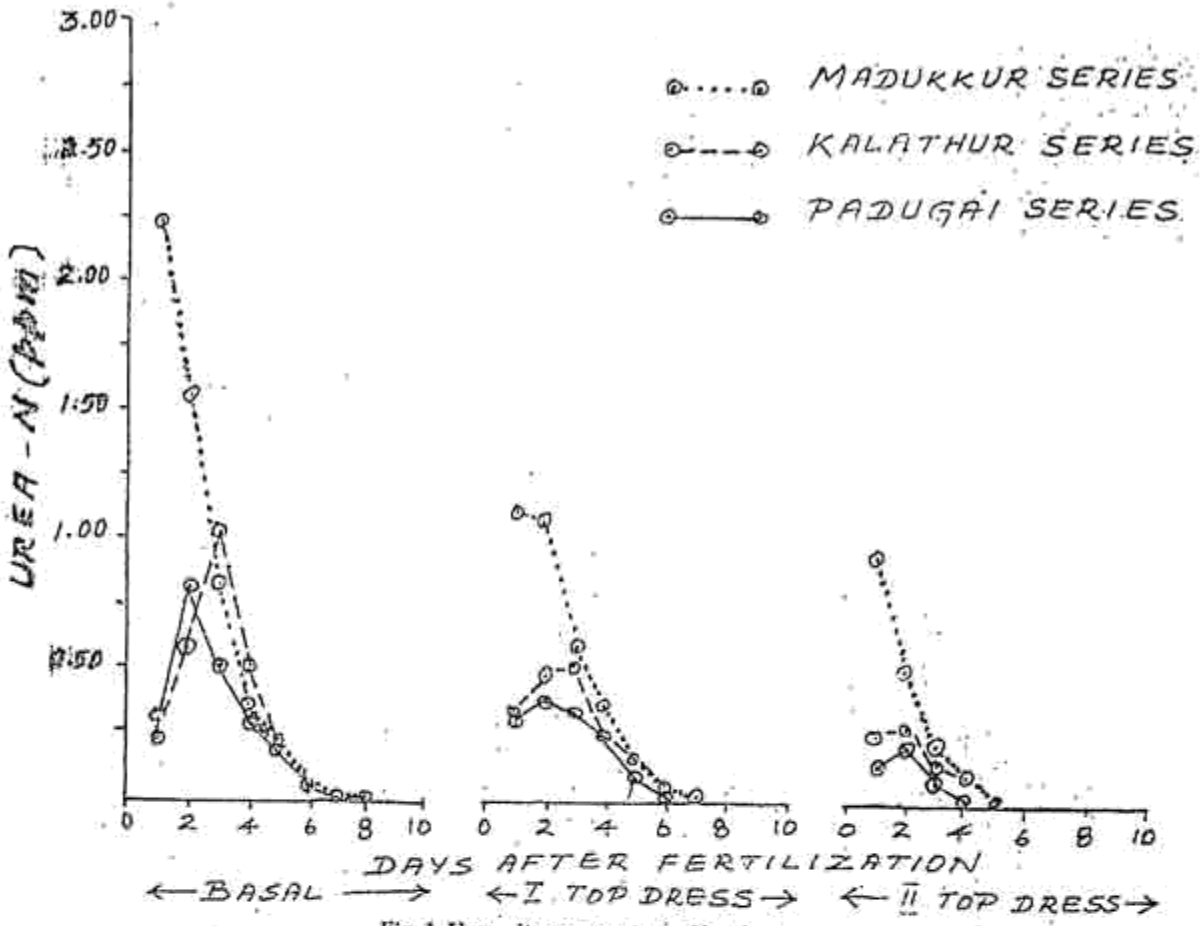

Fig. 1. Urea nitrogen content of leachate

Leaching loss of Ammonium -N

The ammonium nitrogen (NH_4-N) content of the leachate ranged from 0.3 to 17.9 ppm in Maddukkur series, 0.3 to 10.1 ppm in Kalathur and 0.3 to 9.00 ppm in Padugai series under different sources and levels of N tried (Fig. 2) The mean value of NH_4-N content was the highest on third day after basal dressing as well as first top dressing in all the soils. During second top dressing, the NH_4-N content was highest on third DAF in Madukkur and Kalathur series while in Padugai soils, it was observed on second DAF itself. The NH_4-N content was higher during basal fertilization followed by first and second top dressings. The NH_4-N in leachate was detected even upto 10 DAF irrespective of the sources of N used as well as phases of observation with a minimum level of 0.5 ppm observed on 10th DAF. The leaching loss of NH_4-N was the highest in Madukkur series (27.9 mg N pot^{-1}) followed by Kalathur (21.1 mg N pot^{-1} and Padugai (18.2 mg N pot^{-1}). This was so in all sources and levels of N (Table 2).

Leaching loss of Nitrate-N.

The nitrate nitrogen (NO_3-N) content of the leachate ranged from 0.12 to 2.63 ppm in Madukkur and Kalathur series and 0.12 to 2.04

Table 2. Total leaching loss of N (mg pot^{-1})

	Soils			Mean
	Mdk	Klt	Pdg	
N sources				
Prilled urea (PU)	37.12	27.89	23.11	29.45
Ammonium chloride (AC)	29.06	26.56	21.27	25.66
Neem coated urea (NCU)	32.25	24.54	21.20	26.02
Coal tar coated urea (CTU)	33.94	26.12	22.45	27.50
Lac coated urea (LCU)	30.55	23.84	20.94	25.17
Urea super granule (USG)	57.40	37.78	29.85	41.65
Mean	36.72	27.78	23.13	29.21
N levels				
Control (N_0)	8.67	7.98	7.13	7.93
51 kg N ha^{-1} (N_{51})	23.90	18.57	16.01	19.49
102 kg N ha^{-1} (N_{102})	33.97	26.73	21.67	27.46
153 kg N ha^{-1} (N_{153})	52.29	38.04	31.72	40.68
Mean	36.72	27.78	23.13	29.21

	SE	CD (5%)
Soils (S)	0.41	0.83
N Sources (F)	0.59	1.18
N levels (L)	0.41	0.83
S x F	1.02	2.04
S x L	0.72	1.44

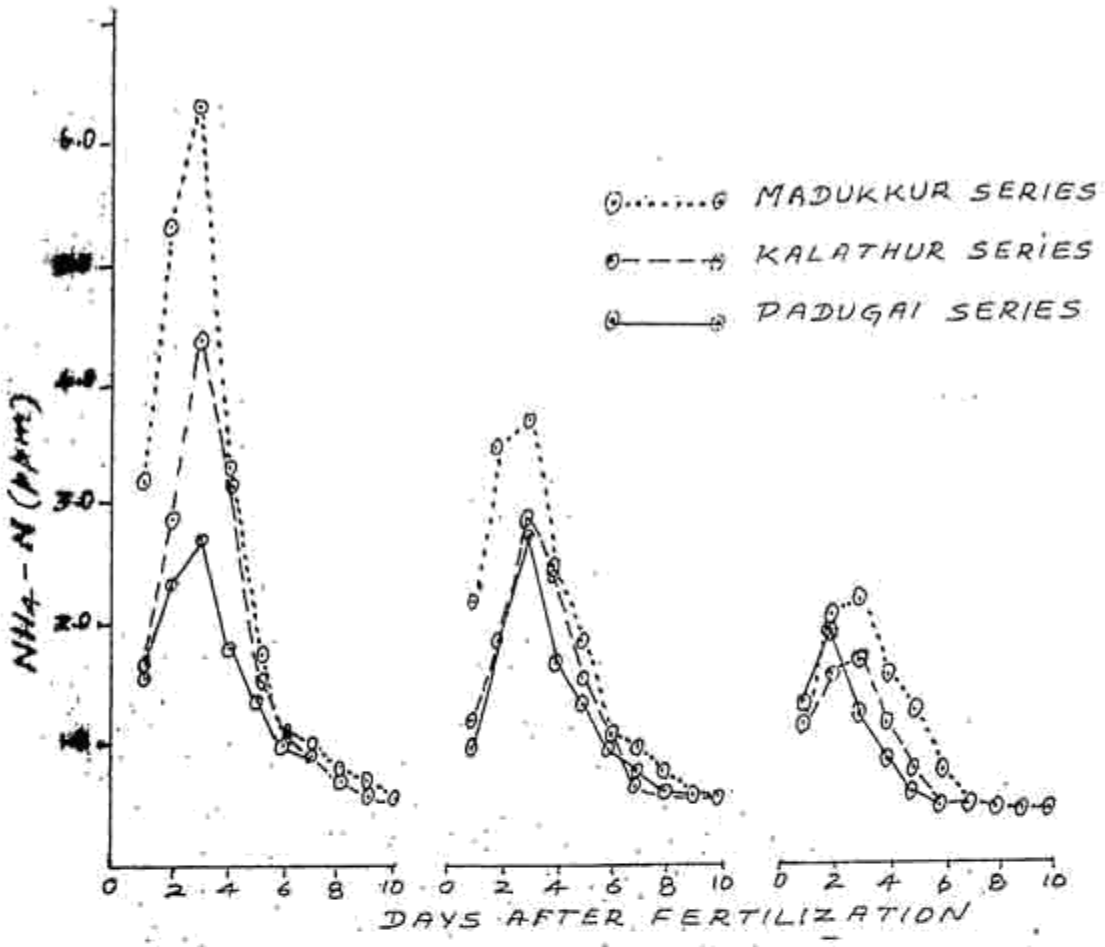

Fig. 2. Ammonium nitrogen content of leachate

ppm in Padugai (Fig.3). In Madukkur series the over all mean value of NO_3-N was the highest on 2nd DAF. A gradual decline in the NO_3-N content was observed there after and it was detected upto 6 DAF during basal dressing and upto 5-6 DAF during top dressings.

In Kalathur and Padugai series, a higher NO_3-N in the leachate was noticed on 2 DAF under all N sources during basal dressing while during top dressings, it was higher on 3 DAF. The NO_3-N was detectable upto 7-8 DAF at basal dressing and upto 6 DAF during top dressings. Kalathur series recorded the highest NO_3-N loss (3.92 mg N pot^{-1}) followed by Madukkur (3.32 mg N pot^{-1}) and Padugai series (2.98 mg N pot^{-1}). This was so under all the N levels tried (Table 2).

Total leaching loss of N

The total leaching loss of N viz., NH_2-N, NH_4-N and NO_3-N was worked out under different soils, sources and levels of N and the data of the mean values are presented in Table 2. The total leaching loss varied from 7.13 to 93.03 mg N pot^{-1}. The loss was the highest in Madukkur series (35.24 mg pot^{-1}) followed by Kalathur (26.78 mg pot^{-1}) and the lowest was in Padugai series (22.31 mg pot^{-1}). This was so under all sources and levels of N tried. The light textured Madukkur series due to its low CEC and higher hydraulic conductivity, recorded higher leaching loss compared to the heavy textured Kalathur and Padugai series which had higher CEC and lower hydraulic conductivity favouring more of adsorption and retension of the applied N.

Considering the overall performance of the various N sources, application of USG recorded the highest leaching loss (41.65 mg N pot^{-1}). followed

Table 3. Proportion of various fractions of N lost (mg pot^{-1}) through leaching

Forms of Nitrogen	Soils			Mean
	Madukkur	Kalathur	Padugai	
NH_2 - N	6.66(14.9)	3.34(9.8)	2.43(8.6)	4.14(11.1)
NH_4 - N	27.85(76.1)	21.05(76.2)	18.20(78.7)	22.35(77.0)
NO_3 - N	3.32(9.0)	3.92(14.0)	2.98(12.7)	3.41(11.9)
Total	36.72(100.0)	27.78(100.0)	23.13(100.0)	29.20(100.0)

(Values in parantheses are the percentage of the total leaching loss of N)

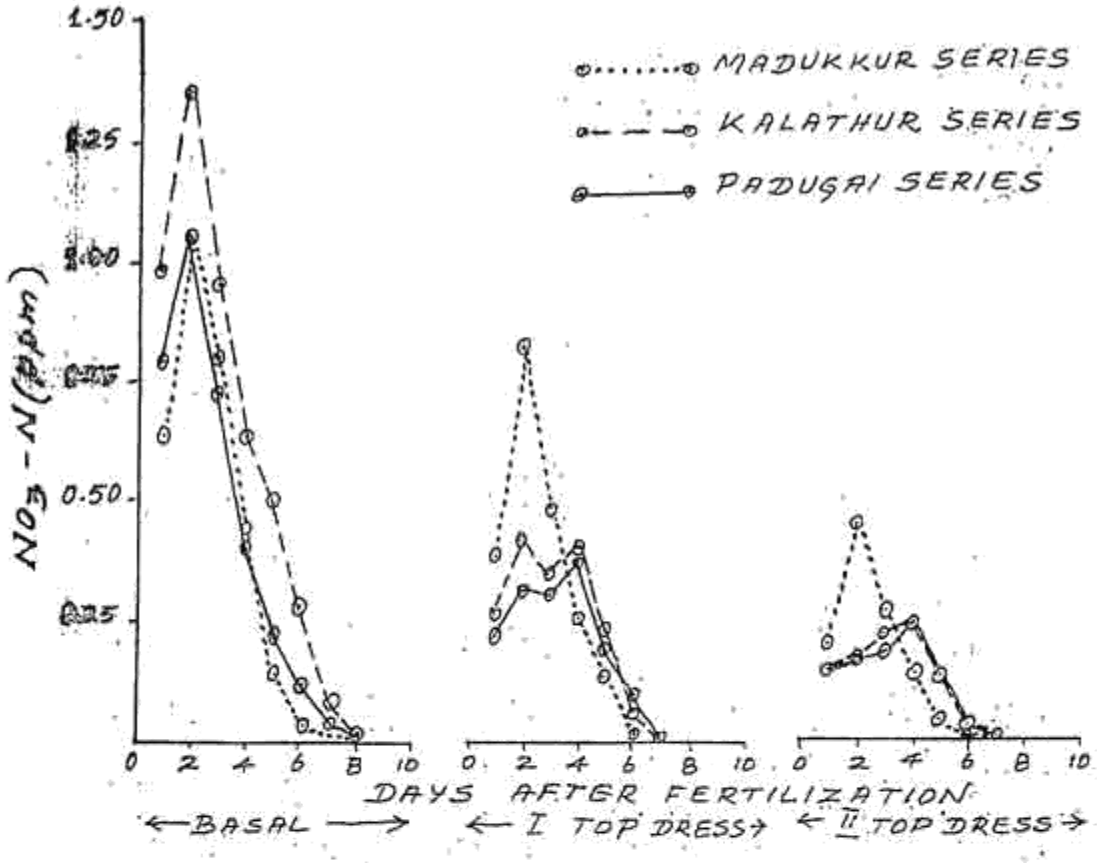

Fig. 3. Nitrate nitrogen content of leachate

by PU, CTU, NCU, AC and LCU in the order, the latter three being comparable. Under all soils and levels of N, USG recorded the highest total leaching loss. With increasing level of applied N, a progressive increase in the total leaching loss of N was observed in all soils and sources of N tried. Point placement of USG at 8 to 10 cm soil depth facilitating easy downward migration of the dissolved and mineralised components of USG coupled with higher localised concentration could have increased the leaching loss of N. This inference is in aggrement with the reports of Vlek *et al.*, (1980) Katyal *et al.*, (1985) and Singh and Singh (1988). Application of other N sources by broadcast and incorporation in the soil might have facilitated better contact and adsorption of the applied N by soil colloids, thereby recorded lower leaching loss compare to USG.

Out of the total leaching loss, about 11.1 per cent was in the form of urea-N, 77.0 per cent as ammonium-N and 11.9 per cent as nitrate-N (Table 3). The leaching loss of urea-N was relatively higher (14.9 per cent) in Madukkur series followed by Kalathur (9.8 per cent) and Padugai (8.6 per cent). More or less an equal amount of ammonium-N loss (76.1-78.7 per cent) was observed among the three soils while in the case of nitrate-N leaching, it was relatively higher in Kalathur series (14.0 per cent) followed by Padugai (12.7 per cent) and Madukkur series (9.0 per cent).

The mineralisation of the applied urea-N was found maximum within 2-3 DAF. Hence, the possibility of N being leached as NH_2-N was for a very shorter period. Similarly, the formation of NO_3-N being limited as observed in the present investigation due to reduced condition previaling under submergence, the loss as NO_3-N was also less. Though the NH_4-N was said to be greatly adsorbed on the clay complex and the utilization of the rice crop was also reported to be more in the NH_4-N form, still the proportion of the NH_4-N lost through leaching was relatively very high. The results of the present study are in line with the findings of Patrick and Mahaptra (1968), Pande and Adak (1971) and Singh and Singh (1988) who were of the opinion that in water logged soils, ferrous and manganouse ions resulting from the reduction of their oxidised state displace NH_{4+} from the

exchange complex to the soil solution, which accumulate in greater amounts in the leachate, and get lost.

REFERENCES

KATYAL, J.C., BIJAYSINGH, VLEK, P.L.G. and CRASWELL, E.T. (1985). Fate and efficiency of nitrogen fertilizers appliced to wet land rice: II Punjab, India. **Fert. Res. 6:** 279-290.

OWENS, L.D. (1960). Nitrogen movement and transformations in soils as evaluated by a lysimeter study utilizing isotopic nitrogen. **Soil Sci. Soc. Am. Proc., 24** : 372 - 376.

PANDE, A.K. and ADAK, N.K. (1971). Leaching losses of N in submerged rice cultivation. **Expt. Agric., 7:** 329 - 336.

PATRICK, W.H. Jr and MAHAPATRA, I.C. (1968). Transformations and availability to rice of nitrogen and phosphorus in waterlogged soils. **Adv. Agron., 20:** 323 - 359.

REDDY, K.R. PATRICK, W.H.Jr. and PHILIPPS, R.E. (1980). Evaluation of five selected processes controlling nitrogen loss in a flooded soil. **Soil Sci. Soc. Am. J., 44:** 1241 - 1246.

SANCHEZ, P.A. (1973). Puddling tropical rice soils : I. Growth and nutritional aspect. **Soils Sci., 115:** 149 - 158.

SINGH, M. and SINGH, T.A. (1988). Leaching losses and use efficiency of nitrogen in rice fertilized with urea super granules. **J. Indian. Soc. Soil Sci., 36:** 274 - 279.

VLEK, P.L.G., BYRNES, B.H. and CRASWELL, E.T. (1980). Effect of urea placement on leaching losses of N from flooded rice soils. **Pl. Soil. 54:** 441 - 449.

(Received : November 1996 Revised : March 1998)

Madras Agric. J., 85(5,6): 278 - 280 May, June 1998

FARMERS DEALER LOYALTY FOR PESTICIDES IN COIMBATORE DISTRICT

N.R. PADMANABAN.

Department of Agricultural Economics
Agricultural College and Research Institute
Tamil Nadu Agricultural University
Coimbatore 641 003

ABSTRACT

A study was conducted in Coimbatore district with 120 farmers to analyse the dealer loyalty of farmers towards pesticides purchase through a linear multiple regression. The results revealed that the credit availability and quality products were significant at one per cent level, malpractices significant at one per cent but negatively, price and availability of preferred brand were significant at five per cent level. The study also showed that farmers are loyal to the dealers.

KEY WORDS : Dealer, regression, significance, loyalty

There is an urgent need for increasing the agricultural production to keep pace with ever increasing population. It is necessary to ensure timely and increased availability of critical inputs like fertilizers, pesticides, machinery, hybrid seeds and improved package of practices to the farmers. The pesticides, in fact, play the crucial role of insuring the efficiency of all the associated inputs plus time, efforts and energy spent on the cultivation of various crops and also protect them from pests, diseases and weeds. The pesticide use pattern of cultivators was based on their expectations with regard to time and intensity of pest attack and the effectiveness of pesticides. Mohanan (1980) observed that choice of pesticides has been influenced by past experience and quality. Singh and Singh (1986) observed that the choice of dealer was based on the provision of incentives particularly in the form of subsidy. Co-operatives and private dealers were the initial suppliers of pesticides. Agricultural department was approached by farmers because of provision of subsidy and technical guidance.

Coimbatore district is an important and agriculturally well developed district in Tamil Nadu. The farmers in this district are practising modern agricultural technologies for various crops. An attempt was made to study the farmers attitude towards dealers *i.e.*, their loyalty towards dealers in respect of purchase of pesticides.

MATERIALS AND METHODS

The study was conducted purposively in Coimbatore district during 1993. In this district, three blocks *viz.*, Anaimalai, Udumalpet and Pollachi (South) were selected randomly. In each of these blocks, four villages were again selected