Annals of Arid zone 30 (3) : 203-207, 1991

AMMONIA VOLATILIZATION AS INFLUENCED BY AMENDMENTS IN A LIGHT TEXTURED ALKALI SOIL

B.M. SHARMA, R.K. AGGARWAL AND PRAVEEN KUMAR

Central Arid Zone Research Institute, Jodhpur, 342 003

ABSTRACT

An alkali soil, treated with gypsum (50 and 100 per cent of its gypsum requirement) and flyash (8 and 15 per cent by weight of soil) and followed by leaching with water was studied for ammonia release and changes in available nutrient content There was drastic reduction in NH_3 losses with the application of gypsum and flyash which was partly due to reduction in soil pH. The magnitude of reduction was higher in gypsum than flyash amended soil and increased with the dose of amendments. The treated soil showed significant increase in the availability of macro and micro nutrionts.

INTRODUCTION

One of the primary reason for low recovery of fertilizer nitrogen is the significant loss of N from root zone. Volatilization of ammonia is one of the important avenues of nitrogen loss and depends upon temperature, moisture, pH. clay, $CaCO_3$ and a number of other factors (Terman 1979). The N losses in alkali soils under arid condition are very high because of high pH and exchangeable Na percentage of soil (Gandhi and Paliwal 1976), high temperature and low moisture condition prevailing in the region.

Efforts are being made to bring alkali soil under cultivation by the use of various amendments, Flyash, a by product of burnt coal, can also be used for reclamation of saline alkali soils (Mahalingam 1973). Among several physico chemical changes brought about by the application of amendments, reduction in soil pH is most important from plant nutrition point of view. The objective of the present investigation was to evaluate the effect of gypsum and flyash on ammonia volatilization from urea in a light textured alkali soil.

MATERIAL AND METHODS

The experiment was conducted under laboratory conditions on alkali soil (pH 9.6, EC 1.0 dSm^{-1}) collected from a nearby village (Doli) of Jodhpur. Soil belonged to Typic Camborthid. The gypsum requirement (G.R.) of the soil as determined by Schoonover's method (Richard 1954) was 0.5 g 100^{-1} gs oil. Gypsum at 50 and 100% of G.R. and filyash at the rate of 8 and 15 per cent by weight were mixed in the soil. Important physical and chemical properties of flyash used in the study are presented in Table 1.

Table 1. Properties of Fly ash.

Properties	
Particle diameter (mm)	
2-0.02 (%)	90.5
0.02-0.002 (%)	3.8
≤ 0.002 (%)	4.2
Available water capacity (%)	12.4
Saturation percentage	60.2
pH*	5.2
EC* (dSm^{-1}	0.8
Available sulphur ($\mu g\ g^{-1}$)	116.0
Total sulphur (%)	0.12

*Measured in 1:2 Fly ash water suspension.

The soil mixed with the amendments was transferred to high density polyethylene columns having perforated bottoms and leached three times with uniform quantity of distilled water to remove the soluble reaction products. The leached soil was air dried, processed and used for the experiment. Available N and P were determined by the standard methods described by Jackson (1967). Available Fe, Mn, Zn and Cu were extracted witn DTPA (Lindsay and Norvell 1978) and estimated on double beam atomic absorption spectrophotometer.

To ascertain the ammonia volatilization losses, 100 g of the treated and control soils were taken in the conical flask in duplicate, 100 mg of urea was applied and kept at 50% field capacity at 30°C in a BOD incubator. The ammonia evolved was trapped in 2% boric acid with mixed indicator and titrated against standard sulphuric acid (Aggarwal and Kaul 1978). Measurements were made at regular intervals until the release of ammonia was negligible.

RESULTS AND DISCUSSION

Cumulative losses of ammonia from applied urea in various treatments are shown in Fig 1. The peak values of ammonia volatilization were observed at 8 days in the control and in the soil treated with flyash (8 and 15%). In gypsum treated soil, the peak values were obtained on 4th day. Thereafter, volatilization of NH_3 gradually declined and practically no release of NH_3 was observed after 16 days. The lower rate of volatilization during initial days may be attributed to delay in hydrolysis of urea which would primarily be carried out by native soil urease activity which seems to be low in these soils due to their high pH (Rao and Ghai 1985). In the untreated soil (control), about 21.6% of the applied nitrogen was lost due to volatilization in 16 days. The losses were considerably reduced to 7.2% and 14% respectively in the soil treated with gypsum equivalent to 50% GR and 8% fly ash. Higher doses of gypsum and fly ash further reduced the losses, the magnitude

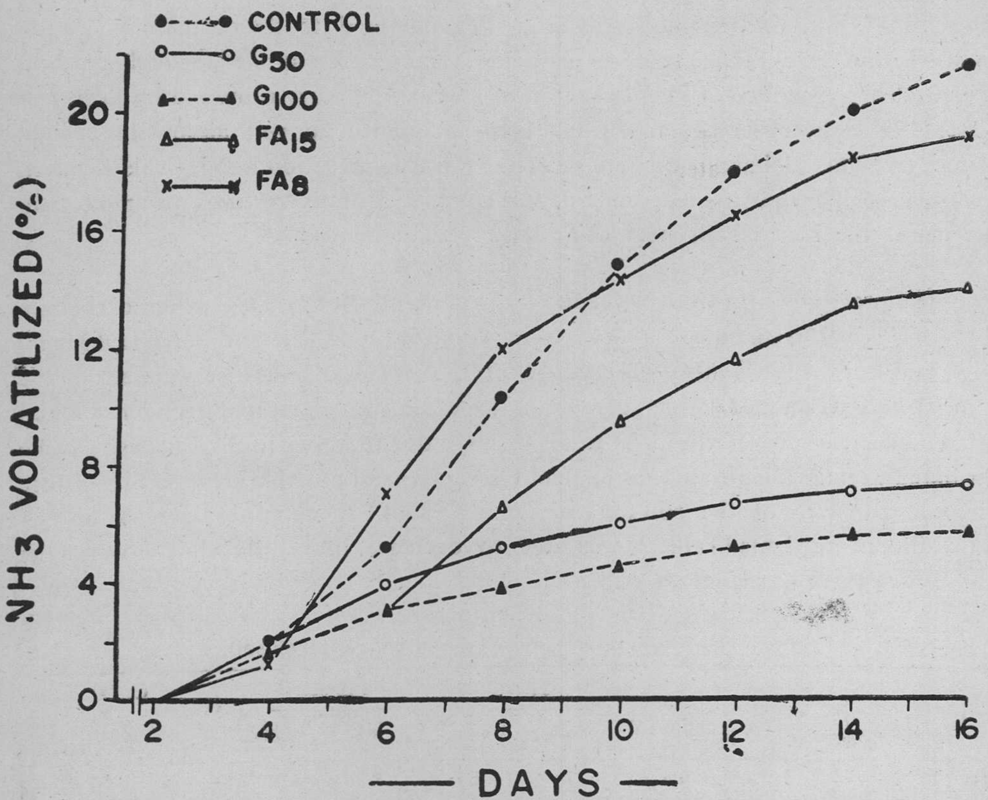

Fig. 1. Effect of amendmcnts on Cummulative losses of ammonia ln alkali soil

of reduction being more with gypsum than with fly ash. Effectiveness of the amendments in reducing the losses can be attributed to the decrease in soil pH resulting from the exchange reaction of sodium with calcium applied through gypsum. The effect of gypsum can be explained on the basis of theory proposed by Fenn and Kissel (1973) who observed that when urea is applied to soil alongwith cacium nitrate, calcium sulphate or calcium chloride, a drastic reduction in NH_3 volatilization takes place. They postulated that as a result of hydrolysis of urea to ammonium carbonate, the increase in pH precipitates calcium carbonte.

The precipitation of $CaCO_3$ reduced the concentration of ammonium carbonate in the soil which resulted in a decline in volatilization. Rao and Batra (1983) and Singh and Bajwa (1987) also observed that the losses of ammonia were negligible from partially reclaimed soil as compared to extensive losses in unreclaimed alkali soil. The decrease in volatilization losses of NH_3 due to application of fly ash can be attributed to its available sulphur content (116 ppm) and possible increase in moisture retention capacity of the soil (Sharma et al. 1990). A marginal increase in the availability of nutrients (Table 2) was due to decrease in soil pH which governs the solubility of these nutrients.

Table 2. Effect of gypsum and fly ash on availability of nutrlents in alkali soil.

		Gypsum		Fly ash		C. D.
	Control	G_{60}	G_{100}	8%	15%	(5%)
pH	9.4	7.98	7.58	8.40	8.20	0.57
EC (dSm^{-1})	0.78	0.99	1.66	0.63	0.66	0.45
Available nutrients						
N (%)	0.006	0.007	0.009	0.006	0.008	NS
P (ppm)	3.4	4.5	4.0	4.5	5.0	NS
Fe (ppm)	3.0	3.8	4.0	3.2	3.2	NS
Mn (ppm)	8.6	9.0	9.2	9.28	9.40	NS
Zn (ppm)	0.72	0 76	0.93	0.74	0.79	0.109
Cu (ppm)	0.85	1.00	1.38	0.90	0.91	NS

REFERENCES

Aggarwal, R. K. and Kaul, P. 1978. Loss of nitrogen as ammonia volatilization from urea on loamy sand soil of Jodhpur. Annals of Arid Zone 17 : 242-245.

Fenn, L. B. and Kissel, D. E. 1973. Ammonia volatilization from surface application of ammonium compounds on calcareous soil. I. General theory. Soil Science Society of America Proceedings 37 : 855-859.

Gandhi, A. P. and Paliwal, K. V. 1976. Mineralization and gaseous losses of nitrogen from urea and ammonium sulphate in salt affected soils. Plant and Soil 45 : 247-255, Jackson, M.L. 1967. Soil chemical analysis. Prentice Hall of India Pvt. Ltd. New Delhi.

Lindsay, W.L. and Norvell, W.A. 1978. Development of DTPA soil test for zinc, copper and manganese. Soil Science Society of America Journal. 42 : 421-428. iron

Mahalingam, P.K. 1973. Ameliorative properties of flyash in reclaiming saline and alkali soils. Madras Agriculture Journal. 68 : 1055-1057.

Rao, D.L.N. and Batra, L. 1983. Ammonia volatilization from applied nitrogen in alkali soil. Plant and Soil 70 : 219-228.

Rao, D.L.N. and Ghai, S.K. 1985. Urease and dehydrogenase activity of alkali and reclaimed soil. Australian Journal of Soil Research 23 : 661-665.

Richards, L.A. (Ed.) 1954. Diagnosis and improvement of saline alkali soils. USDA Handbook 60.

Sharma, B.M., Aggarwal, R.K. and Praveen Kumar 1990. Water retention and nutrient availability in a fly ash amended desert sandy soil : A study in vitro. Arid Soil Research and Rehabilitation 4 : 53-58.

Singh, B. and Bajwa, M.S. 1987. Ammonia volatilization from salt affected soils fertilized with urea under submerged conditions. Journal of the Indian Society of Soil Science 35 : 358-364.

Terman, G.L. 1979. Volatilization losses from nitrogen as ammonia from surface applied fertilizers, organic amendments and crop residues. Advances in Agronomy 31 : 189-223.