

Some aspects of Storage of Mixed Fertilizers*

by

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Synopsis: The results of a simple laboratory study undertaken to assess how far the deficiency of the nutrients in a manure mixture, when stored, could be attributed to the different nitrogenous fertilizer materials involved, are discussed in this paper.

Introduction: The Third Five Year Plan envisages an all round increase in food production by better farming methods, improved seeds, fertilizers and irrigation facilities. Out of these the role of fertilizers needs no emphasis. Only very recently our farmers have become fertilizer conscious and their knowledge regarding the nutrient requirements for various crops is rather very meagre. Further, due to the short supply of straight fertilizers like Ammonium sulphate, Urea etc. in our country and the unavailability at the appropriate time, the farmers have found it more convenient to go in for the mixed fertilizers, manufactured by a number of firms. With the increase in consumption of the fertilizers there is the danger of spurious and sub-standard fertilizer infiltrating into the market. In order to assure the quality of the fertilizer mixtures marketed by the mixing firms, the Government of India have brought a piece of legislation called 'Fertilizer Control Order' in 1957, with a view to serve the interests of the cultivators. The quality of the mixed fertilizers sometimes suffer due to faulty mixing and also due to the physical and chemical properties of the fertilizer materials in the mixture during storage. A simple laboratory study was therefore undertaken to assess as to how far the deficiency of the nutrients in a manure mixture, when stored, could be attributed to the different nitrogenous fertilizer materials involved. The results of these studies are presented in this paper.

Review of Literature: Information available on the keeping quality of the fertilizers is rather scanty. Mukerjee (1960) while studying the problem has stated that the keeping quality of a fertilizer material depends upon the critical relative humidity for the material. He found that fertilizer mixtures containing nitrates absorb moisture from air at relatively low humidity and high temperature. Bladimir and Herald (1958) have mentioned the possibility of actual loss of plant nutrients or their conversion into less available forms due to incompatibility in mixed fertilizers. Beeson (1937) has shown that di-ammonium-phosphate either alone or in mixtures will lose half of its ammonia in 15 to 30 days at 60° centigrade depending upon

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the proportion of phosphate present in the mixture. If the mixture contains calcium sulphate the liberated ammonia will not be lost but Ammonium sulphate and dicalcium phosphate will be formed. Ross (1934) found that in the ammoniation of superphosphate, calcium phosphate more basic than tricalcium phosphate will be formed and they may result in the loss of available phosphoric acid. He has also reported that chemical reactions that will take place in a mixed fertilizer depends upon the properties of the material involved. The rate at which reaction proceeds is dependent upon such factors as moisture content, temperature, particle size and intimacy of contact between particles.

A review of the analytical data relating to the samples of mixed fertilizers drawn under the 'Fertilizer control order Scheme' in Madras State during the last four years (1958-'62) indicate that the number of samples deficient in water soluble phosphoric acid was maximum (28% to 39%), while those deficient in nitrogen (17% to 30%) and total phosphoric acid (9% to 22%) followed next in the order. The number of samples deficient in potassium was minimum, i.e., 2 to 5% only. These results seemed to suggest that apart from the possibility of defective mixing of the fertilizer ingredients, the physical and the chemical properties of the ingredients, and the chemical reactions between them during storage are also likely to cause considerable deterioration in their quality.

Methods and Materials: Three mixtures of the constituents detailed below were taken for storage trial. The object of choosing these particular mixtures was to have mixtures having different materials to supply the inorganic nitrogen in the mixtures. In mixture C super phosphate serves as an additional supplier of water soluble P_2O_5 .

Mixture A		Mixture B		Mixture C	
Calcium ammonium nitrate	40%	Ammonium sulphate	40%	Urea	50%
Ammonium phosphate	15%	Ammonium phosphate	15%	Ammonium phosphate	10%
Groundnut cake	20%	Groundnut cake	20%	Super phosphate	3%
Rock phosphate	11%	Rock phosphate	11%	Rock phosphate	10%
Filler (Gypsum)	14%	Muriate of Potash	10%	Groundnut cake	14%
		Filler (Gypsum)	4%	Muriate of Potash	5%
				Filler (Gypsum)	8%
	100		100		100

The mixtures were kept in screw-capped bottles under laboratory conditions. Samples were drawn out at regular monthly intervals for a period of six months. Analysis were carried out as per A. O. A. C. methods, for total nitrogen, organic nitrogen, total P_2O_5 , water soluble P_2O_5 , total potash, free acid and mixture.

Results and Discussion: The results of analysis are given in table I. It will be seen that all the mixtures showed an increase in moisture content with passage of time. The increase was highest in Mixture A, next in Mixture C and lowest in Mixture B. Calcium ammonium nitrate was used in the preparation of Mixture A. This being highly hygroscopic would have absorbed moisture from atmosphere and contributed in the high increase in moisture content. Similarly in Mixture C, the presence of urea, which is also hygroscopic, was responsible for the increase in moisture content. There was not much variation in moisture content on storage in Mixture B, in which ammonium sulphate was used as the source of inorganic nitrogen.

TABLE I
Results of analysis of Mixtures during Storage (on moisture free basis)

Month	Moisture %	Total Nitrogen %	Organic Nitrogen %	Water soluble N %	Total P ₂ O ₅ %	Water soluble P ₂ O ₅ %	Total K ₂ O %	Free Acid (As H ₂ SO ₄) %
<i>Mixture A.</i> December, 1961	6.57	13.49	0.98	12.51	12.46	7.20	...	1.14
January, 1962	8.58	13.47	1.07	12.40	12.47	7.16	...	1.10
February, 1962	10.68	13.49	1.09	12.40	12.44	6.36	...	3.30
March, 1962	13.00	13.46	1.15	12.31	12.45	4.02	...	3.02
April, 1962	12.06	13.39	1.27	12.12	12.45	4.00	...	2.50
May, 1962	14.09	13.09	1.38	11.71	12.44	2.20	...	3.57
<i>Mixture B.</i> December, 1961	3.60	12.71	0.80	11.91	11.79	8.48	8.13	1.13
January, 1962	4.80	12.70	0.82	11.88	11.79	8.47	8.07	1.08
February, 1962	5.09	12.71	0.82	11.89	11.80	8.44	7.90	3.04
March, 1962	5.07	12.65	0.81	11.84	11.81	8.43	7.84	3.12
April, 1962	4.00	12.65	0.86	11.79	11.78	8.38	7.70	2.94
May, 1962	4.62	12.64	0.88	11.76	11.76	8.14	7.82	3.12
<i>Mixture C.</i> December, 1961	4.88	13.25	0.90	12.35	9.55	4.29	3.78	2.52
January, 1962	8.52	13.23	0.92	12.31	9.53	4.22	3.79	2.48
February, 1962	8.35	13.23	0.89	12.36	9.54	3.93	3.77	2.99
March, 1962	7.70	13.24	0.90	12.34	9.53	3.25	3.74	2.85
April, 1962	7.14	13.22	0.89	12.33	9.55	3.24	3.75	2.62
May, 1962	8.13	13.16	0.84	12.32	9.49	2.96	3.76	3.22

With regard to nitrogen content, all the mixtures seemed to be fairly stable under the conditions of study, except in Mixture A, wherein there was a slight decrease in nitrogen content after six months' storage.

Total phosphoric acid in all the mixtures remained constant throughout the period of study. However, the water soluble phosphoric acid decreased considerably in Mixtures A and C, while in Mixture B there was

no appreciable loss. It may be seen that in Mixture A, the loss of water soluble P_2O_5 was comparatively very low during the first two months and from the third month onwards, with the increase in moisture content to 11%, the decrease in water soluble P_2O_5 was marked. At the end of the six months, with an increase in moisture percentage to 14.09% the water soluble P_2O_5 content had gone down to less than one third of the original value, i.e., to 2.20% from the original value of 7.20%.

With regard to Mixture C, the reduction in water soluble P_2O_5 occurred markedly after the third month of storage and at the end of six months, the water soluble P_2O_5 had gone down to nearly 3% from the original value of 4.29%.

In Mixture B there was a small loss of about 0.3% of water soluble P_2O_5 after six months' storage.

The comparatively higher rate of reversion in Mixture A may be due to the presence of highly hygroscopic material like calcium ammonium nitrate and its chemical reaction with ammonium phosphate converting it into insoluble calcium phosphate. In Mixture C, wherein Urea was used, the moisture absorbed by the fertilizer might have brought about the reversion of phosphoric acid by the interaction of ammonium phosphate with super. The deterioration of water soluble P_2O_5 content would probably have been much aggravated if the trials had been conducted in the monsoon period instead of the comparatively dry period of December to May.

The potassium content of all the mixtures remained more or less constant throughout the period of study.

The free acid content in all the mixtures showed an increasing tendency. But this does not seem to have any relation with regard to the reversion of phosphoric acid. All the mixtures have showed an increase in free acid. But only in Mixtures A and C there was reversion. In Mixture B there was no reversion. The presence of free acid may be attributed to the presence of groundnut cake in all the mixtures, which gets deteriorated during storage releasing organic acids.

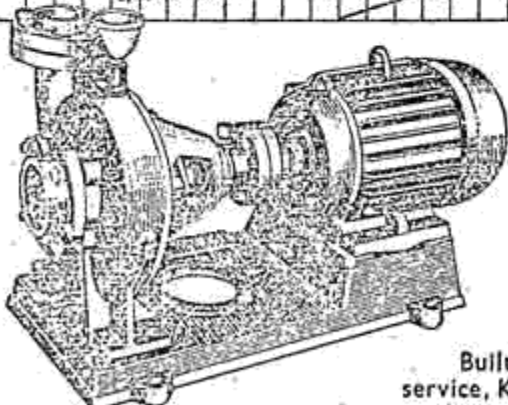
Summary and Conclusions: An observational laboratory trial was conducted to study the effect of storage on mixed fertilizers. Mixtures were kept under laboratory conditions and analysed for major plant nutrients for a period of six months. Only water soluble P_2O_5 was found to get reduced due to storage in mixtures containing calcium ammonium nitrate and Urea. Other nutrients like nitrogen, total P_2O_5 and potassium

were not markedly influenced due to storage. The deficiencies of nitrogen, total P_2O_5 and potassium in mixtures may be attributed to faulty mixing of fertilizer ingredients rather than to storage losses. Free acid content showed an increasing tendency in mixtures A and B.

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