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Effect on the Availability of P_2O_5 when Super is Mixed with Various Nitrogenous Fertilizers

by

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Synopsis: The results of a laboratory study to know the effect of Super phosphate when stored alone and in combination with various organic and inorganic nitrogenous fertilizers are discussed in this paper.

Introduction: More and more super is being used by our farmers as straight phosphatic fertilizer and in recent years this is being widely used in the fertilizer mixtures. In the present study, it is intended to determine how far super phosphate will be affected due to storage by keeping it alone and by mixing it with various organic and inorganic nitrogenous fertilizers.

Terman *et al* (1960) noted that heavy ammoniation decreased the water solubility of phosphorus from 70% to 14% in ordinary super and from 89% to 57% in concentrated super mainly due to the conversion to CaHPO4 and more basic phosphates. Miller and Vij (1962) have shown that water soluble phosphoric acid gets reduced when ammonium sulphate and super both compressed into pellets at high pressure and kept for 3-10 weeks. Ross (1934) found that in the ammoniation of super, Calcium phosphate more basic than tri-calcium phosphate will be formed and this may result in the loss of available phosphoric acid. Marshall and Hill (1940) have come to the conclusion that citrate soluble phosphates result from reaction of mono-basic acid which combines with calcium salts. Matson (1915) has shown that as the concentration of free phosphoric acid in super decreases with cure, the complex mono-basic acid probably changes to a water insoluble but citrate soluble calcium salt of the complex acid. Ramasubramani *et al* (1962) have proved that there is no considerable fixation of super in mixtures and that the reversion does not deteriorate the value of phosphorus. Sirur and Saolapurkar (1962) have indicated that prolonged storage of urea-super phosphate mixtures leads to the reversion of water soluble phosphates to water insoluble di-calcium phosphates. The work done by the author (1962) has proved that water soluble phosphoric acid gets reduced due to storage in mixtures containing calcium ammonium nitrate and urea.

Materials and methods: In the present work, super phosphate was stored alone, and in combination with organic and inorganic nitrogenous fertilizers. Nitrogenous materials may vary in their physical properties. To compare them in mixtures compounded with them, it is desirable that the quantity of nitrogen and P_2O_5 is maintained constant in all the treatments. Ingredients were therefore, mixed to give approximately equal quantity of nitrogen and P_2O_5 with a constant amount of gypsum as filler in all cases. The idea was to obtain a uniform treatment with gypsum at equal nitrogen and P_2O_5 level. The mixtures

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were stored in polythene lined jute bags and kept under laboratory conditions Samples were drawn at periodic intervals and analysed for moisture, total nitrogen, water soluble P_2O_5, total P_2O_5 and available P_2O_5 as per A. O. A. C methods and were statistically analysed.

TABLE I

Composition of Mixtures

S. No.	Constituents of mixture		
1.	Super phosphate		
2.	143 gms. groundnut cake plus 62 1/2 gms. super plus 25 gms. gypsum.		
3.	40 gms. Ammonium chloride plus	do	do
4.	21.74 gms. of urea plus	do	do
5.	47.62 gms. of Ammonium sulphate	do	do
6.	47.62 gms. Calcium Ammonium Nitrate plus	do	do
7.	40. gms. of Ammonium sulphate Nitrate plus	do	do

Note: Mixtures 2 to 7 contain approximately 10 gms. of N and 10 gms. of P_2O_5 with constant amount (25 gms.) gypsum.

Results and discussion: The results of analysis are given in Table II.

MOISTURE: In the first month of storage trial i. e. January, all the mixtures including super have recorded maximum moisture.

TABLE II

Results of analysis of Mixtures during storage (on moisture free basis)

	Moisture	Total N_2	W. S. P_2O_5	Total P_2O_5	Available P_2O_5
Super 1:					
January	7.06	Nil	18.48	19.40	18.62
February	6 00	Nil	18.46	19.20	18.60
March	5.85	Nil	18 41	12.23	18.52
April	5.93	Nil	18.34	19.23	18.54
Mixture 2:					
January	7.77	5.83	4.48	6.49	5.47
February	7.01	4.98	4.50	6.50	5.43
March	5.48	4.97	4.44	6.51	5.44
April	5.49	4.57	4.45	6.50	5.11
Mixture 3:					
January	5.46	8.74	9.38	10.27	9.52
February	5.53	8.73	8.83	10.20	9.00
March	3.00	8.71	8.44	10.08	8.25
April	2.90	8.72	8.12	9.99	8.21

TABLE II *(Contd.)*

	Moisture	Total N_2	W. S. P_2O_5	Total P_2O_5	Available P_2O_5
Mixture 4:					
January	8.00	11.61	10.86	11 20	10.89
February	9.06	10.21	10.44	11.15	10.84
March	7.68	10.11	9.86	11.14	10.82
April	7.40	9.84	8.35	11.15	10.21
Mixture 5:					
January	4.43	8.20	8.54	9.10	8.73
February	2.50	8.09	8.52	9.08	8.58
March	6.31	8.12	8.52	9.09	8.55
April	1.55	7.93	6.94	8.99	8.01
Mixture 6:					
January	10.30	7.95	4.95	8.95	6.69
February	8.38	7.92	0.82	8.91	6.55
March	8.33	7.93	0.27	8.92	6.50
April	7.70	7.93	Nil	8.94	6.42
Mixture 7:					
January	10.85	9.51	9.16	10.08	9.27
February	7.86	8.76	8.14	10.04	8.82
March	7.10	7.98	8.12	10.02	8.80
April	6.10	7.92	8.16	9.98	8.20

TABLE III

Statistical analysis for moisture content—Analysis of variance

Source	D. F.	S. S.	M. S.	F	
Months	3	20.67	6.89	5.60	**
Manures	6	89.61	14.94	12.15	**
Months x Manures	18	22.06	1.23		
Total	27	132 34			

CONCLUSION:

(a) *Months:* I, II, III, IV

All the mixtures recorded less moisture content in months succeeding January. The months of March and April are on a par. The reduction in the moisture content of the mixtures during the succeeding months of storage may be attributed to the fall in humidity of the period of storage itself. Further the addition of gypsum as a filler might have acted as a drier in the mixtures.

(b) *Manures:* 6, 4. 7, 2, 1, 3, 5,

Mixture 6 is on a par with the mixtures 4 and 7 and has recorded highe moisture content than the rest. Mixtures 3 and 5 are on a par and have recorde the lowest moisture content. In respect of the moisture content, mixtures 2 an 1 are on a par, but mixture 2 alone is on a par with mixtures 4 and 7. Th fairly higher moisture content in mixtures 6, 4 and 7 may be attributed to th hygroscopic nature of the nitrogenous fertilizers used in the preparation of thes mixtures, namely calcium ammonium nitrate, urea and ammonium sulphat nitrate respectively.

TABLE IV

Total Nitrogen—Analysis of variance

Source	D. F.	S. S.	M. S.	F.
Months	3	1.9693	0.6564	4.74 *
Manures	6	285.6211	47.9369	346.11 **
Months x Manures	18	2.4926	0.1385	—
Total	27	292.0830	—	—

CONCLUSION:

(a) *Months:* I, II, III, IV

In the month of January, which was the first month of the storage trial, maximum nitrogen content has been recorded followed by the months of February, March and April, the latter three months being on a par. This may be due to the loss of nitrogen in the form of ammonia brought about by chemical reactions during the succeeding months of storage.

(b) *Manures:* 4, 3, 7, 5, 6, 2, 1

The mixture 4, containing urea, has recorded the maximum nitrogen content followed by the mixture 3, which is on a par with mixture 7. Mixtures 7 and 5 are on a par. Mixtures 5 and 6 are on a par. Mixture 1 does not have nitrogen. The total nitrogen content of all the mixtures excepting mixtures, 2, 4 and 7 seems to be fairly stable. In mixture 2, wherein groundnut cake was used, the observed loss in nitrogen content may be attributed to the reaction of $CaCo_3$ present in natural gypsum with the ammoniacal nitrogen of groundnut cake. In mixture 4, in which urea constitutes the nitrogen, urea might have hydrolysed to form ammonium carbonate which in turn dissociated into ammonia and Co_2. The released ammonia is likely to have been lost. With regard to mixture 7, the free acid of super phosphate might have caused the loss of nitrogen from ammonium sulphate nitrate.

TABLE V

Water soluble phosphoric acid—Analysis of variance

Source	D.F.	S.S.	M.S.	F.	
Months	3	9.84	3.28	4.37	*
Manures	6	662.64	110.44	147.25	**
Months x Manures	18	13.47	0.75	—	
Total	27	685.95			

CONCLUSION :

(a) *Months :* I, II, III, IV

Water soluble P_2O_5 was maximum in the month of January. Gradually it got reduced on the advancement of the storage period. This may be attributed to the reversion of water soluble P_2O_5 into water insoluble P_2O_5 on the advancement of the storage period.

(b) *Manures:* 1, 4, 3, 7, 5, 2,6

Super has recorded the maximum water soluble P_2O_5 and mixture 6 the minimum. Mixture 2 has recorded more water soluble P_2O_5 than mixture 6. The other mixtures are on a par. Water soluble P_2O_5 in super phosphate and mixture 2 were almost constant throughout the period of storage. All other mixtures from 3 to 7 showed a decreasing tendency as the storage period advanced. This may be due to the reversion of mono-calcium phosphate of super into di-calcium phosphate which is not water soluble. In the case of mixture 6, where calcium ammonium nitrate was used as the source of nitrogen, the conversion is about 85% in the 1st month itself and absolute 100% after a further period of 3 months. This may be due to the combined effect of calcium ammonium nitrate and gypsum on mono-calcium phosphate of superphosphate in reverting it into di-calcium phosphate.

TABLE VI

Total P_2O_5—Analysis of variance

Source	D.F.	S.S.	M.S.	F.	
Months	3	0.0380	0.0127	4.54	*
Manures	6	391.1207	65.1868	23281.00	**
Months x Manures	18	0.496	0.0028		
Total	27	391.2084			

CONCLUSION :

(a) *Months:* I, II, III, IV

In the month of January, Total P_2O_5 content is found to be more than in the months of March and April. There is no significant difference between the months of February, March and April.

(b) *Manures:* 1, 4, 3, 7, 5, 6, 2

Super has recorded the highest total P_2O_5 content followed by mixtures 4, 3, 7, 5, 6 and 2 in order.

TABLE VII

Available P_2O_5 — Analysis of variance

Source	D. F.	S. S.	M. S.	F.
Months	3	1.53	0.51	10.20 *
Manures	6	446.67	74.45	1589.00 **
Months x Manures	18	0.98	0.05	—
Total	27	449.18		

CONCLUSION:

(a) *Months:* I, II, III, IV

Available P_2O_5 was maximum in the beginning and gradually got reduced during the storage period. This may be attributed to the reversion of citrate soluble di-calcium phosphate into more stable tri-calcium phosphate in the presence of calcium.

(b) *Manures:* 1, 4, $\overline{7,\ 3,\ 5,}$ 6, 2

Super has recorded more available P_2O_5 content than mixture 4, which has recorded more P_2O_5 content than the rest. Mixtures 7, 3 and 5 are on a par. Mixture 2 has recorded the least.

In an earlier work (Mustafa 1962) it was observed that mixtures containing calcium ammonium nitrate and urea brought down the water soluble P_2O_5 from 7.20 to 2.20% and 4.29 to 2.96% respectively during a storage period of 5 months. In this work also the water soluble P_2O_5 got reduced from all the mixtures except super phosphate and the mixture containing groundnut cake. In the case of mixture containing calcium ammonium nitrate the reversion of water soluble P_2O_5 into water insoluble P_2O_5 is absolute 100%, thus confirming the early findings.

Summary and conclusion: A laboratory storage trial was conducted to study the behaviour of super phosphate with various organic and inorganic nitrogenous fertilizers. Mixtures were kept in polythene lined jute bags and analysed for moisture, total nitrogen, water soluble P_2O_5, total P_2O_5 and available P_2O_5, for a period of 4 months. The results were statistically analysed. The nitrogen content got reduced due to storage in mixtures containing super along with groundnut cake, urea and ammonium sulphate nitrate. Total P_2O_5 was not much affected due to storage. Water soluble P_2O_5 in all the mixtures got reduced as the period of storage advanced and the water soluble P_2O_5 was completely lost in mixture 6 wherein calcium ammonium nitrate was used. Available P_2O_5 in all the mixtures, including super, got gradually reduced.

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