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Influence of phosphates on the growth, yield and composition of cholam crop *

by

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Synopsis: A field trial was conducted to test how far the organic or inorganic fertilisers (on equal phosphorus basis) or a judicious combination of both would help in obtaining maximum yields of *cholam* as well as maximum uptake of phosphorus in that crop. This study has shown that superphosphate is better than compost when applied singly but a judicious combination of superphosphate plus compost with a lower amount of the latter is far better, than either of them applied singly.

Introduction: The value of any manure or fertiliser depends on its capacity to produce higher yield of crops. Application of phosphates with bulky organic manures was found beneficial for acid soils by Raychaudhri (1956). Salter and Schollenberger (1939) and Dalton *et al* (1952) stated that the availability of Phosphorus to plants in organic manure was either equal to or in some cases exceeded that applied in chemical fertilisers. Stewart (1953) found that phosphorous supplied through inorganic source is superior to organic. Sree Ramulu *et al* (1959) reported an increase in yield of paddy on increasing the dosage of Phosphorus as superphosphate. Sanyasi Raju *et al* (1954) and Coulter and Lockyard (1955) found that the application of phosphorus increased the uptake of phosphorus in paddy.

Smirnov and Ploshkov (1955) reported that maximum uptake of phosphorus by plants was obtained when superphosphate alone was applied. But higher yield of crop was obtained when it was mixed with compost. Significant results were obtained by many workers (Srivastsava *et al* 1955; Sen and Bains, 1955) on the total phosphorus content of grain when superphosphate alone and in combination with organic manure were applied. They found that the application of organic manure alone had no appreciable effect on the total phosphorus content of grain. In view of these conflicting evidences, regarding the use of inorganic or organic manures and the superiority of one over the other, Sree Ramulu (1960) studied the above subject in detail on Ragi crop and the present investigation was taken up on *cholam* crop.

Materials and Methods: Compost as the organic source and superphosphate as the inorganic source for the supply of phosphorus were taken. Phosphorus supplied as superphosphate and compost were on equal phosphorus basis. Two strains of *cholam*, one of long duration variety, Co. 1 and another of short duration variety, Co 18 were chosen in order to study the differences due to strains. The following were the fifteen different treatments replicated four times.

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1. Control (No Manure)
2. Superphosphate to supply 15 lb. P_2O_5 / acre.
3. do. 30 lb. do.
4. do. 45 lb. do.
5. do. 60 lb. do.
6. Compost to supply 15 lb. do.
7. do. 30 lb. do.
8. do. 45 lb. do.
9. do. 60 lb. do.
10. Superphosphate to supply 15 lb. P_2O_5 / acre + compost to supply 15 lb. P_2O_5 / acre.
11. do. do. + 30 lb. do.
12. do. do. + 45 lb. do
13. do. 30 lb. do. + 15 lb. do
14. do. do. + 30 lb. do
15. do. 45 lb. do. + 15 lb. do

Design – Split Plot ... . Plot size = 20' × 6'
Net size = 18' × 5'

Seeds were sown from 16—9—1961 to 18—9—1961. Height measurements were taken from 30—10—1961 onwards at an interval of 15 days till flowering stage and finally at harvest stage. Ten plants were selected at random in each plot and the mean height measurements were recorded. Plant material samples were drawn from the experimental plots during the growth period at 1½ month, 2½ month and finally at harvest stage. Composite samples from all replications for each treatment were taken up for analysis.

The short duration variety Co. 18 was harvested on 2—1—'62 and the long duration variety was harvested on 25—1—'62. The yield of grain and straw from each plot was recorded separately in each case and was subjected to statistical analysis.

Results and Discussion: (a) *Height Measurements:* During the first stage in Co. 1 long duration variety there was not much difference in height measurements between the treatments while all of them were slightly better than the plants in plots reciving 60 lb. P_2O_5 (as superphosphate to supply 30 lb. P_2O_5 + Compost to supply 30 pounds P_2O_5) which were found to be better than the others (15 lb. Super + 30 lb. Compost and vice versa). During the subsequent stages of growth, the height of the plants received both the forms of manures was better than the others. But the plants receiving superphosphate alone was slightly shorter than those receiving compost alone. But this was not very significant. In almost all cases the mean height of plants increased upto 40 lb. P_2O_5 / acre level when applied either as superphosphate or as compost and decreased above that level. The reason for better growth in compost than superphosphate alone, may be attributed to the presence of other nutrients like nitrogen, potash etc.

In the case of short duration variety Co. 18 also there was not much difference in height in the biginning. But in later stages it was found that the combination was better than the individuals. But no marked difference was noticed between the individuals. However, in all forms of applications with increasing amounts of phosphorus application, the average height of the plants also increased upto 45 lb. P_2O_5 / acre.

(b) *Yield:* The yield data of the *cholam* crops are presented in Table I. The yield of *cholam* grain in Co. 1 (long duration variety) increased with increase in phosphorus levels. But, however, the combination of both the forms of manure gave better yields than all other treatments for the same amount of phosphorus applied. The yield in superphosphate treated plots was slightly higher than that of compost. In the combinations lower amounts of compost gave better yield than the higher level (viz., 45 lb. compost). In the case of straw, with increasing amounts of phosphorus (Superphosphate) the yield also was increased. Combination with higher amounts of Superphosphate (30 lb. P_2O_5) and lower amounts of compost (15 lb. compost) gave higher yields than compost alone applied separately.

Just as in the long duration variety, in the short duration variety Co. 18 also, the combination gave better yield than superphosphate which gave better yield than compost alone. However, there was a slight decrease in yield when the combination had larger proportions of compost (viz., 30 lb. and 45 lb.) In general, there was an increase in yield with increase in levels of phosphorus upto 45 lb. level either as individuals or as combinations.

Statistical analysis of yield: Statistical analysis of yield data is furnished in Appendix I. It reveals that in respect of grain yield, Co. 18 is superior to Co. 1. The application of phosphate markedly increases grain yield. Phosphate in the form of super is superior to phosphate through compost (due to immediate availability). Super at 30 lb. P_2O_5 plus compost at 15 lb. P_2O_5 as well as the former at 15 lb. plus the latter at 30 lb. have given the best results in grain yield among the combined applications. The combination of organic and inorganic phosphates has given better grain yields than applying either form singly. In Co. 1, the grain yield has not appreciably increased due to phosphate application, while in Co. 18, there is very marked increase. With no phosphate, the two strains are not much different in grain yield, being more than twice that of Co. 1. In Co. 1, the organic or inorganic form of phosphate is of no consequence, but in Co. 18, super surpases compost in grain yield. Under both super and compost, Co. 18 has recorded markedly greater yields of grain than Co. 1.

In regard to straw yield, the two varieties are on a par. Here again, there is marked response to application of phosphate. Also, super is superior to compost. Among the doses of both super and compost, all the three higher doses are on a par and superior to 15 lb. P_2O_5. The combination of super at 30 lb. plus compost 15 lb. P_2O_5 is again the best but on a par with 45 lb. of super plus 15 lb. compost. Co. 1, has registered a good response to phosphate in the yields of

TABLE 1

Average Yield of Cholam straw and Grain of both the varieties and the uptake of Phosphorus

S. No.	Amount of Phosphorus (P_2O_5) lb./acre supplied as		Cholam Co. 1 Yield in lb./acre		Cholam Co. 18 yield in lb./acre		Cholam Co. 1 Uptake of Phosphorus P_2O_5 in lb./acre		Cholam Co. 18 Uptake of Phosphorus (P_2O_5) in lb./acre	
	Superphosphate	Compost	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain
1.	Control		2,520	586	4,900	813	5·04	2·07	39·69	6·91
2.	15		4,563	688	5,264	1,220	21·90	3·51	46·32	12·44
3.	30		5,520	760	6,988	1,860	32·02	4·48	64·29	16·55
4.	45		6,752	865	7,260	2,033	45·91	6·40	83·49	18·30
5.	60		7,977	790	6·034	1,786	50·26	5·61	55·51	16·25
6.		15	4,006	706	5,173	1,383	19·23	4·24	41·90	14·25
7.		30	4,589	698	5,436	1,220	18·82	4·89	42·94	10·98
8.		45	5,688	722	6,988	1,433	25·03	3·32	54·50	16 34
9.		60	5,780	692	5,082	1,220	22·54	3·25	39·64	10·61
10.	15	+ 15	5,788	798	6,012	1,402	29·52	3·67	55·31	15·42
11.	15	+ 30	4,998	904	7,289	2,058	18·99	5·42	53·21	19·76
12.	15	+ 45	5,008	798	5.808	1,586	25·54	3·06	46·46	12·21
13.	30	+ 15	7,775	910	7,328	2,068	34·21	7·28	57·16	19·85
14.	30	+ 30	6,108	810	5,808	1,562	32·37	4·13	29·62	14·84
15.	45	+ 15	7,128	820	6,080	1,678	35·64	3·85	34·66	12·59

straw, while Co. 18 has not. Without phosphate, Co. 18, is superior to Co. 1 in the yields of straw, while with phosphate, both strains are on a par. In Co. 1, the response of straw yields to increased dose of phosphate is evident, but in Co, 18, the straw yield tends to go down beyond 45 lb. P_2O_5. Both strains yield on a par at all doses of phosphate, though the trend changes beyond 45 lb. P_2O_5.

(c) *Composition of Plant materials samples:* (i) *Phosphorus: Co. 1 long duration variety:* In Co. 1 variety, phosphorus content of the young plants was more or less equal in all superphosphate and compost treated plots than the combined treatments. But it was found to be the highest in treatment 15 lb. P_2O_5 Superphosphate + 15 lb. P_2O_5 compost. Later the variation was regular in most of the cases and at harvest stage it was found to be maximum at 45 lb. P_2O_5 / acre level supplied in the form of superphosphate. The phosphorus content in compost treated plot decreased with increase in phosphorus level. There was not much variation in phosphorus content in the combination treatments.

In general, phosphorus content was found to be the highest in earlier stage corresponding to the period of root development, after which there was a decline due to the translocation of nutrients to the grain. This supports the findings of Acharya (1931) who had reported that in sorghum crop, phosphorus content reached its maximum level corresponding with the seedling stage of the plant and a rapid fall in phosphorus was noticed till it reaches the stage of grain formation.

Regarding the uptake of phosphorus in Cholam Co. 1 straw, superphosphate was found to be superior either to compost or to the combination of both. Maximum uptake was found at superphosphate 60 lb. level and 45 lb. level was on a par with 60 lb. level.

Co. 18 Variety: The straw of Co. 18 strain from superphosphate treated plots had higher phosphorus content than compost treated plots. This may be due to the increased amounts of available phosphorus in the superphosphate treated plots than the compost treated plots during the earlier stages of growth. Because of the increased availablity and increased yield, the uptake of phosphorus also reached maximum at 45 lb. P_2O_5 / acre level. The phosphorus content of the straw in the compost treated plot was less than that of superphosphate. The depression of phosphorus in the straw from compost treated plot was found in both strains at harvest stage in all levels. Increase in application of phosphorus in the form of compost had resulted in depression of phosphorus content and the uptake of phosphorus also. This depressing effect was also noticed by Fuller and Dean (1949); they observed that by using organic materials containing 0·11 to 0·15 per cent P_2O_5 a very marked reduction, not only in yield, but also in Phosphorus uptake by the rye grass. Fuller and Rogers (1951) also noticed a reduction in phosphorus uptake by rye grass. Stanford and Pierre (1953) attributed this effect, in part, to a widening of carbon : Phosphorus ratio and to changes in the nature of the carbon constituents. From the above it is clearly

understood that organic matter present in compost treated plot resulted in depression of phosphorus content of straw evidently because of widening of C : P ratio and C : N ratio of soil which also supports the results obtained by Sree Ramulu (1960) for ragi crop.

Grain Co. 1 and Co. 18 Varieties : The phosphorus content of Co. 1 *cholam* grain from superphosphate treated plots increased with increasing doses of superphosphate application. The phosphorus content was maximum at 45 lb. P_2O_5 / acre level whereas in compost treated plot it was found to decrease with increasing dosages above 30 lb. level. But at 15 lb. and 30 lb. level it was found to be more than that of superphosphate treated grains at the same levels. In the case of combination the phosphorus content was more or less equal to the amount of phosphorus from super treated plots. The increase was marked at 30 lb. super + 15 lb. compost level. The higher amount of phosphorus in grain from combined treated plot is due to the amount of phosphorus made available by the influence of decomposition of organic matter. This had resulted in increased uptake of phosphorus by the grains. Certain studies, using plant residues tagged radiophosphorus, also show that utilisation of soil phosphorus was increased by incorporation of green manures (Fuller and Dean 1949 and Neilson 1952). The work of Midgley and Dunklee (1945) has been particularly valuable in showing that superphosphate is much more effective when intimately mixed with manure prior to application than when these materials are applied separately. Hester and Shelton (1937) demonstrated marked increases in the effective use of super by plants from adding various organic materials containing low amount of organic matter. Similarly, in the case of cholam grains (both the varieties) the yield as well as uptake also were found to be the highest at low level of compost and higher level of super. The maximum uptake of phosphorus was found to be at 45 lb. level (super 30 lb. plus compost 15 lb.) for both the strains.

The reason for the depression of phosphorus content and phosphorus uptake in compost may evidently be due to the widening of C : P ratio (Stanford and Pierre 1953).

(ii) *Nitrogen :* There was a sudden fall in the nitrogen content of straw in both the strains which is in conformity with Acharya's work (1931) evidently due to the translocation of the accumulated nitrogen to the grain. It was also found that the increase of nitrogen was not in regular sequence as in phosphorus.

(iii) *Potash :* In the case of potash content of straw in both the strains there was no regular variations except it was decreased during harvest stage, thus confirming with the findings of Blair and Prince (1939) and Sree Ramulu (1960). In the grain also, the variations were not regular except it was more at 45 lb. level either as superphosphate alone or as superphosphate 30 lb. + compost 15 lb. in the case of Co. 1. But in Co. 13, grains from the superphosphate, compost or combination were almost equal or slightly less than one over the other.

(iv) *Calcium and Magnesium:* Calcium content in the straw, as found out in this study was that the maximum absorption of calcium was found in the initial stages of crop growth and subsequently this decreased and reached a minimum at harvest stage. The same is found in the case of magnesium also but the minimum was found at flowering stage. Increased applications of Phosphorus either in the form of super or compost resulted in slight increase in calcium content in most cases. Though the increase was not regular it is in accord with the results reported by Gupta and Das (1954). This effect was found in straw and grain of both the strains.

Summary and Conclusion: The following salient features emerged out during the course of the study.

1. It is found that superphosphate is superior to compost with regard to the yield of grain and straw while a judicious combination of both with low amount of compost (15 lb. compost *+ 30 lb. Super) is far superior to either of them applied singly.

2. Statistical analysis shows that Co. 18 is superior to Co. 1 in the yield of grain but in the case of straw both are on a par.

3. It is found that on an equal phosphorus basis superphosphate is more effective in raising the phosphorus content of grain and straw than compost.

4. Maximum uptake of phosphorus in the grain of both the strains is noticed in the combined treatment at 45 lb. P_2O_5 level (as superphosphate @ 30 lb. + compost @ 15 lb.). Between the individuals, maximum uptake is found at 45 lb. P_2O_5 level as superphosphate.

5. In the case of straw of both the strains, superphosphate is superior to either compost or combination. Maximum uptake is obtained at 45 lb. level for Co. 18. But for Co. 1, uptake of phosphorus at 45 lb. level is on a par with 60 lb. which is found to be the maximum level.

6. Application of manure (either in the form of compost or superphosphate) produced a slight increase in potash, nitrogen and calcium contents of grain in some cases but it is not regular.

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APPENDIX I

Superphosphate *vs* Compost

Grain yield in oz. per plot :

Analysis of variance :—

Source	D. F.	S. S.	M. S.	F.
Replications	3	1,053·02	351·01	
Strains	1	35,742·01	35,742·01	505·12**
Error(i)	3	212·29	70·76	
Phosphates	14	11,094·97	792·50	5·20**
Control *vs* Rest	1	3,578·75	3,578·75	23·50**
Super *vs* Compost	1	1,903·14	1,903·14	12·50**
Between doses	3	1,031·79	343·93	2·26
Manures x Doses	3	1,191·18	397·06	2·61
Between combination of super and compost	5	2,153·86	430·77	2·83*
Between super and compost singly and in Combination	1	1,236·25	1,236·25	8·12*
Strains x Phosphates	14	4,340·86	310·06	2·04*
Strains x control *vs* Rest	1	1,261·87	1,261·87	8·28**
Strains x Super *vs* compost	1	763·14	763·14	5·01*
Strains x Doses	3	439·56	146·52	...
Strains x Manures x Doses	3	628·66	209·55	1·38
Strains x Combinations	5	1,063·85	212·77	1·40
Strains x Single *vs* compost	1	183·78	183·78	1·21
Error (2)	84	12,794·44	152·31	...
Total	119	65,237·59	...	...

* — Significant at P = 0·05 level.

** — Significant at P = 0·01 level.

Straw yield in oz. per Plot :

Analysis of varieties :—

Source	D. F.	S. S.	M. S.	F.
Replications	3	7,831	2,610	...
Strains	1	11,310	11,310	1·08
Error (i)	3	31,488	10,496	...
Phosphates	14	2,42,296	17,396	5·17 **
Control *vs* Phosphates	1	78,419	78,419	23·44 **
Super *vs* compost	1	36,672	36,672	10·96 **
Between Doses	3	62,889	20,963	6·27 **
Manure x Doses	3	11,871	3,957	1·18
Between Combination of super and compost	5	46,468	9,294	2·78 *
Between super and compost singly and in Combination	1	5,977	5,977	1·79
Strains x Phosphates	14	79,854	5,704	1·71
Strains x controls Rest	1	15,604	15,604	4·66 *
Strains x Super *vs* compost	1	4,831	4,831	1·44
Strains x Doses	3	31,980	10,660	3·19 *
Strains x Manures x Doses	3	1,793	564	...
Strains x Combinations	5	25,576	5,115	1·53
Strains x Single *vs* Combinations	1	70	70	...
Error (2)	84	2,80,979	3,345	...
Total	119	6,53,758	...	...

* — Significant at P — 0·05 level.

** — Significant at P — 0·01 level.