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Efficacy of Organic and Inorganic Form of Phosphates on the Growth and Yield of Paddy Crop - Part I

by

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Introduction: The importance of organic matter in Agricultural system is well founded. Besides improving the soil physically, chemically and biologically, it serves as a source of readily available plant nutrients to the crop. The organic matter also serves to mobilize the soil native phosphorus and added inorganic phosphorus into readily available forms. Most of the past studies on organic matter and green manure have been made mainly as a soil amendment and as a mobilizing agent of soil phosphorus. In the present study, the result of green manuring of paddy, as a source of organic 'P' in combination with added inorganic 'P' in different proportion is presented.

Review of Literature: Sen and Bains (1956) reported that the superphosphate in combination with Farm Yard Manure increased the yield of both cowpeas and wheat in the rotation as compared to super or Farm Yard Manure alone. Summarising the result of a 20 years fertilizer trial with rotation crop (cereals, root crops and rape) on a sandy loam (pH 5·5 to 5·9), Amberger (1957) reported the phosphorus utilization was about equal from both mineral and inorganic fertilizers. The addition of Super to the Farm Yard Manure decreased the ornanic matter loss (Lefevre, 1957).

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Ghose *et al.* (1960) found that the effect of phosphatic manures increased when applied in conjunction with green manure to rice. The superiority of the combination of organic and inorganic sources in increasing the yield of grain and straw of *ragi* was reported by Sree Ramulu (1960). Raheja (1962) found that bulky organic manures are as efficient sources as super at 16, 32 and 64 lb. P_2O_5 level for berseem. Ghosh (1963) revealed that the increased yield of paddy has been observed where mixture of organic matter with super or basic slag has been used. Kamalam (1964) reported that a judicious combination of super phosphate and compost with lower amount of the latter was far better than either of them applied singly, for *cholam* crop. The increase in available 'P' by green manuring by its solubilizing effect on native soil 'P' and added inorganic 'P' in paddy culture was reported by Khadeer and Raja (1964).

Materials and Methods: The field experiment was conducted with two strains of paddy, Co. 29 (110 days) and Co. 19 (180 days) in wet lands, Agricultural College and Research Institute, Coimbatore. The experiment was laid out in a split plot design with three replications and with fifteen treatments for three seasons. The manurial treatments were (1) Control (O. P.); treatments 2–5 - Super alone to supply 15, 30, 45 and 60 lb. P_2O_5 per acre respectively; treatments 6–9 - Sesbania alone to supply 15, 30, 45 and 60 lb. P_2O_5 per acre respectively; treatments 10–15 - combination of super and sesbania at (10) super 15 lb. P_2O_5 + sesbania 15 lb. P_2O_5 per acre, (11) super 15 lb. P_2O_5 + sesbania 30 lb. P_2O_5 per acre, (12) super 15 lb. P_2O_5 + sesbania 45 lb. P_2O_5 per acre, (13) super 30 lb. P_2O_5 + sesbania 15 lb. P_2O_5 per acre, (14) super 30 lb. P_2O_5 + sesbania 30 lb. P_2O_5 per acre, (15) super 45 lb. P_2O_5 + sesbania 15 lb. P_2O_5 per acre.

From each plot ten plants were selected at random and the height measurements and tiller counts were recorded one month after planting, then after the completion of flowering and finally before harvest. The yield of paddy grain and straw from each plot was recorded separately and the mean yield of paddy grain and straw was calculated for both strains and presented in Table 1.

TABLE 1. *Mean yield of grain and straw in lb. per acre.* (1962—'63, 1963—'64 and 1964—'65)

Treatment	Mean grain yield		Mean straw yield	
	Co. 29	Co. 19	Co. 29	Co. 19
1.	2796	3323	3279	5488
2.	2881	3665	3319	6178
3.	2929	3875	3385	7617

TABLE 1. *(Contd.)*

Treatment	Mean grain yield		Mean straw yield	
	Co. 29	Co. 19	Co. 29	Co. 19
4.	3185	4350	3542	7480
5.	3118	3690	3786	6716
6.	2806	3652	3851	8456
7.	2862	4156	3718	8931
8.	2624	4380	4607	9739
9.	2930	4033	3902	8348
10.	3075	4103	3922	9234
11.	3104	4369	4304	7451
12.	2974	4646	4402	9689
13.	2893	4018	3750	7229
14.	3274	4394	3936	9040
15.	3434	4234	4385	9324

Results: 1. *Height measurements:* In Co. 29, there was not much difference in height between the treatments in the early stage of growth. At flowering stage, however, the plots receiving both forms of phosphorus *i. .e*, combination and also sesbania were better than the crop applied with super alone.

No wide variation was noticed in respect of height after 30 days of planting in Co. 19. During the subsequent period of growth, the height of plants in the plots receiving sesbania alone was slightly taller than the plants in the plots applied with super alone. An increase in the height of plants with increased level of P_2O_5 upto 45 lb. and a decrease in height at 60 lb. level especially in plots manured with sesbania at 60 lb. P_2O_5 were observed.

2. *Tiller counts:* In both the strains Co. 29 and Co. 19, during the early stages, the number of tillers were more in number. It was observed, that as the growth of the crop advanced, the tillers got reduced in number. The crop, which received the combination with sesbania and super was observed to have more tillers than the crop in the other plots. Plants that received sesbania alone had greater number of tillers than the plants that received super alone.

3. *Yield of grain and straw:* Except in the first year, the treatmental effects are significant. The treatmental effects also varied with the short and long duration varieties as shown by the significant interactions of varieties x treatments. Though the magnitude of yield is higher in Co. 19 in all the three seasons, than in Co. 29, the combination of super and green leaf manures have proved better than the application of either one alone. This is shown in Table 2.

TABLE 2. *Yield of grains and straw (lb. per acre) (Mean for three years)*

Strains	Control (No-manure)	Super	Sesbania	Combination of Super + Sesbania	
				Low amount of super	Low amount of sesbania
GRAIN YIELD					
Co. 19	3323	3895	4055	5706	4215
Co. 29	2796	3028	2806	3051	3200
STRAW YIELD					
Co. 19	5488	6998	8869	8791	7861
Co. 29	3279	3508	4020	4219	4024

The lower proportion of super with higher proportion of sesbania is found to be beneficial for long duration rice crop, while higher proportion of super is found to be advantageous for short duration rice. The application of sesbania alone has produced yield in the short duration rice which is on par with control only.

The straw yield unlike grain yield, showed significant variations in all the three years and the over-all effect of applying super, sesbania and their combinations are given in Table 2.

The combination of super and sesbania have recorded lower straw yield than sesbania alone. In both the strains, super had the effect of reducing straw yields and increassing grain yields. The effect of sesbania on grain yield is dependent on the varieties as indicated earlier.

Comprison of phosphorus in soils, super and sesbania: To compare the relative value of the efficiency of utilisation of phosphorus in the soil, super and sesbania, the Bray's efficiency factor is calculated for soil, super and sesbania 'P' for short and long duration crop. The values are given below :

Efficiency Factor.

	Soil 'P'	Super 'P' C_1	Sesbania 'P' C_2
Co. 19	0·028	0·014	0·015
Co. 29	0·037	0·009	0·002

The efficiency of sesbania 'P' is found to be little higher than the efficiency of 'P' in super for Co. 19. This is also reflected in higher yields due to combinations of manuring with larger proportions of sesbania for Co. 19. Similarly the efficiency of super 'P' is higher than sesbania 'P' for Co. 29 which is also reflected in the treatment of combined manuring with higher amount of super resulting in higher grain yields.

The efficiency factors thus explain the difference in treatment effects observed in the two varieties. To study whether the efficiency factors are independent of each other, the relative yield is calculated using these factors for combinations of super and sesbania for the two varieties. The results are given below:

Relative Yield.

Combinations Super and Sesbania		Co. 19		Co. 29	
		Calculated	Observed	Calculated	Observed
15	15	89·8	88·3	87·6	89·5
15	30	94·0	94·0	88·5	90·4
15	45	96·4	100·0	89·4	86·7
30	15	93·6	87·0	90·9	84·2
30	30	96·2	94·6	91·3	95·3
45	15	97·7	91·2	94·4	100·0

The co-efficient of variation in field trials is reported to be 3 per cent for most crops (Van Der Pasun, 1956). The average co-efficient of variation in the field trials observed during the three years is 3 per cent and using the efficiency factors it is possible to predict the yield for combination of super and sesbania within 3 per cent in most cases. The efficiency of use of added 'P' is found to be more in long duration crop. The short daration crop utilizes more of soil native 'P' and readily available 'P' is essential for short duration crop, while the green manure itself is sufficient as source of 'P' for long duration crop.

Discussions: The height measurements indicate that the combination of super and green manure are more effective in inducing early growth and total growth as revealed by higher final height in the combinations of super and green manure treatments. The number of tillers was also more in the long duration variety and in the treatments receiving phosphates. The combination of super and green manure have also showed a slight increase in tillering compared to the treatments receiving either super or sesbenia alone.

The effect on growth and tillering due to combinations of super and sesbania is also reflected in the yield of grain in both the strains. This is shown by the significant effect of treatments in the last two years of experimentation. But the straw yield shows significant differences due to treatments in all the years. The combinations of super and sesbania have given increased straw yield compared to the application of sesbania alone. Even in combinations, low proportion of inorganic phosphorus to organic phosphorus (sesbania) is found to have more conspicuous effect on the straw yield. The studies made on the trends in available 'P' during the crop growth indicate that the green manure puddling increases the available phosphorus status of soil by its solubilizing effect on native as well as added inorganic 'P' (Khadeer and Raja, 1964).

This effect is not so much left in the short duration variety as discussed earlir. Probably the decomposition of green manure takes a longer time, and only the long duration crop is able to utilise the full benefits of organic mater decomposition. Therefore, it sppears from the studies that larger proportion of inorganic 'P' with readily available 'P' will be beneficial for short duration crop, while the green manure itself can act as source of 'P' for the long duration crop with an efficiency equal to that of inorganic 'P' within the limits of experimental error. The yields can be predicted with the efficiency factors for different sources of phosphorus. The efficiency factors may be affected by the presence or absence of either of them, but within the limits of experimental error. It was found difficult to establish such interactions, between the forms of 'P' in the efficiency factor within the limits of experimental error, though an interaction is expected based on previous knowledge on the solubilizaton of added and native 'P' by the decomposing green manure.

Summary: The results of growth, tillering and yield of grain and straw of an experiment conducted to study the efficacy of green manure as a source of phosphate to paddy either alone or in combination with super are reported. The following results are obtained.

1. Long duration crop utilizes 'P' from super and green manure effectively. The efficiency factor for green manure 'P' is more than the

super 'P'. Therefore, it appears that green manure itself can act as a source of 'P' for long duration crop. The combination with large proportion of green manure has given higher yields. Moreover, unlike in short duration variety, the application of green manure alone has also increased the yield significantly.

2. The short duration variety utilizes 'P' from super more effectively than 'P' from green manure. The combination with larger proportion of super has given increased yields. The application of green manure alone has not increased the yield significantly.

These observations indicate that the application of phosphatic fertilizer with readily available 'P' will be beneficial for short duration crop, while green manure can itself act as a source of 'P' for long duration crop. Within the limits of experimental error, it is possible to predict the yield for the different combinations using efficiency factors. It was also found difficult to establish the interaction between the forms of 'P' in the efficiency factors within the limits of experimental error.

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