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Calcium in Food and Agriculture

by

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Introduction : Calcium is one of the most important elements in plant animal nutrition and is necessary to the healthy growth of all animals and green plants with the exception only of some of the lower algae. The animals get their calcium requirements from the plants on which they feed. Thus the plant is the great intermediary by which calcium in the soil is assimilated and made available to animals and man.

The luxuriance of a plant is not necessarily a criterion of its nutritive value or its calcium contents. Man and animals may develop marked symptoms of disease on calcium deficient but apparently fertile soils. An example, commonly cited to prove the inadequacy of calcium in the laterite soils of West Coast, is the poor build of the local cattle, apparently resulting from the lack of calcium in the feed.

Calcium deficiency in the soil has come to be plant nutrient problem number one in agricultural production and calcium is now considered to be far more important in the production of food and food rich in nutritive value than was formally believed. The present concept of the value of calcium includes its importance in mobilizing nitrogen and phospohorous or in other words, in producing proteinaceous rather than carbonaceous vegetation. Calcium is apparently more significant in growth promtion than direct measurement of calcium content of crops would make it appear.

In general, the calcium content of plants is lowest on acid soils and crop failures on acid soils are well-known to farmers and to scientific workers interested in plant nutrition and to both the remedy of liming is equally familiar. There exists, however, little knowledge concerning the relative importance of various factors which produce the injurious effects observed on acid soils. The main probable causes of injury to healthy growth of plants as discussed by Russell may be (1) lack of available calcium (2) lack of available phosphorous (3) direct injury of hydrogen-ion and (4) excess of soluble aluminium, iron and manganese.

Objective : The present paper deals with the results of an investigation taken up for studying the effects of different doses of lime on (1) the yield of paddy grain and straw and their nutritive

value (2) on the availability of phosphate and calcium in the soil (3) the effect of liming on the pH of laterite soils and (4) soluble iron, aluminium and manganese content of laterite soils (by conducting laboratory experiments).

The laterite soils of West Coast are very acid in reaction and the pH values, usually below 5·0; high in iron, aluminium and manganese and very low in available P_2O_5. They are poor in bases like calcium. Paddy crop which is a common crop in West Coast, ranks among the most acid tolerant crops. Hence it is improbable that paddy crop suffered from the effect of Hydrogen-ion or acidity of the soil whose pH is usually between 4·5 pH and 5·0 pH.

Experimental methods: (1) *Laboratory experiments:* Preliminary laboratory scale experiments were conducuted to study the effect of lime on free Fe, Al and Mn. content of the soil.

(2) *Chemical analysis:* Chemical analysis of soil, paddy grain and straw were done to study the fertility status of soil and nutritive values of grain and straw raised in the experimental plots.

(3) *Field Experiments:* Field experiments were laid out and conducted at Pattambi to study the effect of lime on paddy yield and their values (Phosphate fixation studies in laterite soils of Pattambi experiments).

Results and discussion: All crops require iron and manganese but only in very small amounts. If they are present in the soil solution in more than very low concentrations, they exert a toxic effect on plant growth. Soils with the usual reactions between 5·5 pH to 7·0 pH supply plants with ample quantities of iron and manganese in the soluble forms. But excess of iron and manganese may become available at pH value below 5·5 pH and toxic influences on plant growth may result. This is also true of the non-essential element - Aluminium. It appears that manganese becomes toxic to plant growth before iron and aluminium go into solution in sufficient quantities to be toxic. It is reported that the percentage of manganese in plants increases as the soil pH decreases.

Laboratory experiments were conducted to find out how liming influences (1) the solubility of iron, aluminium and manganese (2) available P_2O_5 and Ex-cao and (3) pH of the soil.

Influences of lime on solubility of iron, aluminium and manganese in the laterite soils.

Free Fe % $Na_2 S_2 O_4$ Method			Free Al % $Na_2 S_2 O_4$ Method			Free Mn % ...		
Lime at			Lime at			Lime at		
O	3000	6000	O	3000	6000	O	3000	6000
1·56	0·83	0·32	0·23	0·11	0·031	...	...	....

Liming the soil at different doses, had no marked difference in soluble Mn. content in the soil.

Influence of lime on soil pH

Lime applied as Cao in lbs/acre.	Soil pH
0	4·7
500	4·7
1000	4·8
2000	5·0
3000	5·2
4000	5·5
5000	5·8
6000	6·1
7000	6·4
8000	6·8

Influence of lime on the availability of $P_2 O_5$ and exchangeable calcium in the soil (after 6 applications of lime at 1500 lbs and 3000 lb/acre).

		Lime at		
		O	1500	3000
1.	Av. $P_2 O_5$ x 10,000	10	22	33
3.	Ex. calcium	2·5 (m. e.)	5·1	7·2

The response of paddy to lime seems to be directly proportional (within certain limits). On the very fertile soils, receiving sufficient available plant nutrients such as in the form of chemical fertilizers, it does not respond to the lime as much as on the in-fertile soils receiving only some organic manures. Soils of low pH are generally poor soils. Therefore paddy responds to lime on laterite soils. But there is no relationship existing between the pH values of the soils and their lime requirements for growing paddy, since the adaptability of paddy to soil reaction is very wide.

Influence of lime on paddy grain and straw yield

(Average of six crops raised)

Straw yield lbs./acre Lime at			Grain yield lbs./acre Lime at		
0	1500	3000	0	1500	3000
1516	1963	2242	601	1015	1080

In general, the calcium content of plants is lowest on acid soils. The application of lime to the soil is beneficial not because it corrects the soil acidity but because it increases the replaceable calcium in the soil. A deficiency of calcium is also believed to cause a disturbance in the translocation of carbohydrates and proteins. Loew ascribed a highly important function to calcium, regarding it as one of the important mineral bases which enter into the constitution of the proteins composing the cell nucleus and plastids.

Influence of lime on nutritive values of grain and straw

(Average of six analysis)

	Straw Lime at			*Grain Lime at*		
	0	1500	3000	0	1500	3000
Protein	5·99%	6·63%	6·99%	9·86%	10·13%	10·07%
P_2O_5	0·14%	0·185%	0·180%	0·52%	0·50%	0·50%
Cao	0·51%	0·52%	0·55%	0·094%	0·120%	0·115%

In the animals, calcium is the outstanding single constituent of bones and teeth which together contain all but a small fraction of this element in body. However, this small fraction; circulating in the blood and permeating the soft tissues is tremendously important in determining the state of health. The normal rythm of the heart muscle and the excitability of the other muscles and nerves depend on their being constantly bathed with blood, containing physiologically normal amount of calcium. The clotting of the blood and the regulation of the permeability of the membrane also depend on a constant maintenance of this element. Lack of calcium in the food in sufficient quantity will lead to stunted growth and will upset the calcium-phosphorous-Vitamin D balances and will lead to one of the several forms of rickets. Disturbed reproduction processes are another consequence of calcium deficiency. Male animals may lose their breeding capacity on deficient forage feeds grown on calcium deficient soils.

The different doses of lime have shown strikingly marked effect of lime in increasing the lime content, both in grain and straw. The application of lime has increased the phosphorous content of straw; but in grain, it is seen, the lime slightly depresses it. The protein content, both in grain and straw is influenced by lime application. Thus we find that each pound of limed grain and straw is about 10% to 15% more efficient in feeding value to man and animals.

The different doses of lime have shown strikingly marked increase in available P_2O_5 and exchangeable bases like calcium, pH of the soil has reached near neutral condition which is favourable for bacterial activity and these have been strikingly reflected in the increase in yield of both straw and grain. The application of lime alone has shown increase in available P_2O_5 originally present in the soil.

Conclusion: The addition of lime to the soil is beneficial because it increases the replaceable calcium in the soil. It corrects the acidity of the soil and reduces the fixation of available P_2O_5. Addition of lime accelerates the decomposition of organic matter in the soil, hence the release of available nitrogen. The latter two are most important as lack of phosphorous and nitrogen more than any other element are the cause of low crop production.

Thus calcium has got a most important role both in our food and scientific agriculture.

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