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Short Communication

Effect of dolomite and calcite on growth, yield and economics of rice in strongly acidic soils of Kanyakumari district

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Rice (*Oryza sativa* L.) is one of the chief grains of India. India is the world's first producer of rice and the largest exporter of rice in the world. In India the rice cultivated area with 45.8mha, production with 124.37 mt and average productivity of 2.72 t ha^{-1} (Indiastat, 2021). The country increased production from 53.6 million tons in financial year 1980 to 120 million tons in financial year 2020-21 (Ministry of Agriculture and Farmers Welfare, India, 2021). In Tamil Nadu the rice cultivated area with 2.04 mha, production with 6.88 mt and average productivity of 3.38 t ha^{-1} (Indiastat, 2021). Rice crop has got wide physical adaptability. Hence, it is grown on diverse soil, climatic and hydrological conditions. Demand for rice is growing every year. To sustain present self-sufficiency of food and to meet future food requirements, India has to increase rice yield per unit area. Soil acidity is an important yield limiting factors for crop production. In India acid soils occupy about 49 m ha area, of which 26 m ha has pH below 5.5 and 23 m ha has pH between 5.6 and 6.5 (Behera and Shukla, 2015). Acid soils exhibit both nutrient deficiency and toxicity, leading to restricted plant growth. Soil acidity affects the resources, goods, and services offered by the soils for human beings (Mol and Keesstra, 2012) and thereby reduce the sustainability which needs to be corrected by proper management decisions. Correcting soil acidity with proper amendments and addition of required nutrients are important to achieve a higher yield of crops. Addition of different amendments improves soil pH and thereby the availability of nutrients (Moon *et al.,* 2014). Use of liming materials like calcite ($CaCO_3$) and dolomite ($CaCO_3.MgCO_3$) is a practical way for correction of soil acidity (Goulding, 2016). It has been the traditional material used for acid soils. Liming increases the soil pH, improves the availability of plant nutrients and crop growth, increases nutrient uptake, stimulates biological activity, decreases soil acidity and reduces the toxicity of some elements (Reddy and Subramanian, 2016).

The application of dolomite and calcite is potential and cost effective in reducing soil acidity. The present investigation was carried out to study the amelioration capacity of dolomite and calcite in strongly acidic soil and its influence on growth, yield and economics of rice crop. A field experiment was conducted in farmers' fields at Gananadhasapuram village of Thovalai taluk (strongly acidic soil) during *Pishanam* season, Kanyakumari district, Tamil Nadu with test crop of rice (TPS 3) to study the effect of dolomite and calcite on growth, yield and economics of rice in strongly acidic soils. The experiment was laid out in randomized block design with three replications and ten treatments. The treatment combinations include, treatment T_1 is absolute control, the treatment T_2 was the application of recommended dose of fertilizers with $ZnSO_4$ @ 25 Kg ha^{-1}, For the treatments from T_3, T_5, T_7 and T_9, dolomite at different levels based on lime requirements 0.25 LR (2.12 and 0.8 t ha^{-1}) (T_3), 0.50 LR (4.24 and 1.6 t ha^{-1}) (T_5), 0.75 LR (6.36 and 2.4 t ha^{-1}) (T_7) and 1.0 LR (8.48 and 3.2 t ha^{-1}) (T_9), respectively for pishanam season along with recommended dose of fertilizers and $ZnSO_4$ was tested. For the treatments T_4, T_6, T_8 and T_{10}, calcite at different levels based on lime requirement 0.25 LR (2.32 and 0.88 t ha^{-1}) (T_4), 0.50 LR (4.63 and 1.76 t ha^{-1}) (T_6), 0.75 LR (6.95 and 2.64 t ha^{-1}) (T_8) and 1.0 LR (9.25 and 3.22t ha^{-1}) (T_{10}) during pishanam season along with recommended dose of N, P, K fertilizers and $ZnSO_4$ was tested. The experimental plot size was 4 x 3 m. Soil samples collected from field before cultivation of rice were analyzed for pH – 5.1 (Jackson, 1973), organic carbon – 4.5 per cent (Walkley and Black, 1934), available N– 210 Kg ha^{-1} (Subbiah and Asija, 1956), phosphorus – 8.4 Kg ha^{-1} (Jackson, 1973), potassium– 107 Kg ha^{-1} (Stanford and English, 1949), exchangeable Ca - 2.3 and Mg – 3.4 c mol (p^+) Kg^{-1} (Jackson, 1973) and lime requirement (Shoemaker *et al.,* 1961) by using standard procedures. Randomised Block design (RBD) and analysis of variance (ANOVA) was adopted for statistical analysis and interpretation of the data. Five plants from each plot were selected at random, tagged and growth and yield parameters were recorded. The grains collected from the net plot area of different treatments were dried, threshed and after drying grain yield was recorded at 12 per cent moisture from each plot and expressed as Kg ha^{-1}. The straw yield from each plot was also recorded. The net return was worked out for all the treat mental combinations. The cost of inputs, labour charges and prevailing market rates of farm produce were taken into consideration for working out the economics. Cost benefit analysis were worked out for all the treatments. The data collected were statistically analyzed as suggested by Gomez and Gomez (2010).

The data pertaining to the effect of liming and fertilizers application on the growth parameters *viz.,* plant height and number of tillers m^{-2} at tillering, active tillering, panicle initiation and at harvest of rice is presented in Table 1. During pishanam season dolomite, calcite and fertilizers application significantly increased the plant height and number of tillers m^{-2} of rice at tillering, active tillering, panicle initiation and at harvest stage. Significant difference in plant height was absorbed at the critical crop growth stages of rice. The highest plant height (36.9, 55.1, 75.4 and 100 cm) and number of tillers m^{-2} (298, 325, 396 and 411) at tillering, active tillering, panicle initiation and at harvest stages respectively, during pishanam season in the strongly acidic soil was recorded by the application of RDF + $ZnSO_4$ @ 25 Kg ha^{-1} + dolomite (0.75 LR) (T_7) followed by the application of RDF + $ZnSO_4$ @ 25 Kg ha^{-1} + calcite (0.75 LR) (T_8). This increase in growth parameters may be attributed to the improvement in nutrients availability in soil during growth period of rice upon 75% of LR of dolomite application in strongly and acidic soils due to maintenance of optimum pH for higher productivity of rice. The improved supply of nutrients to plants due to liming might have resulted in acceleration of photosynthesis process, carbohydrates metabolism, protein synthesis, synthesis of growth promoting substances, cell division and cell elongation which resulted in increase of plant height and number of tillers m^{-2}. The findings were supported by Ferdous *et al.* (2018). The yield contributing characters such as number of productive tillers m^{-2}, thousand grain weight and grain and straw yield were influenced significantly due to application of dolomite and calcite, NPK fertilizers and $ZnSO_4$ (Table 2).

In the present study, the application of dolomite and calcite had significantly exhibited its superiority to increase the number of productive tillers m^{-2}, thousand grain weight, grain and straw yield of rice. The highest productive tillers m^{-2} (375), thousand grain weight (26.6 g), grain (7.09 t ha^{-1}) and straw yield (10.3 t ha^{-1}) of rice was recorded with RDF + 25 Kg $ZnSO_4$ + Dolomite @ 0.75 LR (T_7) followed by T_8 (356, 26.2 g, 6.85 and 8.53 t ha^{-1} of productive tillers m^{-2}, thousand grain weight, grain and straw yield respectively), which received RDF + 25 Kg $ZnSO_4$ + Calcite @ 0.75 LR in the pishanam season.

The yield benefits can be ascribed to the increase in soil pH upon dolomite and calcite along with the associated improvement in nutrients availability, reduced Fe availability and many other attributes of soil fertility (Manoj-Kumar *et al.,* 2012; Singroha *et al.,* 2022). The application of dolomite and calcite in acid soil significantly increased the yield. The above results are in agreement with the findings of Crusciola *et al.* (2010), Osundwa *et al.* (2013) and Arenjungla *et al.* (2021).

Table 1. Effect of dolomite and calcite on growth attributes during the growth stages of rice

Treatments	Plant height (cm)				Number of tillers m^{-2}			
	Tillering	Active tillering	Panicle initiation	Harvest	Tillering	Active tillering	Panicle initiation	Harvest
T_1 - Control	20.6	37.4	55.8	76.1	189	204	254	282
T_2 - RDF + $ZnSO_4$ @ 25 Kg ha^{-1}	33.0	50.6	70.8	91.4	246	255	303	382
T_3 - T_2 + Dolomite (0.25 LR)	33.4	51.6	72.6	93.9	266	292	318	352
T_4 - T_2 + Calcite (0.25 LR)	33.2	51.1	72.7	93.5	253	281	311	337
T_5 - T_2 + Dolomite (0.50 LR)	34.7	52.9	74.7	96.9	280	303	329	370
T_6 - T_2 + Calcite (0.50 LR)	34.6	52.7	73.6	95.7	266	300	326	363
T_7 - T_2 + Dolomite (0.75 LR)	36.9	55.1	75.4	100	298	325	396	411
T_8 - T_2 + Calcite (0.75 LR)	35.9	54.1	74.5	99.0	293	314	344	381
T_9 - T_2 + Dolomite (1.0 LR)	29.7	48.9	67.6	91.2	226	252	274	326
T_{10} - T_2 + Calcite (1.0 LR)	27.5	44.9	66.1	90.8	200	226	270	311
SEd	0.70	1.32	1.25	2.33	28.6	17.5	12.7	10.2
CD (P=0.05)	1.5	2.8	2.6	4.9	60.0	37.0	27.0	21.0

CD = Critical difference; SEd = Standard error of deviation

Table 2. Effect of dolomite and calcite on yield attributes and yields of rice

Treatments	No. of Productive tillers m^{-2}	Thousand grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
T_1 - Control	280	23.5	2.46	4.24
T_2 - RDF + $ZnSO_4$ @ 25 Kg ha^{-1}	318	25.1	4.59	7.79
T_3 - T_2 + Dolomite (0.25 LR)	332	25.7	5.25	8.03
T_4 - T_2 + Calcite (0.25 LR)	323	25.3	4.97	8.02
T_5 - T_2 + Dolomite (0.50 LR)	352	26.1	6.33	8.11
T_6 - T_2 + Calcite (0.50 LR)	337	25.9	5.66	8.10
T_7 - T_2 + Dolomite (0.75 LR)	375	26.6	7.09	10.3
T_8 - T_2 + Calcite (0.75 LR)	356	26.2	6.85	8.53
T_9 - T_2 + Dolomite (1.0 LR)	304	24.7	4.39	7.06
T_{10} - T_2 + Calcite (1.0 LR)	295	24.6	3.85	6.45
SEd	11.2	0.48	0.19	0.07
CD (P=0.05)	23.5	1.0	0.40	0.20

CD = Critical difference; SEd = Standard error of deviation

Higher crop productivity with lesser cost of cultivation could result in better economic parameters like net returns and B:C ratio. The identified treatment should be economically viable so that farmers can to sustain the higher income. The cost of cultivation, gross return, net return and B:C ratio were worked out for the different treatments in terms of soil management and fertilizers application in acidic soil (Fig. 1). The maximum and economic yield with high net return and B:C ratio (Rs. 54, 018 and 1.86, respectively) was recorded with application of dolomite @ 0.75 LR along with RDF and $ZnSO_4$ (T_7) in the strongly acidic soil (pH 5.1). The high economic return could be realized if liming is applied in acidic soil was also reported by Kumar *et al.* (2014) and Kumar (2015). From this study, it can be concluded that application of dolomite @ 0.75 LR (6.36 t ha^{-1}) (T_7) along with recommended dose of fertilizers and $ZnSO_4$, could be considered as a better option for achieving higher productivity of rice and profitability of strongly acidic soils in the high rainfall zone of Kanyakumari district.

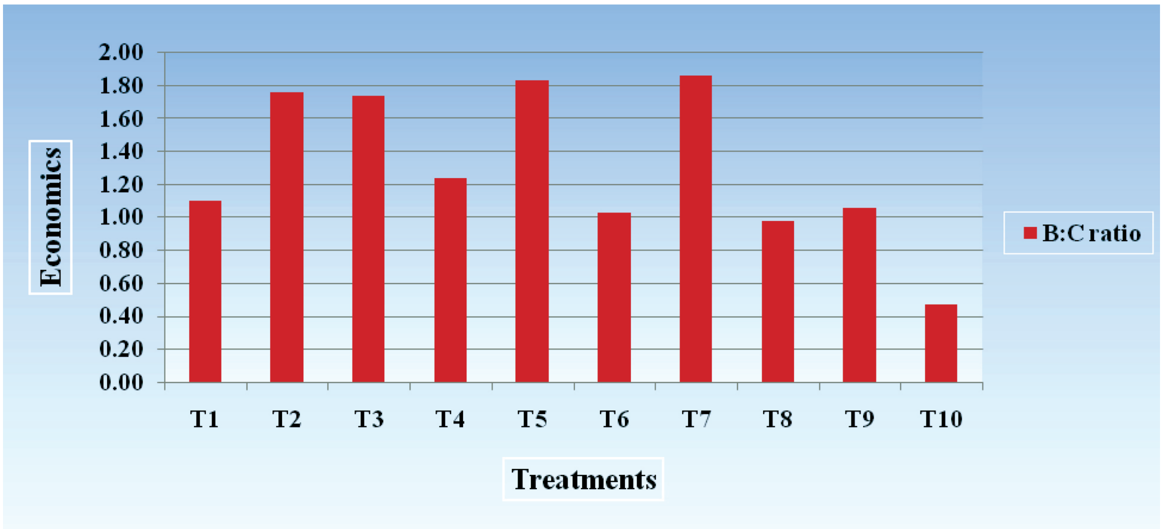

Fig 1. Effect of dolomite and calcite on benifit: bost ratio of treatments

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Authors, contributions

Designing of experiment, data collection, analysis and preparation of manuscript has been done by both the authors.

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