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Productivity enhancement of Rajma (*Phaseolus vulgaris* L.) through organic nutrient management and soil acidity management in Meghalaya, North-East India

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Abstract
A study was conducted at farmers' field of Ri-Bhoi District of Meghalaya to test the effect of organic sources of soil nutrient management with Lime for soil acidity management and for yield improvement of Rajma (*Phaseolus vulgaris* L.). The experiment was conducted by following 3 treatments: TO1: Lime @ 400 kg/ ha in furrows + FYM @ 5 t/ha + Neem cake @400 kg/ha+ vermicompost @ 5 t/ha + Azospirillum 10kg/ha, TO2: FYM @ 5 t/ha + Neem cake @400 kg/ha+ vermicompost @ 5 t/ha + Azospirillum 10kg/ha, TO3: Farmers' Practice (FYM) (imbalance fertilizer with N: P_2O_5: K_2O:: 30:20:12 kg/ha) with 5 replications following randomized block design during 2021-22. From the results it is revealed that TO1: Lime @ 400 kg/ ha in furrows + FYM @ 5 t/ha + Neem cake @400 kg/ha+ vermicompost @ 5 t/ha + Azospirillum 10 kg/ha had showed significant increase in yield i.e. 6.2 q/ ha and B:C ratio of 2.82 followed by FYM @ 5 t/ha + Neem cake @400 kg/ha+ vermicompost @ 5 t/ha + Azospirillum 10 kg/ha (4.3 q/ha yield, B:C ratio 2.15) and Farmers practice (2.21 q/ha yield, B: C ratio 1.7). Moreover, improved soil nutrient status was achieved in T1 followed by T2 and T3.

Keywords: On farm testing, lime, organic nutrient management, biofertilizer, vermi-compost, rajma (kidney beans)

Introduction
The productivity of crop is very low in North East region of India due to the improper soil nutrient management coupled with various factors. Although the maximum portion of the population (around 81%) is depends on agriculture for income generation, the farmers are mostly preferring the traditional methods of cultivation with low input application (Anonymous, 2011, Bordoloi, 2021 a) [1, 2]. Pulse is an important leguminous crop widely grown and consumed in India and it accounts for 6-7% of the total food grain production of the country. Northeast India is suffering from soil acidity problem (around 84% of area) due to high rainfall, which causes the reduction of crop yield. Moreover, severe deficiencies of phosphorus, calcium, magnesium, molybdenum and toxicities of aluminium and iron in the acidic soils is found in this area (Sanjay-Swami and Yadav, 2021, Lyngdoh and Sanjay-Swami, 2020) [18, 11, 14]. Moreover, improper soil nutrient management also a cause of low productivity of crops in this area (Bordoloi, 2021 b; Bordoloi, 2021 c; Sanjay-Swami and Singh, 2020) [3, 4, 7]. Rajma (*Phaseolus vulgaris* L.) [3,4]. Rajma which is also known as kidney beans is a very good source of protein and due to its capacity of biological nitrogen fixation plays an important role in sustainable agriculture by enriching the soil nutrient status (Tiwari and Shivhare, 2016) [19]. Pulse productivity depends mainly on appropriate nutrient management practices (Kumpawat, 2010) [10]. The improved methos of soil fertility management along with Lime can enhance the productivity of pulse crop (Bordoloi, 2021 b) [3]. The application of lime along with organic or may with inorganic fertilizes gives higher productivity along with improved soil nutrient status in Ri-Bhoi District of Meghalaya (Bordoloi, 2020, Sanjay-Swami *et al*., 2020, Bordoloi and Islam, 2020) [7, 16, 6]. Satya and Sanjay-Swami (2020) [17] reported significantly highest seed yield of pulse crop and soil nutrient status by application of 50 kg of P_2O_5 per ha. Along with 1.5 kg of B per ha. In Ri-Bhoi District of Meghalaya. An experiment was carried out at Ri-Bhoi District of Meghalaya in the year 2021-22 to test the feasibility of the technology on soil nutrient dynamics and its effect on productivity enhancement of Rajma (*Phaseolus vulgaris* L.)

Materials and Methods

To test the effects of organic sources of nutrients along with lime a trial was conducted at 3 villages of Ri-Bhoi District of Meghalaya during the year 2021-22 for soil acidity management and for yield improvement of Rajma (*Phaseolus vulgaris* L.). The trial was conducted by adopting 3 treatments: TO1: Lime @ 400 kg/ ha in furrows + FYM @ 5 t/ha + Neem cake @400 kg/ha+ vermicompost @ 5 t/ha + Azospirillum 10 kg/ha, TO2: FYM @ 5 t/ha + Neem cake @400 kg/ha+ vermicompost @ 5 t/ha + Azospirillum 10 kg/ha, TO3: Farmers' Practice (FYM) (imbalance fertilizer with N: P2O5: K2O:: 30:20:12 kg/ha) with 5 replications following randomized block design during 2021-22. The B: C ratio is analysed by taking the data related to yield and yield attributes. Moreover, soil samples were collected and analysed before the implementation of the programme and after the harvesting of the crop. The data's were analysed using the standard statistical packages and some descriptive statistics for interpretation.

Results and Discussion

Seed yield and Economics

From the Table 1 and Figure 1 it is revealed that TO1: Lime @ 400 kg/ ha in furrows + FYM @ 5 t/ha + Neem cake @400 kg/ha+ vermicompost @ 5 t/ha + Azospirillum 10 kg/ha, showed significant increase in yield i.e. 6.2 q/ ha and B:C ratio of 2.82 followed by FYM @ 5 t/ha + Neem cake @400 kg/ha+ vermicompost @ 5 t/ha + Azospirillum 10kg/ha, (4.3 q/ha yield, B:C ratio 2.15) and Farmers practice (2.21 q/ha yield, B:C ratio 1.7). This may be due to improvement of soil pH and other soil nutrients requirement by the application of the Treatments of TO1. Similar results of yield improvement for the pulse crop in Meghalaya reported by Sanjay-Swami and Singh (2020) [7]. The increase yield of pulse crop with the implementation of improve technology is reported by many scientist (Kumari *et al*., 2007 and Choudhary *et al*., 2006) [20, 8]. Satya and Sanjay-Swami (2021) [18] also reported improvement in yield of pulse crop with soil fertility management in acid Inception of Meghalaya. The B: C ratio is calculated by taking the prevailed cost of commodities during the year of demonstration. From the Table 1 it is seen that the Net Return is highest in the application of TO 1 i. e. Rs. 40,000 /- followed by TO 2 and TO3 i.e. Farmers practice. Similar results of highest yield and B: C ratio of crop by the application of Lime along with vermicompost also recorded by Bordoloi, 2021d [5], Kumari *et al*., (2007) [20].

Soil Fertility Status

The soil fertility status is analyzed before the implementation of the programme and after the completion of the experiments. The soil of the experimental site is are found to be acidic and organic matter content also high (Table 2). In TO1: Lime @ 400 kg/ ha in furrows + FYM @ 5 t/ha + Neem cake @400 kg/ha+ vermicompost @ 5 t/ha + Azospirillum 10kg/ha the Organic Carbon, available nitrogen, available phosphorus and available potassium is significantly higher followed by TO2: FYM @ 5 t/ha + Neem cake @400 kg/ha+ vermicompost @ 5 t/ha + Azospirillum 10kg/ha and TO3: Farmers' Practice (FYM) (imbalance fertilizer with N: P2O5: K2O:: 30:20:12 kg/ha). So, the treatment TO 1 can be successfully use to the Farmers field to improve the pH level and soil fertility status for increased the productivity of the crops. Similar results of integration of lime with organic and inorganic fertilizer for yield improvement of crop were also reported by many researchers (Bordoloi, 2021 d; Maier *et al*., 2002; Saha *et al*., 2010) [5, 12, 13].

Table 1: Yield and Economics of Rajma Crop

Treatments	Yields (q/ha)	% Increase over Control	Net return (Rs/ha)	B:C Ratio
TO 1	6.2	280.58	40,000	2.82
TO 2	4.3	194.57	26,000	2.15
TO 3	2.21		9,100	1.7
CD (p d" 0.05): 7.16				

Table 2: Effect of Lime and Organic Nutrients in acid soils of Meghalaya

Treatments	pH		Organic C (kg/ha)		% Increase	Available N (kg/ha)		% Increase	Available P (kg/ha)		% Increase	Available K (kg/ha)		% Increase
T O1	4.66	5.02	0.92	1.29	140.22	306.42	402.45	131.34	18.96	28.91	152.47	36.09	49.54	137.26
T O2	4.76	4.86	0.91	1.09	119.78	310.29	342.54	113.09	17.85	24.21	135.63	34.21	41.12	120.2
T O3	5.09	5.16	1.04	1.11	106.73	309.45	319.12	103.12	18.07	22.09	122.25	35.5	39.09	110.11
CD (pd" 0.05)		0.07		0.08			7.58			2.39			1.52	
%=% increase														

Fig 1: Rajma crop at Farmers' Field

Conclusion

The farmers of Ri-Bhoi District of Meghalaya are preferring the cultivation of pulses along with cereals and vegetables for their income generation and for household consumptions. The productivity of crop in North East India can be improved by dissemination of proper technology of organic farming, which will be the boon for the farmers of this region. The suitable B: C ratio reveals the economic viability of the technology in the farmer's field for adoption of new technology for socio economic development of this region. Further research are required and supports from the Government side also very much required for successful organic farming with high productivity of crop for improve the livelihood of the farmers of this region.

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