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Productivity of Groundnut as Influenced by Integrated Use of Lime, Organics, Inorganic Fertilizers, and Biofertilizers in Acidic Soil of Tripura

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A field experiment was carried out on acidic soil of Khowai district of Tripura during 2017 and 2018 to study the effect of application of various combinations of lime, farmyard manure (FYM), poultry manure (PM), and rhizobium with the recommended doses of NPK on groundnut (*Arachis hypogaea* L.) productivity. The experiment was conducted in a completely randomized block design with 13 treatments; each replicated thrice. The application of the recommended dose of NPK @ 20:60:40 kg ha^{-1} along with lime @ 1/5th Lime Requirement (LR), PM @ 5 t ha^{-1} and seed treatment with *Rhizobium* @ 20 g kg^{-1} of seed significantly increased the seed yield and recorded the highest Benefit : Cost ratio (B:C) compared to the recommended dose of NPK alone as well as other treatments combinations. Thus, in achieving higher groundnut productivity with better return in acidic soils of Tripura, integrated use of inorganic fertilizers (NPK @ 20:60:40 kg ha^{-1}) combined with lime @ 1/5th LR, PM @ 5 t ha^{-1}, and seed treatment with *Rhizobium* @ 20 g kg^{-1} of seed might be recommended.

Keywords: Arachis hypogaea; productivity; lime; organic manure; fertilizers; biofertilizers; acid soil.

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1. INTRODUCTION

Soils of Tripura state of India are acidic, ranging from slightly acidic (6.1 to 6.5) to highly acidic (< 4.5). The productivity of acid soils is low as usually there are deficiencies of phosphorus, calcium, magnesium, molybdenum, boron, and toxicities of aluminium and iron in these soils (Bhat al. [1]; Kundu [2]; Kundu [3]). Liming in acid soils neutralizes soil acidity and provides a favourable environment for microbial growth and activity, enhancing the release and thereby increasing the availability of nutrients to plants (Sharma and Sarkar [4]). But knowledge of the application of lime is very minimum among the farming community of the state. Most of the state's land remains fallow after paddy harvesting, which can be brought under cultivation with reasonable management practices that can improve the state's farmers' economy and increase the state's cropping intensity. There is tremendous potential to introduce crops like groundnut after rice in this aspect. Groundnut is a legume-oilseed crop and the requirement of P, S, and Ca is comparatively high. Liming with integrated nutrient management (INM) is a better option to alleviate this nutrient deficiency. The conjoint application of plant nutrients both from organic and inorganic sources improves the productivity and profitability of field crops and helps sustain the soil fertility status (Kannan et al. [5]). Kanwar et al. [6] opined that with balanced fertilization the groundnut productivity can be enhanced noticeably. Despite the economic significance and maximum yield of groundnut, very minimum information is available on the effect of combined use of lime, biofertilizer, organic and inorganic sources of nutrients on groundnut productivity grown in acid soil of Tripura, India. Under this background, the present investigation was undertaken to study the effect of the combined use of lime, organics, inorganic fertilizers, and bio-fertilizers in increasing the productivity of groundnut in acidic soils of Tripura.

2. MATERIALS AND METHODS

The field experiments during 2017 and 2018 were carried out in an acid soil (pH 5.43) of the Chebri Village of Khowai district of Tripura, India located at an altitude of 23m, latitude 23.84 N, longitude 91.27E to study the effect of application of various combinations of lime, farmyard manure (FYM), poultry manure (PM), and rhizobium with the recommended doses of NPK (RDF) on groundnut (*Arachis hypogaea* L.) productivity. The experiment was conducted in a completely randomized block design with 13 treatments, each of which was replicated thrice. The following treatment combinations were undertaken: T_1: Control (only recommended dose of NPK (20:60:40 kg/ha) (RDF); T_2: Liming @1/10th LR (limestone) + RDF; T_3: Liming @1/5th LR (limestone) + RDF; T_4:Liming @1/10th LR (limestone) + RDF + FYM @ 5t/ha [T_2 + FYM]; T_5: Liming @1/5th LR (limestone) + RDF + FYM @ 5t/ha [T_3 + FYM]; T_6 : Liming @1/10th LR (limestone) + RDF + PM @ 5t/ha [T_2 + PM]; T_7: Liming @1/5th LR (limestone) + RDF + PM @ 5t/ha [T_3 + PM]; T_8 : Liming @1/10th LR (limestone) + RDF + Rhizobium (seed treatment @ 20g/kg seed) [T_2 + Rhizobium]; T_9 : Liming @1/5th LR (limestone) + RDF + Rhizobium (seed treatment @ 20g/kg seed) [T_3 + Rhizobium]; T_{10} : Liming @1/10th LR (limestone) + RDF + FYM @ 5t/ha + Rhizobium (seed treatment @ 20g/kg seed) [T_4 + Rhizobium]; T_{11} : Liming @1/5th LR (limestone) + RDF + FYM @ 5t/ha + Rhizobium (seed treatment @ 20g/kg seed) [T_5 + Rhizobium]; T_{12} : Liming @1/10th LR (limestone) + RDF + PM @ 5t/ha + Rhizobium (seed treatment @ 20g/kg seed) [T_6 + Rhizobium]; T_{13} : Liming @1/5th LR (limestone) + RDF + PM @ 5t/ha + Rhizobium (seed treatment @ 20g/kg seed) [T_7 + Rhizobium]. Liming material ($CaCO_3$) was applied on the basis of Lime Requirement (LR) 15 days earlier to the sowing. Organic manures were applied before sowing as per the treatments. Bio-fertilizers were applied as seed treatment before sowing. Row to row and plant to plant spacing of 45 cm and 15 cm were maintained. Seed yield of groundnut per hectare and Benefit: Cost ratio (B:C) of groundnut production in both the year 2017 and 2018 were recorded.

3. RESULTS AND DISCUSSION

We noted significant differences in seed yield among the treatments imposed in both 2017 and 2018 (Table 1). Among the treatments, the lowest pooled seed yield (1.61 t ha^{-1}) of groundnut was observed in T_1, where the only recommended dose of NPK (20:60:40 kg/ha) (RDF) was applied. The highest pooled seed yield of 2.98 t ha^{-1} was recorded in T_{13} treatment where liming @1/5th LR (limestone) + RDF + PM @ 5t/ha + Rhizobium (seed treatment @ 20g/kg seed) was imposed which was however statistically at par with T_{11} (RDF + 1/5th LR + FYM + Rhiz); T7 (RDF + 1/5th LR + PM) and T5 (RDF + 1/5th LR + FYM) with their seed yields of 2.88, 2.82 and 2.72 t ha^{-1}. It was noted that significantly higher seed yield than control was

observed in all the treatments where 1/5th or 1/10th of LR was applied singly or in combination with PM, FYM, RDF, and biofertilizer. There were 16.8 % and 47.2% increases in seed yield (pooled) in T2 (RDF + 1/10 LR) and T3 (RDF + 1/5 LR), respectively, compared to control (only recommended dose of NPK). Again, we noted a further 10.6 and 14.8% increase in seed yield of groundnut over RDF + 1/10 LR and RDF + 1/5 LR when FYM was applied in combination RDF + 1/10 LR and RDF + 1/5 LR, respectively. However, 19.1% and 19.0% increase in seed yield of groundnut over RDF + 1/10 LR and RDF + 1/5 LR was perceived when PM was applied in combination RDF + 1/10 LR and RDF + 1/5 LR, respectively. Experimental data revealed a 14.3 and 21.5% increase in seed yield of groundnut over RDF + 1/10 LR + FYM and RDF + 1/5 LR + FYM when rhizobium (biofertilizer) was applied in combination RDF + 1/10 LR + FYM and RDF + 1/5 LR + FYM, respectively. However, there were 23.4 and 25.7% increases in seed yield of groundnut over RDF + 1/10 LR and RDF + 1/5 LR when rhizobium (biofertilizer) was applied conjointly with RDF + 1/10 LR + PM and RDF + 1/5 LR + PM, respectively. So, we observed that the application of lime and integrated nutrient management had a significant effect on groundnut yield. The application of organic manure is also had a positive influence on the groundnut yield. Our results are in good confirmatory with the previous findings like Sharma and Subehia [7], who, based on 141 field experiments across Assam and Meghalaya, reported a 14-50% increase in yield of crops in response to lime application @ 2-4 q/ha, 22-100% yield increase by the recommended dose of NPK application (i.e., 100% NPK), and 49-390% increase in productivity due to conjoint use of NPK and lime related to control (i.e., farmers' practice) which might be due to balanced nutrition of crops. Farmyard manure supplied nutrients and improved soil conditions to produce higher yields (Jagdev and Singh [8]). Dharma [9] reported that FYM might have stimulated the activities of microorganisms that make the plant nutrients readily available to the crops. Balasubramanian and Palaniappan [10] reported that microbial inoculants combined with FYM favored groundnut production. Deka et al. [11] opined that applying lime @ 25 % LR produced a higher pod yield of groundnut compared to control which was, however, statistically equal with 50 % lime requirement in an acid sandy loam soil of Assam. Singh et al. [12] reported that the application of lime significantly increased pod yield of groundnut over control. Plot treated with lime + FYM + 50% NPK recorded 6.80 and 13.14 percent higher productivity over FYM + 50% NPK and 100% NPK, respectively, signifying the positive effect of liming in enhancing the productivity of groundnut. While doing the

Table 1. Effect of integrated use of lime, organics, inorganic fertilizers and biofertilizers on seed yield of groundnut

Treatment	Seed yield (t/ha)		
	2017	**2018**	**Pooled**
T1: RDF	1.60	1.62	1.61
T2: RDF + 1/10 LR	1.87	1.88	1.88
T3: RDF + 1/5 LR	2.35	2.38	2.37
T4: RDF + 1/10 LR + FYM	2.06	2.09	2.08
T5: RDF + 1/5 LR + FYM	2.70	2.73	2.72
T6: RDF + 1/10 LR + PM	2.23	2.25	2.24
T7: RDF + 1/5 LR + PM	2.80	2.83	2.82
T8: RDF + 1/10 LR + Rhiz	1.96	1.98	1.97
T9: RDF + 1/5 LR + Rhiz	2.42	2.45	2.44
T10: RDF + 1/10 LR + FYM + Rhiz	2.14	2.16	2.15
T11: RDF + 1/5 LR + FYM + Rhiz	2.85	2.90	2.88
T12: RDF + 1/10 LR + PM + Rhiz	2.30	2.33	2.32
T13: RDF + 1/5 LR + PM + Rhiz	2.96	2.99	2.98
Sem	*0.12*	*0.14*	*0.14*
CD at 5%	*0.36*	*0.41*	*0.40*
CV (%)	*9.09*	*10.27*	*10.22*

RDF = N:P:K @ 20:60:40 kg/ha; LR = Lime requirement @ 3.2 t/ha; FYM= Farm yard manure @ 5t/ha; Rhiz= Seed treatment with Rhizobium @ 20g/kg seed

Table 2. Effect of integrated use of lime, organics, inorganic fertilizers and biofertilizers on benefit: cost (B:C) ratio of groundnut

Treatment	Benefit: cost (B:C) ratio		
	2017	2018	Pooled
T1: RDF	2.09	2.14	2.11
T2: RDF + 1/10 LR	2.19	2.29	2.24
T3: RDF + 1/5 LR	2.79	2.83	2.81
T4: RDF + 1/10 LR + FYM	2.21	2.28	2.24
T5: RDF + 1/5 LR + FYM	2.92	3.00	2.96
T6: RDF + 1/10 LR + PM	2.38	2.51	2.45
T7: RDF + 1/5 LR + PM	2.93	3.00	2.97
T8: RDF + 1/10 LR + Rhiz	2.30	2.39	2.35
T9: RDF + 1/5 LR + Rhiz	2.83	2.90	2.87
T10: RDF + 1/10 LR + FYM + Rhiz	2.29	2.34	2.32
T11: RDF + 1/5 LR + FYM + Rhiz	3.02	3.06	3.04
T12: RDF + 1/10 LR + PM + Rhiz	2.46	2.52	2.49
T13: RDF + 1/5 LR + PM + Rhiz	3.04	3.05	3.05

RDF = N:P:K @ 20:60:40 kg/ha; LR = Lime requirement @ 3.2 t/ha; FYM= Farm yard manure @ 5t/ha; Rhiz= Seed treatment with Rhizobium @ 20g/kg seed

economic analysis, we had seen that application of the recommended dose of NPK @ 20:60:40 kg ha^{-1} along with lime @ $1/5^{th}$ LR, PM @ 5 t ha^{-1}, and seed treatment with *Rhizobium* @ 20 g kg^{-1} of seed documented a higher Benefit: Cost ratio (B:C) compared to the recommended dose of NPK alone and other treatments combinations (Table 2). Pattanayak et al. [13] in acid soils of Odisha reported that combined application of 50% NPK + lime + FYM improved the farmers' income by ~ 75% over normal farmers' practice.

4. CONCLUSION

Significant improvement in groundnut productivity was observed with the combined application of a recommended dose of NPK @ 20:60:40 kg ha^{-1}, lime @ 1/5th Lime Requirement (LR), poultry manure (PM) @ 5 t ha^{-1}, and seed treatment with *Rhizobium* @ 20 g kg^{-1} of seed compared to control i.e., only recommended dose of NPK as well as other treatments combinations. The economic analysis showed that the Benefit : Cost ratio (B:C) of the treatment mentioned earlier was higher than the recommended dose of NPK alone and other combinations of treatments. Thus, the application of a recommended dose of NPK @ 20:60:40 kg ha^{-1} conjointly with lime (@ 1/5th LR), poultry manure (@ 5 t ha^{-1}), and treating the seeds with *Rhizobium* @ 20 g kg^{-1} of seed might be recommended to the farmers in achieving higher groundnut productivity with better return in acidic soils of Tripura.

DISCLAIMER

The products used for this research are commonly and predominantly used products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by the personal efforts of the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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