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Effect of nutrient management on soil fertility in rice (*Oryza sativa*)- greengram (*Vigna radiata*) cropping system

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ABSTRACT

A field experiment was conducted at the Agronomic Main Research Farm, Odisha University of Agriculture and Technology, Bhubaneswar to study the effect of nutrient management on soil fertility in rice (Oryza sativa L.) greengram (Vigna radiata L. Wilezek) cropping system during 2017-18. The treatments comprised of three main plots (soil test based fertilizer 100 kg N + 40 kg P : 50 kg K ha^{-1}, soil test based fertilizer + green manuring with Sesbania and soil test based fertilizer + green manuring with Sesbania + liming @ 0.2 LR to green manure crop) and three sources of fertilizer in sub plots (urea + SSP + MOP, DAP as basal and urea as top dressing + MOP, urea as basal and DAP as top dressing + MOP) with three replications in a split plot design. The climate was more or less congenial for crop growth and development. The combination of liming with green manure crop + soil test based fertilizer and DAP as basal and urea as top dressing + MOP improved the soil fertility by increasing soil pH from 5.4 to 5.9, 5.9 to 5.8 and 5.83 to 5.87 at post harvest of rice, pre sowing of greengram and post harvest of greengram, respectively. The soil available nitrogen, phosphorus and potassium status increased with the combination of liming to green manure crop + soil test based fertilizer and DAP as basal and urea as top dressing + MOP to the extent of 292, 17 and 106 kg ha^{-1} and the lowest values 245, 14 and 74 kg ha^{-1} were recorded in the combination of STBF and urea + SSP + MOP, respectively in post harvest of rice. The soil fertility was either improved or maintained at the end of the cropping cycle indicating sustainability of the system.

Key words: Liming, rice–green gram cropping system, soil fertility, sustainability.

INTRODUCTION

Rice is an essential staple food and a source of income for millions of others, making rice production one of the planet's most important economic activities. Globally, India ranks first in rice area and second in rice production after China. The area coverage under rice is estimated to have 43.70 million hectares during 2017-18. As per the fourth advance estimates for 2016-17 **(**Department of Agriculture, Cooperation & Farmers Welfare, GOI), production of rice is estimated at a new record of 110.15 million tonnes, which is 5.50 % more than that of the production of 104.41 million tonnes during 2015-16. Rice and rice based cropping systems are mainly important for food security mainly in South and South East Asia. Rice and Pulse are the major portion of the human diet. With growing awareness about human health, soil quality and environmental safety, need has been felt to reevaluate over existing agricultural practices viz. continuous monocropping which has led to decline or stagnation of productivity due to deterioration of soil physio- chemical properties. This problem can be partly overcome with more focus on agricultural practices such as green manuring, recycling of crop residues and inclusion of legumes in rotation. The selection of component crops needs to be suitably planned to harvest the synergism among them towards efficient utilization of resource base and to increase overall productivity (Anderson 2005 and Kumar et al 2018). To boost the agricultural production, the agronomist should think of harvesting higher yield from vertical rather than horizontal expansion of net cropped area. Productive agriculture is dependent upon sound soil nutrient management practices. Use of chemical fertilizers not only increased crop yield but also triggered many environmental imbalances by reducing soil fertility and thereby making the crop productivity unsustainable.Incorporating green manure crops into soil makes it productive by fixing 45 kg N/ha and may increase P bioavailability for succeeding crops and also improves physical structure of the soil The application of lime is added advantage by increasing phosphorus and potassium availability in the soil and their transfer into above ground plant organs**.** Nutrient

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management technology is oriented towards better utilization of organic sources that may be available cheaply or improving the formulation, timing and placement of chemical fertilizers so that the nutrient uptake by plants is maximized. In intensive agriculture practices, the small land holdings of farmers may not permit for six to seven weeks exclusively for green manure cultivation without any revenue (Kannaiyan 2000). In India the area coverage under green manure was observed 6.7 million hectares, which accounts for 4.5 per cent of net (142 million ha) sown area (Nayak 2016). Hence, the present investigation was conducted to improve soil fertility status and moreover our results can support a choice for achieving sustainability in rice – greengram cropping system.

MATERIALS AND METHODS

A field experiment was conducted at Agronomy Main Research Farm, Odisha University of Agriculture and Technology, Bhubaneswar during 2017-18. It is located in Agro-climatic zone of (East and South Eastern plains zone of Orissa with latitude of 20°15'N, longitude of 85°52'E and altitude of 25.9 m above mean sea level. The climate was more or less congenial for crop growth and development. The experimental design was split plot with three replications along with three main plots (soil test based fertilizer 100 kg N + 40 kg P + 50 kg K ha^{-1}, soil test based fertilizer + green manuring with *Sesbania* and soil test based fertilizer + green manuring with *Sesbania* + liming @ 0.2 LR to green manure crop) and three sources of fertilizer in sub plots (urea + SSP + MOP, DAP as basal and urea as top dressing + MOP, urea as basal and DAP as top dressing + MOP) to study the effect of liming to green manure crop on soil fertility in rice – greengram cropping system. All the plots demarcated by 10 cm high ridges on all sides. The experiment was conducted on rice – greengram cropping system where Naveen variety of rice was grown as *kharif* crop and greengram (variety IPM 0214) as residual crop. The initial soil was acidic pH (5.42), EC (0.13 dSm^{-1}), well drained, sandy loam, medium in organic carbon (6.62 g/kg) and low in available nitrogen (253.5 kg ha^{-1}), medium in phosphorus (12 kg ha^{-1}), low in potassium (59 kg ha^{-1}), adequate in exchangeable calcium (3.60 meq/100g soil), low in exchangeable magnesium (0.3 meq/100g soil) and low in sulphur (11 kg ha^{-1}). Post harvest soil samples were collected from individual treatment plot after completion of each crop and also before sowing of greengram. The soil samples were dried under shade, crushed, sieved through 2 mm sieve and were preserved in polythene with proper label for analysis. The soil samples of the experimental plots were analyzed for different chemical properties, available N, P, K and S by adopting standard procedures. (Jackson 1973).

RESULTS AND DISCUSSION

Soil pH

Initial soil pH was 5.42 and it was improved in STBF + green manuring with *Sesbania* + liming @ 0.2 LR to green manure crop when compared with others. The highest value of soil pH was observed 5.95, 5.83 and 5.87 in combination of STBF + green manuring with *Sesbania* + liming @ 0.2 LR to green manure crop and DAP as basal and urea as top dressing + MOP at post harvest of rice, pre sowing of greengram and post harvest of greengram respectively and the lowest value of soil pH recorded 5.18, 5.11, 5.16 in combination of STBF and urea + SSP + MOP at post harvest of rice, pre sowing of greengram and post harvest of greengram respectively (Fig. 1). Application of lime to acid soil increases pH and favours the desired growing environment for the microbes and crop plants. The reduction in soil pH by dhaincha might be due to the fact that the dhaincha leaves sap has a pH value of 4.0 and being strongly acidic in nature. After decomposition, it exerts a marked influence in neutralizing the high pH of soil due to the production of organic acids. Before sowing of the greengram, the soil pH was drastically decreased by the incorporation of rice stubbles into the soil. This might be due to the rice straw which acted as a main source of electrons for reduction of the soil.. After harvest of greengram the soil pH was increased slightly, the rate of increase is higher in case of no green manured plots. This might be due to the legumes tend to absorb less anions, and the cations surplus uptake strongly acidifies the soil.

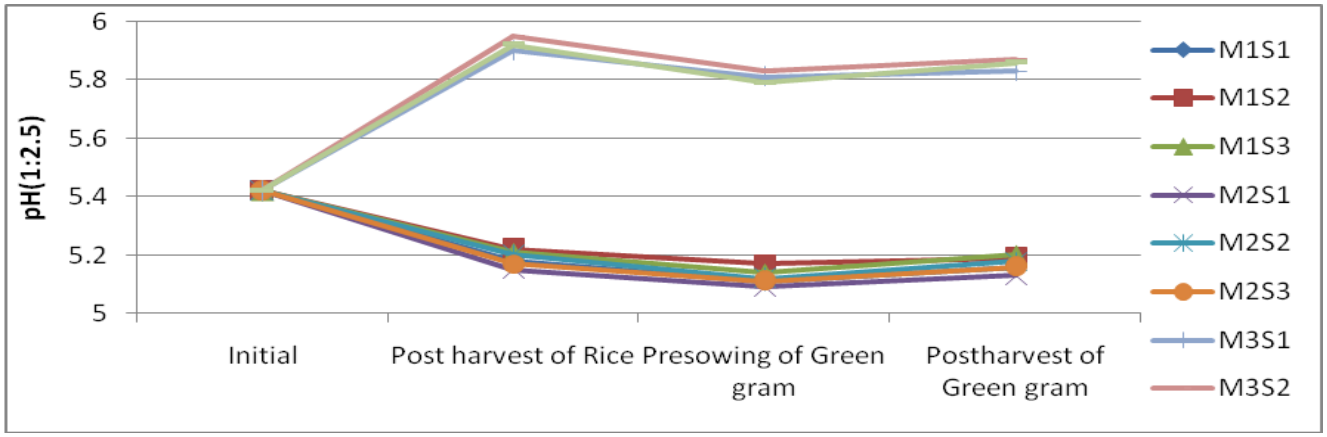

Fig. 1 Effect of nutrient management practices in rice – greengram cropping system on soil pH

Soil EC

The values of soil EC increased in post harvest of rice. The soil EC values decreased drastically varying from 0.13 to 0.18dSm^{-1} at post harvest of greengram. The concentration of soluble salts was 0.13dSm^{-1} initially. There was an increase in the concentration of soluble salts (ranging from 0.13to 0.32dSm^{-1}) after harvest of rice (Fig. 2). This might be due to the decomposition of organic matter and their mineralization released from different nutrients which increased the concentration of soluble salts. The concentration of soluble salts was increased (ranging from 0.32 to 0.34 dSm^{-1}) after incorporation of rice stubbles into the soil. Mohd Aizat *et al.* (2014) also reported that soil pH may probably affect the solubility of salts and soil moisture content. Soluble salts concentration was drastically decreased after harvest of greengram crop (ranging from 0.13to 0.18 dSm^{-1}). Similar findings were reported by Bruckner (2012).

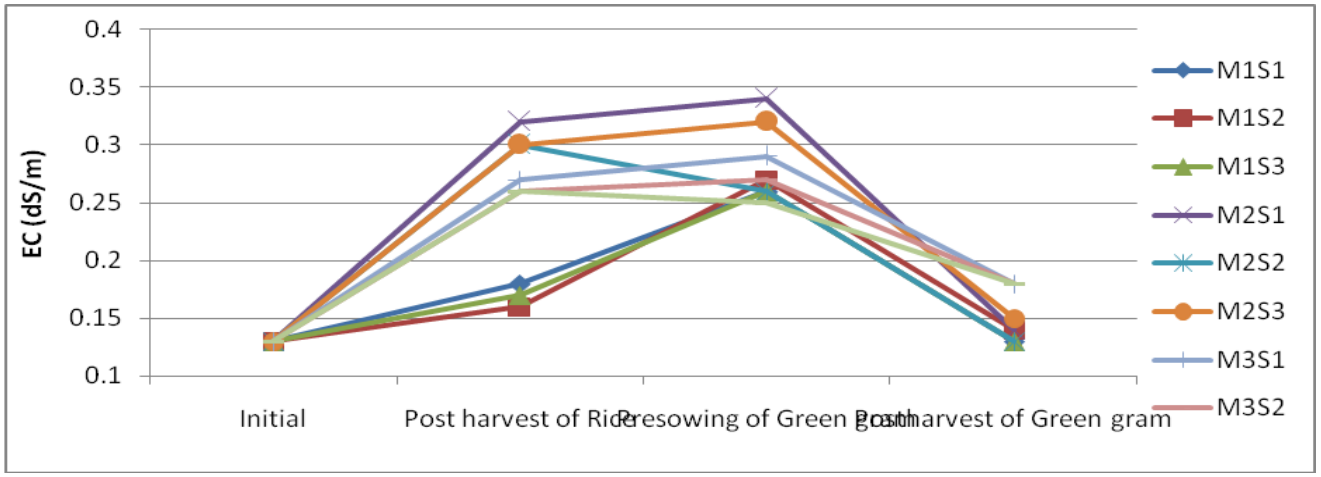

Fig. 2 Effect of nutrient management practices in rice – greengram cropping system on soil EC

Soil Organic carbon:

Initial soil OC was 6.62 g kg^{-1} and the soil OC improved in STBF + green manuring with *Sesbania* + liming @ 0.2 LR to green manure crop when compared with others. The highest value of soil OC was observed 6.38, 6.31 and 5.74 g kg^{-1} in combination of STBF + green manuring with *Sesbania* + liming @ 0.2 LR to green manure crop and DAP as basal and urea as top dressing + MOP at post harvest of rice, pre sowing of greengram and post harvest of greengram, respectively and the lowest values were recorded 6.18, 6.15

and 5.18 g kg^{-1} in combination of STBF and urea + SSP + MOP at post harvest of rice, pre sowing of greengram and post harvest of greengram respectively (Fig.3). The soil OC values decreased drastically in all the treatments at post harvest of greengram. The soil OC recorded higher in case of limed plots when compared with others. This might be due to liming in acid soils in the long run, will increase organic matter returns and soil organic matter content. Similar results were reported by Paradelo *et al.* (2015).

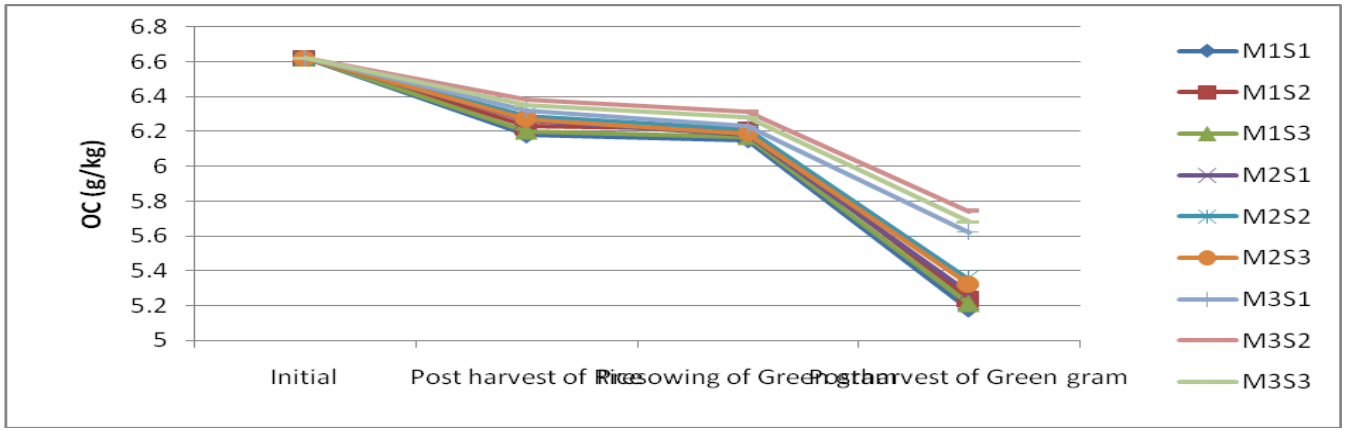

Fig. 3 Effect of nutrient management practices in rice – greengram cropping system on soil OC

Available Nitrogen

Available N status improved in STBF + green manuring with *Sesbania* + liming @ 0.2 LR to green manure crop when compared with others. The highest values of soil N (292, 198 and 174 kg ha^{-1}) were recorded in combination of STBF + green manuring with *Sesbania* + liming @ 0.2 LR to green manure crop and DAP as basal and urea as top dressing + MOP at post harvest of rice, pre sowing of greengram and post harvest of greengram, respectively and the lowest values (245, 108 and 118 kg ha^{-1}) were recorded in combination of STBF and urea + SSP + MOP at post harvest of rice, pre sowing of greengram and post harvest of greengram, respectively (Fig. 4). The soil N values were decreased drastically in all the treatments at post harvest of greengram. After harvest of rice the available soil N was recorded the highest in liming to green manured treatment (M_3) followed by green manured treatment (M_2) and the lowest available soil N was recorded in no green manured plot (M_1). Similar results were reported by Jayaramasoundari (2001). After harvest of rice, 55% of the N from the fertilizer applied was found in the soil. The effect of liming to green manuring plus chemical fertilizers was found effective which are in conformity with Matsuo *et al.* (2015).

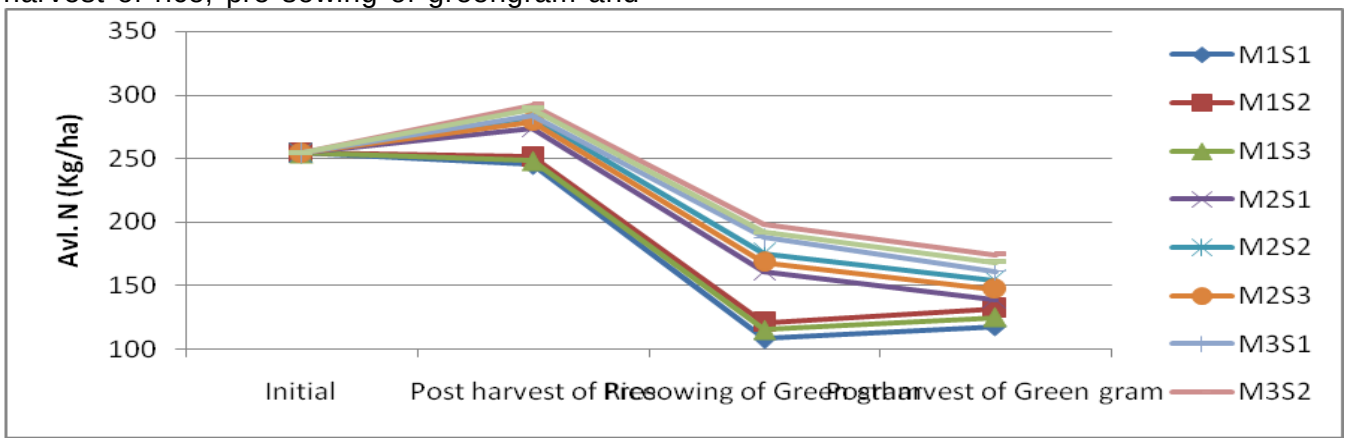

Fig. 4 Effect of nutrient management practices in rice – greengram cropping system on soil available N

Available phosphorus

Soil P improved in STBF + green manuring with *Sesbania* + liming @ 0.2 LR to green manure crop when compared with others. The highest values were observed (17, 18 and 9 kg ha^{-1}) in combination of STBF + green manuring with *Sesbania* + liming @ 0.2 LR to green manure crop and DAP as basal and urea as top dressing + MOP at post harvest of rice, pre sowing of greengram and post harvest of greengram, respectively and the lowest values of soil P were (14, 14 and 6 kg ha^{-1}) in combination of STBF and urea + SSP + MOP at post harvest of rice, pre sowing of greengram and post harvest of greengram, respectively (Fig. 5). The soil P values were decreased drastically in all the treatments at post harvest of greengram. The efficient use of phosphorus by plants can be improved by green manuring. Similar results were concluded by Choudhury *et al.* (2007). Phosphorus is particularly sensitive to pH and become a limiting nutrient in strongly acidic soils but by liming process results in the P availability as there is an increase in soil pH values.

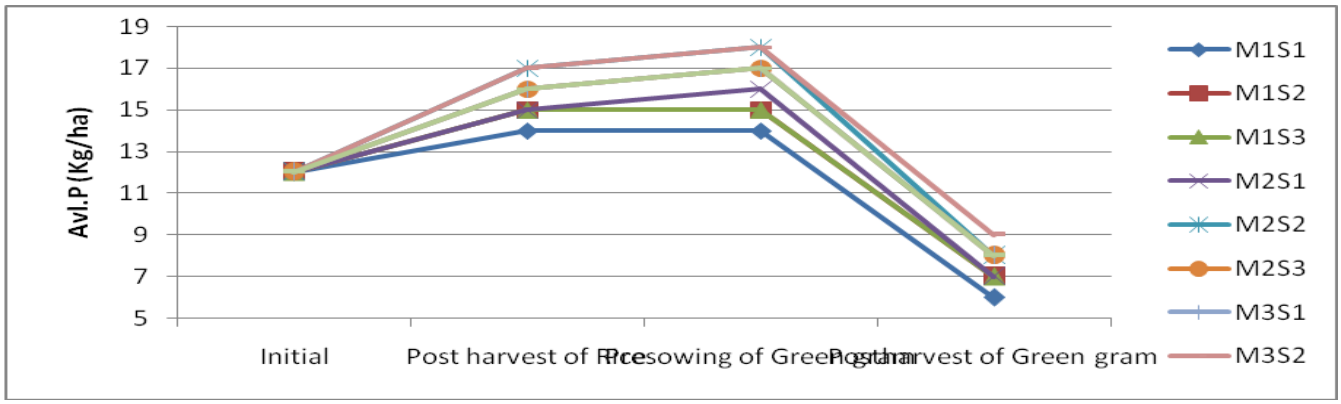

Fig. 5 Effect of nutrient management practices in rice–greengram cropping system on soil available P

Available potassium

The highest values of soil K (106, 161 and 128 kg ha^{-1}) were recorded in combination of STBF + green manuring with *Sesbania* + liming @ 0.2 LR to green manure crop and DAP as basal and urea as top dressing + MOP at post harvest of rice, pre sowing of greengram and post harvest of greengram, respectively and the lowest values (74, 124 and 98 kg ha^{-1}) were recorded in combination of STBF and urea + SSP + MOP at post harvest of rice, pre sowing of greengram and post harvest of greengram, respectively (Fig. 6). With judicious application of organic and inorganic sources in right proportion, the leaching of the nutrients subjected chemical fertilizer applicaton alone could be reduced and maintained the nutrient content at sustained level. Similar results are in accordance with Senthivelu (2007).

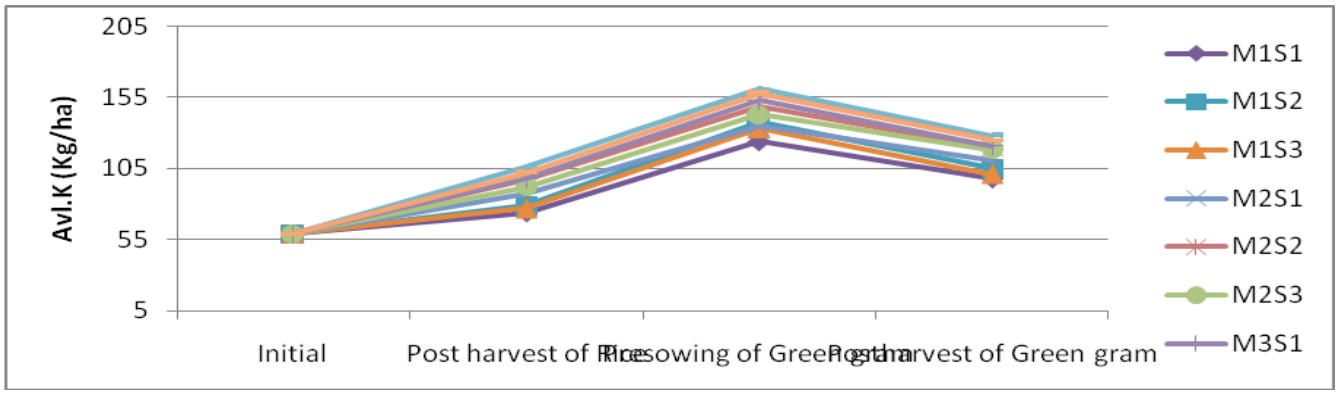

Fig. 6 Effect of nutrient management practices in rice–greengram cropping system on soil available K

Soil Exch. Ca and Soil Exch. Mg

Data (Fig. 7) indicated that exchangeable calcium was maintained in STBF + green manuring with *Sesbania* + liming @ 0.2 LR to green manure crop when compared with others. The highest values (3.2, 3.28 and 3.21 meq/100gms) of soil were recorded in combination of STBF + green manuring with *Sesbania* + liming @ 0.2 LR to green manure crop and DAP as basal and Urea as top dressing + MOP at post harvest of rice, pre sowing of greengram and post harvest of greengram, respectively. On the otherhand, the lowest value of soil Exch. Ca (2.1, 2.2 and 2.17 meq/100gms) were recorded in combination of STBF and urea + SSP + MOP at post harvest of rice, pre sowing of greengram and post harvest of greengram, respectively. The highest values of soil exch. Mg (0.25, 0.26 and 0.24 meq/100gms of soil) were recorded in combination of STBF + green manuring with *Sesbania* + liming @ 0.2 LR to green manure crop and DAP as basal and urea as top dressing + MOP at post harvest of rice, pre sowing of greengram and post harvest of greengram respectively and the lowest values (0.11, 0.13 and 0.11 meq/100gms) in combination of STBF and urea + SSP + MOP at post harvest of rice, pre sowing of greengram and post harvest of greengram respectively. This may be due to the application of lime to acid soil increase the soil pH and favours the desired growing environment for the microbes and crop plants, which also influences the nutrient availability.

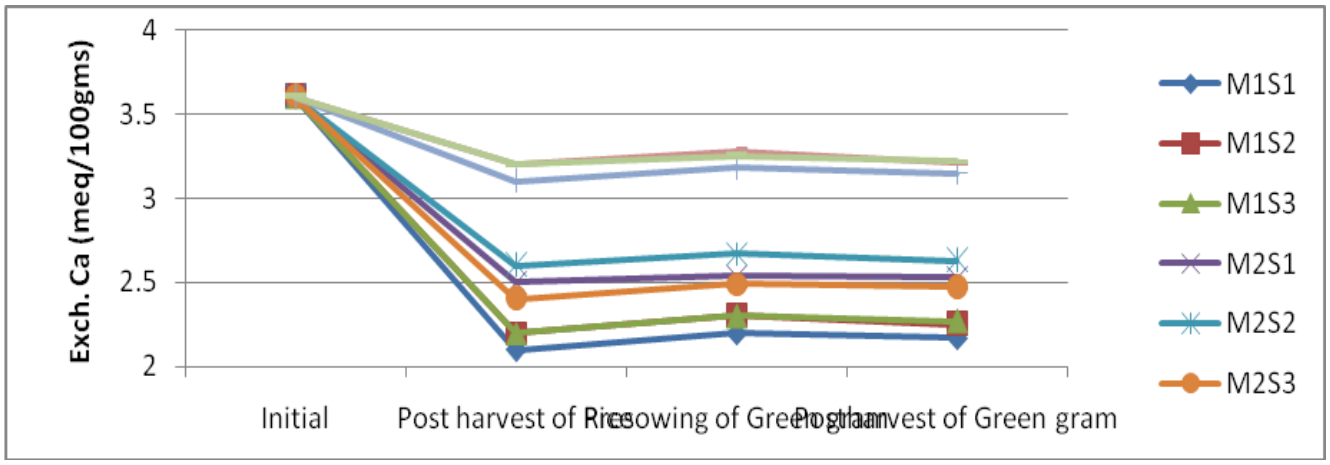

Fig. 7 Effect of nutrient management practices in rice–greengram cropping system on soil Exch. Ca

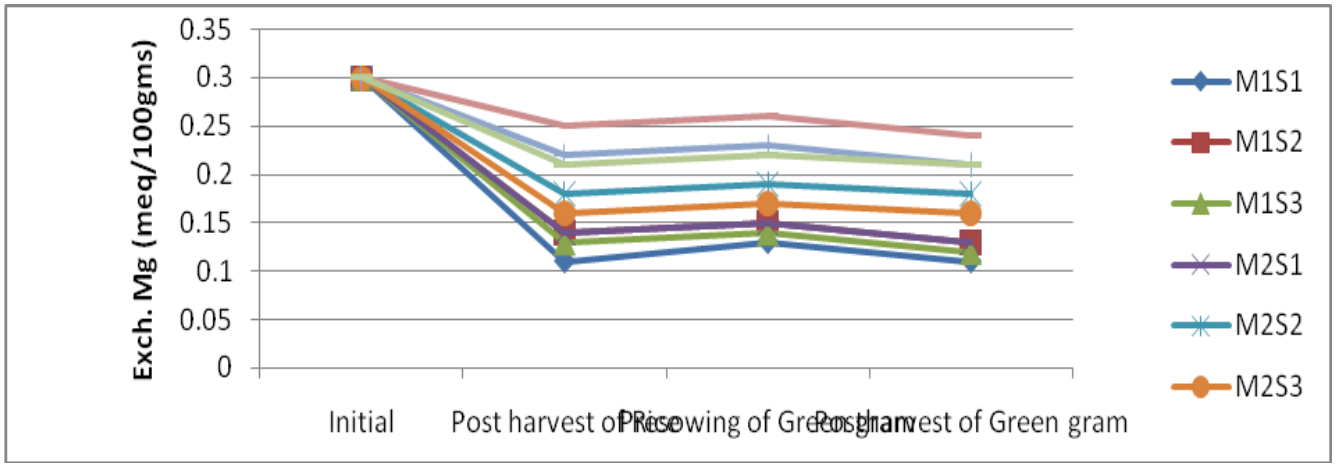

Fig. 8 Effect of nutrient management practices in rice–greengram cropping system on soil Exch. Mg

Available sulphur

The Fig.9. indicated that the highest values of soil S (21, 22 and 15 kg ha^{-1}) were recorded in combination of STBF + green manuring with *Sesbania* and DAP as basal and urea as top dressing + MOP at post harvest of rice, pre sowing of greengram and post harvest of greengram, respectively and the lowest values (15, 16 and 12 kg ha^{-1}) were recorded in combination of STBF + green manuring with *Sesbania* + liming @ 0.2 LR to green manure crop and urea + SSP + MOP at post harvest of rice, pre sowing of greengram and post harvest of greengram, respectively. After harvest of rice the increase in available S content in soil over the initial sulphur status of the soil is due to the addition of added S and also the additional benefits derived from green manuring. Similar findings were in conformity with the findings of Ghosh (2015) and Karan (2015).

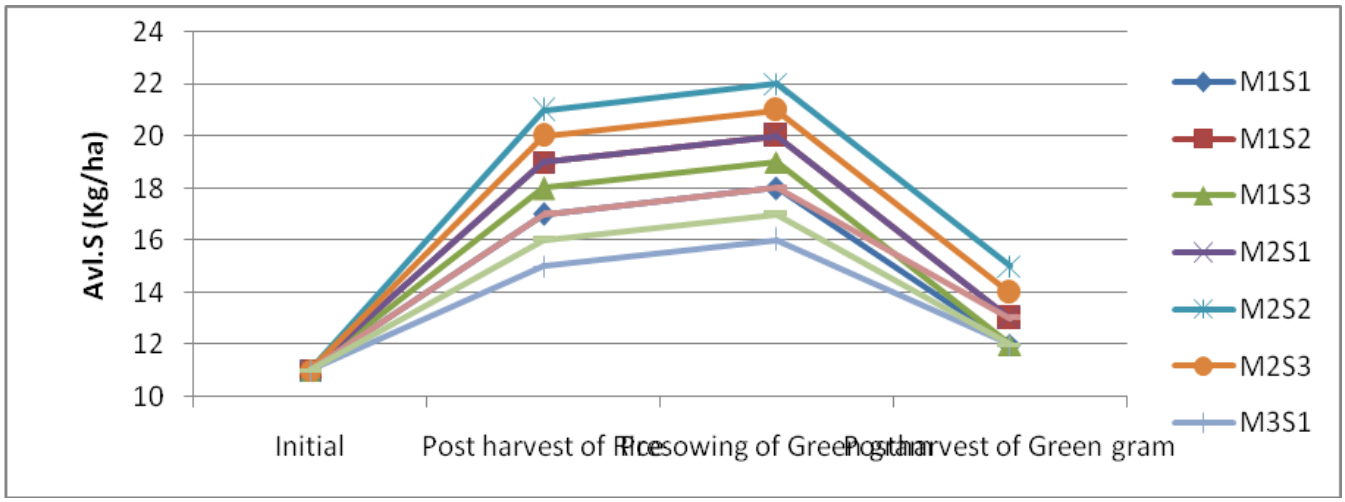

Fig. 9 Effect of nutrient management practices in rice-greengram cropping systemon soil available S

It may be concluded that the application of lime to acid soil increased the soil pH and favors the desired growing environment for the microbes and crop plants, which also influences the nutrient availability and maintains soil health in rice – green gram cropping system.

REFERENCES

Anderson, R.L. (2005) Are some crops synergistic to following crops, *Agronomy Journal*, **97**(1): 7-10.

Bruckner, M.Z. (2012) Water and soil characterization- pH and electrical conductivity, Microbial *life educational resources,* Montana State University Bozeman.

Choudhury, A.T.M.A., Kennedy, I.R., Ahmed, M.F., Kecskes, M.L. (2007) Phosphorus fertilization for rice and control of environmental pollution problems, *Pakistan Journal of Biological Sciences* **10**(13): 2098-2105.

Food and Agriculture Organization of the United Nations. (2017) Food and Agriculture Organization Corporate Statistical Database Statistics Division, Rome: FAO.

Ghosh, G.K. and Bera, M. (2015) Efficacy of sulphur sources on green gram (*Vigna radiata* L.) in red and lateritic soil of West Bengal, *International Journal of Plant, Animal and Environmental Sciences* **5**(2): 109 – 116.

Jackson, M. L. (1973) Soil chemicals analysis. Prentice Hall of India Private Limited, New Delhi.

Jayaramasoundari, R. (2001) Studies on the influence of sources and combinations of phosphorus at various biomass levels of intercropped green manure in wet seeded rice – green gram cropping system, Ph.D. (Agronomy). thesis submitted to Tamil Nadu Agricultural University, Coimbatore. pp : 83-84.

Kannaiyan, S. (2000) Integrated nutrient management strategy in wetland rice ecosystem. In: Integrated Nutrient Management. (Ed.) S. Kannaiyan *et al.* Tamil Nadu Agriculture University.and Tamil Nadu Dept. of Agric., p. 1-32.

Karan, A.K., Singh, V.K. and Kar, S. (2015) Effects of liming, soil moisture regimes and application of sulphur and some micronutrients on soil plant availability of nutrients and yield of rice (*Oryza sativa* L) in acid laterite soil, *International Journal of Agriculture, Environment and Biotechnology* **8**(3) : 625 -637.

Kumar S., Vishwakarma, D., Lenka, S and Jain, R.C. (2018) Effect of conservation tillage and organics and inorganics on soil fertility in different aggregate size classes, *Annals of Plant and Soil Research* 20 (**2**): 168-171.

Matsuo, K, Ae N, Vorachit N, Thadavon, Souvanh. (2015) Present soil chemical status and constraints for rice – based cropping systems in Vientiane Plain and neighboring areas, Lao PDR, *Plant Production Science* 18(3): 314-322.

Mohd Aizat, A., Mohamad Roslan, M. K., Wan Nor Azmin, S. and Daljit. S. K. (2014) The relationship between soil pH and selected soil properties in 48 years logged-over forest, *International Journal of Environmental Sciences* **4**(6): 1129-1140.

Nayak, B.H. (2016) Standardization of seed production techniques in dhaincha (*Sesbania aculeate).* M.sc. (Ag) Seed science and technology thesis submitted to Professor Jayashankar Telangana State Agricultural University,College of Agriculture, Rajemdranagar, Hyderabad.

Paradelo, N.R., Vitro, I., Chenu, C. (2015) Net effect of liming on soil organic carbon stocks: a review, *Agriculture, Ecosystems & Environment* 202:98-107

Senthivelu, M. and Surya Prabha, A.C. (2007) Studies on nutrient uptake, post harvest nutrient availability and nutrient balance sheet under integrated nutrient management practices in wet seeded rice, *The Asian Journal of Soil Science* (**2**): 33-39.

Tan, D., Jin, J., Huang, S., Li, S. and He, P. (2007) Effect of long term application of K fertilizer and wheat straw to soil on crop yield and soil K under different planting systems, *Scientia agricultura Sinica.* (In Chinese), 6: 200-207.