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Effect of Integrated Nutrient Management on Soil Physico-Chemical Properties of Rajmash in Acid Soil of Nagaland

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Abstract

A field experiment at demonstration field of Krishi Vigyan Kendra (KVK) at Porba village, Phek District, Nagaland was conducted during the kharif season of 2012 and 2013 to study the effect of integrated nutrient management on soil physico-chemical properties of a rajmash in acid soil of Nagaland. The field experiment was laid out in randomized block design (RBD) with three replications and 18 treatments. The integrated treatments involving both organic and inorganic fertilizer influenced favourably the fertility status of the soil as compared to the control. Both bulk density and particle was found to decrease in all the treatments in both the experimental year over the initial value. There was an increase in the pH of the soil at the end of the cropping sequence from the initial value. Organic carbon content, EC and CEC of the soil were found to be increased in all the treatments over the initial value and the highest value was recorded in treatments where 5 ton FYM + Biofertilizer + Lime+ 50% NPK were applied.

Keywords: INM, Physico-Chemical properties, *Phaseolus vulgaris* L..

Introduction

Cultivation of pulses is gaining importance all over the World due to their increasing demand and high market value. In India, pulses are grown mostly on marginal and sub-marginal lands without proper inputs occupying first in pulse production with 23 Million hectare. Among pulse crop, Rajmash is becoming popular with the farmers due to its high profit in comparison to other pulses and unlike other pulse crop. Rajmash is a stable cash crop free from insect pests and diseases. Rajmash (*Phaseolus vulgaris* L) belongs to the Leguminasae family and is also known as French bean, kidney bean, common bean. Rajmash is consumed as green vegetables as well as grain pulse. For vegetable purpose, round podded type with more flesh and less string is preferred. Among all the beans, it is the most extensively grown bean because of its short duration and nutritive value. It is a valuable source of protein, vitamins and minerals (Ramana *et al*. 2011). The protein from pulses is easily digestible and relatively cheaper and has high biological value besides they maintain soil fertility through biological nitrogen fixation in soil and thus play a vital role in furthering sustainable agriculture (Kannaiyan 1999). Globally, French bean is cultivated over an area of 29.92 million hectares with an annual production of 23.23 million tons while in India it is commercially cultivated in Nagaland, and other North-Eastern states and peninsular India, Himachal Pradesh, Jammu and Kashmir, hills of Uttrakhand covering an area of 10.80 million hectares with an annual production of 4.87 million tons (Anonymous 2010). In Nagaland, kholar bean is cultivated over an area of 14840 hectares with an annual production of 18590 MT (Anonymous 2014). Integrated Nutrient Management (INM) envisages the use of chemical fertilizers in conjunction with organic manures, legumes in cropping systems, use of biofertilizer and supply and use of plant nutrients from chemical

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fertilizers and organic manures has shown to produce higher crop yields than when each is applied alone. Hence, integrating their use in soil fertility management is a must. Integration of chemical and organic sources and their management have shown promising results not only in sustaining the productivity but have also proved to be effective in maintaining soil health and enhancing nutrient use efficiency (Laxminarayana *et al*. 2011, Kumar *et al*. 2012).

The present experiment was undertaken to study the effect of integrated nutrient management on soil physico-chemical properties of rajmash in acid soil of Nagaland.

Materials and Methods

The experiment was conducted during the *kharif* season of 2012 and 2013 at the demonstration farm of Krishi Vigyan Kendra at Porba Village, Phek District, Nagaland. The farm is located at latitude of 25°62'N and longitude of 95°33'E and at an elevation of 1842 m above the mean sea level. The experiment was laid out in randomized block design (RBD) with three replications. The treatments comprised of 18 treatments viz.,

T_1- Control, T_{2-} 50% NPK, T_{3-} 100% NPK, T_{4-} Biofertilizer, T_5-Biofertilizer + 50% NPK, T_{6-} Biofertilizer + 100% NPK, T_{7-} Biofertilizer + Lime, T_{8-}Biofertilizer + Lime + 50% NPK, T_{9-} Biofertilizer + Lime + 100% NPK, $T_{10\,-}$ 5 ton FYM, T_{11} –5 ton FYM + 50% NPK, T_{12} –5 ton FYM + 100% NPK, T_{13-} 5 ton FYM + Biofertilizer, T_{14-} 5 ton FYM + Biofertilizer + 50% NPK, T_{15-}5 ton FYM + Biofertilizer + 100% NPK, T_{16-} 5 ton FYM + Biofertilizer + Lime, T_{17-} 5 ton FYM + Biofertilizer + Lime + 50% NPK and T_{18-} 5 ton FYM + Biofertilizer + Lime + 100% NPK. Different doses of nutrients were applied through different sources as per the need of the treatments. The recommended level (100%) of N (Urea), P (Single super phosphate) and K (Muriate of potash) are100, 40 and 20 kg ha^{-1} respectively. Initial values of soil as pH 5.12, EC (dS/m)-0.10,Organic carbon (%) 0.58 (Jackson, 1973).,CEC [cmol (p^+) kg^{-1}]-5.33,(Jackson, 1973)., Bulk density (Mg m^{-3})-1.42 and Particle density(Mg m^{-3})-2.72. Soil samples were collected before sowing and after harvest of rajmash and analyzed as per standard methods

Results and discussion

Bulk density (Mg m^{-3})

The effect of INM on the bulk density of soil depicted in Table 1 showed significant effect with respect to treatments. In both 2012 and 2013, T_1 (1.41 and 1.42 respectively) recorded the highest value and was statistical at par with T_2 (1.40) and T_3 (1.39) in 2012 and only with T_2 in 2013 (1.40). The treatment T_4 to T_9 in 2012 and only T_4 to T_6 in 2013 were statistically at par with each other. T_{10} to T_{16} also did not show much difference among them. The lowest value (1.27 Mg m^{-3}) was observed in the treatment T_{17} (5 ton FYM + Biofertilizer + Lime + 50% NPK) in both years and it was at par with T_{18} (1.29 Mg m^{-3} in 2012 and 1.28 Mg m^{-3} in 2013).

In both the experimental period, bulk density was found to decrease in all the treatments over the initial value (1.42 Mg m^{-3}). Slight decrease in bulk density was found in the treatment receiving both organic and inorganic sources. This may be ascribed to better aggregation, more pore space and due to incorporation of root biomass in the soil as evident from accumulation of organic matter content of the soil and thus reduces bulk density. Similar findings were also observed by Ali *et al*. (1996), Sharma (2000), and Singh *et al*. (2000).

Particle density (Mg m^{-3})

Variation in particle density of soil was observed to be significant and the highest particle density (2.71 Mg m^{-3}) was found under control in both 2012 and 2013 and was statistically at par with the treatments T_2 (2.70 Mg m^{-3}), T_3 (2.69 Mg m^{-3}) and T_4 (2.68 Mg m^{-3}) in both the year (Table 1). The lowest particle density (2.61 Mg m^{-3}) was found in treatment T_{17} (5 ton FYM + Biofertilizer + Lime + 50% NPK) in both the experimental period-2012 and 2013 respectively.

In all the treatments, the particle density of the soil was found to be in decreasing trend in both the experimental period. This might be due to the fact that

Table 1: Effect of integrated nutrient management on bulk density and particle density of soil after the harvest of Rajmash.

Treatment	Bulk density (Mg m^{-3})		Particle density (Mg m^{-3})	
	2012	2013	2012	2013
T_1- Control	1.41	1.42	2.71	2.71
T_{2-} 50% NPK	1.40	1.40	2.70	2.70
T_{3-} 100% NPK	1.39	1.39	2.69	2.69
T_{4-} Biofertilizer	1.38	1.38	2.68	2.68
T_5-Biofertilizer + 50% NPK	1.37	1.37	2.67	2.67
T_{6-} Biofertilizer + 100% NPK	1.37	1.37	2.67	2.67
T_{7-} Biofertilizer + Lime	1.36	1.36	2.66	2.67
T_{8-}Biofertilizer + Lime + 50% NPK	1.36	1.36	2.65	2.66
T_{9-} Biofertilizer + Lime + 100% NPK	1.36	1.36	2.65	2.65
T_{10} – 5 ton FYM	1.35	1.35	2.66	2.65
T_{11} –5 ton FYM + 50% NPK	1.34	1.34	2.64	2.64
T_{12} –5 ton FYM + 100% NPK	1.34	1.34	2.63	2.64
T_{13-} 5 ton FYM + Biofertilizer	1.32	1.32	2.64	2.63
T_{14-} 5 ton FYM + Biofertilizer + 50% NPK	1.33	1.34	2.63	2.63
T_{15-} 5 ton FYM + Biofertilizer + 100% NPK	1.31	1.31	2.62	2.63
T_{16-} 5 ton FYM + Biofertilizer + Lime	1.31	1.31	2.62	2.62
T_{17-} 5 ton FYM + Biofertilizer + Lime+ 50% NPK	1.27	1.27	2.61	2.61
T_{18-} 5 ton FYM + Biofertilizer + Lime+ 100% NPK	1.29	1.28	2.62	2.62
Initial value	1.42	-	2.72	-
SEm±	0.008	0.006	0.010	0.013
CD (P=0.05)	0.023	0.016	0.028	0.04

with increase in organic matter of the soil, the particle density decreases. The decrease in particle density in both chemical and integrated treatments was also reported by Baruah and Barthakur (1997).

Soil pH

Data on soil pH are presented in Table 3. The initial soil pH recorded in 2012 was 5.12. After the harvest of the crop, the pH of the soil varied from 5.15 to 5.85 in 2012 and 5.11 to 5.83 in 2013. The highest pH (5.85) was recorded in the treatment T_{17} (5 ton FYM + Biofertilizer + Lime + 50% NPK) in 2012 and was found to be statistically at par with the treatments T_{18} (5.83) and T_{16} (5.81). The lowest pH (5.15) was found under treatment T_1 (control).

Similarly, in 2013 the highest pH (5.83) was recorded in the treatment T_{17} (5 ton FYM + Biofertilizer + Lime + 50% NPK) in 2012 and the lowest (5.11) under treatment T_1 (control) and the second lowest (5.23) under treatment T_2 receiving 50% NPK fertilizer.

In the integrated treatment plots, pH value was found

Table 2: Effect of integrated nutrient management on Soil pH and EC after the harvest of Rajmash.

Treatment	Soil pH		EC(dS m^{-1})	
	2012	2013	2012	2013
T_1- Control	5.15	5.11	0.08	0.08
T_{2-} 50% NPK	5.22	5.23	0.10	0.09
T_{3-} 100% NPK	5.24	5.25	0.10	0.09
T_{4-} Biofertilizer	5.26	5.27	0.10	0.10
T_5-Biofertilizer + 50% NPK	5.27	5.30	0.12	0.12
T_{6-} Biofertilizer + 100% NPK	5.30	5.32	0.11	0.10
T_{7-} Biofertilizer + Lime	5.70	5.72	0.11	0.11
T_{8-}Biofertilizer + Lime + 50% NPK	5.74	5.74	0.12	0.11
T_{9-} Biofertilizer + Lime + 100% NPK	5.73	5.76	0.12	0.12
$T_{10\,–}$ 5 ton FYM	5.33	5.30	0.10	0.10
T_{11} –5 ton FYM + 50% NPK	5.34	5.31	0.12	0.11
T_{12} –5 ton FYM + 100% NPK	5.36	5.32	0.11	0.12
T_{13-} 5 ton FYM + Biofertilizer	5.36	5.33	0.10	0.11
T_{14-} 5 ton FYM + Biofertilizer + 50% NPK	5.34	5.31	0.10	0.12
T_{15-} 5 ton FYM + Biofertilizer + 100% NPK	5.35	5.33	0.11	0.11
T_{16-} 5 ton FYM + Biofertilizer + Lime	5.81	5.64	0.12	0.11
T_{17-} 5 ton FYM + Biofertilizer + Lime+ 50% NPK	5.85	5.83	0.14	0.13
T_{18-} 5 ton FYM + Biofertilizer + Lime+ 100% NPK	5.83	5.63	0.13	0.12
Initial value	5.12	-	0.10	-
Sem±	0.02	0.05	0.007	0.006
CD (P=0.05)	0.05	0.15	0.02	0.02

to be slightly increased over initial value as a result of continuous incorporation and decomposition of organic materials which release basic cations and thus increased the pH. Increase in pH value with application of both organic and inorganic fertilizers was also reported by Prakash *et al*. (2002) and Kisinyo *et al. (*2012).

Electrical conductivity (dS m^{-1})

The EC as a result of different treatments was found to be significant as it is evident from Table 3. In 2012, the maximum EC (0.14 dS m^{-1}) was recorded in T_{17} (5 ton FYM + Biofertilizer + Lime + 50% NPK) followed by the treatment T_{18} (0.13 dS m^{-1}) whereas the minimum EC was recorded under the treatment T_1 (Control) giving a value of 0.08 dS m^{-1}.

In 2013, the highest EC (0.13 dS m^{-1}) was recorded in T_{17} (5 ton FYM + Biofertilizer + Lime + 50% NPK) followed by the treatment T_{18} (5 ton FYM + Biofertilizer + Lime + 100% NPK) as 0.12 dS m^{-1}, while the minimum EC (0.08 dS m^{-1}) was observed under control treatment.

The EC of the soil did not show any significant variation compared to initial EC status of the soil before sowing. This might be due to slow chemical changes that occurs in the soil profile and affected by environmental and biological factors.

Organic carbon (%)

Organic carbon content of the soils after harvesting of the crop as influenced by INM has been presented in Table 4 . The initial organic carbon content recorded in 2012 was 0.58 %. In the first year (2012), after the harvest of the crop, organic carbon varied from 0.60 to 0.98%. Maximum organic carbon (0. 98%) was recorded in the treatment T_{17} (5 ton FYM + Biofertilizer + Lime + 50% NPK which was at par with treatments T_{18} (0.97%) receiving 5 ton FYM + Biofertilizer + Lime + 100% NPK and T_{16} (5 ton FYM + Biofertilizer + Lime) as 0.96 %, while the minimum organic carbon content (0.60%) was recorded in the control plot.

In the second year (2013), the highest organic carbon (0.99 %) was recorded in the treatment T_{17} (5 ton FYM + Biofertilizer + Lime + 50% NPK) followed by T_{18} (0.97 %) and was found to be at par with the treatment T_{16} (0.95 %). While the lowest (0.60%) was recorded in the treatment T_1 (control) and at par with T_2 (0.61%), T_3 (0.63%) and T_5 (0.64%).

Integration of organic sources and their subsequent decomposition brought about a significant increase in organic carbon content of the soil. Thus, after the harvest of the crop, the treatments receiving both organic and inorganic fertilizers showed a marked increase in organic carbon content over the initial value (0.58 %) which might be due to direct addition of organic manure in the soil which stimulated the growth and activity of microorganisms and also due to better root growth, resulting in the higher production of biomass, crop stubbles and residues (Moharana *et al.* 2012). Although, organic carbon content was found to decrease in the only chemical treatments which might be due to lesser amount of crop residue accumulation. A similar trend was observed by Yaduvanshi (2001) and Prakash *et al*. (2002).

CEC [cmol (p^+) kg^{-1}]

It is evident from Table 4, there was a significant effect of treatments on the CEC of the soil. In 2012, it varied from 5.24 to 6.22 cmol$(p^+)kg^{-1}$ as compared to initial value of 5.33 cmol$(p^+)kg^{-1}$. In the first year of experimentation (2012), the highest value was observed in the treatment T_{17} (5 ton FYM + Biofertilizer + Lime + 50% NPK) as 6.22 cmol$(p^+)kg^{-1}$ followed by the treatment receiving T_{16} [6.19 cmol$(p^+)kg^{-1}$] and T_{18} [6.16 cmol$(p^+)kg^{-1}$]. The lowest CEC of 5.24 cmol$(p^+)kg^{-1}$ was recorded in the control treatment T_1 .

Similarly, in 2013 the maximum [5.81 cmol$(p^+)kg^{-1}$) was recorded in T_{17} (5 ton FYM + Biofertilizer + Lime + 50% NPK) which was found to be statistically at par with the treatments T_{16} as 5.76 cmol$(p^+)kg^{-1}$, T_{18} and T_{14} as 5.75 cmol$(p^+)kg^{-1}$ and the minimum was recorded in T_1 (control) as 5.21 cmol$(p^+)kg^{-1}$ and it was at par with the treatments 50 % NPK [5.22 cmol$(p^+)kg^{-1}$] and 100 % NPK [5.23 cmol$(p^+)kg^{-1}$].

The increase in CEC could be attributed to the improvement in the organic carbon content of soil and also due to formation of humus as a result of decomposition of organic matter which might increase the surface area and developed more negative charge due to dissociation of H ion from functional group. A similar finding was also reported by Bijan *et al*. (1992) and Yagi *et al*. (2003).

Conclusion

Based on these results, it can be concluded that treatment T_{17} (5 ton FYM + Biofertilizer + Lime+ 50% NPK) may be recommended for growing rajmash in the acid soil of Nagaland. Almost all the soil physico-chemical properties *viz*., soil pH, EC, organic carbon, CEC and percent base saturation were found to be highest in the treatment receiving 5 ton FYM + Biofertilizer + Lime+ 50% NPK (T_{17}) except bulk density and particle density was found to be in decreasing trend in both the years of experimentation and was recorded highest in the control plot.

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Table 3: Effect of integrated nutrient management on organic carbon and CEC after the harvest of Rajmash.

Treatment	Organic carbon (%)		CEC [cmol $(p^+)kg^{-1}$]	
	2012	2013	2012	2013
T_1- Control	0.60	0.60	5.24	5.21
T_{2-} 50% NPK	0.63	0.61	5.28	5.22
T_{3-} 100% NPK	0.66	0.63	5.31	5.23
T_{4-} Biofertilizer	0.69	0.65	5.35	5.28
T_5 -Biofertilizer + 50% NPK	0.72	0.64	5.42	5.33
T_{6-} Biofertilizer + 100% NPK	0.77	0.68	5.46	5.36
T_{7-} Biofertilizer + Lime	0.80	0.68	5.46	5.39
T_{8-}Biofertilizer + Lime + 50% NPK	0.84	0.70	5.52	5.46
T_{9-} Biofertilizer + Lime + 100% NPK	0.86	0.72	5.56	5.57
$T_{10\,-}$ 5 ton FYM	0.88	0.74	5.60	5.61
T_{11} –5 ton FYM + 50% NPK	0.90	0.76	5.65	5.67
T_{12} –5 ton FYM + 100% NPK	0.91	0.82	5.67	5.70
T_{13-} 5 ton FYM + Biofertilizer	0.94	0.91	6.10	5.74
T_{14-} 5 ton FYM + Biofertilizer + 50% NPK	0.94	0.91	6.15	5.75
T_{15-} 5 ton FYM + Biofertilizer + 100% NPK	0.95	0.93	6.16	5.71
T_{16-} 5 ton FYM + Biofertilizer + Lime	0.96	0.95	6.19	5.76
T_{17-} 5 ton FYM + Biofertilizer + Lime+ 50% NPK	0.98	0.99	6.22	5.81
T_{18-} 5 ton FYM + Biofertilizer + Lime+ 100% NPK	0.97	0.97	6.18	5.75
Initial value	0.58	-	5.33	-
SEm±	0.007	0.02	0.01	0.02
CD (P=0.05)	0.02	0.04	0.03	0.06

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