Blended Amendments: A Sustainable Approach for Managing Nutrient Deficiency in Rice Fields

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ABSTRACT

The application of chemical fertilizer provides absorbable soluble macronutrients for increasing rice yield while reducing the availability of micronutrients and occasionally halting nitrogen mineralisation in the soil. To lessen some of these undesirable effects of chemical fertilization, an effort has been made to prepare blended soil organic amendments by mixing organic materials like rice straw, dried cow-dung and compost prepared from eco-friendly wastes from the kitchen, backyard garden and dried cow-dung mixed in the ratio 1:2:2. Such prepared amendments were applied in the rice field by growing three high-yielding rice cultivars *Dikhow*, *Chandrama* and *Naveen*, in three different rice cropping seasons, pre-monsoon (*Ahu)*, monsoon *(Sali)* and summer *(Boro*) during 2015-2016 and 2016-2017 for studying soil properties, crop growth and yield. The key finding of the investigation was that the soil amended with chemical fertilizer showed improvement in soil moisture compared to unamended soil in all three rice fields. However, chemically fertilized soil exhibited lower amounts of available phosphorus, available potassium, diethylenetriaminepentaacetic acid (DTPA) extracted iron and copper in *Ahu* field, DTPA extracted iron, copper and zinc in *Sali* field and immobilizing nitrogen in *Boro* field than blended amendments. Overall, chemical fertilizer + rice straw displayed more available nitrogen and yield in *Ahu* field, whereas, chemical fertilizer + dried cow dung showed the highest amount of zinc and copper along with the highest yield in *Sali* rice field and chemical fertilizer+compost had better moisture and soil organic carbon amounts with an ideal acidic pH supporting maximum yield in *Boro* rice field.

1. INTRODUCTION

Rice is a staple food for half of the world's population regardless of their economic status (Mackill et al., 2012). It supplies more than 27% of daily calories in developing countries while creating a gargantuan need for its production (Carrijo et al., 2017; Naresh et al., 2018). This increasing demand for rice production is attained by growing more rice-rice crop sequences, diversifying the rice ecosystem through irrigation, and managing nutrients in rice fields (Singh et al., 2002).

The nutrients of the rice soil have increased by the application of fertilizer in rice soil which rose during the latter half of the twentieth century following the introduction of high-yielding rice varieties (Khush, 1999; Davies, 2003). These varieties have 20% more grain production than traditional varieties and are more responsive to chemical fertilizers. But overuse of chemical fertilizers to get high yield triggers environmental issues like increased greenhouse gas emission, groundwater contamination, and surface water eutrophication (Cai et al., 2018). It also causes soil degradation by altering the natural microflora and increasing soil acidity, nutrient imbalances, micronutrient deficiencies (Singh, 2000; Leip et al., 2014; Lehmann and Kleber, 2015; Gunina and Kuzyavok, 2015; Dimkpa and Bindraban, 2016; Elemike et al., 2019), thus, reducing the availability of nutrients for plant uptake for effective plant functioning and biomass accumulation (Faisal and Farooq, 2019). Moreover, a reduction in the concentration of iron and zinc in rice soil affects uniform grain maturity and productivity.

Organic materials gathered from the neighbouring locality of a rice field have a share in improving soil properties (Arunrat et al., 2020). The

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immediate positive effects of the application of organic materials are soil aggregation and increasing the moisture content, and long-term benefits on micronutrient and organic carbon storage (Hans et al., 2018) on complete decomposition. The application of too much organic materials in the soil produces toxic effects arising from the reduced metabolic intermediates on the degradation of these materials (Liang et al., 2003). In reality, organic materials solely may not meet the rice plants' requirements due to the comparatively low nutrient contents and the gradual release of plant nutrients (Elemike et al., 2019). So, an approach used for sustainable rice cultivation is to apply organic materials blended with chemical fertilizer. Such organic materials like rice straw and dried cow dung provide recalcitrant carbon and nutrients, whereas compost derived only from biodegradable organic material provides humified carbon, supports carbon sequestration and soil formation.

There are reports on the use of organic materials with chemical fertilizer in rice fields which emphasise the increase in yield, dissolved organic carbon, microbial biomass carbon, different soil organic carbon fractions like humic acid, fulvic acids, and reducing greenhouse gases emission (Moscatelli et al., 2005; Bharali et al., 2018; Iqbal et al., 2020). But studies to specify nutrients variation at harvest stage by cultivating high-yielding varieties in acidic sandy soil in a sub-tropical type of climate are limited. The application of blended amendments in rice fields improve soil fertility and ultimately increases the yield of high-yielding rice varieties. So, the objectives of this study were (1) to assess the effect of blended amendments on soil properties like soil temperature, soil moisture, soil pH, soil organic carbon, available nitrogen, available phosphorus, available potassium and DTPA extracted iron, copper, manganese and zinc; (2) to determine the combined effect of blended amendments on plant height, yield, and partial factor productivity at harvest. The influence of chemical and blended amendments investigated by growing high-yielding three rice cultivars *Dikhow*, *Chandrama* and *Naveen*, in three different rice cropping seasons in *Ahu* (pe-monsoon), *Sali* (monsoon) and *Boro* (summer) during 2015-2016 and 2016-2017.

2. METHODOLOGY

2.1 Study area, amendments applied and field design

The study was carried out in the Tezpur University campus Napaam comes under the Sonitpur district of Assam, India. The site is at 26º37′59″ N latitude and 92º47′59″ E longitude at an elevation of 74 m above sea level and falls under the North Bank Plains Agroclimatic zone of Assam. The site experiences a humid and subtropical climate and has more or less hot wet summers and dry winters. The climatic data of the experimental years are in Figure 1. The pre-monsoon rice (*Ahu*) variety of *Dikhow* (Parents: Heera and Ananda; duration of the variety: 90-100 days), monsoon rice (*Sali)* variety of *Chandrama* (ARC6650 and CR94-721-3; duration of the variety: 135-140 days) and summer rice (*Boro*) variety *Naveen* (Parents: Sattari and Jaya; duration of the variety: 115-130 days) were taken for performing the field experiments. *Dikhow* is a short-duration variety growing well in flooded soil conditions, and *Chandrama and Naveen* are semi-dwarf varieties that grow both in *Sali* and *Boro* seasons. The investigation was carried out from March 2015 to June 2016 and similar experiment was redone again at the same field in following year 2016-2017. A plot size of 4 m^2 was done with four replicates in randomised block design with six amendments (Figure 2), T1-No application of amendments, T2-mineral fertilizer (NPK), T3-NPK+ rice straw (5 ton/ha), T4-NPK+dried cow dung (5 ton/ha), T5-NPK+dried cow dung (10 ton/ha) and T6-NPK+compost (2.5 ton/ha) (Table 1). The chemical fertilizer NPK was applied in the form of urea (N), superphosphate (P_2O_5) and muriate of potash (K_2O) at the rate of 40:20:20 kg/ha for *Ahu* and 60:20:40 for *Sali* and 60:30:30 for *Boro* rice cropping seasons. The amendments with the recommended dose of chemical fertilizer were incorporated in the field at the final puddling for even mingling, maintaining a gap of 50 cm between two plots to prevent intermixing of the amendments. Here, only 50% of urea is applied at this stage and the remaining 50% is applied after transplantation. The rice straw is the harvested straw of previous rice cultivation, chopped into 5cm pieces. The cow dung mixed with urine was dried under the sun and ground into a fine granular texture. The compost was made using kitchen wastes, garden wastes, and dried cow dung in the ratio of 1:2:2 by compositing in a dug-up soil for two months before application. Nitrogen supplied through organic materials is positively linked to mineralizable nitrogen but varies with texture, groundwater level and land use. However, no such predictive value is introduced into fertilizer recommendation schemes (Rose et al., 2011). Hence, the quantity of organic materials is selected based on cost, handiness, accessibility and

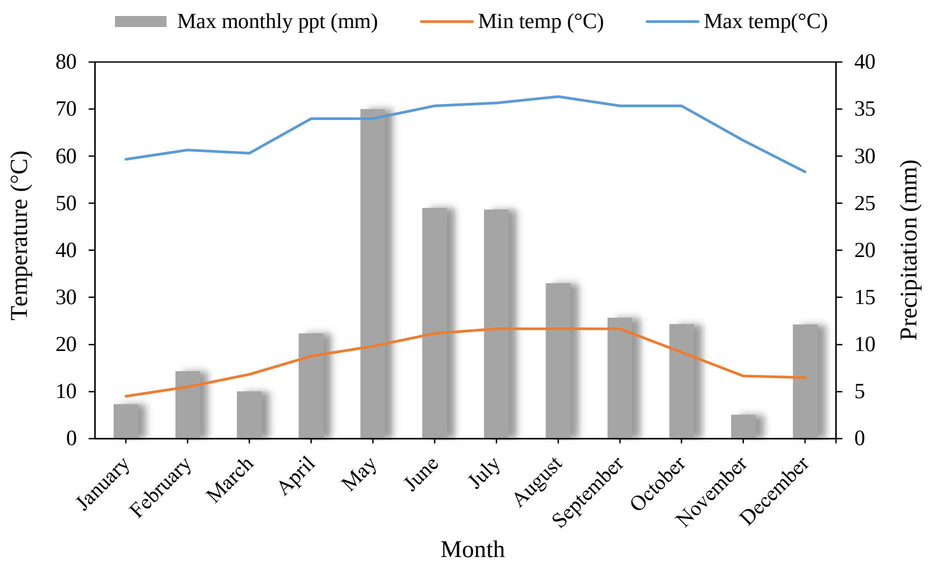

Figure 1. Monthly maximum temperature, monthly minimum temperature, and Monthly maximum precipitation with mean values recorded for 2015-2017

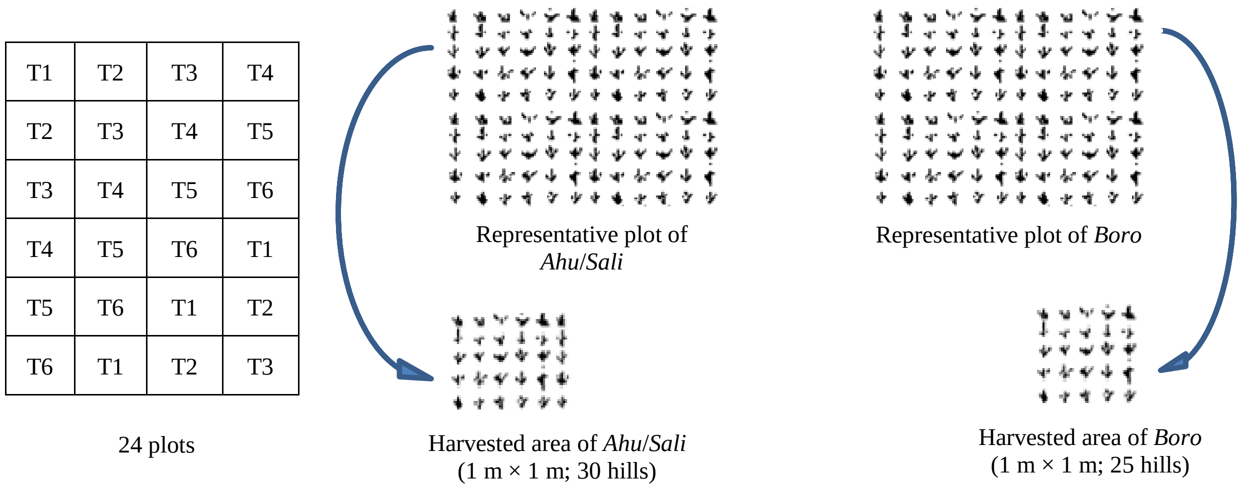

Figure 2. Schematic representation of field layout RBD-(Randomised Block Design) of *Ahu*, *Sali* and *Boro*

Table 1. The detail of amendments presented in Tabular format

Amendment	Nature of the amendment
T1	No amendment
T2	NPK (recommended dose)
T3	NPK + crop residues (5 ton/ha)
T4	NPK + farmyard manure (5 ton/ha)
T5	NPK + farmyard manure (10 ton/ha)
T6	NPK + compost (2.5 ton/ha)

Recommended dose of NPK: *Ahu* (40:20:20), *Sali* (60:20:40) and *Boro* (60:30:30)

availability. In the current experiment, the crop residue in the form of straw supplied 1 Mg carbon (5 ton) per ha was blended with urea (<200 kg). As most of the carbon supplied through cow dung in the tropical climate are mineralised, two rates of cow dung addition were chosen, 5 ton/ha and 10 ton/ha, to facilitate grain yield, increase soil nutrients and soil organic carbon quantity. Whereas the amount of compost was maintained at 2.5 ton/ha as it can immediately supply plant available nutrients. Rice straw (C:N=49.70 and moisture content=12.7%), dried cow dung (C:N=14.02 and moisture content=46.94%) and compost (C:N=10.28 and moisture content=35.49%) were applied in *Ahu*, *Sali* and *Boro* rice ecosystems for two years of cropping cycles. Since the crops of *Ahu* and *Sali* are rain supported (rainfed), no irrigation is required after the establishment of the crop as advised by the Government of Assam. However, for soaking land before the preparatory tillage and the final puddling, irrigation has been applied. The water management adopted for *Boro* rice is in the scheme of flooding-dry-re-flooding. The irrigation was done in plots to maintain 5 cm of standing water and at an interval of three days till panicle initiation. Fertilizer dose, spacing and other agronomic practices were retained for two consecutive years according to the package of practice issued by the Government of Assam, India.

2.2 Soil sample and crop growth analysis

Soil samples collected randomly were examined before crop growth and at harvest to determine the influence of the amendments on soil moisture by gravimetric method, pH by pH meter, soil temperature by soil thermometer, total carbon (TC) and total nitrogen (TN) by CHN analyser (model: 2400 series2, USA) and values (TC/TN) were divided to get C:N ratio, soil organic carbon oxidisable at 24 N sulphuric acid by Walkley and Black (1937) method. Available nitrogen, available phosphorus and available potassium were determined as per Page et al. (1982), and 0.005 N Diethyletriaminepenta acetic acid (DTPA) extracted micronutrients (copper, iron, manganese, zinc) by mass spectrophotometer. Plant height at harvest was measured from the base of the stem to the tip of the panicle with a measuring tape from the field itself. The matured grains containing 10% moisture were gathered for the calculation of yield. The partial factor productivity (PFP_N, kg grain/kg N applied) was calculated from grain yield with N use divided by applied N amount (Guo et al., 2017).

$$\text{PFPN} = \frac{\text{kg grain}}{\text{kg N applied}}$$

2.3 Statistical analysis

The data were pooled from two experimental years and were analysed statistically using the SPSS 15.0 software package. The one-way ANOVA compares the values of amendments T2 to T6 with unamended T1. The least significant difference and Tukey's Honest difference tests estimate the significant difference at $p<0.05$ level. The least significant difference rejects the blended amendments that do not affect soil properties in Table 2 whereas, Tukey's Honest difference finds the difference among the plant height, yield, and PFP_N in Table 3.

3. RESULTS

3.1 Soil properties

The physico-chemical properties of soil of the three experimental fields were done before the crop cultivation. From the analysis it was found that soil was sandy, slightly acidic having pH varying from 5.40 to 5.67 with a bulk density of 1.34 kg/m^3, porosity 37.04%, water holding capacity 47.01% and with low organic carbon content (11.3-18.5 g/kg). The availability of nitrogen is low (113.56-238 kg/ha) due to occurrence of leaching in humid climates whereas available phosphorus varies from 12.50 kg/ha to13.90 kg/ha. The soil also experiences available potassium in the range of 70.65 kg/ha to 86.17 kg/ha with low organic carbon and zinc.

3.2 Effects of blended amendments on soil properties, plant growth and yield

In *Ahu* rice field, excluding soil temperature, all other soil properties differed slightly from each other among amendments with T2 showing the lowest available potassium, DTPA extracted iron and copper. The amendment T5 presented the highest value for DTPA extracted iron, zinc and copper (Table 2). The T3 and T1 plots had the highest and the lowest plant height (Figure 3). The *Ahu* fields had the lowest partial factor productivity of nitrogen in comparison to other rice fields with T6 (11.17±0.00 kg/kg) showing the highest values while T5 had the lowest values (8.45±0.00 kg/kg). The lowest nitrogen utilisation efficiency resulted in the lowest rice production and shows no significant difference among the amendments; T3 exhibiting the highest yield (13.50±0.02 Q/ha) and T1 the lowest yield (8.70±0.00 Q/ha).

In response to amendments in *Sali* rice fields, soil organic carbon and available nitrogen showed significant differences among the soil parameters. The soil nutrients, such as available phosphorus, DTPA extracted iron and zinc at harvest were more in blended amendments (T3-T6) than T2. Also, T2 recorded the lowest value of iron, zinc and copper, while T4 showed the highest value of iron and manganese. T5 recorded the highest value for zinc, copper, and yield (53.65±0.01 Q/ha). The T1 plots showed the lowest plant height (111.40±0.70 cm) and the lowest yield (40.00±0.01 Q/ha).

Table 2. Variation of soil properties at harvest stage indicated by mean under amendments from data pooled for two years

Cropping season	Amendment	ST (ºC)	SM (%)	pH	SOC (g/kg)	C:N	AN (kg/ha)	AP (kg/ha)	AK (kg/ha)	Fe (mg/kg)	Zn (mg/kg)	Mn (mg/kg)	Cu (mg/kg)
Pre-monsoon (*Ahu*)	T1	32	34.28	5.73	16.05	7.03	213.40	12.19	80.15	18.93	1.00	3.42	1.82
	T2	32	35.70	5.47	18.25	5.45	222.90	11.59	70.01	18.72	1.09	3.76	1.81
	T3	32	36.64	5.39	18.85	2.10	254.87*	10.10	71.40	19.85	1.18	3.74	2.00
	T4	32	37.98	5.39	16.70	3.48	238.67	13.25	80.97	20.04	1.25	3.80	1.91
	T5	32	34.87	5.34	18.90	2.16	240.87	12.31	79.16	20.52	1.46	3.78	2.10
	T6	32	35.15	5.44	17.05	2.35	234.76	13.81	71.72	19.22	1.24	3.32	1.87
Monsoon (*Sali*)	T1	31	28.21	5.73	12.30	29.50	242.50	13.19	85.15	19.94	1.51	3.52	1.86
	T2	31	30.26	5.44	11.70*	14.08	266.50	12.59	78.01	19.78	1.19	3.81	1.88
	T3	31	29.04	5.38	13.60	11.59	295.50*	12.10	76.40	20.87	1.22	3.84	2.01
	T4	31	28.59	5.39	13.30	11.23	285.00*	14.25	83.97	22.05	1.35	3.89	1.98
	T5	31	31.26	5.33	11.80*	13.66	287.50*	14.31	80.17	21.51	1.56	3.84	2.13
	T6	31	30.85	5.43	0.98*	16.07	262.50	14.81	71.73	21.43	1.34	3.35	1.88
Summer (*Boro*)	T1	33	29.55	4.91	11.71	2.08	225.00	10.91	79.79	15.08	0.78	9.31	2.41
	T2	33	34.58	4.78	14.39	1.77	284.83*	11.43	114.94	19.24*	0.88	11.38	2.51
	T3	33	34.01	4.72	14.85	2.44	304.00*	13.01	102.55	20.02*	0.88	11.66	2.47
	T4	33	33.77	4.97	13.21	2.19	308.83*	10.72	94.98*	20.38*	0.88	11.65	2.53
	T5	33	32.25	4.92	15.64*	2.28	294.00*	12.32	119.25	22.01*	0.97	11.78	3.05
	T6	33	38.88*	5.16	16.94*	2.34	308.50*	11.34	93.35	21.38*	0.92	11.82	2.73

Note: Values marked with (*) are significantly different from the corresponding values under T1 by least significant difference test at $p<0.05$. ST-Soil temperature, SM-Soil moisture, C:N-carbon:nitrogen, SOC-Soil organic carbon, AN- Available Nitrogen, AP-Available phosphorus, AK-Available potassium, Fe-Iron, Zn-Zinc, Mn-Manganese and Cu-Copper

Table 3. Variation of crop growth at harvest stage indicated by mean under amendments from data pooled for two years

Cropping season	Amendments	Plant height (cm)	Yield (Q/ha)	PFP_N (kg/kg)
Pre-monsoon (*Ahu*)	T1	83.66±1.60	8.70±0.00	-
	T2	93.00±1.00	9.80±0.00	11.13±0.00
	T3	108.50±1.26*	13.50±0.02	11.06±0.01
	T4	102.80±1.75	10.30±0.01	9.76±0.00
	T5	106.60±1.78	10.40±0.20	8.45±0.00
	T6	103.00±2.64	10.05±0.02	11.17±0.00
Monsoon (*Sali*)	T1	111.40±0.70	40.00±0.01	-
	T2	119.75±0.35*	46.00±0.01	34.85±0.00
	T3	116.23±0.14*	50.00±0.01*	30.12±0.00
	T4	119.00±0.57*	52.00±0.02*	35.45±0.00
	T5	120.00±0.44*	53.00±0.01*	32.33±0.00
	T6	121.50±0.28*	49.00± 0.01*	36.13±0.00
Summer (*Boro*)	T1	80.36±0.31	32.72±3.10	-
	T2	106.40±0.30*	46.08±4.31	52.28±0.04
	T3	93.43±0.64*	43.41±4.06	35.2±0.04
	T4	98.43±0.31*	43.62±4.14	41.71±0.4
	T5	107.83±0.44*	47.47±2.51	38.22±0.02
	T6	104.50±0.28*	53.34±2.10	56.15±0.02

Values are means±standard error with (*) under the same column are significantly different from the corresponding value of T1 of a growth stage at 5% level of probability by Tukey honest difference test. PFP_N -Partial factor productivity

A significant variation in the value of soil properties of *Boro* rice fields at the harvest stage was observed (Table 2). The T6 exhibited the highest soil moisture, pH, soil organic carbon and manganese whereas, T1 exhibited the lowest soil organic carbon, available nitrogen, available potassium, iron, zinc, manganese and copper. In addition, available phosphorus and available potassium concentrations in T6 soil increased as compared to T2. This may be due to the fact that T6 plots received nutrients both from chemical fertilization and compost. The plant height was the highest in (T5) whereas the lowest in (T1). Also, the lowest yield of 32.72±3.10 Q/ha was found in T1 and the highest yield of 53.34±2.10 Q/ha and PFP_N of 56.15±0.02kg/kg was recorded in T6 (Table 3).

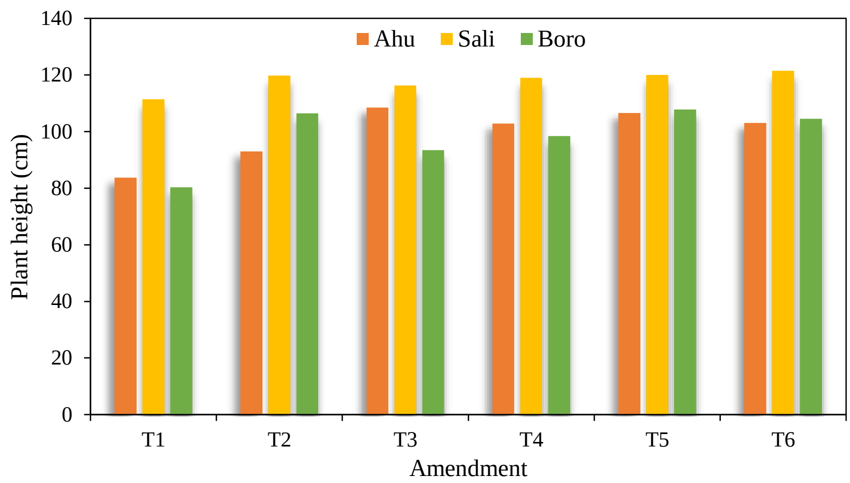

Figure 3. A comparison of rice plant growth at harvest of each amendment in each cropping season

4. DISCUSSION

The agriculture method depends on chemical fertilizer with damaging effects on soil quality, crop yield, and environment (Moe et al., 2019; Naher et al., 2019; Chandini et al., 2019). The amelioration of nutrient status, carbon transformations, and maintaining soil structure for sustainable crop production are key research topics (Kibblewhite et al., 2007; Al-Khuzai and Al-Juthery, 2020). Thus, the objective of this study was to determine the effect of blended amendments on soil properties, plant height, yield, and partial factor productivity in the acidic sandy soil of the sub-tropical climatic region.

At harvest, soil samples analysed from three rice fields exhibited that chemical fertilized plots had a deficiency in nutrients while T3-T6 containing blended amendments prevented a reduction in macro and micronutrients in varying proportions. Soil temperature, soil moisture, and pH influence microbial activity to conserve native soil organic matter enhancing soil organic carbon quantity across the blended amendments with T5, T3, and T6 showed the highest amount in *Ahu*, *Sali*, and *Boro* fields at the time of harvest. Soil organic carbon is an indicator of soil quality (Ngatia et al., 2021). Overall, the untreated soil (T1) took in the lowest soil moisture among the amendments in all three cropping seasons at the harvest stage. Thus, the application of amendments (inorganic or organic) provides easy access to nutrients favouring microbial growth and turnover, increasing moisture availability, promoting a positive soil environment for plant growth, and eventually enhancing rice yield (Dhaliwal et al., 2019). The pH of T2-T6 was lower than T1 except for T6 under *Boro* cropping seasons. The plants' growth in T2-T6 dropped the soil pH under amendments in three cropping cycles as hydrogen ions discharged in soil by microbial decomposition from applied nitrogen fertilizer were consumed in nitrate formation. These might be the reason for lower soil pH in T2-T6 than an unfertilized soil T1. The T6 of *Boro* cropping seasons picked up the hydrogen ions formed during irrigation and nitrogen fertilizer solubilisation. Thus, lowering the pH to 5.15 was favourable for the rice plant's growth. The amendments immobilised the nitrogen in the soil in *Ahu* and *Boro* cropping cycle. This nitrogen is mineralised by heterotrophic microbes only on the death of these organisms. The process of mineralisation being slow would lead to a residual effect. At the same time, the amount of nitrogen will decrease in succeeding cultivation. A plant requires nitrogen for making amino acids, proteins, and cells. When there is a nitrogen deficiency in the soil, the growth of plants stops. However, when nitrogen is abundantly available, its concentration in plant tissue after transplanting increases and gradually decreases towards maturity. There is the proper development of rice plants if there is an adequate supply of nitrogen at all growth stages for prolific tillering, satisfactory panicle formation, good seed setting, and proper filling of those grains (Djaman et al., 2018).

On the whole, the concentration of micronutrients extracted by DTPA followed the order Fe>Mn>Cu>Zn. The amount removed by DTPA can be implicitly related to the amount taken by plants. Shukla and Behera, (2019) reported that 36.50% of the soil of India is deficient in available zinc, 12.80% in iron, 7.10% in manganese and 4.20% in copper. The dried cow dungs an effective micronutrients provider like iron, zinc, copper and manganese in the T5 among the amendments in *Ahu* cropping season. But rice yield under blended amendments with *Dikhow* crop variety was at par with NPK or even decreased under additional organic input. Although organic materials mixed with chemical fertilizer as blended amendment input increases micronutrients quantities, a large amount of organic material should be avoided to maintain crop yield. Therefore, in order to identify the best strategies for increasing rice productivity in the *Ahu* ecosystems, a few more field experiments are needed.

The nitrogen utilisation was better in *Sali* and *Boro* fields than *Ahu* field, T6 producing the highest efficiency in *Sali* and *Boro* fields. Thus, better nitrogen utilisation efficiency can be attributed to variation in weather conditions and average rainfall more during this period of the cropping season. The availability of nutrients increases with the addition of blended amendments, and they also promote the decomposition rate of native soil organic nitrogen. In addition, these blended amendments enhanced rice productivity by improving the nitrogen supply capacity from vegetative parts of plants to grains. The emergence of widespread micronutrient deficiencies is a constraint on productivity. A balanced supply of NPK and micronutrients is necessary for crop growth, yield, and nitrogen utilisation efficiency. Other reports have established the positive effects of micronutrients on rice yield and nitrogen utilisation efficiency, and the positive effects varied with the type of rice and nutrient (Li et al., 2019; Nadeem and Farooq, 2019). The high-yielding cultivar takes away nutrients from the soil besides utilizing mineral fertilizers and lowers micronutrients from the rice soil through leaching. However, regular use of dried cow-dung or other organic supplies stops the reduction of extractable micronutrient levels from the rice soil of India reported by Pal et al. (2015). In submerged fields, zinc is the most commonly deficient micronutrient, while the iron is the most usual toxic micronutrient. As in flooded conditions, biochemical characteristics of soil change to reductive nature, making zinc less available and more of iron to rice plants. The application of chemical fertilizer+dried cow dung in the right amount partially mitigates the problems.

Nutrients are already present in the soil. The rice plants still need more macronutrients in amount from chemical fertilizers, particularly for higher yields. If chemical fertilizer replaces blended amendments consisting of chemical fertilizer and organic materials, the breakdown of such material produces definite organic acids, which lower the pH of the soil to a favourable acidic pH range and ultimately increased the availability of nutrients for the plants. Various investigators like Linquist et al. (2007), Moe et al. (2019), Bhardwaj et al. (2020), and Datta and Devi (2020) have reported that organic material increased the availability of a maximum number of nutrients. There is a positive association between organic material and nutrient elements and presumably by providing soluble complexing mediators that delay their fixation in the soil. The North Bank plain zone part of the agroecosystem, with high rainfall and the mean temperature, is found favourable for rice cultivation throughout the year except for winter where the temperature is low. So, mostly monsoon and summer crops of rice are grown during the months from May to November. The *Boro* rice system showed the maximum yield among the three ecosystems. This higher production in the summer season is attributed to more soil organic matter, higher solar radiation, better water control (irrigation), fertilizer responsive rice varieties. Thus, seasonal weather conditions influence crop production.

5. CONCLUSION

The results reveal that chemical fertilization of rice soil increases the soil moisture more than unamended soil for all three rice fields. But chemical fertilized soil showed the lowest amount of available phosphorus, available potassium, DTPA extracted iron and copper in *Ahu* field, DTPA extracted iron, copper, and zinc in *Sali* field, and immobilizing nitrogen in *Boro* field. The chemical fertilizer+rice straw (T3) showed the highest available nitrogen and yield in the *Ahu* rice field whereas, the chemical fertilizer+dried cow dung (T5) showed the most zinc, copper, and rice yield in the *Sali rice* field and the chemical fertilizer+compost (T6) had better moisture and soil organic carbon and an ideal acidic pH sustaining maximum yield attainment in the *Boro* rice field. On the whole, after the addition of blended amendments to acidic sandy soil, there is an increase in soil organic carbon and other soil nutrients with a positive effect on rice yield.

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