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Research Communication

In-situ green-manuring for enhanced rice (*Oryza sativa*) productivity under north eastern hill region

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ABSTRACT

An experiment on was conducted during the rainy (*kharif*) season of 2019 at Barapani, Meghalaya, to study the comparative effect of buckwheat (*Fagopyrum esculentum* Moench) and ricebean [Vigna umbellate (Thunb.) Ohwi & H. Ohasi] green manures on growth and productivity of rice (*Oryza sativa* L.), to assess the economic feasibility of various nutrient-management options in rice-production system. The results revealed that, plant height growth, dry-matter accumulation, tillers, grain yield and economics were improved under green-manuring buckwheat and rice bean along with RDF combination. In situ green manuring of and nutrient management (RDF 100, 75 and 50%) significantly (P≤0.05) influenced the grain yield (t/ha) of direct-seeded, upland rice. Maximum grain yield (4.55 t/ha) was obtained with buckwheat green-manuring + 100% recommended dose of fertilizer. Soil-microbial activity in terms of enhanced enzymatic activity of acid phosphatase was observed under green-manuring with RDF (1005). Hence buckwheat proved to be a superior green manure along with 100 recommended doses of fertilizers.

Key words: Buckwheat, Direct-seeded, Economics, Green manuring, Upland rice, Yield

Rice (*Oryza sativa L.*) is one of the major crops of India, covering 43.85 million ha with a production of 113.5 million tonnes (Economic Survey, 2018). The low rice productivity in North-Eastern India, despite of the congenial weather conditions is a concern. Presently rice self-sufficiency is only about 80% in north-eastern India. The poor agronomic management and obsolete rice cultivars, further lead to low productivity. The NPK use in the NE region is very less. Therefore, the standardization and validation of efficient nutrient-management practices hold great promises. Green-manuring increases the crop yields and the maintains soil fertility, and a green-manure crop can be a substitute to 50–60 kg fertilizer N/ha (Sharma *et al.,* 2013). Buckwheat as green-manure crop releases nutrients especially potassium for uptake by the subsequent crop (Kumar *et al.,* 2008). It has an excellent ability in sequestering P, Ca, and micronutrients from the soil, and makes these nutrients available to the crop plants. It has been reported that, P uptake by buckwheat is about 10 times higher than wheat, and on being decomposition this P will be made available to next crop (Zhu *et al.,* 2002). Rice bean reduces N loss and improves rice yield (Yingliang *et al.,* 2014). With this background, an experiment was carried in north eastern hills region under direct-seeded upland conditions, to study the comparative effect of buckwheat and rice bean green manures on growth and productivity of rice.

The field experiment was conducted during the rainy season (*kharif*) of 2019 at the ICAR-Research Complex for North-Eastern hills Region, Barapani, Meghalaya. The experiment was laid out in randomized block design, replicated thrice with 11 treatments. 'Bhalum 2' rice variety was used. Eleven treatments comprised, control, buckwheat green manure (GM), buckwheat GM + recommended dose of fertilizer (RDF), buckwheat GM + 50% RDF, buckwheat GM + 75% RDF, buckwheat GM + 50% RDF + biofertilizer, rice bean GM, ricebean GM + RDF, Rice bean GM + 50% RDF, rice bean GM + 75% RDF and Ricebean GM + 50% RDF + biofertilizer. Throughout the crop period, hand-weeding was done at 15, 35 and 55 days after sowing (DAS). The soil was clay loam and acidic. It was rich in organic carbon content (1.62%), with *p*H 4.8. Available nitrogen (258 kg/ha) was medium, available phosphorus (6.6 kg/ha) was low and available potassium

Based on

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(355 kg/ha) was high. The annual rain ranges between 2,500 and 3,200 mm. After sun-drying, the produce was threshed plot-wise using thresher.

Plant height and dry-matter accumulation at harvesting of upland rice increased due to green manuring with buckwheat and rice bean and also with combination of recommended dose of fertilizer and green-manuring (Table 1) at all stages of the crop during 2019. Irrespective of stages of the crops, buckwheat green-manuring + 100% RDF resulted in significantly higher plant height (101.5 cm) of upland rice at harvesting. Green-manure generally has a considerable amount of biomass which comprises aboveground and below-ground biomass. The biomass has the ability to increase solar energy harvesting and C flux into the soil and provides food for soil macro- and micro-organisms (Dabney *et al.,* 2001). Green manuring with buckwheat and rice bean with 100% RDF (T_3) resulted in almost equal number of tillers/m^2. This was owing to rapid release of plant nutrients from these green manure crops on being incorporated in to the soils, and the inorganic nutrient sources also helps in release of nutrient and lessening the immobilization of plant nutrients (Kumar *et al.,* 2011; IIRI 2020).

In-situ green-manuring and nutrient management (recommended dose of fertilizer 100, 75 and 50%) significantly (P≤0.05) increased the grain yield of direct-seeded, upland rice (Table 1). The maximum grain yield (4.55 t/ha) was obtained from treatment T_3 and it remained statistically at par with treatment T_8 (rice bean green-manuring + 100 recommended dose fertilizer) (4.43 t/ha). Green-manuring of buckwheat with 100% recommended dose fertilizer resulted in significantly higher grain yield than + 50% RDF, but remained at par with buckwheat green-manuring + 75% recommended dose fertilizer nutrient-management (4.33 t/ha). Owing to green-manuring before rice sowing/transplanting an increase of rice grain yield 45 to 130%, depending on environmental conditions and management practices adopted have been reported by Ladha *et al.,* (1992). Further, if green-manure incorporation is combined with fertilizer N application, rice yields are higher than those obtained with an equivalent amount of N alone (Babu *et al.,* 2014). Acid phosphatase enzyme speeds up soil organic phosphorous decomposition and, hence enhances soil phosphorus bioavailability. Phosphatases are capable of catalyzing hydrolysis of esters and hydrides of phosphoric acid. Acid phosphatase activity in the soil, managed under different nutrient-management options had significantly influenced (Fig. 1). At flowering stage, the maximum acid phosphatase activity (205.0 µg p-NP/g 24/hr) was recorded under T_8 (rice bean green-manuring + 100% recommended dose of fertilizer) and closely followed under (buckwheat green-manuring 100% recommended dose of fertilizer) with a value of 204.7 µg p-NP/g 24/hr. The economics of nutrient-management options with green-manuring with buckwheat and rice bean was significantly influenced (Table 1). The maximum net returns were obtained under buckwheat green-manuring with 100% RDF (₹58,138/ha) and it was closely followed by net returns under green-manuring with rice bean with 100% RDF (56,533/ha). Sharma and Prasad (1998) and IRRI (2020) also reported enhanced net returns and profitability owing to green-manuring in rice crop. This was owing to balanced supply of plant nutrients, which lead to enhanced plant growth, seed yield. Over all, better response to ap-

Table 1. Growth, yield attributes and yields of direct seeded, upland rice under *in-situ* green-manuring and nutrient management in North Eastern Hills region

Treatment	Plant height (cm)	Dry weight (g/m^2)	Tillers/m^2	Panicle length, (cm)	Filled grain/ panicle	Harvest index	Grain yield (t/ha)	Net returns (₹×10^3/ha)
T_1, Control	90.1	900.3	238.0	21.83	92.7	0.34	3.06	38.48
T_2, Buckwheat green-manure	92.0	930.0	241.3	23.33	97.0	0.35	3.44	43.68
T_3, Buckwheat green-manure + 100% RDF	101.5	1,108.3	252.3	28.33	120.0	0.37	4.55	58.32
T_4, Buckwheat green- manure + 50% RDF	90.7	1,052.0	243.0	24.50	106.3	0.36	4.15	52.78
T_5, Buckwheat green-manure + 75% RDF	96.4	1,086.0	246.3	26.83	108.3	0.37	4.33	55.30
T_6, Buckwheat green-manure + 50% RDF + BF	91.5	1,051.0	243.0	24.67	105.3	0.36	4.2	53.15
T_7, Rice bean green-manure	90.3	921.7	240.0	22.67	95.0	0.35	3.41	43.14
T_8, Rice bean green-manure + 100% RDF	99.1	1,094.7	250.7	27.17	114.0	0.37	4.43	56.53
T_9, Rice bean green-manure + 50% RDF	90.0	1,044.7	242.0	24.83	104.7	0.37	4.18	53.46
T_{10}, Rice bean green-manure + 75 RDF	95.2	1,085.3	245.0	27.00	105.7	0.37	4.31	55.05
T_{11}, Rice bean green-manure 50% RDF + BF	90.2	1,045.7	243.3	25.00	107.3	0.36	4.21	53.23
SEm±	1.59	4.46	3.45	0.45	1.64	0.004	0.10	2.21
CD (P=0.05)	4.69	13.16	10.18	1.33	4.85	0.011	0.28	4.52

RDF, recommended dose of fertilizer; BF, biofertilizer

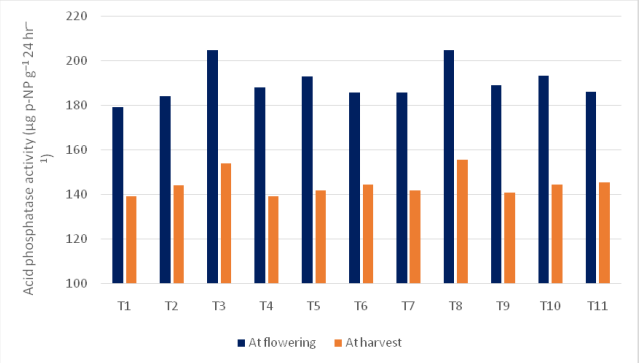

Fig. 1. Effect of *in-situ* green manuring and nutrient management on acid phosphatase of the soil under direct seeded upland rice under North Eastern hills region

plied fertilizers resulted in enhanced economics from rice crop. Thus *in-situ* green manuring with buckwheat with 100% recommended dose of fertilizer resulted in significantly higher grain yield than buckwheat green-manuring + 50% recommended dose of fertilizer, but remained at par with buckwheat green-manuring + 75% recommended dose of fertilizer nutrient-management (4.33 t/ha).

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