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Effect of promising rice (*Oryza sativa* L.) varieties and nutrient management practices on growth, development and crop productivity in eastern Himalayas

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Abstract

A field experiment was conducted at the Experimental Farm of ICAR-Research Complex for North Eastern Hill Region, Barapani, Meghalaya during *Kharif* 2016 to study the effect of promising rice varieties and nutrient management practices on plant growth, development, and grain and biological yield of lowland rice in Eastern Himalayas. The experiment was laid-out in split-plot design replicated thrice consisting of 12 treatment combinations *viz.* 4 nutrient management practices [100% organic, 100% inorganic (RDF), INM (50% RDF through fertilizers + remaining 50% RDF through FYM and rock phosphate), and absolute control] in main-plot, and 3 promising rice varieties [Shahsarang-1, Lumpnah and Megha semi-aromatic-2] in sub-plots. The results showed that the plant height, dry matter accumulation (DMA), leaf area index (LAI), growth indices like absolute growth rate (AGR), crop growth rate (CGR), relative growth rate (RGR) and net assimilation rate (NAR) improved constantly with the succession of crop growth period *i.e.* 30 to 90 days after transplanting (DAT) as well as at harvest. Plant height, DMA, LAI, and growth indices in rice crop were observed to be considerably influenced by different nutrient management practices. Among different nutrient management practices, significantly higher magnitude of above parameters was found in integrated nutrient management (INM) practice followed by inorganic practice, organic practice and control, respectively. Among rice varieties, Shahsarang-1 exhibited higher magnitude of above growth parameters followed by Lumpnah and Megha SA2, respectively. These rice varieties both under INM as well as under inorganic practice gave higher amount of growth parameters *viz*. plant height, DMA, LAI, growth indices in rice greater than their other counterparts. Grain yield was significantly higher (4.18 t ha^{-1}) in INM practice followed by inorganic, organic and control treatment. The trend of grain yield was INM>inorganic>organic>control treatment, respectively. Similar trend was also observed for biological yield. Among rice varieties, Shahsarang-1 produced significantly highest grain yield (3.86 t ha^{-1}) followed by Lumpnah (3.60 t ha^{-1}) and Megha SA2 (3.19 t ha^{-1}), respectively. Similar trend was also observed for biological yield. In nutshell, INM practice (50% RDF through fertilizers + remaining 50% RDF through FYM and rock phosphate) is the best nutrient management technology to harness better growth and crop productivity in eastern Himalayas. Similarly, Shahsarang-1 was the best performer in terms of growth and crop productivity over other two promising rice varieties *viz*. Lumpnah and Megha SA2 in north-eastern Himalayan region.

Key words: Eastern Himalayas, growth, lowland rice, nutrient management practices, productivity, rice varieties.

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Rice (*Oryza Sativa* L.) plays a vital role in food and nutritional security of India in general and north-eastern India in particular. It is cultivated in an area of about 3.5 m ha in north-eastern states of India which contributes to about 6.5% of country's total rice production. The productivity of rice in the region is only about 1.6 t/ha compared to national averages (Das *et al.,* 2010). About 80% of the total cultivated area in north-eastern hilly region (NEHR) is occupied by rice. The diverse agro-climatic conditions alongwith other physiographic conditions have led to immense variability among rice cultivars in the NEHR besides affecting their achievable yields. The another production constraint is the use of sub-optimal doses of chemical fertilizers in rice coupled with their meager nutrient-use efficiency owing to high N leaching and percolation losses under high rainfall areas and conventionally grown lowland rice as well as fixation of applied-P as insoluble aluminium and iron phosphates in the acid soils of the region. Thus, major reasons for low productivity of rice in NEHR are non-adoption of high yielding varieties (HYVs') and low fertilizer use besides poor crop management (Das *et al.,* 2010; Kumar *et al.*, 2016). In order to harness better crop yield, it is the genotype of any crop which play a pivotal role in growth, development and yield expression under given set of environmental and crop management situations (Choudhary *et al.,* 2010). Thus, the development and screening of location-specific high yielding rice varieties w.r.t. to given set of input/production factors like efficient nutrient management etc., and their adoption is highly important to harness the production potential of rice in this far eastern part of the country having diverse agro-climatic variability. With this background, the current study was conducted during *Kharif* 2016 using promising rice varieties at different nutrient management practices to assess the plant growth, development and crop productivity of lowland transplanted rice in eastern Himalayas.

Materials and Methods

The field experiment was conducted at the *'Lowland Rice Research Block'* of the Research Farm of ICAR-Research Complex for North Eastern Hill Region (ICAR-RC-NEHR), Barapani, Meghalaya, India [Latitude of 25°30′ N; Longitude 91°51′ E; Altitude 950 m amsl] in Eastern Himalayas. The soil of the Experimental Farm of ICAR-RC-NEHR, Barapani, Meghalaya was acidic in reaction with pH 4.8 and sandy-clay loam in texture. The initial soil analysis data reveals that the soil of experimental site had Walkley-Black C (oxidizable-SOC) 2.45%, alkaline $KMnO_4$ oxidizable-N 236.0 kg ha^{-1}, 0.5 M $NaHCO_3$ extractable-P 6.3 kg ha^{-1} and 1 N NH_4OAc extractable-K 293.4 kg ha^{-1}. Thus, the soil was high in soil organic carbon (SOC), low in available-N and available-P_2O_5 but high in available-K_2O. The total rainfall during the growing season was 1622.6 mm. The experiment consisted of 12 treatment combinations and was laid out in split plot design with 3 replications. The treatments consisted of 4 main-plot treatment *viz.* 100% organic through FYM, 100% inorganic (recommended dose of fertilizer-RDF), INM (50% RDF + 50% FYM) and absolute control, while in the sub-plots the three varieties *viz.* Shahsarang-1,Lumpnah and Megha SA-2 was taken and transplanted on 16^{th} July, 2016 with plant spacing of 20 cm × 20 cm. Mineral N, P and K was applied through urea, single super phosphate and muriate of potash @ 80:60:40 kg/ha, respectively for inorganic nutrient management. In INM plots, it was applied through 50% RDF and 50% FYM and remaining through rock phosphate. Plant nutrients in organic plots were applied through FYM and rock phosphate. For absolute control, nothing was applied for entire crop season. The field observations on plant growth and development parameters, growth induces, and grain and biological yield were assess using standard procedures (Rana *et al.*, 2014; Kumar *et al.,* 2015).

Results and Discussions

Growth and Development

Data pertaining to average plant height of rice plants revealed that in general the plant height increased consistently with the progression of crop growth stages *i.e.* 30 days after transplanting (DAT) to till harvest (Table 1). At 30 DAT, the significantly taller plants were found in integrated nutrient management (INM)

Table 1. Effect of different nutrient management practices and rice varieties on growth and development of rice at 30 days interval.

Treatments	Plant height (cm)				Dry matter accumulation (g m^{-2})				Leaf area index (LAI)		
	30 DAT*	60 DAT	90 DAT	At harvest	30 DAT	60 DAT	90 DAT	At harvest	30 DAT	60 DAT	90 DAT
Nutrient management practices											
Organic	55.6	75.1	92.5	94.2	235.1	495.3	915.8	974.4	1.51	4.43	4.43
INM	63.4	79.1	102.1	102.7	226.0	548.9	954.2	1044.4	1.73	5.29	5.34
Inorganic	60.7	79.3	99.8	100.7	213.4	513.5	936.4	1018.0	1.63	5.03	4.64
Control	51.6	72.7	89.4	90.1	147.1	311.5	580.3	637.5	1.44	3.42	3.69
SEm ±	1.82	0.55	0.48	0.70	14.88	9.75	2.63	10.06	0.02	0.16	0.19
CD (P=0.05)	6.15	2.27	3.71	3.43	51.5	46.1	9.1	34.8	0.09	0.55	0.67
Rice varieties											
Shahsarang-1	55.4	76.9	96.9	96.9	220.9	497.6	871.3	946.4	1.57	4.52	4.60
Lumpnah	58.3	76.0	95.9	96.6	217.6	463.1	847.8	915.1	1.63	4.62	4.50
Megha SA2	59.8	76.8	95.1	97.3	177.7	441.3	820.8	894.2	1.52	4.49	4.48
SEm ±	1.43	0.70	0.45	0.55	7.34	7.69	5.56	5.49	0.03	0.15	0.13
CD (P=0.05)	2.7	NS	NS	NS	22.0	23.1	16.7	16.5	NS	NS	NS
Interactions											
SEm ±	3.15	0.95	0.82	1.20	14.69	15.38	11.13	10.98	0.03	0.28	0.33
Sub-plot at same main-plot											
CD (P=0.05)	NS	NS	NS	NS	NS	NS	33.4	32.9	NS	NS	NS
SEm ±	2.96	1.26	0.87	1.13	19.11	15.90	9.46	13.48	0.06	0.29	0.29
Main-plots at same / diff. sub-plot CD (P=0.05)	NS	NS	NS	NS	NS	NS	28.7	43.9	NS	NS	NS

***DAT**: Days after transplanting

practice (63.4 cm) followed by inorganic and organic nutrient management practices, respectively all of which remained statistically at par with each other. Similarly, control treatment produced shorter plants and all the above nutrient management practices showed significant differences with control treatment. Among rice varieties, significantly taller plants (59.8 cm) were found in Megha Semi-aromatic-2 (Megha SA2) followed by Lumpnah both of which remained statistically at par with each other while Shahsarang-1 which produced significantly shorter plants. At 60 DAT, significantly taller plants were found in inorganic nutrient management practice followed by INM practice both of which remained statistically at par with each other but significantly superior over organic and control treatments both of which produced quite shorter plants. The varieties did not show any significant differences for plant height at 60 DAT; however, Shahsarang-1 reported tallest plants followed by Lumpnah and Megha SA2, respectively. At 90 DAT, the significantly taller plants were found in INM practice followed by inorganic practice which remained at par with each other but showed significantly superior plant height compared to organic practice and control treatment both of which again remained statistically at par with each other. Among rice cultivars, the significant differences were not observed at 90 DAT. At harvest, INM practice produced taller plants (102.7 cm) followed by inorganic, organic practice and control treatment. At harvest, the significant differences were not observed among varieties and followed the similar trend as that observed at 60 DAT. At all the growth stages of rice crop, the control treatment remained as a least performer. Likewise, no interaction effect of different nutrient management practices and rice varieties was observed at 30, 60 and 90 DAT as well as at harvest for plant height of rice crop (Table 4.1).

Data pertaining to total dry matter accumulation (DMA) m^{-2} of rice (Table 1) revealed that DMA improved consistently and considerably with progression of crop growth stages *i.e.* from 30 DAT to till harvest. At 30 DAT, highest DMA was recorded in organic practice and lowest in control, however, organic, INM and inorganic practices were on par with each other but significantly superior over control treatment. Among varieties, Shahsarang-1 exhibited highest DMA followed by Lumpnah and Megha SA2, respectively. At 60 DAT, 90 DAT and at harvest, highest DMA m^{-2} was observed in INM practice followed by inorganic practice, organic practice and least DMA m^{-2} was recorded in control treatment. Among rice varieties, Shahsarang-1 exhibited higher DMA m^{-2} at 60 DAT, 90 DAT and at harvest followed by Lumpnah and Megha SA2, respectively. All these varieties showed significant differences with each other for DMA at 60 DAT, 90 DAT and at harvest. The interaction effect between main-plot and sub-plot treatments was non-significant at 30 and 60 DAT; but at 90 DAT as well at harvest, the interaction effects were found significant between different nutrient management practices and varieties (Table 1).

The leaf area index (LAI) of rice crop improved consistently with the progression of crop growth stages *i.e.* 30 DAT to till 90 DAT. At 30 DAT, LAI was found highest for INM practice (1.73) followed by inorganic and organic practice and lowest in control treatment. At 60 DAT. the INM practice exhibited highest LAI (5.29) followed by inorganic practice both of which remained statistically at par with each other but significantly superior to that of organic practice and control treatment. At 90 DAT, the INM practice again recorded highest LAI (5.34) followed by inorganic and organic practice all of which remained statistically at par with each other. Among rice varieties, at 30, 60 and 90 DAT none of these three varieties showed significant differences for LAI, however lowest LAI was recorded in Megha SA2. Likewise, interaction effects for main-plot and sub-plot treatments were found non-significant at 30, 60 and 90 DAT (Table 1).

Data on total number of tillers m^{-2} of rice (Fig. 1) depicted that total number of tillers m^{-2} enhanced constantly and significantly with

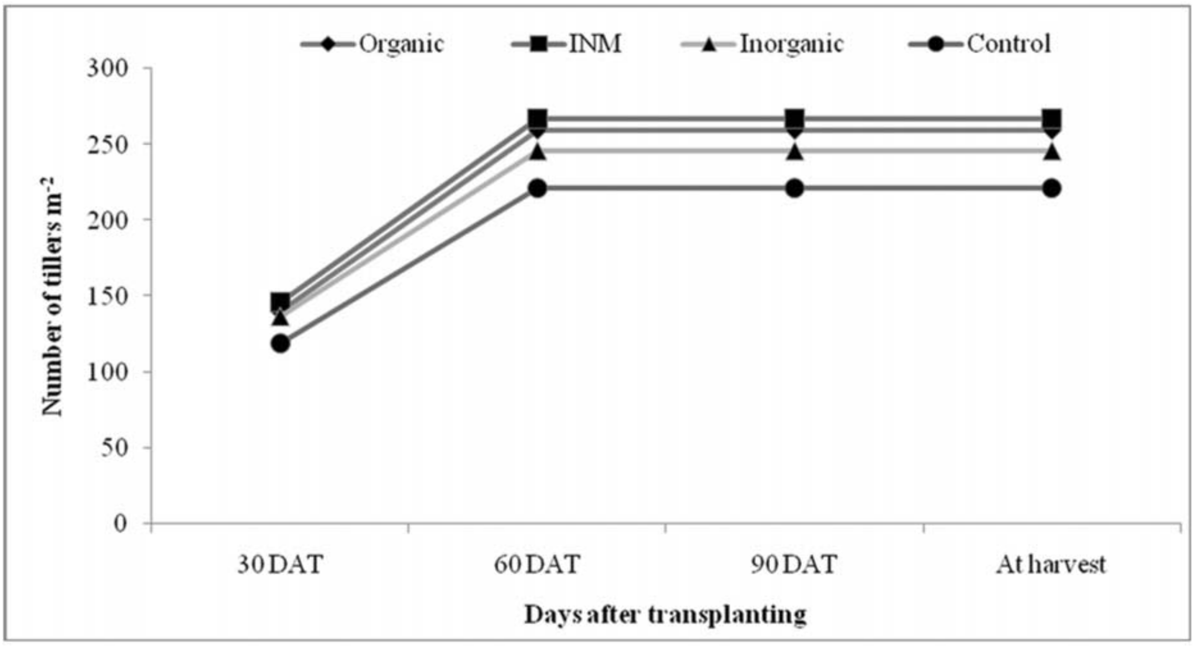

Fig. 1. Effect of different nutrient management practices on number of tillers m^{-2} of rice at 30 days interval.

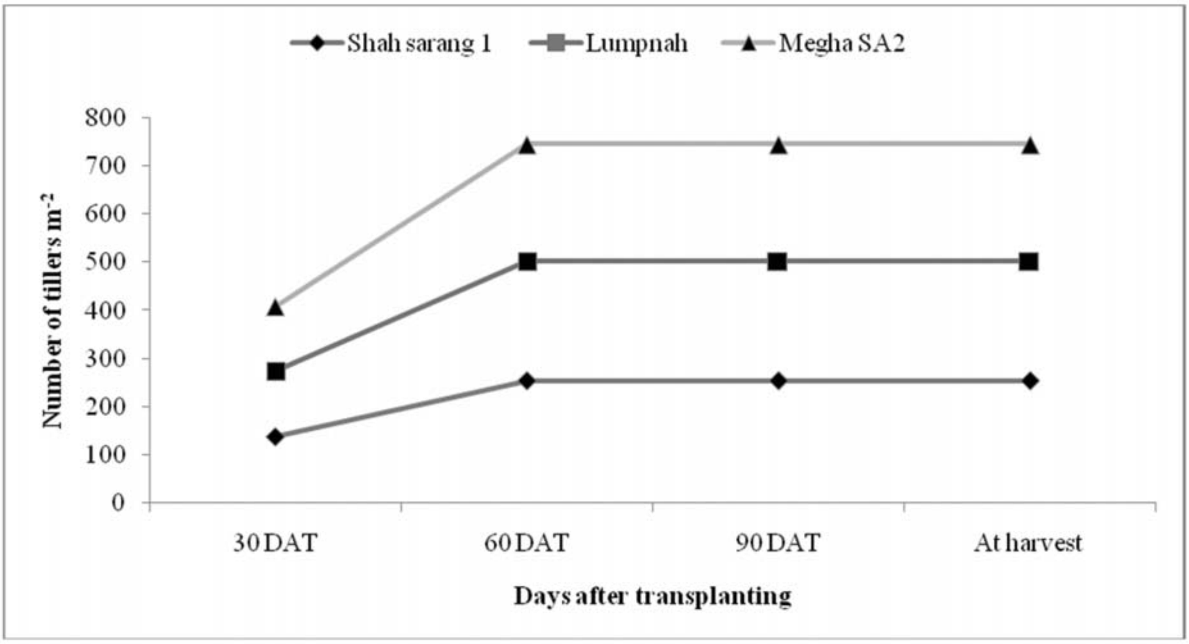

Fig. 2. Effect of different rice varieties on number of tillers m^{-2} of rice at 30 days interval.

progression of crop growth stages *i.e.* from 30 DAT to till harvest (Fig. 1 & 2). At 30 DAT, highest number of tillers m^{-2} was recorded in INM practice followed by organic and inorganic practices. Among rice varieties, Shahsarang-1 gave highest number of tillers followed by Lumpnah and Megha SA2, respectively (Fig. 2). At 60 DAT, 90 DAT and at harvest, highest number of tillers m^{-2} was observed in INM practice (267.2 m^{-2}) followed by organic practice, inorganic practice with least number of tillers m^{-2} in control treatment (Fig. 1). After 60 DAT, number of tillers m-2 got stabilized up to harvest (Fig. 1 & 2). Interaction effect between main-plot and sub-plot treatments was found significant at 30, 60 & 90 DAT and at harvest.

Growth Indices

The effect of different nutrient management practices and rice varieties on growth indices of rice is presented in Table 2. Among different nutrient management practices, the absolute growth rate (AGR) was found maximum for organic practice during 31-60 DAT interval followed by control treatment, inorganic practice and INM practice, respectively, however, all the nutrient management practices showed non-significant variation w.r.t. AGR during 31-60 DAT. For rice varieties, AGR remained non-significant during 31-60 DAT. The interaction effect was also non-significant for AGR during 31-60 DAT. During 61-90 DAT, the AGR was recorded highest for both organic and inorganic practices followed by INM practice and control treatment, respectively. Among varieties, maximum AGR was recorded for Shahsarang-1 followed by Megha SA2 and minimum AGR was recorded in Lumpnah, however, all the three varieties differed significantly w.r.t. AGR with each other. No interaction effect was found at 61-90 DAT between nutrient management practices and varieties for AGR (Table 2).

The crop growth rate (CGR) was found maximum for INM practice (10.8 g m^{-2} day^{-1}) during 31-60 DAT followed by inorganic practice, organic practice and control treatment, respectively where all the nutrient management practice were significantly higher over control treatment. For rice varieties, CGR remained non-significant during 31-60 DAT. The interaction effect was also non-significant for CGR during 31-60 DAT. During 61-90 DAT, crop growth rate was recorded maximum for inorganic practice followed by organic, INM practice and control

Table 2. Effect of different nutrient management practices and rice varieties on growth indices, and grain and biological yield of rice crop.

Treatments	AGR (cm day^{-1})		CGR (g m^{-2} day^{-1})		RGR (mg g^{-1} day^{-1})		NAR (mg cm^{-2} day^{-1})		Grain yield (t/ha)	Biological yield (t/ha)
	31-60 DAT	61-90 DAT	31-60 DAT	61-90 DAT	31-60 DAT	61-90 DAT	31-60 DAT	61-90 DAT		
Nutrient management practices										
Organic	0.88	0.22	8.7	14.0	327.8	267.5	3.50	5.69	3.74	9.79
INM	0.74	0.19	10.8	13.5	393.9	240.6	3.75	4.69	4.18	10.54
Inorganic	0.76	0.22	10.0	14.1	384.6	262.0	3.65	5.14	4.02	10.31
Control	0.87	0.15	5.5	9.0	329.3	272.6	2.59	4.26	2.26	6.16
SEm ±	0.07	0.01	0.55	0.30	34.32	6.44	0.21	0.11	0.06	0.07
CD (P=0.05)	NS	0.02	1.9	1.0	NS	NS	0.73	0.39	0.21	0.24
Rice varieties										
Shahsarang 1	0.81	0.25	9.2	12.5	354.6	243.6	3.58	4.87	3.86	9.59
Lumpnah	0.85	0.09	8.2	12.8	330.1	266.1	3.14	5.01	3.60	9.26
Megha SA2	0.78	0.24	8.8	12.7	392.0	272.3	3.40	4.96	3.19	8.75
SEm ±	0.05	0.02	0.30	0.28	17.46	6.44	0.12	0.11	0.05	0.06
CD (P=0.05)	NS	0.06	NS	NS	NS	19.31	NS	NS	0.15	0.18
Interactions										
SEm ±	0.11	0.04	0.59	0.56	34.93	12.88	0.24	0.21	0.10	0.12
Sub-plot at same main-plot										
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	0.64	NS	NS
SEm ±	0.11	0.03	0.73	0.55	44.60	13.33	0.29	0.21	0.10	0.12
Main-plots at same / diff. sub-plot CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	0.65	NS	NS

treatment, respectively. Among varieties, maximum CGR was recorded for Lumpnah (12.8 g m^{-2} day^{-1}) followed by Megha SA2 and minimum for Shahsarang 1 where all the three varieties differed significantly w.r.t. CGR (Table 2).

Relative growth rate (RGR) of rice was found non-significant among different nutrient management practices but maximum for INM practice during 31-60 DAT followed by inorganic practice, control treatment and lowest in organic practice, respectively. For rice varieties, RGR was again found to be non-significant during 31-60 DAT. No interaction effect between nutrient management practices and rice varieties was found for RGR during 61-90 DAT. During 61-90 DAT, relative growth rate was found to be non-significant but maximum for control treatment followed by organic, inorganic and INM practice, respectively. For rice varieties, RGR was found significant during 61-90 DAT. No interaction effect between nutrient management practices and rice varieties was found for RGR during 61-90 DAT (Table 2).

Net assimilation rate (NAR) of rice was found maximum for INM practice during 31-60 DAT followed by inorganic, organic practice and control treatment, respectively. For rice varieties, NAR was found non-significant during 31-60 DAT. The interaction effect was also non-significant for NAR during 31-60 DAT. During 61-90 DAT, NAR was significantly highest for organic practice followed by inorganic and INM practice. Among varieties, maximum NAR was recorded for Lumpnah (5.01 mg cm^{-2} day^{-1}) followed by Megha SA2 and minimum for Shahsarang 1, however, all these three varieties were found non-significant with each other w.r.t. NAR during 61-90 DAT. Interaction effect was found significant for NAR during 61-90 DAT between nutrient management practices and varieties (Table 2).

Crop Productivity

The results revealed that grain yield was significantly higher in INM practice (4.18 t ha^{-1}) followed by inorganic and organic practice and least in control treatment (2.26 t ha^{-1}). INM, inorganic and organic practices were significantly different and superior over control treatment. Among varieties, Shahsarang-1 was the highest yielder (3.86 t ha^{-1}) followed by Lampnah (3.60 t ha^{-1}) which is an average yielder among three varieties; and lowest yield was recorded for Megha SA2 (3.19 t ha^{-1}) and all these varieties differed significantly different among each other. The trend in grain yield for different nutrient management practices was INM > inorganic > organic > control, respectively. The trend in grain yield for rice varieties was Shahsarang-1 > Lumpnah > Megha SA2, respectively. No significant interaction effect was found for grain yield between different nutrient management practices and rice varieties (Table 2).

The results also revealed that biological yield was significantly higher in INM practice (10.54 t ha^{-1}) followed by inorganic practice and organic practice and least in control treatment (6.16 t ha^{-1}). INM, inorganic and organic practices were significantly superior over control treatment. Among rice varieties, Shahsarang-1 was the highest yielder (9.59 t ha^{-1}) followed by Lampnah (9.26 t ha^{-1}) which is an average yielder among three varieties while lowest yield was recorded for Megha SA2 (8.75 t ha^{-1}) and also all these varieties differed significantly among each other. The trend in biological yield for different nutrient management practices was INM > inorganic > organic > control, respectively. The trend in biological yield for different rice varieties was Shahsarang-1 > Lumpnah > Megha SA2, respectively. No interaction effect was found for biological yield between different nutrient management practices and rice varieties (Table 2).

Rice crop is a moderate feeder of nutrients required in available forms throughout the growing season. Growing of rice under combined application of both organic and inorganic sources of nutrients helped in supplying nutrients throughout the growing season that led to improved growth parameters of rice varieties (Choudhary and Suri, 2009, 2013, 2014). Likewise, organic sources of nutrients also nourish the soil microorganisms and thereby increased the root parameters (dry weight, volume and length) of rice varieties (Choudhary and Suri, 2009, 2013, 2014). Early emergence and synchronized tillering, being dependent on the mineral nutrition and hereditary characters of the crop determine the tiller numbers and tiller emergence in later growth stages (Choudhary *et al.*, 2006, 2007). Generally, tiller emergence after maximum tillering is also checked by reduced radiation (mutual shading) as well as availability of nutrients. That's why the tiller number under different nutrient management practices and rice varieties was stable after 60 DAT (Fig. 1 & 2). The accumulation of carbon and crop biomass depends upon the formation of organs for nutrient absorption (root) and photosynthesis (leaf canopy). Important determinants of these organs as well as the photosynthetic rate are the availability of NPK and other essential nutrient elements. In tillering crops like rice, the number of tillers per unit area, the plant height and leaf size are the physical components influencing dry matter production during different time intervals. At early growth stages, the root and leaf development are small, therefore, dry matter accumulation is also small (Table 1). But, during grand growth period, these organs are active and result in higher dry matter production due to accumulation of photosynthates. Consequently, with the increase in plant height and number of tillers (Table 1 and Fig. 1 & 2) with higher nutrient levels under different nutrient management practices, dry matter accumulation also increased (Table 1) at all the dates of observation. Dry matter accumulation increased with increase in crop age upto maturity. Also, the differential growth behaviour of various rice cultivars depends upon their genetic ability as well as varying response to nutrient management practices which might have led to variation in resultant growth parameters (Table 1), as also reported by earlier studies (Choudhary *et al.*, 2010).

The DMA and LAI both influence the growth indices like absolute growth rate, crop growth rate, relative growth rate and net assimilation rate. Since, DMA and LAI were higher under INM practice, thereby; better growth indices were also reported under INM practice. The beneficial effect of organic manures and chemical fertilizers in improving the physical, chemical and biological environment of soil is conducive for better plant growth (Paul *et al.*, 2014). This improvement in soil fertility might have favored the growth and development of rice crop in current study. The overall additive effect of FYM additions on the improvement of soil properties might have resulted in significant improvement in growth of crop plants. Many researchers have also reported that judicious and conjunctive use of chemical and organic fertilizers can improve the crop growth and development of the rice crop (Choudhary and Suri, 2009, 2013, 2014; Paul *et al.*, 2014; Dass *et al.*, 2016, 2017). Likewise, the magnitude of growth parameters was higher under Shahsarang-1 variety followed by Lumpnah and Megha SA2, respectively. Since, these varieties have differential genetic characters and production potential (Diwakar, 2009; Choudhary *et al.*, 2010) which might have led to differential response to applied nutrients/ nutrient management practice leading to variation in growth parameters in current study.

The increase in growth parameters led to increase in grain and biological yield. The highest grain and biological yield were observed under INM practice may be due to good early vigour of rice and growth of seedling transplanted under INM practice. In addition to the above, LAI might have helped in better photosynthesis and assimilation rate resulting in more dry matter and better growth indices, which ultimately showed effect on yield attributes. Better performance of rice varieties under INM practice was probably because of good crop establishment and better anchorage of roots (Choudhary *et al.*, 2006, 2008; Choudhary and Suri, 2009, 2014; Paul *et al.*, 2014; Dass *et al.*, 2017). Under intensive farming, it is widely recognized that neither sole use of organic manures alone nor sole use of chemical fertilizers will help in achieving the sustainability of crop yields at desired level. The increasing cost of chemical fertilizers and their undesirable effects on soil properties have led to inclusion of INM in crop production (Choudhary *et al.*, 2006, 2007, 2008; Choudhary and Suri, 2009). INM aims at efficient and judicious use of all the major sources of plant nutrients in an integrated manner (Choudhary *et al.*, 2007, 2008; Choudhary and Suri, 2009). Thus, combined use of organic manures and inorganic fertilizers helps in maintaining yield stability through correction of marginal deficiencies of secondary and micronutrients, enhancing efficiency of applied nutrients by providing favorable soil conditions (Paul *et al.*, 2014). That's' why, the INM practice exhibited higher magnitude of grain and biological yield over their respective counterparts which might be the outcome of better crop growth parameters. In current study, the grain and biological yield were also higher under Shahsarang-1 variety followed by Lumpnah and Megha SA2, respectively. Since, these varieties have their differential production potential (Diwakar, 2009) which might have led to differential response to applied nutrients/ nutrient management practice leading to variation in yield attributes and yield response in current study.

Overall, it is concluded that the growth parameters, grain yield (3.86 t ha^{-1}) and biological yield (9.59 t ha^{-1}) of rice were significantly higher in INM practice which was followed by inorganic, organic practice and control treatment, respectively. Among rice varieties, Shahsarang-1 produced significantly highest grain yield (3.86 t ha^{-1}) followed by Lumpnah (3.60 t ha^{-1}) and Megha SA2 (3.19 t ha^{-1}), respectively. In nutshell, INM practice (50% RDF through fertilizers + remaining 50% RDF through FYM and rock phosphate) is the best nutrient management technology to harness higher crop productivity in north-eastern Himalayan region (NEHR). Similarly, Shahsarang-1 was the best performer in terms of growth and crop productivity over other two promising rice varieties *viz*. Lumpnah and Megha SA2 in NEHR.

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