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Sunita Kumari
Krishi Vigyan Kendra, Vaishali, Dr. RPCAU, Pusa, Bihar, India

MS Yadav
Department of Agronomy, BAU, Ranchi, Jharkhand, India

Ashok Kumar Singh
Department of Agronomy, BAU, Ranchi, Jharkhand, India

Amarjeet Kujur
Department of Agronomy, BAU, Ranchi, Jharkhand, India

Corresponding Author:
Sunita Kumari
Krishi Vigyan Kendra, Vaishali, Dr. RPCAU, Pusa, Bihar, India

Influence of integrated nutrient management on dry matter accumulation and days taken for onset of different phenophases of direct seeded rice (*Oryza sativa*)

Sunita Kumari, MS. Yadav, Ashok Kumar Singh and Amarjeet Kujur

Abstract
A field experiment on direct seeded rice was conducted during *kharif* 2017 and 2018 at Rice Research Farm, Birsa Agricultural University, Kanke, and Ranchi to evaluate the effect of integrated nutrient management in direct seeded rice (*Oryza sativa*). The soil was clay loam in texture, acidic in nature with mean pH 5.97, mean EC 0.30, low in available N (mean value 223.81 kg/ha), medium in P (mean value 23.35 kg/ha) & K (mean value 169.44 kg/ha) and low in organic carbon (mean value 0.39%). The experiment comprised ten treatments viz. control (no fertilizer or manure), 50% RDF, 75% RDF, 100% RDF, 50% RDF +50% N through FYM, 50% RDF + 50% N through vermi compost, 75% RDF +25% N through FYM, 75% RDF+25% N through vermi compost, 100% RDF +25% N through FYM and 100% RDF +25% N through vermi compost were laid out in randomized block design with three replications. The experiment was conducted in Randomized Block Design (RBD). Pooled data of two years experimentation indicated that the application of various integrated nutrient management practices significantly increased dry matter accumulation on 30 DAS, 60 DAS, and 90 DAS and at maturity but days taken to maximum tillering, 50% flowering and maturity of rice had not been significantly influenced. Among all treatments, application of 100% RDF + 25% N through VC resulted in higher dry matter accumulation on 30 DAT (159.5 g/m^2), 60 DAT (394.1 g/m^2), 90 DAT (916.4 g/m^2) and at maturity (1200.5 g/m^2) which was superior to rest of the treatments. Two year study indicates that the application of 100% RDF + 25% N through VC was the best for higher dry matter accumulation and yield from rice.

Keywords: dry matter accumulation, integrated nutrient management, yield

Introduction
Rice (*Oryza sativa*) is one of the most important cereal crops of south-east Asia. Rice is a major source of food for more than half of the world's population. It covers 161.2 million hectares to contribute 471.09 million tonnes in the global food grain basket, thus occupying second position among cereals. Rice is cultivated in India on a wide range of agro-ecology covering about 43.4 million hectares accounting for 104.32 million tonnes in total food grain production during 2016-17. (Anonymous, 2016-17) [1]. Yield trends from continuous (intensive) cropping have indicated that rice yield is declining over time even with best available cultivars and scientific management. Also, continuous use of inorganic fertilizers has detoriated soil productivity. Amongst many factors, soil fertility status is an important factor for decrease of rice productivity and it is mainly due to imbalance use of fertilizers for years and in addition large quantities are being practiced to harvest more and more in crops like rice & wheat. Excessive use of inorganic fertilizer results in its poor utilization by crop and adversely affects soil health. Hence Integrated Nutrient Management (INM) is need of the hour to increase the productivity of a crop by maintaining soil fertility as well as productivity. Several studies have indicated that application of FYM, vermicomposting, green manure, crop residue, biofertilizer and/or other wastes either alone or along with inorganic fertilizers increases organic carbon and other plant nutrient in soil (Kumar *et al*., 2005) [3]. Thus use of fertilizers with organic sources holds a great promise not only to secure high level of crop productivity but also is against emergence of micro nutrient deficiencies in soil and plant. Thus, it maintains good soil health (Patil & Singh, 2009) [4]. Keeping these points in view, a field experiment was conducted to evaluate the effect of integrated nutrient management in direct seeded rice (*Oryza sativa*).

Materials and Methods
A field experiment on direct seeded rice was conducted during *kharif* 2017 and 2018 at Rice.

Research Farm, Birsa Agricultural University, Kanke, Ranchi. Soil samples from 1-50 cm were collected from different locations of the experimental plot and analyzed. The soil was clay loam in texture, acidic in nature with mean pH 5.97, mean EC 0.30, low in available N (Mean value 223.81 kg/ha), medium in P (Mean value 23.35 kg/ha) & K (Mean value 169.44 kg/ha) and low in organic carbon (Mean value 0.39%). The experiment comprised ten treatments viz. control (no fertilizer or manure), 50% RDF, 75% RDF, 100% RDF, 50% RDF +50% N through FYM, 50% RDF + 50% N through vermi compost, 75% RDF +25% N through FYM, 75% RDF+25% N through vermi compost, 100% RDF +25% N through FYM and 100% RDF +25% N through vermi compost were laid out in randomized block design with three replications. Rice (var. - Sahbhagidhan) was sown by using seed rate of 60 kg/ha on 22 June and 24 June in 2017 and 2018 respectively at 20 cm x 10 cm spacing. The seed was placed at about 3-4 cm depth. A week after sowing of rice crop, gap sowing was done wherever it was felt necessary. Well decomposed FYM and vermi compost were incorporated in soil 15 days before sowing of rice as per treatment. The quantity of organic manure was calculated on the basis of nitrogen content (%). The crop was fertilized with recommended doses of fertilizers viz. 80:40:20 kg N, P_2O_5, K_2O /ha. Half dose of N and full dose of P_2O_5 and K_2O were applied as per treatment through Urea, DAP and MOP as basal application just before sowing of rice and balance N were top – dressed in 2 equal splits – one fourth at active tillering (30- 35 DAS) and the remaining one – fourth at panicle – initiation (60- 65 DAS) stage of the crop. During course of investigation rice plants from 0.25 m row length were cut from the ground surface at 30, 60, 90 DAT and at maturity stage. These plants were sun dried for 2-3 days and were kept in oven at 65 ± 5^0C for 48 hours till a constant weight was achieved. After complete oven drying the dry weight was recorded and converted into g/m^2. All the data were subjected to analysis of variance (ANOVA) as per the standard procedures and comparison of treatment means was made by critical difference (CD) at 5% probability.

Results and Discussion

Effect on dry matter accumulation: It is clear from the data (Table. 1) that the dry matter accumulation/m^2 increased as the growth progressed and the incremental value were found maximum between 60 and 90 days after sowing (DAS). At 30 DAS, the data revealed that level of inorganic fertilizers and its integration with organic sources viz. FYM and VC significantly influenced the dry matter accumulation/m^2 in rice crop at each stage of crop growth. 100% RDF + 25% N through FYM produced maximum dry matter/m^2 (160.5 g) which was significantly higher than 50% RDF and 50% RDF + 50% N through FYM but remained comparable to 100% RDF + 25% N through VC and to the rest treatments. Minimum value was noticed under control treatment (100.3 g) which was significantly *at par* with 50% RDF, 75% RDF, 100% RDF, 50% RDF + 50% N through FYM, 50% RDF + 50% N through VC and 75% RDF + 25% N through FYM. While at 60 DAS, the maximum dry matter accumulation/m^2 (394.1 g) was recorded with the application of 100% RDF + 25% N through VC which was significantly superior to 50% RDF, 75% RDF, 50% RDF + N through FYM and 50% RDF + 50% N through VC but remained *at par* with 100% RDF + 25% N through FYM, 75% RDF + 25% N through FYM, 75% RDF + 25% N through VC AND 100% RDF. Control treatment registered minimum value (290.2 g/m^2) which was significantly *at par* with all treatments except 100% RDF + 25% N through FYM, 100% RDF + 25% N through VC and 75% RDF + 25% N through VC. At 90 DAS, trend of increase in dry matter accumulation/m^2 among different treatments of integrated nutrient management was noticed similar as at 60 DAS. Value of dry matter accumulation ranged from 426.1 to 9.16.4 g/m^2 in control treatment and with the application of 100% RDF + 25% N through VC, respectively. At later stage i.e. at harvest, 100% RDF + 25% N through VC (1200.5 g/m^2) produced significantly higher dry matter/m^2 which was comparable to 100% RDF + 25% N through FYM, 75% RDF + 25% RDF N through VC and 100% RDF but superior to other all treatments. Control treatment recorded minimum value (576.7 g/m^2) of dry matter accumulation which was significantly *at par* with 50% RDF, 75% RDF and 50% RDF + 50% N through FYM. The increase in dry matter accumulation/m^2 was the cumulative effect of increase in different growth characters like plant height, number of tiller/m^2, chlorophyll content and LAI. The dry matter accumulation is considered to be the reliable index of crop growth. Application of 100% RDF + 25% N through VC (T10) recorded the highest dry matter at harvest, this might be due to better availability of nutrient throughout growth period of plant resulted in higher plant height, number of tillers and LAI which ultimately increase dry matter accumulation/m^2resulted in significantly higher yield of rice This is in agreement with the findings reported by Sujathamma and Reddy (2004) [6], Senthivelu *et. al*. (2009) [5] and Jeyakumar *et.al*. (2014) [2].

Table 1: Effect of integrated nutrient management on dry matter accumulation/m^2 (g) of direct seeded rice. (Pooled data over two years)

Treatments	30 DAS	60 DAS	90 DAS	At maturity
T_1: Control	100.3	290.2	426.1	576.7
T_2: 50% RDF	106.0	299.8	715.9	905.8
T3: 75% RDF	121.4	322.4	776.8	978.2
T4: 100% RDF	130.3	337.1	837.3	1077.0
T5 : 50%RDF+50%NFYM	110.1	308.9	765.3	974.8
T6 : 50% RDF+ 50% NVC	118.7	318.5	777.8	994.2
T7: 75%RDF+25%NFYM	120.9	328.2	797.6	1052.1
T8:75%RDF+25%NVC	154.6	374.3	873.0	1142.7
T9:100%RDF+25%NFYM	160.5	387.4	903.8	1180.4
T10:100%RDF+25%NVC	159.5	394.1	916.4	1200.5
SE m±	15.26	23.93	40.67	44.64
CD at 5%	45.33	71.08	120.80	132.61

Effect on days taken to 50% flowering, maximum tillering and maturity of rice crop

The growth of a plant from germination to maturity can be considered as a series of discrete periods, each identified by an accompanying process of change in the shape, size or weight of specific organ. It is evident from data (Table. 2) that the effect of different treatments of integrated nutrient management on days taken for 50% flowering that was found to be non – significant. Maximum days taken for 50% flowering (85) was registered with 100% RDF + 25% N through FYM and 50% RDF + 50% N through VC, while minimum value (83) was found with control. Close examination of data regarding days taken to maximum tillering revealed that it had not been significantly influenced by different treatments of integrated nutrient management. Days taken to maximum tillering was highest (61 days) in the application of 75% RDF + 25% N through VC, 50% RDF + 50% N through VC, 50% RDF + 50% N through FYM and 75% RDF. Minimum value (59) was observed with 50% RDF treatment and control. A critical study of the data related to days taken to maturity of rice crop showed that critical difference due to different treatments of integrated nutrient management was non-significant. 100% RDF + 25% N through FYM and 50% RDF + 50% N through FYM recorded maximum days taken to maturity (117). Minimum value (114 days) was with 50% RDF treatment. On the basis of above findings, it may be concluded that application of 100% RDF + 25% N through VC in rice increased dry matter accumulation as well as maximized grain yield significantly, but didn't affect the days taken for maximum tillering, 50% flowering and maturity of the crop.

Table 2: Effect of integrated nutrient management on days taken to maximum tillering 50% flowering and maturity of direct seeded rice. (Pooled data over two years).

Treatments	Maximum tillering	50% flowering	Maturity	Yield of grain (q/ha)
T_1: Control	59	83	115	17.59
T_2: 50% RDF	59	83	114	30.38
T3: 75% RDF	61	84	116	34.49
T4: 100% RDF	59	85	115	36.92
T5 : 50%RDF+50%NFYM	61	84	117	35.04
T6 : 50% RDF+ 50% NVC	61	85	116	36.01
T7: 75%RDF+25%NFYM	60	84	116	40.11
T8:75%RDF+25%NVC	61	84	116	42.49
T9:100%RDF+25%NFYM	60	85	117	43.17
T10:100%RDF+25%NVC	60	84	116	43.90
SE m±	0.65	0.67	1.38	1.92
CD at 5%	NS	NS	NS	5.69

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