Effect of Integrated Nutrient Management on Growth and Development Stages of Rice under Rice–Wheat Ecosystem

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A B S T R A C T

A field experiment was conducted during 2010-11 and 2011-12 on agricultural farm of Institute of agricultural Sciences, Banaras Hindu University, Varanasi to evaluate the effect of Integrated Nutrient Sources and chemical fertilizers on growth and development of rice under rice- wheat cropping system. The experimental finding indicated that the growth attributes viz: plant height (cm), number of tillers hill-1, numbers of green leaf hill-1, Dry matter g hill-1, LAI, and chlorophyll content was markedly decline with curtailment in level of chemical fertilizer from 100%RDF to both rice and wheat (T5) to control (T1). All the Growth attributing character recorded highest value in T6 where 50% RDF + 50% N through FYM was applied to rice accompanied with 100% RDF to wheat plots but it remained statistically comparable to T7, T10, T11, T8, and T9 most of the stages during both the years of observation. The minimum value was observed in T1 (Control) and found inferior from Farmer’s practice (T12). However, decreasing in level of inorganic sources from 100% RDF to both rice and wheat (T4) and to Control (T1) delays the flowering and maturity. In INM sources T6 took minimum days to flowering and maturity followed by T7, T10, T11, T8, and T9 and maximum by T1 (control).

Introduction

The rice - wheat is the most dominant cropping system in Asian subtropical countries viz. China, India, Nepal, Bangladesh and Pakistan, where it is practiced in about 24 million hectares (Mahajan and Gupta, 2009).

In India too rice-wheat cropping system (RWCS) is most widely adopted system, covering over 10.5 million ha – mostly in the Indo Gangetic Plains. Among cereals, rice and wheat are the most important crops, which account for about 60 per cent of world’s human energy requirement. In India, total area under rice is 43.13 million hectares and that of wheat is 29.57 million hectares with production of 100.45 and 90.38 million tonnes of respectively. However, the productivity of both rice and wheat is low i.e. 2,323 and 3056 kg/ha, respectively (GOI, 2015).

The rice–wheat production system provides staple grain for more than 400 million people. During the Green Revolution era in the 1960s, enhanced production resulted from increases
in both rice–wheat area and system productivity. But little additional land is now available and traditional farmlands are increasingly lost to urbanization. In addition, of this rapid increasing population create huge demand in upcoming decades.

Therefore, future demand for food will have to be met mainly through increases in production per unit of harvested area (Ladha et al., 2003). The combination of poor soil fertility and inadequate, unbalanced, and inefficient use of fertilizers contributes much to this problem (Yadav et al., 2000; Dwivedi et al., 2001).

The imbalanced use of fertilizer has disturbed the natural equilibrium of the nutrient elements operating in the soils is being mostly applied for a long period. The studies have shown that the sustainability of this important system could only be achieved through integrated use of chemical and organic sources in a balanced manner.

**Materials and Methods**

Looking at the importance of rice–wheat system under irrigated ecosystem of Varanasi region, declining factor productivity and soil health, it is imperative to study the integrated use of chemical fertilizers and organic sources in rice–wheat system on long term basis. Therefore, with these facts in view present study conducted during 2010-11 and 2011-12. The geographical situation of the experiment lies in the Northern Gangetic Alluvial plain at 25°18’ North latitudes, 83°03’ East longitude and at an altitude of 128.93 meters above the mean sea level.

The experimental soil is sandy loam in texture with varying pH 7.72 to7.78, bulk density 1.39 to 1.56 g cc⁻¹ as well as 146 to 221, 10.5 to 20.84 and 152 to 206 kg ha⁻¹ N, P, and K, respectively. There were 12 treatments comprising 5 purely inorganic Viz. 50% RDF to both rice and wheat (T2), 50% RDF to rice and 100% RDF to Wheat (T3), 75% RDF to both rice and wheat (T4), 100% RDF (120kg N + 60kg P₂O₅ + 60 kg K₂O ha⁻¹) both rice and wheat (T5) and farmer’s practice with (80kg N + 40kg P₂O₅ + 20 kg K₂O ha⁻¹) (T12) to both rice and wheat. Six treatment are integrated integration of inorganic and organic sources i.e. (T6) 50% RDF + 50% N through FYM to rice and 100% RDF to wheat, (T7) 75% RDF + 25% N through FYM for rice and 75% RDF to wheat, (T8) 50% RDF + 50% N through crop residue to rice and 100% RDF to wheat, (T9) 75% RDF + 25% N through crop residue to rice and 75% RDF to wheat, (T10) 50% RDF + 50% N through green leaf manuring to rice and 100% RDF to wheat, (T11) 75% RDF + 25% N through green leaf manuring to rice and 75% RDF to wheat, along with one control having no nutrient nutrition application in either of the season (T1). Rice variety HUR-105 and wheat variety HUW-234 were selected for the study. The treatments (12) were arranged in randomized block design with 4 replications. Plot size was kept 11 x 6 m² (gross) and 10 x 5 m² (net) with 1 m plot border.

The observations on growth characters viz. plant height, LAI and SPAD value, dry matter accumulation, number of green leaves and number of tillers per hill for rice were recorded at 30, 60, 90 DAT and at harvest, and

**Growth of rice**

**Plant height (cm)**

It is apparent from table 1 that plant height increased progressively up to maturity stage. Plant height declined markedly with the curtailment of fertilizer doses from 100% RDF to both rice and wheat (T5) to control at all the stages of observation. Being at par with
T4 (75% RDF to both rice and wheat), T5 recorded significantly higher plant height than lower doses of inorganic nutrient application (T12, T3, T2, and T1). The plant height was highest in T6 (50% RDF through fertilizers + 50% N through FYM to rice and 100% NPK through fertilizers to wheat) at all the stages of observation during both the years. Though, it did not show significant differences over 75% RDF + 25% N through FYM to rice and 75% RDF to wheat (T7), 50% RDF + 50% N through GM to rice and 100% RDF to wheat (T10), 75% RDF + 25% N through GM to rice and 75% RDF to wheat (T11) and 100% RDF to both rice and wheat (T5) but produced significantly taller plants than (50% RDF + 50% N through wheat straw to rice and 100% RDF to wheat (T8) and 75% RDF + 25% N through wheat straw to rice and 75% RDF to wheat (T9) at most of the stages during both the years.

**Number of tillers hill**

The number of tillers hill increased upto 60 DAT and thereafter showed a declining trend till maturity. Increasing levels of fertilizer application upto 100 % RDF to both the crops in sequence (T5), showed marked improvement in number of tillers hill at all stages during both the years. Though, T5 remained par with T4 (75% RDF to both rice and wheat) both produced significantly more number of tillers hill than other treatments involving inorganic sources of nutrients and control (Table 2). Highest number of tillers hill were recorded under T6 (50% RDF + 50% N through FYM to rice accompanied with 100% RDF to wheat) at all the stages during both the years. However, it did not differ significantly T7 (75% RDF + 25% N through FYM to rice and 75% RDF to wheat), T10 (50% RDF + 50% N through green manure to rice and 100% RDF to wheat) and T11 (75% RDF + 25% N through green manure to rice and 75% RDF to wheat). Farmer’s practice (T12) also produced higher in number of green leaves hill over T2 (50% RDF to both rice and wheat) and control (T1) and the difference were significant at maturity during both the years.

**Dry matter accumulation**

It is apparent from table 4 that dry matter accumulation increased progressively upto maturity stage. Marked declined in dry matter production was observed with decreasing levels of fertilizer application from T5 (100% RDF to both rice and wheat) to T1 (control) during both the years. Being comparable to T4 (75% RDF to both rice and wheat) T5 produced significantly higher dry matter hill than other treatments of inorganic nutrient sources except farmer’s practice at taller stages. The higher dry matter accumulation was recorded under T6 (50% RDF + 50% N
through FYM to rice and 100% RDF to wheat) significantly, though, it remained at par to T_7 (75% RDF + 25% N through FYM to rice and 75% RDF to wheat), T_10 (50% RDF + 50% N through green manure to rice and 100% RDF to wheat) and T_11 (75% RDF + 25% N through green manure to rice and 75% RDF to wheat) produced significantly superior to other treatments at all the stages during both the years.

Farmer’s practice of fertilizer application (T_{12}) was significantly superior to control (T_1) and inferior to most of the treatments during both the years.

**SPAD value**

As number the number of green leaf hill\(^1\) the chlorophyll content in terms of SPAD also increased upto 60 DAT and thereafter decreased at 90 DAT.

Decreasing levels of fertilizer application from T_5 (100% RDF both rice and wheat) to T_1 (control) decreased SPAD value in leaves (Table 5). However, there was no significant difference between T_5 and T_4 (75% RDF both to rice and wheat) at any of the stages in during two years of experimentation.

Highest SPAD vale was recorded under T_6 (50% RDF + 50% N through FYM to rice accompanied with 100% RDF to wheat) at all the stages during both the years.

Nevertheless, it did not differ significantly with T_7 (75% RDF + 25% N through FYM to rice and 75% RDF to wheat), T_10 (50% RDF + 50% N through green manure to rice and 100% RDF to wheat) and T_11 (75% RDF + 25% N through green manure to rice and 75% RDF to wheat). Farmer’s practice of fertilizer application (T_{12}) was significantly superior to control (T_1) and inferior to most of the treatments during both the years.

**Leaf area index**

Leaf area index as influenced by various inorganic and organic sources of nutrient application at different growth stages are presented in table 6. Perusal of the data revealed that leaf area index was markedly affected by different treatments at 30, 60 and 90 DAT during both the years. Leaf area index increased upto 60 DAT and declined at 90 DAT.

Decreasing doses of inorganic nutrient application from T_5 (100% RDF to both rice and wheat) to T_1 (control) resulted in corresponding decrease in leaf area index at 30, 60 and 90 DAT during both the years. Nevertheless, T_5 remained comparable to T_4 (75% RDF to both rice and wheat) at almost all the stages of observation.

Maximum leaf area index was recorded under T_6 (50% RDF + 50% N through FYM to rice accompanied with 100% RDF to wheat) and being at par with T_7 (75% RDF + 25% N through FYM to rice and 75% RDF to wheat), it recorded markedly higher LAI than other treatments.

However, it did not differ significantly to T_5, T_{10} and T_{11} at 30 DAT and T_{10} and T_{11} at 60 DAT. Farmer’s practice of fertilizer application (T_{12}) was significantly superior to control (T_1) and inferior to most of the treatments during both the years.

**Development stages**

**Day to 50% panicle emergence**

It is apparent from the Data present in table 7 that the number of days taken for 50% panicle emergence after transplanting was significantly influenced under different treatments.
It was recorded earliest in T6 (50% RDF + 50% N through FYM) to rice + 100% RDF to wheat), whereas, control (T1) take maximum period.

Though, T6 remained comparable to T7, T10 and T3 attained 50% panicle emergence in significantly less period than T1, T2 and T12 during both the years.

**Days to maturity**

The maturity of rice was also significantly affected by fertilizer levels and integrated nutrient management treatments. Application of fertilizer significantly hastened the crop maturity during both the years (Table 7).

Days taken to maturity after transplanting was lowest in treatment where 50% RDF was applied through fertilizers + 50% N through FYM to rice and 100% RDF to wheat (T6) but it could show significant superiority only over T1, T2 and T12 during both the years and over T3 during 2011 in reducing the maturity period. Crop maturity was significantly prolonged when no fertilizer and manure were applied (T1).

**Results and Discussion**

Data on growth of rice at periodic intervals revealed that as compared to control and application of nutrients through inorganic fertilizers the INM treatments progressively improved all the growth parameters.

Organic manure application release nutrients slowly and gave favourable conditions to plant that is associated to Vigorous growth and higher growth rate.

The plant height in both the crops during both the years continued to increase with age and there was no further increase as crop proceeded towards maturity, while dry matter accumulation increased upto maturity because of accumulation of photosynthates in sink. Number of tillers in both the crops was increased only upto 90 days of transplanting /sowing and number of leaves, chrolophyll content and leaf area index increased only upto 60 days after transplanting / sowing, thereafter, there was no increase in tillers, leaves, chrolophyll and leaf area index upto maturity.

Addition of different organic materials like Sesbania green manure, FYM and compost enhanced the organic matter percentage of the soil that played a key role for improving soil fertility and crop growth.

The increase in organic matter content of soil improved the physical properties of the soil. The betterment in physical properties of soil reduced the soil pH as various acid and acid forming compounds were released with the addition of organic materials.

The reduction in soil pH increased the availability of plant nutrients and resultantly more uptake of various nutrients by the plants occurred. The increased uptake of nutrients by rice improved metabolic activities in the plants. As a result of all above processes growth of rice was positively affected. (Mehdi et al., 2011)

The soil organic matter is measured to be the panacea for plant life by high calibre of being a source of almost all the essential macro and micronutrients.

The organic manures good provider of N, P, K and also added other essential macro and micronutrients for plant growth. In association with soil micro-organisms, organic manures are also help in synthesis of certain phytohormones and vitamins which promote the growth and development of crops (Sharma, 1983).
Table 1 Effect of Integrated Nutrient Management on plant height (cm) of rice

| Treatments                                      | 30 DAT  | 60 DAT  | 90 DAT  | At Harvest |
|------------------------------------------------|---------|---------|---------|------------|
|                                                | 2010    | 2011    | 2010    | 2011       | 2010    | 2011    |
| T<sub>1</sub> Control*                         |         |         |         |            |
| T<sub>2</sub> 50% RF                           | 38.70   | 39.65   | 60.86   | 62.96      | 73.80   | 75.61   |
| T<sub>3</sub> 50% RF                           | 39.60   | 40.57   | 67.89   | 70.23      | 76.75   | 78.63   |
| T<sub>4</sub> 50% RF                           | 40.50   | 41.49   | 70.50   | 72.93      | 79.90   | 81.86   |
| T<sub>5</sub> 75% RF                           | 46.70   | 47.84   | 78.95   | 81.67      | 86.58   | 88.70   |
| T<sub>6</sub> 100% RF                          | 47.50   | 49.14   | 82.04   | 85.69      | 92.05   | 95.23   |
| T<sub>7</sub> 50% RF + 50% N through FYM        | 50.45   | 52.19   | 86.88   | 90.75      | 100.03  | 103.48  |
| T<sub>8</sub> 75% RF + 25% N through FYM        | 48.65   | 50.33   | 83.65   | 87.37      | 96.30   | 99.62   |
| T<sub>9</sub> 100% RF + 50% N through CR        | 41.78   | 42.80   | 72.47   | 74.97      | 80.35   | 82.32   |
| T<sub>10</sub> 75% RF + 25% N through CR        | 47.10   | 48.25   | 79.90   | 82.66      | 87.80   | 89.95   |
| T<sub>11</sub> 50% RF + 50% N through GM        | 47.90   | 49.55   | 83.06   | 86.76      | 95.35   | 98.64   |
| T<sub>12</sub> Farmer’s practice**              | 41.35   | 42.37   | 70.68   | 73.12      | 78.88   | 80.81   |
| SEM+                                            | 1.64    | 1.92    | 2.92    | 3.32       | 3.18    | 3.74    |
| CD at 5%                                        | 4.73    | 5.53    | 8.40    | 9.56       | 9.14    | 10.75   |

Table 2 Effect of Integrated Nutrient Management on number of tillers hill<sup>-1</sup> of rice

| Treatments                                      | 30 DAT  | 60 DAT  | 90 DAT  | At Harvest |
|------------------------------------------------|---------|---------|---------|------------|
|                                                | 2010    | 2011    | 2010    | 2011       | 2010    | 2011    |
| T<sub>1</sub> Control*                         | 8.63    | 9.15    | 10.63   | 11.11      | 9.53    | 9.10    |
| T<sub>2</sub> 50% RF                           | 9.19    | 9.57    | 11.19   | 11.66      | 10.19   | 10.66   |
| T<sub>3</sub> 50% RF                           | 10.75   | 11.15   | 12.75   | 12.82      | 11.55   | 11.55   |
| T<sub>4</sub> 75% RF                           | 12.44   | 12.59   | 15.44   | 15.22      | 13.94   | 13.97   |
| T<sub>5</sub> 100% RF                          | 12.50   | 12.78   | 15.50   | 15.52      | 14.00   | 14.27   |
| T<sub>6</sub> 50% RF + 50% N through FYM        | 15.47   | 15.51   | 19.47   | 19.49      | 17.47   | 17.58   |
| T<sub>7</sub> 75% RF + 25% N through FYM        | 15.13   | 15.23   | 19.13   | 18.86      | 17.13   | 16.86   |
| T<sub>8</sub> 75% RF + 50% N through CR         | 11.88   | 12.25   | 14.88   | 15.03      | 13.38   | 13.38   |
| T<sub>9</sub> 75% RF + 25% N through GM         | 12.19   | 12.40   | 15.19   | 15.44      | 13.69   | 13.69   |
| T<sub>10</sub> 50% RF + 50% N through GM        | 14.19   | 14.43   | 18.19   | 18.69      | 16.19   | 16.44   |
| T<sub>11</sub> 75% RF + 25% N through GM        | 12.63   | 12.78   | 15.63   | 15.84      | 14.13   | 14.09   |
| T<sub>12</sub> Farmer’s practice**              | 9.44    | 10.07   | 11.44   | 11.59      | 10.44   | 10.47   |
| SEM+                                            | 0.515   | 0.47    | 0.643   | 0.92       | 0.576   | 0.80    |
| CD at 5%                                        | 1.482   | 1.34    | 1.849   | 2.66       | 1.657   | 2.29    |

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Table 3: Effect of Integrated Nutrient Management on number of green leaves hill⁻¹ of rice

| Treatments                        | 30 DAT       | 60 DAT        | 90 DAT        |
|----------------------------------|--------------|---------------|---------------|
|                                  | 2010 | 2011 | 2010 | 2011 | 2010 | 2011 | 2010 | 2011 |
| T₁ Control*                      | 15.01| 15.06| 30.30| 33.76| 17.76| 18.17|       |      |
| T₂ 50% RF                        | 16.51| 17.02| 33.00| 36.46| 20.16| 22.09|       |      |
| T₃ 50% RF                        | 17.23| 18.19| 34.95| 37.42| 25.65| 26.14|       |      |
| T₄ 75% RF                        | 18.73| 20.17| 37.76| 40.04| 27.81| 28.94|       |      |
| T₅ 100% RF                       | 19.17 | 20.58 | 39.10 | 41.56 | 28.63 | 29.54 |       |      |
| T₆ 50% RF + 50% N through FYM    | 23.50 | 24.61 | 47.40 | 49.86 | 34.41 | 35.29 |       |      |
| T₇ 75% RF + 25% N through FYM    | 23.15 | 23.94 | 45.05 | 46.51 | 32.26 | 32.99 |       |      |
| T₈ 50% RF + 50% N through CR     | 17.90 | 18.74 | 36.10 | 38.41 | 25.95 | 26.51 |       |      |
| T₉ 75% RF + 25% N through CR     | 20.65 | 22.27 | 39.15 | 40.61 | 28.56 | 29.39 |       |      |
| T₁₀ 50% RF + 50% N through GM    | 21.85 | 23.31 | 41.85 | 43.31 | 30.11 | 31.09 |       |      |
| T₁₁ 75% RF + 50% N through GM    | 21.80 | 23.14 | 41.70 | 43.16 | 29.61 | 30.44 |       |      |
| T₁₂ Farmer’s practice**          | 18.24 | 19.12 | 37.18 | 39.61 | 26.51 | 27.76 |       |      |
| SEM+                             | 0.82 | 0.86 | 1.62 | 1.71 | 1.16 | 1.19 |       |      |
| CD at 5%                         | 2.35 | 2.47 | 4.67 | 4.93 | 3.32 | 3.43 |       |      |

Table 4: Effect of Integrated Nutrient Management on dry matter (g) hill⁻¹ of rice

| Treatments                        | 30 DAT       | 60 DAT        | 90 DAT        | At Harvest |
|----------------------------------|--------------|---------------|---------------|           |
|                                  | 2010 | 2011 | 2010 | 2011 | 2010 | 2011 | 2010 | 2011 | 2010 | 2011 |
| T₁ Control*                      | 8.65 | 9.04 | 21.48 | 24.31 | 41.59 | 45.13 | 47.93 | 50.97 |       |      |
| T₂ 50% RF                        | 9.21 | 9.67 | 22.88 | 25.59 | 48.26 | 51.69 | 55.61 | 58.85 |       |      |
| T₃ 50% RF                        | 10.12 | 10.87 | 25.15 | 28.08 | 53.09 | 54.70 | 61.18 | 64.98 |       |      |
| T₄ 75% RF                        | 11.04 | 11.75 | 27.45 | 29.64 | 58.29 | 57.54 | 67.17 | 70.67 |       |      |
| T₅ 100% RF                       | 11.45 | 12.17 | 28.48 | 30.23 | 60.11 | 58.45 | 69.27 | 72.56 |       |      |
| T₆ 50% RF + 50% N through FYM    | 12.84 | 13.90 | 31.95 | 34.61 | 67.99 | 67.52 | 77.85 | 82.12 |       |      |
| T₇ 75% RF + 25% N through FYM    | 12.66 | 13.52 | 31.15 | 34.17 | 65.67 | 54.30 | 75.68 | 79.63 |       |      |
| T₈ 50% RF + 50% N through CR     | 10.34 | 11.16 | 25.70 | 28.39 | 56.07 | 62.39 | 64.62 | 68.08 |       |      |
| T₉ 75% RF + 25% N through CR     | 10.75 | 11.54 | 26.73 | 29.41 | 57.05 | 60.61 | 65.74 | 68.88 |       |      |
| T₁₀ 50% RF + 50% N through GM    | 12.14 | 13.06 | 30.20 | 30.81 | 62.91 | 68.14 | 72.49 | 76.55 |       |      |
| T₁₁ 75% RF + 25% N through GM    | 11.88 | 12.42 | 29.55 | 32.50 | 61.47 | 62.48 | 70.83 | 74.50 |       |      |
| T₁₂ Farmer’s practice**          | 9.82 | 10.63 | 24.40 | 27.14 | 53.73 | 55.48 | 61.92 | 65.05 |       |      |
| SEM+                             | 0.46 | 0.43 | 1.14 | 1.44 | 2.41 | 3.07 | 2.74 | 2.76 |       |      |
| CD at 5%                         | 1.32 | 1.24 | 3.27 | 4.16 | 6.92 | 8.82 | 7.88 | 7.93 |       |      |
Table 5. Effect of Integrated Nutrient Management on chlorophyll content of rice

| Treatments                                      | 30 DAT  | 60 DAT  | 90 DAT  |
|------------------------------------------------|---------|---------|---------|
|                                                | 2010    | 2011    | 2010    | 2011    | 2010    | 2011    |
| T1 Control*                                     | 24.59   | 25.51   | 25.69   | 26.08   | 19.65   | 20.10   |
| T2 50% RF                                      | 26.05   | 26.70   | 27.22   | 27.41   | 21.28   | 21.68   |
| T3 50% RF                                      | 27.64   | 28.25   | 28.89   | 29.46   | 23.05   | 23.47   |
| T4 75% RF                                      | 31.73   | 32.48   | 33.18   | 33.64   | 25.54   | 25.62   |
| T5 100% RF                                     | 32.34   | 33.04   | 33.82   | 34.35   | 26.05   | 26.22   |
| T6 50% RF + 50% N through FYM                  | 36.22   | 37.61   | 37.89   | 38.56   | 29.31   | 29.78   |
| T7 75% RF + 25% N through FYM                  | 33.84   | 34.92   | 35.39   | 36.27   | 28.23   | 28.96   |
| T8 50% RF + 50% N through CR                   | 28.94   | 30.27   | 30.26   | 30.97   | 23.84   | 24.20   |
| T9 75% RF + 25% N through CR                   | 30.12   | 31.61   | 31.49   | 32.67   | 24.71   | 25.29   |
| T10 50% RF + 50% N through GM                  | 33.05   | 34.05   | 34.56   | 35.24   | 27.35   | 28.21   |
| T11 75% RF + 25% N through GM                  | 32.69   | 33.60   | 34.18   | 34.98   | 26.67   | 27.46   |
| T12 Farmer’s practice**                        | 26.65   | 30.98   | 27.85   | 28.29   | 21.62   | 21.86   |
| SEM+                                           | 1.27    | 1.32    | 1.33    | 1.30    | 1.04    | 1.10    |
| CD at 5%                                       | 3.66    | 3.81    | 3.83    | 3.75    | 2.99    | 3.17    |

Table 6. Effect of Integrated Nutrient Management on leaf area index of rice

| Treatments                                      | 30 DAT  | 60 DAT  | 90 DAT  |
|------------------------------------------------|---------|---------|---------|
|                                                | 2010    | 2011    | 2010    | 2011    | 2010    | 2011    |
| T1 Control*                                     | 1.50    | 1.57    | 4.28    | 4.47    | 3.08    | 3.20    |
| T2 50% RF                                      | 1.53    | 1.60    | 4.63    | 5.15    | 3.19    | 3.28    |
| T3 50% RF                                      | 1.65    | 1.73    | 5.32    | 5.58    | 3.78    | 4.01    |
| T4 75% RF                                      | 1.61    | 1.69    | 5.19    | 5.43    | 3.62    | 3.82    |
| T5 100% RF                                     | 1.70    | 1.79    | 5.42    | 5.65    | 4.30    | 4.57    |
| T6 50% RF + 50% N through FYM                  | 1.93    | 2.03    | 6.20    | 6.54    | 4.81    | 5.14    |
| T7 75% RF + 25% N through FYM                  | 1.89    | 2.00    | 6.09    | 6.44    | 4.69    | 5.01    |
| T8 50% RF + 50% N through CR                   | 1.70    | 1.79    | 5.48    | 5.77    | 3.94    | 4.20    |
| T9 75% RF + 25% N through CR                   | 1.67    | 1.74    | 5.37    | 5.61    | 3.86    | 4.07    |
| T10 50% RF + 50% N through GM                  | 1.78    | 1.89    | 5.73    | 6.08    | 4.20    | 4.51    |
| T11 75% RF + 25% N through GM                  | 1.74    | 1.82    | 5.60    | 5.87    | 4.00    | 4.24    |
| T12 Farmer’s practice**                        | 1.55    | 1.62    | 4.99    | 5.22    | 3.41    | 3.40    |
| SEM+                                           | 0.07    | 0.07    | 0.22    | 0.22    | 0.16    | 0.17    |
| CD at 5%                                       | 0.20    | 0.20    | 0.65    | 0.64    | 0.47    | 0.48    |
Table 7 Effect of Integrated Nutrient Management on days to flowering and maturity of rice

| Treatments                      | Days to 50% Flowering DAT | Days to Maturity DAT |
|---------------------------------|---------------------------|----------------------|
|                                 | 2010 | 2011 | 2010 | 2011 |
| T1 Control*                     |      |      |      |      |
| Control                         | 78.25| 78.50| 105.75| 108.00|
| T2 50% RF                       |      |      |      |      |
| 50% RF                          | 75.75| 76.00| 103.75| 105.75|
| T3 50% RF                       |      |      |      |      |
| 100% RF                         | 72.75| 74.25| 100.75| 103.75|
| T4 75% RF                       |      |      |      |      |
| 75% RF                          | 72.50| 74.00| 100.25| 104.00|
| T5 100% RF                      |      |      |      |      |
| 100% RF                         | 72.25| 72.25| 100.25| 102.00|
| T6 50% RF + 50% N through FYM   |      |      |      |      |
| 100% RF                         | 71.25| 71.50| 99.75 | 100.25|
| T7 75% RF + 25% N through FYM   |      |      |      |      |
| 75% RF                          | 71.25| 72.00| 99.75 | 101.25|
| T8 50% RF + 50% N through CR    |      |      |      |      |
| 100% RF                         | 72.75| 74.25| 100.75| 102.50|
| T9 75% RF + 25% N through CR    |      |      |      |      |
| 75% RF                          | 72.50| 74.00| 100.25| 102.75|
| T10 50% RF + 50% N through GM   |      |      |      |      |
| 100% RF                         | 71.50| 73.00| 100.00| 101.50|
| T11 75% RF + 25% N through GM   |      |      |      |      |
| 75% RF                          | 72.25| 73.50| 100.00| 102.00|
| T12 Farmer’s practice**         |      |      |      |      |
| SEM+                            | 0.99 | 0.67 | 0.75 | 1.04 |
| CD at 5%                        | 2.86 | 1.94 | 2.15 | 2.98 |
Development stages

The number of days taken for heading/flowering and maturity in both the crops were hastened in the plots manured with conjoint application of organics [FYM, green manure (dhaincha) and wheat cut straw] and fertilizers in rice as well as succeeding wheat crop due to the direct and residual effect (Mehta, 2004). This is because conjoint application of organics and chemical fertilizers resulted in early boost of vegetative growth due to better nutrition and thus, the attainment of physiological stages was enhanced. These findings are in agreement with Shah et al., (1998).

The experimental finding indicated that the growth attributes viz: plant hight (cm), number of tillers hill-1, numbers of green leaf hill-1, Dry matter g hill-1, LAI, and chlorophyll content was markedly decline with curtailment in level of chemical fertilizer from 100%RDF to both rice and wheat (T5) to control (T1). All the Growth attributing character recorded highest value in T6 where 50% RDF + 50% N through FYM was applied to rice accompanied with 100% RDF to wheat. The minimum value was observed in T1 (Control). However, decreasing in level of inorganic sources from 100% RDF to both rice and wheat (T5) to Control (T1) delay the flowering and maturity. In INM sources T6 took minimum days to flowering and maturity followed by T7, T10, T11, T8, and T9 and maximum by T1 (control).

It was concluded from the result of experiment that integrated nutrient supply improved the growth, and development of rice. Substitution of 50 % N through FYM+ 50% RDF to rice accompanied with 100% RDF to wheat was better than N substitution through crop residue and green manuring as well as chemical treatments.

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