Effect of integrated nutrient management and weed control practices on growth and yield attributes of rice (Oryza sativa L.) in rice-groundnut cropping system

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DOI: https://doi.org/10.22271/tpi.2021.v10.i3d.5771

Abstract

A field experiment was conducted at Instructional farm of Krishi Vigyan Kendra Kendrapara, Odisha during kharif and rabi seasons of 2013-14 and 2014-15 in rice-groundnut cropping system under irrigated medium land situation. The soil of the experimental site was sandy loam in texture with pH of 5.7, organic carbon of 0.52% having available soil nitrogen, phosphorus and potassium of 390.9 kg/ha, 10.1 kg/ha and 190.1 kg/ha respectively. Rice crop (var. Sahabhagi dhan) was transplanted in kharif season taking nine treatments having three levels of nutrient management practice and three level of weed management with three replications. Further during rabi season each main plot was divided into two sub-plots taking groundnut (var. Devi) with two levels of weed management practices under split plot design. The pooled data revealed that growth of rice and yield attributes were significantly higher in treatment of RDF (75% N) with green manuring of dhaincha (Sesbania aculeata) with pre emergence application of herbicide oxadiargyl followed by post emergence bispirbac-sodium which recorded higher plant height (96.35 cm), number of tillers per plant (212.7), Leaf area index (4.4), dry matter accumulation (1347.5 g/plant), panicle length (25.8 cm) and test weight (22.33 g).

Keywords: Rice-groundnut cropping system, yield attributes of rice, oxadiargyl, bispirbac-sodium green manuring of dhaincha

Introduction

Rice (Oryza sativa L.) is one of the most important cereal foods of the world. Rice feeds fifty percent of the world population and contributes nineteen percent of the global calories intake (IRRI, 2014) [3, 20]. Rice is cultivated in 112 countries of world covering every continent and it is consumed by 2.5 billion people in developing countries, mostly in Asia (90%) and the rest (10%) in America, Africa, Australia and Europe. To meet global rice demand, it is projected that an additional 96 million tons of milled rice will be needed by 2040 as compared to 2015 (Valera and Belie, 2020) [20]. India is the world’s top rice producing country in terms of area and ranked second in terms of production. Though eastern India occupies 61.3% of the rice area of the country (27 million ha), it contributes only 48% of the total rice production and it has much lower growth rate of rice yield compared to other regions of the country. Therefore, research initiatives are imperative in this area to address the production constraints and coming up with suitable solutions.

Rice is a heavy nitrogen feeder, but fertilizer nitrogen use-efficiency is very low under tropical conditions, where it rarely exceeds 50% and usually ranges between 15 and 35%. Complementary use of organic and biological source of plant nutrient along with chemical fertilizer is of great importance for the maintenance of soil health and productivity, especially under intensive cropping system. Integrated use of organic manures and chemical fertilizers has advantages over use of only organic manures or chemical fertilizers (Kumar et al., 2009) [3]. Since sourcing of organic manure is difficult and the crop response to them during initial stages is not as spectacular, compared to the chemical fertilizers, an integrated approach of plant nutrition involving the judicious mix of organic and chemical could be helpful to sustain optimum yield and to restore the residual soil fertility. Out of the organic sources available for use in rice production, farmyard manure is the proven source of nutrition, but its availability is quite inadequate (Mishra and Prasad, 2000) [13]. This necessitates searching for organics such as green manuring and use of biofertiliser. Incorporation of farm yard manure and green manure in combination with inorganic fertilizers improve the productivity of component crops in cropping sequence ameliorates and sustain soil health and also economise fertiliser need.
As a green manure crop, dhaincha can substitute for applied fertilizer nitrogen (Raju and Reedy, 2000) [14, 15] in addition to supplying organic matter for the restoration of soil physical conditions. The use of dhaincha (Sesbania aculeata) as a green manure improves soil productivity through biological nitrogen fixation (Ladha, et al., 2000) [8, 9, 16]. Dhaincha as a green manure increases uptake of P, K, Zn, Fe, Mn, and Cu by rice plants (Vaiyapuri and Sriramachandrasekharan, 2001) [19].

Weeds play a key role and reduce the crop yield by more than 35% on an average (Sattin and Berti, 2003) [17]. Weed infestation in rice remains the largest constraint, limiting its productivity. A major hindrance in the successful cultivation of rice is heavy infestation of weeds (Parthipan et al., 2013) [12]. Manual removal of weed is labour intensive, tedious and does not ensure weed removal at critical stages of crop-weed competition. The choice of chemical herbicides depends upon weed type and degree of weed infestation in rice field. Herbicides are effective against weed species but most of them are specific and are effective against narrow range of weed species (Mukherjee and Singh 2005) [10]. Thus effective weed control often requires a combination of cultural, mechanical and chemical control such as an integrated weed management approach to delay herbicide resistance and reduce the herbicide load in the agro-ecosystem (Rao et al., 2007) [16].

### Materials and Methods

The field experiment was conducted at instructional farm of Krishi Vigyan Kendra Kendrapara, Odisha in rice-groundnut cropping system during kharif and rabi seasons of 2013-14 and 2014-15 under irrigated medium land situation where rice was grown as kharif crop and groundnut as rabi crop. The experimental site was situated at 20° 53’N latitude and 86° 46’E longitude at an altitude of 11.9 m above the mean sea level. The soil of the experimental site was sandy loam in texture with pH of 5.7, organic carbon of 0.52% having available soil nitrogen, phosphorus and potassium of 390.9 kg/ha, 10.1 kg/ha and 190.1 kg/ha respectively. The green manure crop dhaincha followed by rice were grown from 22nd standard meteorological week (SMW) (28 May-3 June) to 44th SMW (29-04 November) during kharif 2013 as well as in 2014. Total rainfall amounting to 1731.5 mm in 91 rainy days and 1266.0 mm in 83 rainy days were received during kharif 2013 and 2014 respectively. During kharif season three levels each of nutrient and weed management practices in rice were tried in randomized block design (RBD) with three replications. The same levels of nutrient were added by bispyribac sodium at all its growth stages. It corroborates the findings of Yadav et al. (2010) [25]. Application of herbicide both pre and post also could negatively supported weed density and kept the crop free of crop weed competition which benefited the crop to grow faster.

### Results and Discussions

### Effect of INM and weed control practices on plant height (cm) of rice

Data on plant height of rice recorded at 15 days interval from 15 DAT to 60 DAT and harvest are presented under Table 1. The results revealed that, the plant height at 75% N RDF coupled with pre emergence application of oxadiargyl with one hand weeding (HW) recorded significantly higher plant height in all stages of observations (15 DAT to harvest). Next in order was 100% RDF + oxadiargyl followed by bispyribac sodium. As regards to weed management practices oxadiargyl followed by bispyribac sodium succeeded to all treatments and recorded significantly higher height in all stages of observations during kharif 2013. The impact of nutrient management maintained similar trend to that of results presented in kharif 2013-14. The height was significantly higher with application of oxadiargyl followed by bispyribac sodium at all its growth stages. It corroborates the findings of Yadav et al. (2010) [25]. Application of herbicide both pre and post also could negatively supported weed density and kept the crop free of crop weed competition which benefited the crop to grow faster.

### Effect of INM and weed control practices on tillers/m² of rice

Data on number of tillers per m² on rice was recorded on all stages of observations, during kharif 2013 and 2014. The results revealed that, in respect to nutrient management indicated that 75% N RDF with green manuring of dhaincha recorded significantly higher tillers per m² from 15 DAT to 60 DAT and harvest. In case of weed management practices pre em. Application of oxadiargyl followed by bispyribac sodium recorded significantly higher number of tillers per m² in all 5 stages of observations. However, it was at par with pre emergence application of oxadiargyl + one HW at 25 DAT during kharif 2013. The results on the number of tillers per m² during 2014 revealed that 75% N RDF + green manuring could succeed in recording significantly higher number of tillers as compared to 50% N (RDF) + green manuring of dhaincha. As regards to weed management practices, W₁ had added advantage over W₁ and W₂ in recording significantly higher number of tillers at 15 DAT only, but W₂ succeeded W₁ and W₂ at 30 DAT, 45 and 60 DAT. The result corroborated the findings of Raju and Pandian (2001) [14, 15] and Kiran et al. (2010) [6].
The crop free of competition slowly at harvest. The trend was observed in both fertility level and weed control practices. There was significant increase in LAI due to 100% RDF. It was just followed by 75% N (RDF) and W-RDF (50% N) + GM dhaincha, W1 - Control (Weedy check), W2 - Pre em. oxadiargyl at 3 DAT + HW at 25 DAT, W3 - PE oxadiargyl at 3 DAT + Post em. bispyribac sodium at 15 DAT

Effect of INM and weed control practices on leaf area index (LAI) of rice

| Treatments | 15 DAT | 30 DAT | 45 DAT | 60 DAT | Harvest |
|------------|--------|--------|--------|--------|---------|
|            | 2013   |        |        |        |         |
| N1         | 39.0   | 55.3   | 73.5   | 84.1   | 88.5    |
| N2         | 47.5   | 66.7   | 80.8   | 92.5   | 97.9    |
| N3         | 43.5   | 63.2   | 78.4   | 80.5   | 89.7    |
| SEm±       | 1.4    | 1.5    | 1.6    | 1.1    | 1.6     |
| CD (P<0.05)| 4.2    | 4.5    | 4.8    | 3.3    | 4.8     |
| W1         | 35.5   | 53.6   | 60.5   | 72.0   | 80.5    |
| W2         | 42.6   | 55.7   | 72.5   | 79.5   | 87.5    |
| W3         | 45.5   | 60.8   | 74.5   | 78.8   | 88.5    |
| SEm±       | 1.5    | 1.6    | 1.7    | 1.1    | 1.6     |
| CD (P<0.05)| 4.5    | 4.8    | 5.1    | 3.3    | 4.8     |

| Treatments | 2014   |        |        |        |         |
|------------|--------|--------|--------|--------|---------|
| N1         | 43.0   | 60.1   | 70.5   | 80.1   | 86.5    |
| N2         | 49.6   | 68.5   | 82.8   | 98.4   | 94.8    |
| N3         | 47.4   | 64.2   | 80.1   | 89.6   | 92.5    |
| SEm±       | 1.5    | 1.6    | 1.7    | 1.1    | 1.6     |
| CD (P<0.05)| 4.5    | 4.8    | 5.1    | 3.3    | 4.8     |
| W1         | 39.5   | 56.6   | 63.5   | 75.0   | 82.5    |
| W2         | 46.6   | 53.8   | 75.5   | 84.5   | 91.5    |
| W3         | 49.5   | 62.5   | 78.5   | 79.8   | 83.5    |
| SEm±       | 1.5    | 1.6    | 1.7    | 1.1    | 1.6     |
| CD (P<0.05)| 4.5    | 4.8    | 5.1    | 3.3    | 4.8     |

N1 - RDF (60-30-30 N-P2O5-K2O kg/ha.), N2 - RDF (75%N) + GM dhaincha, N3 - RDF (50% N) + GM dhaincha, W1 - Control (Weedy check), W2 - Pre em. oxadiargyl at 3 DAT + HW at 25 DAT, W3 - PE oxadiargyl at 3 DAT + Post em. bispyribac sodium at 15 DAT

Table 1: Effect of INM and weed control practices on plant height (cm) of rice

Table 2: Effect of INM and weed control practices on tillers/m² of rice
Effect of INM and weed control practices on dry matter accumulation of (g/m²) rice

The data on dry matter accumulation of rice during kharif 2013 and 2014 is presented under Table 4. The data revealed that dry matter production increased progressively up to harvest. Interestingly, N₁ recorded significantly higher dry weight in all stages of growth. It was just followed by N₁ and N₂. As regards to weed management practices in kharif rice, W₃ had the added advantage in recording significantly higher dry matter at all stages of growth and was just followed by W₃ and W₁ during kharif 2014. N₁ recorded significantly higher dry matter production in comparison to N₂ and N₃. N₂ recorded moderate dry matter production and was followed by N₃. The weed management practices applied to kharif rice 2014 was indicative of fact that W₁ (1272g/m²) recorded more dry matter in all stages of growth and the highest recorded of higher matter at crop harvest. Similar results were recorded by Goel and Verma (2000) [3], Singh et al. (2006) [8, 10, 11, 13, 18], Brar and Bhullar (2013) [11] and Kiran et al. (2010) [6].

### Table 3: Effect of INM and weed control practices on LAI of rice

| Treatments | 15 DAT | 30 DAT | 45 DAT | 60 DAT | Harvest |
|------------|--------|--------|--------|--------|---------|
| 2013       |        |        |        |        |         |
| N₁         | 2.7    | 3.75   | 4.54   | 4.95   | 3.95    |
| N₂         | 3.31   | 4.02   | 4.53   | 5.01   | 4.40    |
| SEm±       | 0.11   | 0.04   | 0.08   | 0.06   | 0.04    |
| CD (P=0.05)| 0.33   | 0.12   | 0.23   | 0.17   | 0.16    |
| W₁         | 3.37   | 4.49   | 5.20   | 4.14   | 3.14    |
| W₂         | 3.80   | 5.35   | 5.43   | 4.35   | 4.03    |
| W₃         | 3.99   | 5.58   | 5.64   | 4.69   | 4.24    |
| SEm±       | 0.14   | 0.03   | 0.07   | 0.05   | 0.03    |
| CD (P=0.05)| 0.42   | 0.10   | 0.23   | 0.14   | 0.1     |
| 2014       |        |        |        |        |         |
| N₁         | 3.15   | 3.59   | 3.76   | 5.35   | 3.76    |
| N₂         | 3.25   | 4.3    | 4.15   | 5.7    | 4.15    |
| SEm±       | 0.05   | 0.06   | 0.21   | 0.55   | 0.06    |
| CD (P=0.05)| 0.16   | 0.19   | 0.66   | 1.7    | 0.17    |
| W₁         | 3.18   | 3.79   | 3.92   | 5.43   | 3.92    |
| W₂         | 3.51   | 4.91   | 5.17   | 5.17   | 5.01    |
| W₃         | 3.79   | 4.34   | 5.39   | 5.83   | 5.03    |
| SEm±       | 0.05   | 0.06   | 0.21   | 0.55   | 0.06    |
| CD (P=0.05)| 0.16   | 0.19   | 0.66   | 1.7    | 0.17    |

N₁: RDF (60-30-30 N-P₂O₅-K₂O kg/ha), N₂: RDF (75%N) + GM dhaincha, N₃: RDF (50%N) + GM dhaincha, W₁: Control (Weedy check), W₂: Pre em. oxadiargyl at 3 DAT + HW at 25 DAT, W₃: PE oxadiargyl at 3 DAT + Post em. bispiribac sodium at 15 DAT

### Table 4: Effect of INM and weed control practices on dry matter accumulation (g/m²) of rice

| Treatments | 30 DAT | 45 DAT | 60 DAT | 75 DAT | Harvest |
|------------|--------|--------|--------|--------|---------|
| 2013       |        |        |        |        |         |
| N₁         | 369    | 653    | 818    | 924    | 952     |
| N₂         | 402    | 724    | 929    | 1074   | 1111    |
| N₃         | 446    | 771    | 1018   | 1165   | 1206    |
| SEm±       | 20     | 31     | 32     | 35     | 33      |
| CD (P=0.05)| 60     | 123    | 98     | 107    | 103     |
| W₁         | 401    | 701    | 891    | 1013   | 1044    |
| W₂         | 499    | 881    | 1192   | 1387   | 1437    |
| W₃         | 532    | 925    | 1270   | 1501   | 1562    |
| SEm±       | 18     | 30     | 31     | 34     | 32      |
| CD (P=0.05)| 54     | 120    | 93     | 102    | 96      |
| 2014       |        |        |        |        |         |
| N₁         | 380    | 655    | 837    | 965    | 1014    |
| N₂         | 528    | 889    | 1149   | 1368   | 1445    |
| N₃         | 541    | 922    | 1231   | 1482   | 1601    |
| SEm±       | 14     | 29     | 36     | 44     | 44      |
| CD (P=0.05)| 42     | 88     | 111    | 135    | 135     |
| W₁         | 331    | 595    | 764    | 866    | 903     |
| W₂         | 407    | 714    | 898    | 1036   | 1096    |
| W₃         | 455    | 799    | 1022   | 1209   | 1272    |
| SEm±       | 18     | 30     | 31     | 34     | 32      |
| CD (P=0.05)| 54     | 120    | 93     | 102    | 96      |

N₁: RDF (60-30-30 N-P₂O₅-K₂O kg/ha), N₂: RDF (75%N) + GM dhaincha, N₃: RDF (50%N) + GM dhaincha, W₁: Control (Weedy check), W₂: Pre em. oxadiargyl at 3 DAT + HW at 25 DAT, W₃: PE oxadiargyl at 3 DAT + Post em. bispiribac sodium at 15 DAT.
Effect of INM and weed control practices on yield attributes of rice

Effect of INM and weed control practices on yield attributes of rice during kharif 2013 and 2014 is presented under Table 5. The length of panicle was significantly higher in N\textsubscript{2} than N\textsubscript{1}. It was at par with N\textsubscript{1} during 2013 and 2014. Similarly the panicle length was significantly higher in W\textsubscript{3} than W\textsubscript{1} which was at par with W\textsubscript{2}. The mean length was higher in N\textsubscript{3} but was at par with N\textsubscript{1} and N\textsubscript{2} during kharif 2013. The number of grains per panicle was significantly higher in N\textsubscript{2} in comparison to N\textsubscript{1} and N\textsubscript{3}, but N\textsubscript{2} was at par with N\textsubscript{1}. The data on test weight of rice indicated that N\textsubscript{2} recorded significantly higher test weight of 22.6 g and 22.9 g in 2013 and 2014 respectively. The mean test weight under same treatment was significantly higher to N\textsubscript{1} and N\textsubscript{2}. As regards to weed control methods W\textsubscript{3} had the advantage to record significant higher test weight (22.4 g) as compared to W\textsubscript{1} and W\textsubscript{2} in 2013. Same trend was maintained during 2014. Similar observation were recorded by Halder and Patra (2007)\textsuperscript{[4]}, Singh and Singh (2010)\textsuperscript{[8, 10, 11, 13, 18]}. 

**Table 5: Effect of INM and weed control practices on yield attributes of rice**

| Treatments | Length of panicle (cm) | No. of grains/panicle | Test weight (g) |
|------------|------------------------|-----------------------|----------------|
|            | Year 2013 | 2014 | Mean | 2013 | 2014 | Mean | 2013 | 2014 | Mean |
|------------|-----------|-------|------|-------|-------|------|-------|-------|------|
| N\textsubscript{1} | 23.2      | 23.8  | 23.5 | 158   | 168   | 164  | 21.7  | 22.1  | 21.9 |
| N\textsubscript{2} | 24.1      | 24.7  | 24.4 | 176   | 194   | 185  | 22.6  | 22.9  | 22.75|
| N\textsubscript{3} | 24.5      | 25.4  | 24.9 | 165   | 178   | 172  | 21.9  | 21.8  | 21.85|
| SEm\textsubscript{2} | 0.7      | 0.8   | 0.5  | 7     | 8     | 7    | 0.2   | 0.2   | 0.2  |
| CD (0.05) | 2.3       | 2.5   | 1.4  | 21    | 24    | 21   | 0.6   | 0.6   | 0.6  |
| W\textsubscript{1} | 25.1      | 26.7  | 25.4 | 166   | 158   | 162  | 21.6  | 21.9  | 21.75|
| W\textsubscript{2} | 25.3      | 27.1  | 26.2 | 156   | 144   | 150  | 22.4  | 22.9  | 22.65|
| W\textsubscript{3} | 26.7      | 27.7  | 27.2 | 142   | 148   | 145  | 21.7  | 22.1  | 21.9  |
| SEm\textsubscript{2} | 0.7      | 0.8   | 0.5  | 7     | 8     | 7    | 0.2   | 0.2   | 0.2  |
| CD (0.05) | 2.0       | 2.4   | 1.5  | 21    | 24    | 21   | 0.6   | 0.6   | 0.6  |

N\textsubscript{1}- RDF (60-30-30 N-P\textsubscript{2}O\textsubscript{5}-K\textsubscript{2}O kg/ha), N\textsubscript{2}- RDF (75% N) + GM dhaïncha, N\textsubscript{3}- RDF (50% N) + GM dhaïncha, W\textsubscript{1}- Control (Weedy check), W\textsubscript{2}- Pre em. oxadiargyl at 3 DAT + HW at 25 DAT, W\textsubscript{3}- PE oxadiargyl at 3 DAT + Post em. bispyribac-sodium at 15 DAT

**Conclusion**

The growth parameters of rice viz., plant height, number of tillers per plant, dry matter accumulation per plant and Leaf area Index were significantly varied due to different treatments. It was also noted that all the growth parameters significantly increased by the combine use of organic and inorganic sources of nutrients. Among all the treatments N\textsubscript{3}W\textsubscript{3} i.e. 75% RDFN + green manuring of dhaïncha (Sesbania aculeata) with pre emergence application of herbicide oxadiargyl followed by post emergence bispyribac-sodium expressed maximum plant growth parameters over all the treatments at different growth intervals which recorded higher plant height (96.35 cm), number of tillers per plant (212.7), Leaf area index (4.4), dry matter accumulation (1347.5 g/plant), panicle length (25.8 cm) and test weight (22.33 g) while minimum growth parameters were recorded under control.

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