

# EFFECT OF NITROGEN LEVELS AND WEED CONTROL METHODS ON GROWTH, YIELD AND ECONOMICS OF RICE (*ORYZA SATIVA* L.)

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**Abstract:** A field experiment was carried out during rainy seasons of 2015 at the Rajaula Agriculture Farm, MGCGVV, Satna (M.P.) to study the effect of N-levels and weed control methods on growth, yield and economics of rice. The application of 125 kg N/ha was found the best which produced maximum grain yield (22.58 q/ha) and net return (Rs.24889/ha) from transplanted rice var. PS-5. The weed control treatment W<sub>6</sub> (HW 20 & 40 DAS) proved the best which produced highest grain yield (25.44 q/ha) and net return (Rs.29470/ha) from rice. Among the treatment interactions, N<sub>125</sub> with 2 HW performed the best by producing highest grain yield (27.78 q/ha) and net return (Rs.33018/ha) from transplanted rice var. PS-5. Butachlor 0.75 kg/ha + 2 HW stood the second best (rice grain yield 23.86 q/ha, income Rs.24963/ha). The best substitute of 2 HW with or without butachlor was butachlor + 2, 4-D 0.80 kg/ha or butachlor + bispyribac sodium (20 g/ha) which equally yielded 20.57 to 21.82 q/ha rice grain and gave net income from Rs.22531 to Rs.25334/ha.

**Keywords:** Nitrogen levels, Weed control methods, Growth, Yield, Economics, Rice

## INTRODUCTION

Rice-wheat is one of the major cropping systems in the country. Both the crops are heavy feeder of nutrients which needs to be managed by improved technology including effective weed management. Nitrogen is as a key nutrient in determining the level of crop productivity. The efficiency of applied nitrogen is very low and varies from 20 to 25% in upland rice crop due to the oxidized condition prevailing in uplands and concomitant heavy nitrogen loss through percolating water. Hence, fractional application of nitrogen in right amount and proportion and when it is needed the most seems to be a practical proposition. Weed control also facilitates higher absorption of applied nutrient, thus increases the efficiency of fertilizers application to the crops (Amarjit *et al.*, 2006).

Crop weed competition in direct sowing method is more severe reducing the yield by 20 to 95% (Gogoi, 1998). Manual weeding is expensive, laborious and time consuming as well as difficult in early stage of crop growth. Therefore, the use of pre-emergence herbicides has been found most effective in early stage only, but the second flush of weeds at 25-30 days after sowing (DAS) become problematic. Hence, an integrated weed management practice is the only effective alternative. The moderate nitrogen levels increase the crop yield independent of weed density but higher doses increase the risk of yield loss due to increased weed competition (Cavero *et al.*, 1997). In view of these facts, the present research was taken up.

## MATERIALS AND METHODS

The field experiment was carried out during rainy seasons of 2015 and 2016 at the Rajaula Agriculture Farm, MGCGVV, Satna (M.P.). The soil of the experimental site was sandy-loam in texture and neutral in soil reaction (pH 7.46). The soil was low in nitrogen, medium in phosphorus and high in potash. The total rainfall received during the crop season was 584.3 mm distributed in 31 rainy days.

The experiment was laid out in split plot design with treatments comprising three nitrogen levels viz. N<sub>75</sub> (N<sub>1</sub>), N<sub>00</sub> (N<sub>2</sub>) and N<sub>125</sub> (N<sub>3</sub>) as main-plot treatments and seven weed control treatments viz. (W<sub>1</sub>-butachlor + 1 HW, W<sub>2</sub>-butachlor + 2 MW, W<sub>3</sub>-butachlor + 2,4-D, W<sub>4</sub>-bispyribac sodium, W<sub>5</sub>-butachlor + bispyribac sodium, W<sub>6</sub>-HW-2, W<sub>7</sub>-control) as sub-plot treatments. Before transplanting rice crop, an uniform dose of 60 kg P<sub>2</sub>O<sub>5</sub> + 40 kg K<sub>2</sub>O/ha was applied in all the plots through SSP and MOP, respectively. Nitrogen was applied through urea in 3 split doses i.e. 50% at basal, 25% at tillering and 25% at panicle-initiation stages. The rice crop (PS-5) was transplanted on 16 July in 2015 and on 19 July in 2016. The crop was harvested on 22 November in 2015 and on 12 November in 2016.

## RESULTS AND DISCUSSION

### Growth parameters

Application of different levels of nitrogen upto N<sub>125</sub> significantly enhanced the plant height and tillers/m<sup>2</sup>. Tallest plants (77.5 cm) and more tillers (307/m<sup>2</sup>) were recorded under the highest N level (125 kg/ha).

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This was the highest dose of nitrogen levels which might be due to the fact that nitrogen is essential for building up of protoplasm and protein which induce cell division and initial meristematic activity. These findings are in close agreement with those of Mahajan *et al.* (2010), Pramanik and Bera (2012), Shwetha and Narayana (2014) and Kumar *et al.* (2015). Throughout the growth period all the weed control treatments ( $W_1$  to  $W_6$ ) recorded significantly higher plant height and tillers/m<sup>2</sup> as compared to  $W_7$  (weedy check). At 30, 60 and 90 DAS stages of observations, all the weed control treatments recorded almost significant similar superiority over  $W_7$  in respect to the plant height and tillers formation. Out of weed control treatments viz.  $W_3$ ,  $W_5$  and  $W_6$  performed equally best in enhancing these growth characters.

The superiority in respect to growth characters recorded by all these weed control treatments over control at early and later stages of observations might be due to lesser weed competition than weedy check. Similar results were recorded by Maity *et al.* (2008), Noyingthung (2009), Akbar *et al.* (2011), Yadav *et al.* (2011) and Khalique *et al.* (2012).

#### **Yield-attributes**

Most of the yield-attributes like number of panicles/m<sup>2</sup>, length and weight of panicle, filled grains count/panicle and test-weight showed the superiority under the highest N-level having 125 kg N/ha. Maximum panicles were 295/m<sup>2</sup>, panicle length 20.2 cm and panicle weight 1.86 g, filled grains 92.50/panicle and 18.43 g test weight. In fact, nitrogen is one of the major plant nutrients and it is an integral part of the chlorophyll and all proteins, vigorous growth of plant height and tillers, leaf production and enlargement of leaf surface. This was simultaneously augmented the assimilation of nitrogen by reproductive parts of the plant thus resulting increased yield attributing parameters. Similar results have also been reported by Barik *et al.* (2008), Mahajan *et al.* (2010) Bai *et al.* (2013) and Vishwakarma *et al.* (2014).

The response of highest dose of nitrogen under study might be due to edaphology of site because soil was low in nitrogen content. So the nitrogen response was dominated. Similar findings have been reported by Rammohan *et al.* (2000), Meena *et al.* (2001), Satyanarayana *et al.* (2012) and Kumar *et al.* (2015). It is evident from the results that hand weeding twice ( $W_6$ ) exhibited significant superiority over all other weed control treatments in respect to yield-attributes like number of panicles/m<sup>2</sup>, length of panicle, weight of panicle, number of filled grains and test weight. The maximum panicle number was 319/m<sup>2</sup>, panicle length 22.0 cm, panicle weight 1.97 g, filled grains 96.89/panicle and test weight 19.59 g. This was followed by  $W_2$ . However, all other weed control treatments were also significantly superior over  $W_7$  (unweeded control). The higher values of yield-attributes recorded by  $W_6$  and  $W_2$  over all other weed

control treatments might be due to better control of monocot and dicot weeds which facilitated to greater availability of plant nutrients and ultimately improved yield-attributes. These results are in the close agreement with the findings of Maity *et al.* (2008), Mishra and Singh (2008), Noyingthung (2009), Mehta *et al.* (2010), Yadav *et al.* (2011), Akbar *et al.* (2011) and Khalique *et al.* (2012).

#### **Productivity parameters**

Among the applied nitrogen levels, the highest N level ( $N_{125}$ ) performed the best by producing significantly highest grain yield i.e. 22.58 q/ha as compared to lower N-levels. This might be due to over all better performance of growth and appreciable improvement in yield-attributing characters viz. number of panicles/m<sup>2</sup>, number of filled grains/panicle, length and weight of panicle and test weight. Mahajan *et al.* (2010), Pramanik and Bera (2012 and 2013), Bai *et al.* (2013), Shwetha and Narayana (2014), Vishwakarma *et al.* (2014), Show *et al.* (2014) and Kumar *et al.* (2015) have also found an increase in grain yield of rice with the application of nitrogen up to 150 kg/ha.

The straw yield was found highest under the treatment having lowest 75 kg N/ha. The lowest N level produced 40.76 q/ha straw yield which was significantly superior to the higher N levels. The decrease in straw yield under highest N supply might be due to the better performance of the nitrogen on production of grain over straw.

The significantly highest grain yield (25.45 q/ha) was recorded by  $W_6$  (HW twice), while second best treatment was  $W_2$  (23.86 q/ha), followed by  $W_3$  and  $W_5$  (21.82 and 20.57 q/ha, respectively). The lowest grain yield was recorded by  $W_7$  which produced only 12.89 q/ha grains. Like grain yield, straw yield was also recorded highest by  $W_6$  (45.40 q/ha), followed by  $W_2$  (41.54 q/ha) which was significantly higher than the remaining treatments, while the lowest straw yield was recorded by  $W_7$  (27.78 q/ha). The straw yield was exactly in accordance with the growth parameters in these treatments. The similar yield results were also found by Noyingthung (2009), Mehta *et al.* (2010), Mandal *et al.* (2011), Yadav *et al.* (2011), Akbar *et al.* (2011) and Khalique *et al.* (2012).

#### **Economical gain from rice**

Application of nitrogen up to 125 kg/ha proved the most remunerative giving net return up to Rs.24889/ha, whereas the lowest nitrogen level (75 kg/ha), resulted in the lowest net return (Rs.16893/ha). This was higher by Rs.7996/ha. The higher net return due to increased nitrogen dose may be due to increased growth, yield and yield-attributing parameters which fetched increased market value (gross income). Thus, the higher grain and straw yield means higher net income. The B:C ratio eventually followed the same trend because it is the another way of expressing profitability among the various treatments.

**Table 1.** Growth parameters and yield-attributes of rice (PS-5) as influenced by different treatments (Pooled for 2 years)

| Treatments                                  | Plant height (cm) at 90 DAS | Number of tiller/m <sup>2</sup> (90 DAS) | Weed population/ m <sup>2</sup> at 55 DAS | Weed dry weight (g/m <sup>2</sup> ) at 55 DAS | Numbers of panicles/m <sup>2</sup> | Length of panicle (cm) | Weight of panicle (g) |
|---|-----------------------------|--|---|---|------------------------------------|------------------------|-----------------------|
| <b>Nitrogen levels(kg/ha)</b>               |                             |  |   |   |                                    |                        |                       |
| N <sub>75</sub>                             | 71.5                        | 283.1                                    | 45.3                                      | 41.3  | 260.3                              | 17.9                   | 1.49                  |
| N <sub>100</sub>                            | 75.3                        | 285.0                                    | 49.6                                      | 48.6  | 271.9                              | 19.2                   | 1.70                  |
| N <sub>125</sub>                            | 77.5                        | 307.2                                    | 57.0                                      | 57.5  | 295.0                              | 20.2                   | 1.86                  |
| <b>CD (5%)</b>                              | <b>2.93</b>                 | <b>9.74</b>                              | <b>1.63</b>                               | <b>0.70</b>                                   | <b>14.66</b>                       | <b>0.62</b>            | <b>0.14</b>           |
| <b>Weed control methods</b>                 |                             |  |   |   |                                    |                        |                       |
| W <sub>1</sub> -Buta. (0.75 kg/ha) + 1 HW   | 72.3                        | 294.1                                    | 47.6                                      | 34.4  | 274.1                              | 18.4                   | 1.73                  |
| W <sub>2</sub> -Buta. + 2 MW                | 78.2                        | 319.1                                    | 40.3                                      | 35.5  | 304.1                              | 21.0                   | 1.90                  |
| W <sub>3</sub> -Buta. + 2, 4-D (0.80 kg/ha) | 76.6                        | 308.3                                    | 39.0                                      | 27.8  | 292.8                              | 19.7                   | 1.83                  |
| W <sub>4</sub> -Bispyribac(20 g/ha)         | 72.1                        | 280.1                                    | 58.5                                      | 51.4  | 266.3                              | 18.0                   | 1.69                  |
| W <sub>5</sub> -Butachlor + Bispyribac      | 74.7                        | 299.7                                    | 34.0                                      | 29.9  | 283.7                              | 18.6                   | 1.77                  |
| W <sub>6</sub> -Hand weedings (2)           | 78.5                        | 328.8                                    | 22.7                                      | 24.1  | 319.0                              | 22.0                   | 1.97                  |
| W <sub>7</sub> - control                    | 69.1                        | 212.4                                    | 112.3                                     | 141.2   | 190.2                              | 16.0                   | 0.94                  |
| <b>CD (5%)</b>                              | <b>2.58</b>                 | <b>10.88</b>                             | <b>1.92</b>                               | <b>0.76</b>                                   | <b>13.58</b>                       | <b>0.76</b>            | <b>0.135</b>          |
| <b>Interactions</b>                         | <b>Sig.</b>                 | <b>Sig.</b>                              | <b>Sig.</b>                               | <b>Sig.</b>                                   | <b>NS</b>                          | <b>NS</b>              | <b>NS</b>             |

**Table 2.** Yield-attributes, yield and economics of rice (PS-5) as influenced by different treatments (Pooled for 2 years)

| Treatments                                  | Number of filled grains/ panicle | Number of unfilled grains/ panicle | Test weight of 1000-grains(g) | Grain yield (q/ha) | Straw yield (q/ha) | Harvest index (%) | Weed control efficiency (%) 55 DAS | Net income (Rs/ha) | B:C ratio |
|---|----------------------------------|------------------------------------|-------------------------------|--------------------|--------------------|-------------------|------------------------------------|--------------------|-----------|
| <b>Nitrogen levels(kg/ha)</b>               |                                  |                                    |                               |                    |                    |                   |                                    |                    |           |
| N <sub>75</sub>                             | 89.89                            | 10.13                              | 16.25                         | 18.02              | 40.76              | 30.52             | 54.37                              | 16893              | 1.72      |
| N <sub>100</sub>                            | 90.85                            | 9.27                               | 17.29                         | 20.16              | 36.67              | 35.30             | 55.45                              | 20450              | 1.86      |
| N <sub>125</sub>                            | 92.50                            | 7.50                               | 18.43                         | 22.58              | 35.44              | 38.64             | 54.49                              | 24889              | 2.04      |
| <b>CD (5%)</b>                              | <b>1.63</b>                      | <b>0.65</b>                        | <b>0.98</b>                   | <b>0.97</b>        | <b>1.30</b>        | <b>1.30</b>       | <b>NS</b>                          | <b>--</b>          | <b>--</b> |
| <b>Weed control methods</b>                 |                                  |                                    |                               |                    |                    |                   |                                    |                    |           |
| W <sub>1</sub> -Buta. (0.75 kg/ha) + 1 HW   | 95.30                            | 4.72                               | 16.83                         | 19.22              | 37.14              | 33.73             | 57.74                              | 17790              | 1.73      |
| W <sub>2</sub> -Buta. + 2 MW                | 94.02                            | 6.00                               | 19.38                         | 23.86              | 41.54              | 36.57             | 63.88                              | 24963              | 1.93      |
| W <sub>3</sub> -Buta. + 2, 4-D (0.80 kg/ha) | 92.42                            | 7.60                               | 17.72                         | 21.82              | 38.59              | 36.19             | 65.43                              | 25334              | 2.15      |
| W <sub>4</sub> -Bispyribac(20 g/ha)         | 89.99                            | 10.03                              | 15.72                         | 17.98              | 35.28              | 33.71             | 47.80                              | 17521              | 1.80      |
| W <sub>5</sub> -Butachlor + Bispyribac      | 92.32                            | 7.71                               | 17.36                         | 20.57              | 37.62              | 35.33             | 69.61                              | 22531              | 2.01      |
| W <sub>6</sub> -Hand weedings (2)           | 96.89                            | 3.14                               | 19.59                         | 25.45              | 45.40              | 36.25             | 78.92                              | 29470              | 2.14      |
| W <sub>7</sub> - control                    | 76.63                            | 23.39                              | 14.66                         | 12.89              | 27.78              | 31.63             | 0.00                               | 7600               | 1.37      |
| <b>CD (5%)</b>                              | <b>1.81</b>                      | <b>0.78</b>                        | <b>1.09</b>                   | <b>1.09</b>        | <b>1.45</b>        | <b>1.45</b>       | <b>2.45</b>                        | <b>--</b>          | <b>--</b> |
| <b>Interactions</b>                         | <b>NS</b>                        | <b>Sig.</b>                        | <b>NS</b>                     | <b>NS</b>          | <b>Sig.</b>        | <b>Sig.</b>       | <b>NS</b>                          | <b>--</b>          | <b>--</b> |

Amongst the weed control treatments, W<sub>6</sub> (having hand weeding twice) gave the maximum net return up to Rs.29470/ha, followed by W<sub>3</sub> (butachlor + 2,4-D) or W<sub>2</sub> (butachlor + 2 MW) Rs.25334 or Rs.24963/ha respectively. The lower net return (Rs.17521 to Rs.17790/ha was noted from W<sub>1</sub> (buta.+1 HW) and W<sub>4</sub> where bispyribac sodium only was applied. Both these treatments gave lower yield thereby lower monetary gain. The control (W<sub>7</sub>) gave a monetary gain only up to Rs.7600/ha which may be due to decreased growth and yield of crop as a result of increased weed competition for light, space, moisture and nutrients with the crop plants. The lowest crop yield under W<sub>7</sub> treatment means lowest market sale of the produce (lowest gross income).

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