Journal of Pharmacognosy and Phytochemistry 2020; 9(2): 308-314



**E-ISSN:**2278-4136 **P-ISSN:**2349-8234

<www.phytojournal.com>

JPP 2020; 9(2): 308-314

Received: 04-01-2020

Accepted: 06-02-2020

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**Nutrient and weed management for improving productivity of aromatic rice (*Oryza sativa* L.)**

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**Abstract**

The present investigationwas planned and conducted at Research Farm of Dr Rajendra Prasad Central Agricultural University, Pusa during *Kharif* season of 2017 to study the effect of nutrient levels and weed management on weed dynamics and yield of aromatic rice.The experiment was conducted in split-plot design and was replicated thrice. The treatments comprised three nutrient levels *viz.* (i) 100% RDF (120-60-40 NPK kg/ha) (ii) 75% RDF+5 t FYM (iii) 50% RDF +10 t FYM in main - plot and six weed control treatments *viz.* (i) Brown manuring(ii) Bispyribac-Sodium @ 25g/ha (iii) Chlorimuron Ethyl+Metsulfuron Methyl (Almix) @ 4g/ha at 20 DAT(iv) Pyrazosulfuron @ 25g/ha PoE(v) Weed free and (vi)Weedy checkin sub-plot. Rice variety Rajendra Bhagwati was transplanted on 21.07.2017. Treatment N1 (100% RDF 120-60-40NPK kg/ha) recorded maximum in growth, yield attributes and grain yield (40.37 q/ha). And among weed management practices, treatment W5 recorded the maximum value at all the growth stages and yield attributes as well as grain yield of rice. Weed population and weed dry matter were found maximum in N3 (50% RDF+10t FYM).Among the weed management practices, minimum values were recorded in W5(weed free). Weed control efficiency and weed index was maximum in W5(weed free)and W6(weedy check) respectively. Maximum net returns, gross returns and B: C ratio were recorded in N1 (100% RDF 120-60-40NPK kg/ha) under nutrient management practices. And among weed management practices, maximum value of net returns and B: C ratio were recorded under W2 (Bispyribac-Sodium @ 25g/ha). However, maximum gross returns was obtained in W5 (weed free).

**Keywords:** FYM, Weed, NPK, RDF and rice

**Introduction**

Rice is the staple food for more than 60 per cent of Indian population and it account for 46 per cent of total cereal production. In India, rice is grown in an area of 36.95 million hectares with annual production of 80.41 million tonnes (Directorate of economic and statistics, Department of Agriculture and co-operation 2010-11). To meet the demands of increasing population and to maintain self-sufficiency, the present production level of 80.41 million tonnes needs to be increased up to 120 million tonnes by the year 2020. The slogan “Rice is the life” is most appropriate for India’s livelihood point of view. In India, the area under rice cultivation is 44.5 M ha with an annual production of 106.19 million tonnes and an average productivity of 2.38 t/ha (DRR, Newsletter: Jan-March, 2014). About 32.4% of India’s total rice area, i.e., 15 M ha is under rainfed lowlands. In Bihar rice is cultivated in around 3.18 million hectares with the production of 3.62 million tonnes and productivity 11.38 q/ha (Directorate of Statistic and Evaluation, GOB. 2009-10). Unfortunately in Bihar, out of the total rice growing area, 70 per cent area is under unfavourable situation like rainfed upland (20%), rainfed lowland (40%) and deep water rice (10%).

In the present era there is a great demand for aromatic rice for the purpose of export. Cultivation of aromatic rice is very remunerative as it fetches sufficiently higher price over the coarse varieties, even in the local markets (Bali *et. al*; 2006)[1].Attempts are being made to introduce high yielding aromatic varieties by replacing the traditional photosensitive tall indica scented varieties in the North Bihar region. Export of rice is primarily dependent on the quality it possess. The organic manures are expected to improve the quality of grain. Thus, various organic- inorganic combinations will have to be tested to find out a dose and type of sources to have a balance between the yield and quality of aromatic rice. Weeds pose major problem in rice production due to the prevalence of congenial atmosphere during kharif season and uncontrolled weeds compete with rice and reduce yield. Therefore, an effective and economical weed control strategy needs to be implemented to meet the demand of staple food for increasing population.

Nutrient management must be sound for achieving the production target in sustainable manner.Use of chemical fertilizer is the fastest way of counteracting the pace of nutrient mining. It promotes the growth and development of rice crop and is responsible for over 50 per cent of the crop yield increment. These essential plant nutrients play a vital role in boosting the yield of aromatic rice. It responds to judicious application of fertilizer, especially nitrogen, phosphorus and potassium and gives higher yield from aromatic varieties at a particular fertilizer level (Singh and Virimani 1990) [10]. Nitrogen is known as the key nutrient of rice production. It is one of the most important and essential nutrient which directly influences the growth, development, yield and quality of rice. Nitrogen applied in lowland rice is lost from soil through leaching and denitrification. The next limiting nutrient which reduces the productivity of rice is phosphorus as it is required for cell division, seed formation, crop maturation, root growth and development. The phenomenon of grain filling is influenced by potassium fertilization.

Weed is one of the most important negative factor limiting the rice production, which do not only compete with crop for applied nutrients but also impair the quality of the produce. Yield reduction in transplanted rice has been reported to be 28-45% due to uncontrolled weeds (Singh *et al*. 2003) [9]. Besides yield reduction, weeds deplete nutrient from soil to an extent of 42.07 kg nitrogen, 10 kg phosphorus and 21.80 kg potassium per hectare respectively (Puniya *et al*. 2007) [7]. Weed management is an important component of plant protection improving the production potential of crops. It includes management of weeds in a way that the crop sustains its production potential without being harmed by the weeds. Weeds compete with crops for water, nutrients, light and space and thus reduce the crop yield. Transplanted rice is infested with heterogeneous group of weeds consisting of grassy, broad leaved and sedges. Effective control of these weeds had increased the grain yield by 85.5 per cent (Mukherjee and Singh 2005) [5]. Manual weeding is very effective but it is tedious, time consuming and expensive in large scale cultivation. Continuous rains in rainy season and unavailability of man power make manual weeding difficult. In such situation, herbicides hold great promise as they can arrest weed growth from the beginning of crop growth. Chemical method of weed control is easy and has been found economical. For the last many years, several recommended herbicides viz., butachlor and pretilachlor are being used by farmers as pre-emergence for effective control of weeds, particularly grassy weed in rice crop. Many time due to various constraints at farm level, the application of herbicides within 3-4 days after transplanting is not possible and continuous use of same herbicide might cause resistance in weeds under such situation, the post-emergence herbicide may be another option (Puniya *et al*. 2007) [7].

**Materials and Methods**

The experimental plot was located in the Agronomic Research Block at Dr. Rajendra Prasad Central Agricultural University, Pusa (Bihar) during the Kharif season of 2017.The experiment was laid out in split-plot design with nutrient management in main-plot and weed control in sub-plot with three replications. The treatments were randomised as par procedure given by Cochran and Cox (1952) [2].

Design of Experiment - Split Plot Design

Gross plot size - 4.0 m x 4.0 = 16 m2

Net plot size - 3.2 m x 3.0 m = 9.6 m2

Total number of pods - 54

Spacing - 20 cm x 15 cm

Width of bund - 0.75 cm

Width of path - 1 m

Irrigation channels - 1 m

Test variety - Rajendra Bhagwati

Dr. Rajendra Prasad Central Agricultural University, Pusa is situated in Samastipur district of North Bihar on the Southern and Western bank of the river Burhi Gandak at 25059’ North latitude and 85048’ East latitude with an altitude of 52.92 meters above mean sea level. It has sub-tropical and sub humid climate. The average rainfall of the area is 1276.1 mm out of which nearly 1026.0 mm is received during the monsoon season between June to September Occasional winter showers sometimes occurs during the period between third week of December to first half of the January in this region. The hot weather commences from early March to the end of May. The average maximum temperature during the hottest months of May-June varies between 37.5 0C to 40.6 0C and the average minimum temperature of the same period is from 17.0 0C to 21.8 0C, whereas during monsoon period the average minimum temperature is about 25.3 0C and the maximum temperature is about 33.9 0C. January is the coldest month of the year with an average winter maximum temperature of 7.7 0C and average minimum temperature of 23.1 0C. During the month of December and January, several biots of cold wave condition prevail in the area accompanied by icy wind and dense fog. Normally temperature starts decreasing from the second fortnight of October and falls minimum at the end of December to early January. Again, it starts rising sharply from the end of February reaching the maximum in May-June. The temperature goes up to 43 0C during the month of May having 82 per cent normal humidity at 7 AM. The soil of experimental field was of silt-clay loam in texture with medium fertility. Before the layout of the experiment, the soil samples were collected randomly from different places of the plot upto the depth of 15 cm. A total number of twelve treatments were constituted by making various combinations of organic-inorganic sources for supplying nitrogen.

**Treatment details:**

1. **Main Plot – Nutrient management**

N1 - 100% RDF (120:60:40 NPK Kg/ha)

N2 - 75% RDF + 5 ton FYM

N3 - 50% RDF + 10 ton FYM

1. **Sub plot - Weed management**

W1 - Brown manuring

W2 - Bispyribac Sodium @ 25 gm/ha PE

W3 - Chlorimuron Ethyl + Metsulfuron Methyl (Almix) @ 4 gm/ha at 20DAT

W4 - Pyrazosulfuron @ 25 g/ha (Post-emergence)

W5 - Weed free

W6 - Weedy check

Data pertaining to various plant characters were subjected to statistical analysis as described by (Panse and Sukhatme; 1989) [6]. The significance of treatment effect was tested by ‘F’ test, standard error of differences of different group of treatments and their interaction at 5 per cent probability were calculated where ‘F’ was significant. Data of weed count and dry weight showed considerable variation, hence the data were subjected to square root transformation (x + 0.05) before analysis. The treatment means computed from the original value have also been presented along with transformed values in parentheses. The treatment wise economic studies were done by calculating cost of cultivation and gross return per hectare on the basis of prevailing market rate of inputs and outputs. Net return was obtained by subtracting the cost of cultivation from the gross return obtained by selling the produce (grain + straw). Return per rupee investment was calculated by dividing the net return with cost of cultivation of individual treatment.

**Results and Discussion**

Among the weed control treatments, though the weed free (W5) recorded maximum plant height, plant dry weight, number of panicle/m2,but was found at par with Bispyribac-Sodium @ 25g/ha (W2) and Pyrazosulfuron @ 25g/ha PoE (W4), Chlorimuron Ethyl+Metsulfuron Methyl (Almix) @ 4g/ha at 20 DAT(W3) and brown manuring(W1), which was significantly scored over other herbicidaland cultural weed control treatments at all the growth stages. The nutrient removal by weeds was also to be considered for better nutrient management. The treatment N1 exhibited maximum N uptake whereas N2 involved in P uptake and N3 reflects excellent K uptake. Amongst the weed management practices weed free (W5) plot was exhibited maximum N uptake. Amongst the three herbicidal applications, Bispyribac-Sodium @ 25g/ha (W2) which was significantly superior over Pyrazosulfuron @ 25g/ha PoE (W4), Chlorimuron Ethyl+Metsulfuron Methyl (Almix) @ 4g/ha at 20 DAT (W3) and also over brown manuring (W1) treatment. The treatment weedy check (W6) involved in maximum nutrient removal in the case of P and K uptake. Maximum gross return was observed at N1 level of fertilizer (71779 ₹/ha), which was found at par with N2 level of fertilizer (66488 ₹/ha) and significantly higher than N3 level of fertilizer (62701 ₹/ha). All the weed control treatment recorded significantly higher gross return than weed check (46728 ₹/ha). Among the weed control treatments weed free recorded maximum gross return (76216 ₹/ha) which was at par with Bispyribac-Sodium @ 25g/ha (74221 ₹/ha). Pyrazosulfuron @ 25g/ha PoE (71492 ₹/ha) and significantly higher than Chlorimuron Ethyl+Metsulfuron Methyl (Almix) @ 4g/ha at 20 DAT (68858 ₹/ha) and brown manuring (64422 ₹/ha). Maximum net return was noticed at N1 level of fertilizer (42410 ₹/ha), which was found at par with N2 level of fertilizer (29844 ₹/ha) and significantly higher than N3 level of fertilizer (18765 ₹/ha). All weed control treatments were at par among themselves and recorded significantly higher net return than weedy check (18889 ₹/ha). The B: C ratio varied significantly among the fertilizer levels. The maximum B: C ratio was recorded at N1 level of fertilizer (1.44) while minimum was associated with N3 level of fertilizer (0.42). Among the weed control treatments maximum B: C ratio was recorded in Bispyribac-Sodium (1.00 ₹/Rs) which was at par with Pyrazosulfuron (0.93 ₹/Rs) and Almix (0.89 ₹/Rs) and these significantly surpassed over brown manuring (0.72 ₹/Rs) and weed free (0.72 ₹/Rs) (Upadhay *et al.* 2008).

Treatment N1 (100% RDF 120-60-40NPK kg/ha) recorded maximum in growth, yield attributes and grain yield (40.37q/ha). And among weed management practices, treatment W5 recorded the maximum value at all the growth stages and yield attributes as well as grain yield of rice. Weed population and weed dry matter were found maximum in N3 (50%RDF+10 t FYM). Among the weed management practices, minimum values were recorded in W5(weed free). Weed control efficiency and weed index was maximum in W5(weed free)and W6(weedy check) respectively (Yadav *et al.* 2008) [12]. Maximum net returns, gross returns and B: C ratio were recorded in N1 under nutrient management practices. And among weed management practices, maximum value of net returns and B: C ratio were recorded under W2 (Bispyribac-Sodium @ 25g/ha). However, maximum gross returns was obtained in W5 (weed free) (Singh and Singh; 2010) [4].

**Conclusion**

Higher nutrient levels significantly influenced almost all the growth and yield attributes and ultimately the yield of the crop. N1 (100% RDF) N2 (75% RDF+5t FYM/ha) N3 (50% RDF+10t FYM/ha) recorded the grain yield of 40.37q/ha, 37.44q/ha and 35.31q/ha with resulting net returns of `42,410/ha, `29,844/ha and `18,765/ha, respectively. Weed population and weed dry matter were recorded to be maximum under N3¬ (50% RDF+ FYM 10 t/ha). Among the weed management practices, minimum values of weed biomass under W5 (weed free).Weed control efficiency worked out to be greater under W5 (weed free) while the weed index was the minimum under W2 (Bispyribac-sodium @ 25g/ha) respectively. Different weed management practices tried also favourably influenced several¬ growth and yield attributes and finally the crop yield. Weed free plot and Bispyribac-sodium @ 25g/ha (W2) being statistically alike recorded higher grain yield (43.83 and42.50q/ha) respectively however, net returns and B: C ratio were highest under W2 (`37,237/ha and1.00) respectively.

**Table 1:** Plant height (cm) at different stages of growth as affected by different treatments

|  |  |
| --- | --- |
| **Treatments** | **Plant height (cm)** |
| **30 DAT** | **60 DAT** | **90 DAT** | **at harvest** |
| **Nutrient management** |
| N1 : 100% RDF (120-60-40 NPK kg/ha) | 32.59 | 67.41 | 107.78 | 108.21 |
| N2 : 75% RDF+5 t FYM | 32.49 | 66.11 | 105.82 | 106.51 |
| N3 : 50% RDF +10 t FYM | 31.11 | 64.70 | 104.21 | 105.42 |
| SEm ± | 0.59 | 0.51 | 0.83 | 0.71 |
| CD (P=0.05) | NS | 1.52 | 2.57 | 2.11 |
| **Weed management** |
| W1 : Brown manuring | 31.45 | 64.83 | 104.43 | 105.58 |
| W2 : Bispyribac-Sodium @ 25g/ha | 33.38 | 68.65 | 109.77 | 110.64 |
| W3 : Chlorimuron Ethyl+Metsulfuron Methyl (Almix) @ 4g/ha at 20 DAT | 31.62 | 65.34 | 106.64 | 107.73 |
| W4 : Pyrazosulfuron @ 25g/ha PoE. | 33.28 | 68.11 | 108.11 | 109.31 |
| W5 : Weed free | 34.95 | 70.15 | 110.63 | 111.07 |
| W6 : Weedy check | 27.70 | 59.37 | 96.03 | 98.62 |
| SEm ± | 0.57 | 0.50 | 0.80 | 0.74 |
| CD (P=0.05) | 1.80 | 1.46 | 2.43 | 2.13 |

**Table 2:** Number of tillers/m² at different stages of growth as affected by different treatments

|  |  |
| --- | --- |
| **Treatments** | **Number of tiller/m²** |
| **30 DAT** | **60 DAT** | **90 DAT** | **at harvest** |
| **Nutrient management** |
| N1 : 100% RDF (120-60-40NPK kg/ha) | 145.48 | 270.57 | 249.16 | 238.69 |
| N2 : 75% RDF+5 t FYM | 141.46 | 253.24 | 239.47 | 231.92 |
| N3 : 50% RDF +10 t FYM | 137.44 | 241.44 | 231.47 | 222.56 |
| SEm ± | 1.24 | 4.93 | 4.07 | 3.81 |
| CD (P=0.05) | 3.93 | 14.7 | 12.4 | 11.7 |
| **Weed management** |
| W1 : Brown manuring | 144.48 | 254.20 | 235.90 | 220.67 |
| W2 : Bispyribac-Sodium @ 25g/ha | 142.46 | 272.35 | 250.66 | 245.28 |
| W3 : Chlorimuron Ethyl+MetsulfuronMethyl (Almix) @ 4g/ha at 20 DAT | 139.44 | 262.45 | 244.19 | 229.77 |
| W4 : Pyrazosulfuron @ 25g/ha PoE. | 148.18 | 263.24 | 248.33 | 233.48 |
| W5 : Weed free | 155.96 | 271.46 | 253.33 | 249.71 |
| W6 : Weedy check | 110.39 | 233.80 | 218.78 | 215.41 |
| SEm ± | 1.22 | 5.01 | 3.95 | 3.86 |
| CD (P=0.05) | 3.76 | 15.22 | 11.8 | 11.31 |

**Table 3:** Plant dry weight (g/m2) at different stages of growth as affected by different treatments

|  |  |
| --- | --- |
| **Treatments** | **Plant dry weight (g/m2)** |
| **30 DAT** | **60 DAT** | **90 DAT** | **at harvest** |
| **Nutrient management** |
| N1 : 100% RDF (120-60-40 NPK kg/ha) | 485.60 | 685.10 | 645.58 | 635.92 |
| N2 : 75% RDF+5 t FYM | 411.53 | 605.03 | 598.70 | 575.53 |
| N3 : 50% RDF +10 t FYM | 347.05 | 540.88 | 528.22 | 520.55 |
| SEm ± | 7.95 | 10.55 | 12.57 | 11.82 |
| CD (P=0.05) | 24.81 | 31.44 | 36.84 | 34.17 |
| **Weed management** |
| W1 : Brown manuring | 353.68 | 549.68 | 532.00 | 517.00 |
| W2 : Bispyribac-Sodium @ 25g/ha | 567.83 | 761.83 | 750.50 | 731.83 |
| W3 : Chlorimuron Ethyl+Metsulfuron Methyl (Almix) @ 4g/ha at 20 DAT | 409.91 | 607.91 | 595.90 | 588.57 |
| W4 : Pyrazosulfuron @ 25g/ha PoE. | 449.37 | 644.37 | 630.37 | 627.70 |
| W5 : Weed free | 518.13 | 722.80 | 715.80 | 702.47 |
| W6 : Weedy check | 203.43 | 375.43 | 352.43 | 340.43 |
| SEm ± | 7.88 | 10.18 | 12.23 | 12.07 |
| CD (P=0.05) | 23.72 | 29.63 | 35.61 | 33.91 |

**Table 4:** Yield attributing characters as affected by different treatments

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Treatments** | **No. of panicles/m2** | **No. of grains/panicle** | **Length of panicle (cm)** | **1000- grain weight (g)** |
| **Nutrient management** |
| N1 : 100% RDF (120-60-40 NPK kg/ha) | 230.11 | 105.06 | 23.35 | 27.86 |
| N2 : 75% RDF+5 t FYM | 221.47 | 101.63 | 22.11 | 26.29 |
| N3 : 50% RDF +10 t FYM | 213.77 | 96 | 20.63 | 25.53 |
| SEm ± | 4.58 | 2.16 | 0.37 | 0.28 |
| CD (P=0.05) | 13.41 | 6.47 | 1.11 | NS |
| **Weed management** |
| W1 : Brown manuring | 219.85 | 95 | 19.29 | 25.17 |
| W2 : Bispyribac-Sodium @ 25g/ha | 234.52 | 110 | 25.77 | 27.21 |
| W3 : Chlorimuron Ethyl+Metsulfuron Methyl (Almix) @ 4g/ha at 20 DAT | 228.60 | 100 | 20.88 | 25.60 |
| W4 : Pyrazosulfuron @ 25g/ha PoE. | 225.13 | 101.53 | 21.35 | 24.73 |
| W5 : Weed free | 246.37 | 113.71 | 26.56 | 28.54 |
| W6 : Weedy check | 212.23 | 92 | 18.32 | 22.11 |
| SEm ± | 4.5 | 2.17 | 0.37 | 0.31 |
| CD (P=0.05) | 13.28 | 6.32 | 1.14 | 0.91 |

**Table 5:** Grain yield (q/ha), Straw yield (q/ha), and Harvest Index (%) as affected by different treatments

|  |  |  |  |
| --- | --- | --- | --- |
| **Treatments** | **Grain yield (q/ha)** | **Straw yield (q/ha** | **H.I (%)** |
| **Nutrient management** |
| N1 : 100% RDF (120-60-40 NPK kg/ha) | 40.37 | 56.12 | 41 |
| N2 : 75% RDF+5 t FYM | 37.44 | 51.64 | 42 |
| N3 : 50% RDF +10 t FYM | 35.31 | 48.68 | 42 |
| SEm ± | 0.92 | 1.20 | 0.31 |
| CD (P=0.05) | 2.86 | 3.57 | NS |
| **Weed management** |
| W1 : Brown manuring | 35.57 | 55.60 | 39 |
| W2 : Bispyribac-Sodium @ 25g/ha | 42.50 | 52.25 | 44 |
| W3 : ChlorimuronEthyl+Metsulfuron Methyl (Almix) @ 4g/ha at 20 DAT | 39.43 | 48.51 | 44 |
| W4 : Pyrazosulfuron @ 25g/ha PoE. | 40.23 | 55.63 | 41 |
| W5 : Weed free | 43.83 | 52.37 | 45 |
| W6 : Weedy check | 24.67 | 48.50 | 33 |
| SEm ± | 0.85 | 1.21 | 0.3 |
| CD (P=0.05) | 2.57 | 3.61 | NS |

**Table 6:** Weed population /m2 at different stages of growth as affected by different treatments

|  |  |
| --- | --- |
| **Treatments** | **Weed population/m2** |
| **30 DAT** | **60 DAT** | **90 DAT** |
| **Nutrient management** |
| N1 : 100% RDF (120-60-40 NPK kg/ha) | 23.66 | 20.45 | 20.63 |
| N2 : 75% RDF+5 t FYM | 26.62 | 23.10 | 22.95 |
| N3 : 50% RDF +10 t FYM | 29.61 | 25.51 | 25.28 |
| SEm ± | 0.51 | 0.30 | 0.83 |
| CD (P=0.05) | 1.58 | 0.90 | 0.72 |
| **Weed management** |
| W1 : Brown manuring | 33.98 | 26.12 | 23.36 |
| W2 : Bispyribac-Sodium @ 25g/ha | 16.45 | 12.46 | 11.44 |
| W3 : ChlorimuronEthyl+Metsulfuron Methyl (Almix) @ 4g/ha at 20 DAT | 25.99 | 19.55 | 18.07 |
| W4 : Pyrazosulfuron @ 25g/ha PoE. | 24.57 | 18.36 | 16.95 |
| W5 : Weed free | 14.59 | 11.37 | 10.09 |
| W6 : Weedy check | 44.18 | 50.25 | 57.81 |
| SEm ± | 0.53 | 0.32 | 0.27 |
| CD (P=0.05) | 1.57 | 0.93 | 0.81 |

**Table 7:** Weed Dry matter at different stages of growth as affected by different treatments

|  |  |
| --- | --- |
| **Treatments** | **Weed Dry matter** |
| **30DAT** | **60 DAT** | **90 DAT** |
| **Nutrient management** |
| N1 : 100% RDF (120-60-40 NPK kg/ha) | 47.25 | 37.29 | 39.57 |
| N2 : 75% RDF+5 t FYM | 51.93 | 43.23 | 43.64 |
| N3 : 50% RDF +10 t FYM | 55.66 | 47.13 | 48.46 |
| SEm ± | 0.93 | 0.64 | 0.79 |
| CD (P=0.05) | 2.81 | 1.91 | 2.51 |
| **Weed management** |
| W1 : Brown manuring | 66.92 | 49.31 | 45.23 |
| W2: Bispyribac-Sodium @ 25g/ha | 31.20 | 22.72 | 23.20 |
| W3 : Chlorimuron Ethyl+Metsulfuron Methyl (Almix)@ 4g/ha at 20 DAT | 50.35 | 35.85 | 36.36 |
| W4 : Pyrazosulfuron @ 25g/ha PoE. | 47.26 | 34.44 | 32.89 |
| W5 : Weed free | 27.43 | 21.12 | 20.20 |
| W6 : Weedy check | 86.51 | 91.86 | 105.45 |
| SEm ± | 0.96 | 0.63 | 0.54 |
| CD (P=0.05) | 2.78 | 1.84 | 1.67 |

**Table 8:** Weed Control Efficiency (%) as affected by different treatments

|  |  |
| --- | --- |
| **Treatments** | **Weed Control Efficiency (%)** |
| **30DAT** | **60 DAT** | **90 DAT** |
| **Nutrient management** |
| N1 : 100% RDF (120-60-40 NPK kg/ha) | - | - | - |
| N2 : 75% RDF+5 t FYM | - | - | - |
| N3 : 50% RDF +10 t FYM | - | - | - |
| **Weed management** |
| W1 : Brown manuring | 24.51 | 48.48 | 57.78 |
| W2 : Bispyribac-Sodium @ 25g/ha | 70.32 | 80.05 | 79.47 |
| W3 : Chlorimuron Ethyl+Metsulfuron Methyl (Almix) @ 4g/ha at 20 DAT | 46.61 | 67.32 | 65.91 |
| W4 : Pyrazosulfuron @ 25g/ha PoE. | 51.33 | 68.06 | 71.17 |
| W5 : Weed free | 75.81 | 83.81 | 85.11 |
| W6 : Weedy check | - | - | - |

**Table 9:** Weed index (%) in grain as affected by different treatments

|  |  |
| --- | --- |
| **Treatments** | **Weed Index (%)** |
| **Nutrient management** |
| N1 : 100% RDF (120-60-40 NPK kg/ha) | - |
| N2 : 75% RDF+5 t FYM | - |
| N3 : 50% RDF +10 t FYM | - |
| **Weed management** |
| W1 : Brown manuring | 19.22 |
| W2 : Bispyribac-Sodium @ 25g/ha | 5.74 |
| W3 : Chlorimuron Ethyl+Metsulfuron Methyl (Almix) @ 4g/ha at 20 DAT | 9.38 |
| W4 : Pyrazosulfuron @ 25g/ha PoE. | 8.23 |
| W5 : Weed free | - |
| W6 : Weedy check | 44.16 |

**Table 10:** N, P and K uptake (kg/ha) by crop as affected by different treatments

|  |  |  |  |
| --- | --- | --- | --- |
| **Treatments** | **N uptake** | **P uptake** | **K uptake** |
| **Nutrient management** |
| N1 : 100% RDF (120-60-40 NPK kg/ha) | 50.97 | 23.77 | 9.06 |
| N2 : 75% RDF+5 t FYM | 47.40 | 21.34 | 7.85 |
| N3 : 50% RDF +10 t FYM | 44.14 | 18.90 | 6.78 |
| SEm ± | 0.52 | 0.36 | 0.32 |
| CD (P=0.05) | 2.11 | 1.44 | 1.30 |
| **Weed management** |
| W1 : Brown manuring | 42.94 | 17.39 | 5.36 |
| W2 : Bispyribac-Sodium @ 25g/ha | 55.57 | 27.69 | 11.08 |
| W3 : Chlorimuron Ethyl+Metsulfuron Methyl (Almix) @ 4g/ha at 20 DAT | 49.32 | 21.03 | 7.67 |
| W4 : Pyrazosulfuron @ 25g/ha PoE. | 50.72 | 22.89 | 8.39 |
| W5 : Weed free | 57.77 | 28.30 | 11.91 |
| W6 : Weedy check | 28.71 | 10.72 | 2.98 |
| SEm ± | 1.04 | 0.33 | 0.24 |
| CD (P=0.05) | 3.03 | 0.95 | 0.71 |

**Table 11:** N, P and K uptake (%) by weed as affected by different treatments

|  |  |  |  |
| --- | --- | --- | --- |
| **Treatments** | **N uptake** | **P uptake** | **K uptake** |
| **Nutrient management** |
| N1 : 100% RDF (120-60-40 NPK kg/ha) | 7.26 | 5.06 | 6.79 |
| N2 : 75% RDF+5 t FYM | 5.95 | 5.57 | 7.50 |
| N3: 50% RDF +10 t FYM | 4.58 | 5.37 | 7.54 |
| SEm ± | 0.23 | 0.57 | 0.36 |
| CD (P=0.05) | 0.92 | NS | NS |
| **Weed management** |
| W1: Brown manuring | 2.99 | 5.24 | 7.36 |
| W2 : Bispyribac-Sodium @ 25g/ha | 9.66 | 4.84 | 5.83 |
| W3 : ChlorimuronEthyl+Metsulfuron Methyl (Almix) @ 4g/ha at 20 DAT | 5.04 | 5.30 | 6.83 |
| W4 : Pyrazosulfuron @ 25g/ha PoE. | 6.05 | 5.44 | 7.03 |
| W5 : Weed free | 10.24 | 4.80 | 5.62 |
| W6 : Weedy check | 1.59 | 6.39 | 10.99 |
| SEm ± | 0.41 | 0.71 | 0.54 |
| CD (P=0.05) | 1.19 | NS | 1.57 |

**Table 12:** Protein content (%) in grain as affected by different treatments

|  |  |
| --- | --- |
| **Treatments** | **Protein content (%)** |
| **Nutrient management** |
| N1 : 100% RDF (120-60-40 NPK kg/ha) | 7.94 |
| N2 : 75% RDF+5 t FYM | 7.82 |
| N3 : 50% RDF +10 t FYM | 7.69 |
| SEm ± | 0.01 |
| CD (P=0.05) | 0.06 |
| **Weed management** |
| W1 : Brown manuring | 7.54 |
| W2 : Bispyribac-Sodium @ 25g/ha | 8.17 |
| W3 : Chlorimuron Ethyl+Metsulfuron Methyl (Almix) @ 4g/ha at 20 DAT | 7.81 |
| W4 : Pyrazosulfuron @ 25g/ha PoE. | 7.88 |
| W5 : Weed free | 8.23 |
| W6 : Weedy check | 7.27 |
| SEm ± | 0.01 |
| CD (P=0.05) | 0.03 |

**Table 13:** Gross Return (₹/ha), Net Return (₹/ha) and B:C ratio as affected by different treatments

|  |  |  |  |
| --- | --- | --- | --- |
| **Treatments** | **Gross Return (₹/ha)** | **Net Return(₹/ha)** | **B:C ratio** |
| **Nutrient management** |
| N1 : 100% RDF (120-60-40 NPK kg/ha) | 71,779 | 42,410 | 1.44 |
| N2 : 75% RDF+5 t FYM | 66,488 | 29,844 | 0.81 |
| N3 : 50% RDF +10 t FYM | 62,701 | 18,765 | 0.42 |
| SEm ± | 1150 | 609 | 0.07 |
| CD (P=0.05) | 3450 | 1870 | 0.21 |
| **Weed management** |
| W1 : Brown manuring | 64,422 | 27,049 | 0.72 |
| W2 : Bispyribac-Sodium @ 25g/ha | 74,221 | 37,237 | 1.00 |
| W3 : Chlorimuron Ethyl+Metsulfuron Methyl (Almix) @ 4g/ha at 20 DAT | 68,858 | 32,441 | 0.89 |
| W4 : Pyrazosulfuron @ 25g/ha PoE | 71,492 | 34,533 | 0.93 |
| W5 : Weed free | 76,216 | 31,892 | 0.72 |
| W6 : Weedy check | 46,728 | 18,889 | 0.68 |
| SEm ± | 1143 | 583 | 0.06 |
| CD (P=0.05) | 3362 | 1739 | 0.17 |

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