The Pharma Innovation Journal 2023; 12(4): 2717-2723

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E):2277-7695
ISSN (P):2349-8242
NAAS Rating: 5.23
TPI 2023; 12(4): 2717-2723
© 2023 TPI
www.thepharmajournal.com
Received: 18-01-2023
Accepted: 31-03-2023

Abhishek Banik
All India Co-ordinated Research Project on Weed Management, Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

SU Kakade
All India Co-ordinated Research Project on Weed Management, Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

JP Deshmukh
All India Co-ordinated Research Project on Weed Management, Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

VV Goud
All India Co-ordinated Research Project on Weed Management, Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

ND Parlawar
All India Co-ordinated Research Project on Weed Management, Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

Corresponding Author:
SU Kakade
All India Co-ordinated Research Project on Weed Management, Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

Productivity and economics of rice under different Fertigation levels and weed management practices

Abhishek Banik, SU Kakade, JP Deshmukh, VV Goud and ND Parlawar

Abstract
A field investigation was conducted at AICRP on Weed Management farm, Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during *kharif* (June–September, 2020). The experiment was laid out in split plot design with 3 replications and twenty treatment combinations. Results revealed that, in rice all the growth and yield attributes, grain yield, straw yieldand harvest index were substantially enhanced by drip fertigation with 125% RDNK in 5 splits than lower fertigation levels (75 and 100%) and over conventional soil application with 100% RDF. Drip fertigation at 125% RDNK in 5 splits recorded higher rice grain yield of 5103 $kgha^{-1}$. The drip fertigation at 125% RDNK in 5 splits registered maximum GMR (₹ 120353 ha^{-1}), NMR (₹ 72924 ha^{-1}) and B:C ratio (2.54).
Among the various weed management practices, farmers' practice (2 HW at 15–20 days interval after sowing *fb.* 2 hoeing) significantly improved the major growth and yield parameters whereas, among the herbicides, directed spray of Pretilachlor+Pyrazosulfuron Ethyl @ 0.615 kg a.i. ha^{-1} PE *fb.* Bispyribac sodium @ 0.025 kg a.i. ha^{-1} at 25 DAS recorded significant reduction in weed density, weed dry matter, highest weed control efficiency and the lowest weed index; which ultimately resulted in maximum rice grain yield (5231 $kgha^{-1}$). The herbicidal application of Pretilachlor+Pyrazosulfuron Ethyl @ 0.615 kg a.i. ha^{-1} PE *fb.* Bispyribac sodium @ 0.025 kg a.i. ha^{-1} at 25 DAS registered maximum GMR (₹128755 ha^{-1}), NMR (₹81412 ha^{-1}) and B:C ratio (2.72) among all herbicidal treatments, indicating the feasibility of using herbicides for effective weed management in rice.

Keywords: aerobic rice, drip, economics, fertigation, *Oryza sativa*

1. Introduction
Rice (*Oryza sativa*) is the most important cereal food crop in the world and staple food for more than half of the world's population. Rice is 'a grain of life' for more than 70% of the Asian population and major staple food crop for world's poorest and densely populated regions. Rice provides 30–75% of the total calories to more than 3 billion Asians (Khush, 2004) [7]. Rice is cultivated in 116 countries globally by 144 million farm families in around 162.06 mha with production of milled rice 495.78 mt. In India rice was grown on 44 mha with production of 117.94 mt in the year 2019–20. Rice develops well in water, but recent developments demonstrate that rice can also be grown in dry soils under non-flooded conditions called "Aerobic rice". Saturated soil culture, intermittent irrigation, alternate wetting-drying and aerobic rice are irrigation related technologies which save water in rice. Aerobic rice cultivation saves water input and increases water productivity by reducing water use during land preparation and limiting seepage, percolation and evaporation. (Peng *et al*., 2012) [22]
Traditional rice production involves submerged conditions with approximately 5–10 cm deep standing water throughout the crop growth period. This system requires around 3000 to 5000 L of water for producing one kg of grain which is about twice or even more than that for wheat or maize (Joshi *et al*., 2009) [4]. Unproductive water losses in the form of seepage and percolation from flooded rice fields are very high accounting for 50–60% of the total water input to the field. Irrigated rice with continuous flooding results in low water use efficiency as it consumes 3000–5000 L of water to produce 1 kg of unprocessed rice. The injudicious use of irrigation water and improper weed management practices are the important reasons of low productivity of rice. Precise use of water for potential crop production has become inevitable. Water being scarce natural resource, must be utilized judiciously in agriculture crop production system. As Rice consumes considerable amount of water around 1300–1600 mm (approx.), so precise use of water for potential crop production has become inevitable.

Soman (2018) [29] reported that drip-fertigation offers clear advantage for rice production and yields were higher and water consumption was lower in drip compared to flood. Fertigation system assures precise application of nutrients through use of water-soluble fertilizers which are made available at the root zone along with water for its direct absorption in the crop. Drip fertigation significantly influenced the growth, yield, water productivity and nutrient use efficiency (NUE) in aerobic rice (Kombali *et al*., 2016) [16]. Drip irrigation and fertigation methods have been proved to be the water and nutrient efficient methods, respectively in most of the crops apart from increasing the productivity (Maheswari *et al*., 2007) [10]. Natarajan *et al*. (2020) [16] revealed that in aerobic rice the drip fertigation at 150% daily pan evaporation and 150 kg N ha^{-1} in weekly interval from 21 days after sowing for higher yield and economic returns. Improved weed control practices that include chemical weed control with newer formulations and herbicide mixtures and integrated cultivation need to be developed and refined. Mishra *et al*. (2018) [14] and Malik *et al*. (2021) reported 61.2% and 57% losses respectively due to weeds in rice in India. The hypothesis is that weeds can be controlled efficiently having no adverse effect on soil beneficial microorganisms and yield can be maintained at a lower rate of input practice by improving the weed management strategy. Introduction of new herbicides, chemical weed control with pre-mix combination of herbicide may result in effective weed control in rice. With this background, an effort was made to assess the suitability of split application of nutrients through fertigation and weed management practices on weed control efficiency, yield and economics in rice.

2. Materials and Methods

A field investigation entitled “Productivity and Economics of Rice under Different Fertigation Levels and Weed Management Practices” was conducted at AICRP on Weed management farm, Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during *kharif*, 2020 with an objective to assess the suitability of split application of nutrients through fertigation on growth and yield of aerobic rice and to study the relative performance of different herbicides on weed flora, growth and yield of rice. The experiment was laid out in split plot design with three replications with 20 treatment combinations having 4 different fertigation levels and 5 weed management practices. The main plot treatments comprised of different levels of fertilizer in five splits at 75%, 100% and 125% of recommended dose of N and K fertilizers given through fertigation, however P was applied as basal and these treatments were compared with drip irrigation with 100% soil application of fertilizers (N in 3 splits). Whereas, sub plot treatments comprised of 5 weed management practices *viz*., Pendimethalin @ 1 kg a.i. ha^{-1} PE *fb.* Bispyribac sodium @ 0.025 kg a.i. ha^{-1} at 25 DAS; Pretilachlor+Pyrazosulfuron Ethyl @ 0.615 kg a.i. ha^{-1} PE *fb.* Bispyribac sodium @ 0.025 kg a.i. ha^{-1} at 25 DAS; Pretilachlor @ 0.75 kg a.i. ha^{-1} PE *fb.* Bispyribac sodium @ 0.025 kg a.i. ha^{-1} at 25 DAS; farmer practices- 2 HW at 15–20 days interval after sowing *fb.* 2 hoeing and weedy check. The soil of experimental field was vertisol, low in available nitrogen (170.41 $kgha^{-1}$), medium in phosphorus (18.94 $kgha^{-1}$) and organic carbon (0.42), rich in available potassium (360.41 $kgha^{-1}$) and slightly alkaline in reaction (7.65).

Rice variety Avishkar was sown on 19th June, 2020 at a spacing of 20 cm×10 cm. The experimental site was established with inline drip irrigation system (16 mm) and 9 laterals were laid $treatment^{-1}$ with emitter spacing of 50 cm and dripper discharge of 4 $lphh^{-1}$. Irrigation water was applied through drip irrigation system on every alternate day based on cumulative pan evaporation and surface irrigation water was applied at 1.0 IW/CPE ratio at a depth of 6 cm. The drip irrigation water to be applied $plant^{-1}$ was determined by the following formula given by Michael (2008) [13]. The sources of nutrients were urea (46% N), single super phosphate (16% P2O5), and murate of potash (60% K2O) for nitrogen, phosphorus and potash, respectively. The fertilizer was applied as per the treatments. The application of herbicide was done as per the treatments with manually operated knapsack sprayer attached with a flat fan nozzle. After calibrating the sprayer, water volume used was 700 Lha^{-1}. for PE and 500 Lha^{-1}. for PoE. The observations on weed density and weed biomass were taken at 30 days interval upto harvest from four randomly selected spots by using a quadrate of 50 cm×50 cm quadrate from net plot area. The entire weeds inside the quadrat were uprooted and cut close to the transition of root and shoot in each plot and collected for dry matter accumulation. The samples were first dried in sun and kept in oven at 70+20 C. The dried samples were weighed and expressed as dry biomass (gm^{-2}). Square root transformation was done for weed density and weed biomass by using the formula ($\sqrt{x+1}$) Weed control efficiency (WCE) and weed index was calculated by using standard formula suggested by Mani *et al*. (1973) [11]. Cost of cultivation, gross returns and benefit cost ratio for each treatment were calculated by taking into consideration of total costs incurred and returns obtained. Data on various growth and yield attributing characters were statistically analyzed as per the standard procedure.

3. Results and Discussion

3.1 Weed Flora

The major weed flora present in experimental field was *Cynodondactylon*, *Dinebra Arabica*, *Poaannua*, *Echinochloacrusgalli*, *Eragrostiscilianensis*, *Cyperusrotundus*, *Commelinabenghalensis* among the monocots and *Euphorbia geniculata*, *Digera arvensis*, *Parthenium hysterophorus*, *Celosia argentea*, *Euphorbia hirta*, *Phyllanthus niruri*, *Xanthium strumarium*, *Alternanthera sessillis*, *Tridax procumbens* were prominent dicot weeds observed.

3.2 Effect on weed density and weed dry weight

Data related to the number of total weed population m^{-2} and weed dry matter (gm^{-2}) as indicated in Table 1 showed the significant differences due to fertigation and weed management practices. At 20 and 40 DAS, lowest total weed population m^{-2} was recorded in drip fertigation with 75% RDNK in 5 splits i.e.4.17 and the highest weed count was observed in drip irrigation with 100% RDF soil application. The lowest number of total weed population m^{-2} at 60 DAS was in treatment of drip fertigation with 75% RDNK in 5 splits (7.09) which was at par with drip fertigation with 100% RDNK in 5 splits (7.32). The highest number of total weed population m^{-2} was in drip fertigation with 125% RDNK in 5 splits (7.47). In case of soil application of fertilizers, more portion of fertilizers were consumed by weeds than drip fertigation, so the weeds got good amount of nutrients for their growth. Similar results were reported by Jayakumar *et al*. (2020). But at the later stage it was found that drip fertigation with 125% RDNK in 5 splits was having more weed population than other treatments because fertilizers were applied throughout the irrigated soil volume where the application of nutrients was done only to the wetted soil volume. This might have increased the weed population at the later stage of crop in case of 125% RDNK in 5 splits. This result was in accordance with the result reported by Thakare *et al*. (2019) [33].

Among the herbicidal treatments, the lowest total weed population m^{-2} at 20 DAS was recorded in farmer practices i.e. 2 HW at 15–20 days interval after sowing *fb*. 2 hoeing (4.43) which was at par with Pretilachlor+Pyrazosulfuron ethyl @ 0.615 kg a.i. ha^{-1} PE fb. Bispyribac sodium @ 0.025 kg a.i. ha^{-1} at 25 DAS and with Pretilachlor @ 0.75 kg a.i. ha^{-1} PE fb. Bispyribac sodium @ 0.025 kg a.i. ha^{-1} at 25 DAS and the highest number of total weed population m^{-2} was recorded in weedy check (7.05).At 40, 60, 80 DAS and at harvest the maximum number of total weed population m^{-2} was recorded in weedy check followed by treatment of pendimethalin @ 1 kg a.i. ha^{-1} PE *fb*. Bispyribac sodium @ 0.025 kg a.i. ha^{-1} at 25 DAS and minimum in farmer practices - 2 HW at 15–20 days interval after sowing fb. 2 hoeing). At harvest, total weed population was reported in Pretilachlor+Pyrazosulfuron ethyl @ 0.615 kg a.i. ha^{-1}PE fb. Bispyribac sodium @ 0.025 kg a.i. ha^{-1} at 25 DAS which was 25.47% less than the Weedy check. Pretilachlor+Pyrazosulfuron ethyl @ 0.615 kg a.i. ha^{-1} PE *fb* Bispyribac sodium @ 0.025 kg a.i. ha^{-1} at 25 DAS application was found better than any other herbicidal treatments which showed less weed population. Similar trend was also noticed with regards to weed dry matter at different growth stages of rice. Such type of results was also reported earlier by Sunil *et al*. (2010) [32], Patel *et al*. (2018) [20], Kundu *et al*. (2020) [9] and Saravanane (2020) [26].

3.3 Weed control efficiency and weed index

At 20, 60, 80 DAS and at harvest the maximum WCE (%) was noticed in drip fertigation with 75% RDNK in 5 splits as indicated in Table 1 followed by drip fertigation with 100% RDNK in 5 splits. At harvest the WCE at 75% RDNK was 22.52% more than the 100% RDF. At 20, 60 and 80 DAS and at harvest, WCE was maximum at drip fertigation with 75% RDNK in 5 splits. Weed dry matter was less in case of 75% RDNK than 100% RDF. These results are in accordance with the result reported by Thakare *et al*. (2019) [33]. Among all the herbicidal treatments Pretilachlor+Pyrazosulfuron ethyl @ 0.615 kg a.i. ha^{-1}PE *fb*. Bispyribac sodium @ 0.025 kg a.i. ha^{-1} at 25 DAS was found to be the best in WCE as it was effective in reducing weed dry matter than any other herbicidal treatments. Similar findings were reported by Jadhav *et al*. (2010) [1], Mishra *et al*. (2018) [14], Singh *et al*. (2018) [28] and Kundu *et al*. (2020) [9].

Drip fertigation with 125% RDNK in 5 splits recorded the lowest weed index at harvest (5.30%) than all other fertigation treatments which was 68.90% lower conventional soil application of fertilizers.Drip fertigation increased nutrient absorption by plants, favors'accurate placement of nutrient, ability to "micro dose" feeding to the plants just enough so that nutrients were absorbed and not left to be lost through volatilization, leaching loss of chemicals;the crop yield was more in drip fertigation with 125% RDNK in 5 splits. This might be the reason in minimum weed index at 125% RDNK in 5 splits. In case of drip irrigation with 100%RDF soil application (N in 3 Splits), there was more nutrient loss due to leaching and volatilization, the crop yield was the least, so the weed index might be more. This result is in accordance with the result reported by Thakare *et al*. (2019) [33].

Among the herbicidal treatments, lowest WI (%) was observed in Pretilachlor+Pyrazosulfuron ethyl @ 0.615 kg a.i. ha^{-1} PE*fb*. Bispyribac sodium @ 0.025 kg a.i. ha^{-1}at 25 DAS (2.94%) which was 93.43% less than weedy check. This might be due to higher grain yield as there was less losses of nutrients because of less crop-weed competition during the growing period and available nutrient, solar radiation and water were more to the crop which aided in better grain yield. In case of weedy check there was no weed management and crop-weed competition were maximum due to more weed population which resulted the least yield. This might be reason for the highest weed index in weedy check. Similar findings were reported by Jadhav *et al*. (2010) [1], Mishra *et al*. (2018) [14], Singh *et al*. (2018) [28] and Kundu *et al*. (2020) [9].

3.4 Growth attributes of rice

The data presented in Table 2 revealed that plant height, number of tillers m^{-2}, and dry matter $plant^{-1}$ were significantly influenced by different treatments. The highest value of plant height (95.16 cm), number of tillers m^{-2} (205.59) and dry matter $plant^{-1}$(23.75 g)were observed under application of drip fertigation with 125%RDNK in 5 splits (F_4). However, the lowest value for all these growth attributes were observed in drip irrigation with 100% RDF soil application (N in 3 splits).The favorable increase in growth attributes in terms of plant height and dry matter due to drip fertigation with 125% RDNK was earlier reported by Rekha (2013) [25] and Yamuna and Kumar (2016) [36]. Increase in the levels of N and K through fertigation increases the plant height, number of tillers and dry matter $plant^{-1}$ which might be due to enhanced availability and uptake of nutrients leading to enhanced photosynthesis, expansion of leaves and translocation of nutrients to the reproductive parts as compared to soil application method because of spoon feeding of nutrients in drip fertigation. Pandey *et al*. (2001) [18], Rekha (2014) [24] and Yamuna and Kumar (2016) [36] also reported the similar beneficial effect of higher level of RDNK fertigation on number of tillers and dry matter in wheat crop.

Incase of different weed management practices, highest plant height (87.96cm), number of tillers m^{-2}(187.07) and dry matter $plant^{-1}$(21.77g)atharvest were observed in the application of Pretilachlor+Pyrazosulfuron Ethyl @ 0.615 kg a.i. ha^{-1} PE *fb*. Bispyribac sodium @ 0.025 kg a.i. ha^{-1} at 25 DAS (W2). Whereas the lowest values of growth attributeswere recorded in weedy check treatment throughout the growing period of crop asmore number of weeds mainly suppressed the growth and development of rice because of competition for solar radiation, moisture and nutrients. It was observed that if there was increase in weed intensity, number of tillers $m^{-2}$and dry matter $plant^{-1}$ were decreased. In weedy check treatment (W5),the plant height was very less due to weed competition for plant nutrients, soil moisture and their shading effect on crop plants. These results are quite similar with the results of Jadhav *et al*. (2010) [1], Mishra *et al*. (2018) [14], Patil *et al*. (2019) [21], Singh *et al*. (2018) [28] and Saravanane (2020) [26].

3.5 Yield attributes, yield and harvest index

The data presented in Table 2 indicated that, each higher fertigation level of recommended dose of N and K significantly increased the yield attributing characters like the number of paniclesplant^{-1}, panicle length (cm), weight of panicle (g),Test weight of grain (g), grain, straw and biological yield (kgha^{-1}) over its lower levels and soil application with drip as indicated in Table 2 and 3. The grain yield and straw yield were influenced significantly due to split application of recommended dose of nitrogen and potash through fertigation. The highest values of number of paniclesplant^{-1} (4.15), panicle length (23.98cm), weight of panicle (4.11g), Test weight of grain (22.21g), grain yield (5103 kgha^{-1}), straw yield (7268 kgha^{-1}) and harvest index (41.25%) were observed at 125% RDNK. The fertigation method offered an opportunity for precise application of water-soluble fertilizers and other nutrients to the soils at appropriate time with the desired concentration. The development of root system was extensive in a restricted volume of soil when cultivation was done with drip irrigation and application of fertilizers through drip could efficiently place plant nutrients in the zone of highest root concentration. Fertigation combined water and fertilizer which minimized the nutrient loss that helped in better grain yield, straw yield, biological yield and harvest index in rice. Yield increased with fertigation also a better result from an optimal ionic balance achieved in the rice plants i.e. improved absorption of cations and anions, as illustrated by the increase in the ratio of NO^{3-}:NH^{4+}, measured in the sap extract of the trees that corresponds to the average concentrations of NO^{3-} and NH^{4+} found in the soil solution. Unlike low land rice cultivar that prefers ammonium-N uptake, aerobic rice cultivar prefers nitrate-N uptake. Similar kind of results were observed by Sundrapandiyan (2012) [31], Soman (2014) [29], Vanitha and Mohandass (2014) [35], Yamuna and Kumar (2016) [36], Parthasarathi *et al*. (2018) [19], Patil *et al*. (2019) [21].

Among herbicidal treatments the application of Pretilachlor+Pyrazosulfuron ethyl @ 0.615 kg a.i. ha^{-1}PE *fb*. Bispyribac sodium @ 0.025 kg a.i. ha^{-1}at 25 DAS helped in preventing weed shift towards perennial nature and shifted the crop-weed competition in favour of crop. These all favored in better number of panicle plant^{-1} (4.07), panicle length (22.49 cm), weight of panicle (3.90 g), test weight of grain (21.74 g), grain yield (5231 kgha^{-1}), straw yield (7603 kgha^{-1}) and harvest index of 41.25%.Whereas, in case of weedy check due to high weed population and high nutrient uptake by the weeds there was decrease in yield of rice crop. Pretilachlor was readily taken up by the hypocotyls, mesocotyls and coleoptiles and to a lesser extent by roots of germinating weeds; Pyrazosulfuron ethyl inhibited acetolactate synthase in weeds and Bispyribac sodium inhibited the amino acid formation in weeds. These results were in conformity with the findings of Singh *et al*. (2014) [27], Kumaran *et al*. (2015), Mishra *et al*. (2018) [14], Singh *et al*. (2018) [28], Ramesh and Rathika (2020) [23] and Saravanane (2020) [26].

3.6 Economics of fertigation and weed management practices

Among all the fertigation levels the highest gross monetary return (₹120353), net monetary return (₹72924) and B:C ratio (2.54) were obtained in the treatment receiving drip fertigation at 125% RDNK ha^{-1}. (Table 3). Lowest GMR, NMR and B:C ratio were registered in the drip irrigation with conventional soil application of 100% RDF (N in 3 splits). Adoption of drip fertigation is very much important as it gives higher B:C ratio by minimizing the cost of cultivation. In case of weedy check, GMR was lowest due to heavy weed infestation and very less rice yield. This might be reason behind the lowest B:C ratio in weedy check. Drip fertigation with 125% RDNK was economically viable than other treatments as there more GMR was obtained. Similar types of result were found by the results reported by Sundrapandiyan (2012) [31], Jata *et al*. (2013) [2], Nayak *et al*. (2016) [17], Parthasarathi *et al*. (2018) [19].

Among the herbicides, application of Pretilachlor+Pyrazosulfuron Ethyl @ 0.615 kg a.i. ha^{-1} PE fb. Bispyribac sodium @ 0.025 kg a.i. ha^{-1} at 25 DAS showed the highest gross monetary return (₹128755), net monetary return (₹81412) and B:C ratio (2.72). Weeds are main enemy of crops as they retarded the growth, development of a crop by competing with the crop for nutrients, water, solar radiation etc. In case of weedy check there was lowest cost of cultivation due to lowest GMR the B:C ratio was also low as their crop yield was severelydeteriorated by weeds. Similar types of result were found by the results reported by Mukherjee and Maity (2008) [15], Jadhav *et al*. (2010) [1], Kachroo and Bazaya (2011) [5], Upasani *et al*. (2012) [34], Mishra *et al*. (2018) [14], Patel *et al*. (2018) [20], Ramesh and Rathika (2020) [23] and Munnoli *et al*. (2018) [30].

Table 1: Weed density (Number m-2), weed dry matter (g), Weed control efficiency (%) and weed index (%) as influenced by different fertigation levels and weed management practices in rice

Treatments	Weed Density (Number m^{-2})					Weed Dry Matter (g)					WCE (%) at harvest	WI (%)
	20 DAS	40 DAS	60 DAS	80 DAS	At harvest	20 DAS	40 DAS	60 DAS	80 DAS	At harvest		
A) Fertigation Levels												
F_1:Drip irrigation with 100% RDF soil application (N in 3 Splits)	5.00 (24.50)	6.83 (46.10)	7.42 (54.50)	7.74 (59.47)	8.01 (63.63)	5.30 (27.55)	5.94 (34.81)	6.57 (42.71)	6.89 (47.01)	7.08 (49.56)	57.42	17.04
F_2:Drip fertigation with 75% RDNK in 5 Splits	4.17 (16.87)	6.50 (41.76)	7.09 (49.82)	8.07 (64.68)	8.20 (66.74)	4.33 (18.22)	6.00 (35.45)	6.21 (38.02)	6.65 (43.70)	6.83 (46.15)	60.35	14.33
F_3:Drip fertigation with 100% RDNK in 5 Splits	4.63 (20.98)	6.62 (43.37)	7.32 (53.03)	8.30 (68.38)	8.39 (69.95)	4.75 (22.09)	6.21 (38.12)	6.61 (43.15)	7.04 (49.11)	7.27 (52.32)	55.05	11.67
F_4:Drip fertigation with 125% RDNK in 5 Splits	4.89 (23.46)	6.76 (45.19)	7.47 (55.27)	8.59 (73.26)	8.71 (75.28)	5.34 (28.04)	6.39 (40.29)	6.72 (44.65)	7.11 (50.03)	7.40 (54.22)	53.42	5.30
SE (m)±	0.22	0.08	0.12	0.17	0.16	0.35	0.12	0.16	0.14	0.18	--	--
CD at 5%	0.69	0.24	0.36	0.49	0.50	NS	0.37	0.49	0.43	0.55	--	--

B) Weed Management Practices												
W$_1$: Pendimethalin @ 1 kg a.i. ha^{-1} PE *fb.* Bispyribac sodium @ 0.025 kg a.i. ha^{-1} @ 25 DAS	5.21 (26.61)	7.93 (62.38)	8.80 (76.98)	8.99 (80.27)	9.64 (92.51)	3.79 (13.87)	4.56 (20.25)	5.55 (30.28)	6.37 (40.03)	6.83 (46.20)	60.31	7.14
W$_2$: Pretilachlor+Pyrazosulfuron Ethyl @ 0.615 kg a.i. ha^{-1} PE *fb.* Bispyribacsodium @ 0.025 kg a.i. ha^{-1} at 25 DAS	4.54 (20.15)	6.41 (40.65)	6.65 (43.75)	7.36 (53.61)	7.58 (56.94)	3.60 (12.45)	4.33 (18.25)	5.38 (28.45)	6.35 (39.88)	6.73 (44.80)	61.51	2.94
W$_3$: Pretilachlor @ 0.75 kg a.i. ha^{-1} PE*fb.* Bispyribac sodium @ 0.025 kg a.i. ha^{-1} at 25 DAS	4.60 (20.64)	7.11 (50.08)	7.60 (57.31)	8.60 (73.48)	8.72 (75.60)	3.63 (12.65)	4.51 (19.88)	5.52 (30.00)	6.38 (40.25)	6.75 (45.10)	61.25	5.61
W$_4$: Farmer practices- 2 HW at 15–20 days interval after sowing *fb.* 2 hoeing	4.43 (19.15)	2.87 (7.71)	3.20 (9.71)	3.11 (9.19)	3.23 (9.94)	2.20 (4.35)	2.37 (5.14)	2.36 (5.08)	2.74 (7.02)	2.78 (7.21)	93.81	--
W$_5$:Weedy check	7.05 (49.15)	8.47 (71.18)	9.33 (86.48)	10.03 (100.1)	10.17 (102.9)	6.46 (41.25)	7.93 (62.35)	9.54 (90.58)	10.24 (104.3)	10.81 (116.4)	--	44.73
SE (m)±	0.24	0.17	0.14	0.13	0.16	0.48	0.60	0.96	1.09	1.17	--	--
CD at 5%	0.74	0.57	0.49	0.46	0.55	1.21	1.84	2.91	3.26	3.53	--	--
Interaction (F×W)												
SE (m)±	0.16	0.19	0.25	0.24	0.32	3.00	2.77	2.62	2.34	2.52	--	--
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	--	--
The values in the parenthesis are transferred values ($\sqrt{x+1}$)												

Table 2: Growth characters and yield attributes of rice as influenced by different fertigation levels and weed management practices

Treatments	Plant height (cm)	Number of tillers m^{-2}	Dry matter plant^{-1} (g)	Number of panicles plant^{-1}	Panicle length (cm)	Weight of panicle (g)	Test weight of grain (g)
A) Fertigation Levels							
F$_1$:Drip irrigation with 100% RDF soil application (N in 3 Splits)	79.30	163.10	19.09	3.74	20.33	3.65	20.24
F$_2$:Drip fertigation with 75% RDNK in 5 Splits	82.96	171.43	20.10	3.81	20.82	3.72	20.71
F$_3$:Drip fertigation with 100% RDNK in 5 Splits	86.84	190.73	21.10	3.94	21.93	3.86	21.85
F$_4$:Drip fertigation with 125% RDNK in 5 Splits	95.16	205.59	23.75	4.15	23.98	4.11	22.21
SE (m)±	1.73	5.81	0.59	0.08	0.59	0.06	0.41
CD at 5%	5.99	20.12	2.04	0.28	2.03	0.21	1.41
B) Weed Management Practices							
W$_1$: Pendimethalin @ 1 kg a.i. ha^{-1} PE *fb.* Bispyribac sodium @ 0.025 kg a.i. ha^{-1} at 25 DAS	84.14	181.99	20.16	3.78	21.06	3.76	21.41
W$_2$: Pretilachlor+Pyrazosulfuron Ethyl @ 0.615 kg a.i. ha^{-1} PE *fb.* Bispyribac sodium @ 0.025 kg a.i. ha^{-1} at 25 DAS	87.96	187.07	21.77	4.07	22.49	3.90	21.74
W$_3$: Pretilachlor @ 0.75 kg a.i. ha^{-1} PE*fb.* Bispyribac sodium @ 0.025 kg a.i. ha^{-1} at 25 DAS	85.19	189.92	21.00	3.91	21.82	3.84	21.56
W$_4$: Farmer practices- 2 HW at 15–20 Days interval after sowing *fb.* 2 hoeing	90.24	197.56	22.43	4.24	23.14	4.02	22.23
W$_5$:Weedy check	82.80	157.01	18.69	3.26	19.28	3.42	20.68
SE (m)±	1.19	5.55	0.60	0.11	0.60	0.09	0.49
CD at 5%	3.44	15.99	1.73	0.30	1.72	0.25	NS
Interaction (F×W)							
SE (m)±	2.39	11.10	1.20	0.21	1.19	0.17	0.99
CD at 5%	NS	NS	NS	NS	NS	NS	NS

Table 3: Grain and straw yield (kg ha^{-1}), harvest index (%) and economics of rice as influenced by different fertigation levels and weed management practices

Treatments	Grain yield (kgha^{-1})	Straw yield (kgha^{-1})	Harvest Index (%)	GMR (₹ ha^{-1})	COC (₹ ha^{-1})	NMR (₹ ha^{-1})	B:C ratio
A) Fertigation Levels							
F$_1$:Drip irrigation with 100% RDF soil application (N in 3 Splits)	4471	6593	40.41	108407	45818	62589	2.37
F$_2$:Drip fertigation with 75% RDNK in 5 Splits	4617	6724	40.71	111168	44529	66639	2.50
F$_3$:Drip fertigation with 100% RDNK in 5 Splits	4760	6867	40.94	113871	45818	68053	2.49
F$_4$:Drip fertigation with 125% RDNK in 5 Splits	5103	7268	41.25	120353	47429	72924	2.54
SE(m)±	28.37	45.57	--	536	--	536	--
CD at 5%	101.00	160.30	--	1853	--	1853	--
B) Weed Management Practices							
W$_1$: Pendimethalin @ 1 kg a.i. ha^{-1} PE *fb.* Bispyribac sodium @ 0.025 kg a.i. ha^{-1} at 25 DAS	5004	7294	40.69	124479	48506	75973	2.57
W$_2$: Pretilachlor+Pyrazosulfuron Ethyl @ 0.615 kg a.i. ha^{-1} PE *fb.*	5231	7603	40.76	128755	47343	81412	2.72

Bispyribac sodium @ 0.025 kg a.i. ha^{-1} at 25 DAS							
W_3: Pretilachlor @ 0.75 kg a.i. ha^{-1} PE*fb*. Bispyribac sodium @ 0.025 kg a.i. ha^{-1} at 25 DAS	5087	7402	40.73	126035	47973	78062	2.63
W_4: Farmer practices – 2 HW at 15–20 days interval after sowing *fb*. 2 hoeing	5389	7656	41.31	131749	51520	80229	2.56
W_5:Weedy check	2978	4350	40.64	56233	42946	13287	1.31
SE(m)±	46.29	72.51	--	874	--	874	--
CD at 5%	134.00	212.20	--	2519	--	2519	--
Interaction (F×W)							
SE(m)±	75.43	118.08	--	1748	--	1748	--
CD at 5%	NS	NS	--	NS	--	NS	--

4. Conclusion

On the basis of the data, it could be concluded that application of drip fertigation with 125% RDNK in 5 splits and directed application of Pretilachlor+Pyrazosulfuron ethyl @ 0.615 kg a.i. ha^{-1} PE *fb*. Bispyribac sodium @ 0.025 kg a.i. ha^{-1} at 25 DAS found to be the best for maximizing the yield and beneficial for increasing the productivity and economic returns of rice under different fertigation levels and weed management practices.

5. References

1. Jadhav VT, Kadamand DE, Bhoite SV. Integrated Weed Management in upland direct seeded rice. Journal of Maharashtra Agricultural Universities 2010;35(1):56-59.
2. Jata SK,Nedunchezhiyan M, Saho T.R, Sahoo V. Fertigation in high value tuber Seasons - A review. Odisha Review. 2013;5:68-77.
3. Jayakumar M, Rajavel, M, Surendran U. Impact of drip fertigation on weed population, dry weight and yield of onion in semiarid tropical region of India. National Academy Science Letters, 2020;1-3.
4. Joshi R, Mani SC, Shukla A, Pant RC. Aerobic rice: Water use sustainability. Oryza. 2009;46(1):1-5.
5. Kachroo D, Bazaya BR. Efficacy of different herbicides on growth and yield of direct wet seeded rice. Indian J. Weed Sci. 2011;43(1-2):67-69.
6. Kombali G, Nagaraju H, Rekha B, Sheshadri T, Thimmegowda MN, Mallikarjuna GB. Optimization of water and nutrient requirement through drip fertigation in aerobic rice. International Journal of Bio-resource and Stress Management 2016;7(2):300-304.
7. Khush GS. Harnessing science and technology for sustainable rice-based production systems. In: Proceedings of FAO Rice Conference “Rice is life”. International Rice Commercial Newsletter 2004;53:17-23.
8. Kumaran ST, Kathiresan G, Arthanari PM. Chinnusamy C, Sanjivkumar V. Efficacy of new herbicide (bispyribac sodium 10% SC) against different weed flora, nutrient uptake in rice and their residual effects on succeeding crop of green gram under zero tillage. Journal of Applied and Natural Science. 2015;7(1):279-285.
9. Kundu R, Mondal R, Garai S, Mondal M, Poddar R and Banerjee S. Weed management efficiency of post emergence herbicides in direct seeded rice and their residuality on soil microorganisms. Journal of Experimental Biology and Agricultural Sciences. 2020;8(3):276-286.
10. Maheswari J, Maragatham N, Martin GJ, Relatively simple irrigation scheduling and N application enhancesthe productivity of aerobic rice *Oryza sativa* L. Australian Journal of Plant Physiology. 2007;2(4):261-268.
11. Manin VS, Malla ML, Gautam KC, Das B. Weed killing chemical in potato cultivation. PANS. 1973;23:17-18.
12. Malik S, Duary B, Jaiswal DK. Integrated use of herbicide and weed mulch with closer spacing for weed management in dry direct seeded rice. International Journal of Bio-resource and Stress Management. 2021;12(3):222-227.
13. Michael AM. Irrigation Theory and Practice. Vikas Publishing House Pvt. Ltd., New Delhi, 2008.
14. Mishra G, Luther MM, Mishra GC. Efficacy of new generation herbicides in combination and integrated application on weed control efficiency, production potential and economics in direct seeded rice (*Oryza sativa* L.). IJCS. 2018;6(2):1235-1238.
15. Mukherjee PK, Maity SK. Integrated weed management in dry direct–seeded rainy season rice (*Oryza sativa*). Indian Journal of Agronomy. 2008;52(2):116-120.
16. Natarajan SK, Duraisamy VK, Thiyagarajan G, Manikandan M. Evaluation of drip fertigation system for aerobic rice in Western zone of Tamil Nadu. International Journal of Plant & Soil Science. 2020;32(7):41-47.
17. Nayak BD, Murthy KR, Anitha KV. Economics of drip fertigation in aerobic rice as influenced by levels of irrigation and fertigation. Advances in Life Sciences. 2016;5(2):400-402.
18. Pandey N, Verma AK, Tripathi RS. Effect of planting time and nitrogen on tillering pattern, dry matter accumulation and grain yield of hybrid rice. Indian J. Agri. Science. 2001;71(5):337-338.
19. Parthasarathi T, Vanitha K, Mohandas S, Vered E. Evaluation of drip irrigation system for water productivity and yield of rice. Agronomy Journal. 2018;110(6):2378-2389.
20. Patel TU, Lodaya DH, Italiya AP, Patel DD, Patel HH. Bio-efficacy of herbicides in direct-seeded rice. Indian Journal of Weed Science. 2018;50(2):120-123.
21. Patil L, Gowda RC, Basavaraja PK, Yogananda SB, Krishnamurthy R, Ramachandra C. Effect of graded levels of fertilizer nutrients and irrigation methods on nutrient content and uptake of aerobic rice. Journal of Pharmacognosy and Phytochemistry. 2019;8(5):1240-1246.
22. Peng NL, Bing S, Chen MX, Shah F, Huang JL, Cui KH, Jing X. Aerobic rice for water-saving agriculture - A review. Agronomy for Sustainable Development.0 2012;32(2):411-418.
23. Ramesh T, Rathika S, Subramanian E, Ravi V. Effect of drip fertigation on the productivity of hybrid rice. International Journal of Agriculture, Environment and Biotechnology. 2020;13(2):219-225.
24. Rekha B. Studies on fertilizer management through drip

fertigation in aerobic rice. M.Sc. (Agri.) Thesis, University of Agril. Sciences, Bengaluru; c2014.
25. Rekha G. Effect of PEG-6000 imposed water deficit on chlorophyll metabolism in maize leaves. Journal of stress Physiology & biochemistry. 2013;9(3):243-253
26. Saravanane P. Effect of different weed management options on weed flora, rice grain yield and economics in dry direct-seeded rice. Indian Journal of Weed Science. 2020;52(2):102-106.
27. Singh R, Pal R, Singh T, Singh AP, Yadav S, Singh J. Management of weeds in direct-seeded rice by bispyribac-sodium. Indian Journal of Weed Science. 2014;46(2):126-128.
28. Singh T, Satapathy BS, Gautam P, Lal B, Kumar U, Saikia K, *et al*. Comparative efficacy of herbicides in weed control and enhancement of productivity and profitability of rice. Experimental Agriculture. 2018;54(3):363-381.
29. Soman P. Drip fertigation for rice cultivation: JAINS experience. In: Proceedings of the Fourth International Rice Congress. Bangkok, Thailand, 2014.
30. Munnoli S, Rajakumar D, Chinnusamy C, Nallasamy T. Integrated weed management in aerobic rice. Madras Agricultural Journal 2018;105(4–6):161-164.
31. Sundrapandiyan R. Study on the effect of drip biogation on the productivity of aerobic rice, M.Sc. (Agri.) Thesis, Tamil Nadu Agril. Univ., Coimbatore, 2012.
32. Sunil CM, Shekara BG, Kalyanmurthy KN, Shankaralingapa BC. Growth and yield of aerobic rice as influenced by integrated weed management practices. Indian Journal of Weed Science. 2010;42(3&4):180–183.
33. Thakare SS, Paslawar AN, Deshmukh JP, Kubde KJ, Saoji BV, Shingrup PV. Effect of fertigation levels and weed management practices on weed flora and seed cotton yield of Bt cotton. Journal of Pharmacognosy and Phytochemistry. 2019;8(6):2237-2241.
34. Upasani RR, Kumari P, Thakur R, Singh MK. Effect of seed rate and weed control methods on productivity and profitability of wet land rice under medium land condition. Indian Journal of Weed Science. 2012;44(2):98–100.
35. Vanitha K, Mohandass S. Effect of humic acid on plant growth characters and grain yield of drip fertigated aerobic rice (*Oryza sativa* L.). An International Quality Journal of Life Science. 2014;9:45–50.
36. Yamuna BG, Kuma D. Influence of fertilizer levels applied through conventional and fertigation on yield components and yield of aerobic rice. Journal of Pharmacognosy and Phytochemistry. 2016;9(4):3015-3019.