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Original Research Article

Weed Management in Direct Seeded Rice under Different Row Spacing

Muhammad Zain Ul Abidin[1], Komal Muskan[1], *Danish Alim[2], M Armaghan Khalid[1], Muhammad Adnan[1] and Waheed Abbas[1]

[1]Faculty of Agricultural Science, Bahauddin Zakariya University, Multan, Pakistan
[2]Department of Agronomy, University of Agriculture, Faisalabad, Pakistan

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Abstract

A field study to evaluate the weed management in direct seeded rice under different row spacing was carried out at Agronomic Research Area, University of Agriculture, Faisalabad during summer 2018. Two herbicides Butachlor @ 118.61 g a.i. ha^{-1} (pre-emergence) was applied within 24 hours of sowing of direct seeded rice and combination of two herbicides Butachlor @ 118.61 g a.i. ha^{-1} (pre-emergence) within 24 hours after sowing sequentially followed by Bispyribac Sodium + Bensulfurin Methyl @ 26.7 g a.i. ha^{-1} + 17.8 g a.i. ha^{-1} (post-emergence) was applied 15 days after sowing. Bispyribac Sodium @ 26.7 g a.i. ha^{-1} was applied 15 days after sowing. A weedy check and weed free treatment were also run for comparison. A fine rice cultivar (Basmati 515) was sown during the last week of June in 22.5 cm and 11.25 cm spaced rows using a seed rate of 29 kg ha^{-1}. To fulfill the requirement of nutrients 135 kg N, 88 kg P and 61 kg ha^{-1} K were applied. The experiment was replicated thrice in a randomized complete block design under split plot arrangement. The net plot size was 3 m × 2.25 m. Date regarding weed density (15, 30 and 45 DAS), weed biomass before harvesting and yield components of rice were recorded by following standard procedures and statistically analyzed by applying Fisher's analysis of variance technique. Least significant difference test (LSD) at 5% probability was used to compare treatments means. Results of the study showed that total weed density and weed dry weight were significantly influenced by different row spacing and weed control treatments. Significantly lower weed density and weed biomass were observed under narrow row spacing (11.25 cm) as compared to wider row spacing (22.5 cm). Among weed control treatments application of Butachlor @ 118.61 g a.i. ha^{-1} (pre-emergence) within 24 hrs after sowing of DSR and Bispyribac Sodium @ 26.7 g a.i. ha^{-1} (15 DAS) reduced the total weed density and weed dry weight. Similarly, paddy yield was also significantly influenced by different row spacing and weed control treatments as weed free at 11.25 cm row spacing gave maximum paddy yield (4.0 t ha^{-1}).

Keywords: *Planting Geometry, Seed Variety, Row Spacing, Weeds Management, Seed rate.*

Introduction

Rice, a monocotyledon, belongs to the family Poaceae. Rice is considered as important food item since ancient times. Rice is an important Kharif crop as well as a major food and cash crop worldwide. Rice fulfills our dietary needs as well as it gives net returns in the form of export commodity. In Pakistan, after wheat, it is the second main staple food crop and second major exportable commodity after cotton. During 2017-18, area cultivated under rice has been increased 6.4 % of the corresponding period of last year. In 2018, Pakistan gained $ 1.677 billion and 0.6% of GDP and 3.1% of value-added services through exports (Govt. of Pakistan, 2018). Pakistan constitutes significant status in rice producing nations, each year produce about 6 million ton of rice.

*Corresponding author's ORCID ID: 0000-0002-8198-4464
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The by-products of rice acts as raw materials for different industries e.g. rice husk is used in paper and board making industries. Rice flour is used in bakery and confectionary products. Rice is grown on about 8 million hectares of cultivatable land in Pakistan with about 6.8 million tons of yearly produce (Govt. of Pakistan, 2018). Rice is sown in the productive soils of Punjab and Sindh, where millions of farmers use rice a main source of employment. Basmati are the best-known varieties grown in Pakistan, which are identified for their taste and quality [1]. Pakistan is an important producer of different varieties. In Punjab, districts of upper Punjab including Gujranwala, Sheikhupura and Sialkot along with Narrowal contribute for more than 70% of the country's total basmati production [2].

Majority of South-Asian countries were growing rice commonly by transferring of seedlings in well-prepared fields with standing water (wet tillage). Transplanted rice (TPR) is the most commonly followed method for growing rice crop and it needs a large quantity of water and labour for its development [3]. This region is facing water scarcity problems as well as limited labour due to increasing population and urbanization. Large amount of water is required in conventional rice production system, such as puddled transplanted rice (PTR). Of the total amount of water required for rice culture in a season, about 30% is used for land preparation in puddled systems [3][4]. Farmers were shifting from transplanted rice to direct seeded rice due to limited water availability [5]. Mainly in Pakistan, transplanting is done by paid labor. Any delay in seedling transplanting due to labor shortage may results in lower yields. To prevent water scarcity and to overcome labor shortage direct seeded rice is a good option. Direct seeded rice does not require any amount of water for puddling purpose but preserves constant soil moisture to decrease the overall water requirement for rice production. In direct seeded rice yield loss occurs due to weed infestation [8][7].

Moreover, nursery transplantation does not keep the required plant population, mainly because of the lack of skilful labor and the high cost of transplantation [9][10]. The country's rice produce is stagnant or decreasing gradually. Ideal plant population is of significant importance among the various factors limiting the rice yield in transplanted rice cultures [10][11].

Above stated situation, requirements, alternate approaches of rice production and their possibility needs to be explored under local agro-environmental conditions. A promising technique of rice cultivation is aerobic direct seeding Instead of puddling and transplanting rice seedlings [12][13] as it needs less water, labour and capital input. There are three different ways of direct seeding of rice (DSR) i.e. sowing pre-germinated seed on a puddled soil surface (wet-seeding) or in shallow standing water (water-seeding), or dry seed in a prepared seedbed (dry-seeding) [14]. The directly sown rice crop also matures 7- 10 days earlier as compared to transplanted crop, in this way giving a chance for the succeeding wheat crop to be planted timely [15]. Irrigation in aerobic rice systems can decrease up to 44% relative to conventionally transplanted systems, by decreasing percolation, seepage and evaporative losses, while sustaining yield at an adequate level [16].

The important reasons for low rice yields include water scarcity, weed infestation, pest and disease spread and an unsuitable sowing method that results in a low plant population. The small plant population can be optimized with a suitable sowing method [17][18]. The transplantation of rice required maximum work, resulting in maximum production costs, but planting was delayed due to the shortage of manpower. If the transplanting is replaced by direct seeded rice (DSR) it would be beneficial, which can yield an adequate plant density. Directly sowing rice is another choice to address the water and labour shortage problems linked with the transplanting method [19]. DSR can be sown by different methods such as water sowing, wet sowing and dry sowing [19][20].

However, dense weed invasion is a major limitation to widespread adoption of direct seeding rice at farmer level [21]. Issues like weed invasion and unpredictable emergence need serious attention in growing a successful direct-seeded crop [22].

Weed invasion is the major problem in dry-seeded rice as discussed earlier. Well prepared seedbed, different wet and dry environmental conditions were appropriate for weed germination which may harm yield up to 50–91% [23]. In direct-seeded rice, rice seeds were sown on well prepared field and then irrigated. In some Areas, where drills machines were not accessible, dry seeds were broadcasted and then mixed with the help of tractor-mounted cultivar. The worrisome issue in adoption of direct seeded rice system were weeds. Rice fields mainly have weeds of sedges, grasses and broad leaves [24].

To improve the germination and seedling populations of directly sown rice, recent studies have standardized certain seed priming techniques [25]. These studies showed that good yield are obtained through vigorous and rapid germination, faster and more uniform seedling establishment in directly sown rice under field conditions. It needs more struggles for the eradication of second major obstacle, i.e., thick weed invasion in direct seeded rice cultures [26]. Weeds are controlled more proficiently and cost-effectively by the use of a different methods [27], including manual and chemical means. The most commonly used and consistent method for controlling weeds in rice is chemical control [28]. In aerobic rice fields, when appropriately used, both pre-emergence and post-emergence herbicides were effective in aerobic rice fields [29][30][31]. Sometimes single utilization of these herbicides cann't control a wide range of weeds emerging in alternate flushes. When a single herbicide is used, it can be effective against a particular class of weeds. Thus sequential application of various herbicides in dry seeded rice seems a good option [32][33]. In directly-sown rice, traditional practices such as land preparation, water and fertilizer management have been stated to effect weed invasion [34]. It is discovered that herbicide practices incorporated with cultural methods can broadly effect weeds and should be coordinated with other crop production practices that effect agro-environment. Such measures are contained planting time, crop residual mulching (surface or consolidated), and intercropping, seeding densities and row spacing, just to give some example [35].

In recent times, the consideration in the utilization of cultural approaches in integrated weed management systems is increasing. Narrow row spacing appears to be one significant cultural way to increase crop's ability to compete with weeds [36].

In a recent study, the seedlings of Echinochloacolona and Echinochloa crus-galli were found to have more prominent biomass and seeds in aerobic rice planted at 30 cm spaced rows as compared to 20 cm rows, emerging during the first month of the crop growing season. Chauhan et al. (2011) resulted that in direct-seeded rice row spacing (15-45 cm) had little effect on the grain yield of the crop without weeds however, in competition with weeds the widest spacing caused in expressively lower grain yield [38][37]. However, restricted research information is accessible on the combined impact of chemical and cultural herbicide techniques on weed emergence and growth. Substantial weed invasion is perhaps the major problem in the large scale adoption of directly sown rice production technology in the country. Keeping in view the significance of rice as cash and an export commodity for Pakistan, an economical, practicable and efficient technique for raising the rice crop is vital that in turn needs proficient and cost-effective herbicide for its sustainability [39]40].

The main objective of this research is:

- To calculate the effectiveness of various herbicides against weeds in the DSR.
- To discover optimal spacing between rows for better stand establishment and herbicide.

Materials and Methods

Experimental Conditions

A field trial was carried out at the student Research farm, Agronomy Department, University of Agriculture, Faisalabad. The results of both pre-emergence and post-emergence herbicides were evaluated in two different row spacing methods i.e., 22.5 cm × 22.5 cm and 11.25 cm × 11.25 cm at field conditions during summer, 2018. The experimental design used was randomized complete block design (RCBD) with split plot arrangement and replicated thrice.

Treatments

The experiment was comprised of the following treatments:

Factor A: Row Spacing

G0= R × R 22.5 cm × 22.5 cm G1= R × R 11.25 cm × 11.25 cm

Factor B: Herbicide Application

H0= Control
H1= (Pre-emergence) Butachlor @) 118.61 g a.i. ha-1
H2= (Pre-emergence + Post-emergence) Butachlor @) 118.61 g a.i. ha-1 + Bispyribac Sodium + Bensulfurin Methyl @ 26.7 g a.i. ha-1 + 17.8 g a.i. ha-
H3=(Post-emergence) Bispyribac Sodium+Bensulfurin Methyl @ 26.7 g a.i. ha-1 + 17.8 g a.i. ha-1.

Experimental layout location

Students' Farm, Department of Agronomy, University of Agriculture, Faisalabad.

- N.A.E. = Non Experimental Area (0.5 m)
- N.E.P.= Non Experimental Plot

Table 1 Layout Location

R1	22.5 × 22.5 cm					11.25 × 11.25 cm					Main Water Channel
		N	E	A			N	E	A		
	N.E.P	H_1	H_0	H_3	H_2	H_1	H_0	H_3	H_2	N.E.P	
		N	E	A			N	E	A		
	Sub water channel										
R2	22.5 × 22.5 cm					11.25 × 11.25 cm					
							N	E	A		
	N.E.P	H_3	H_2	H_1	H_0	H_0	H_1	H_3	H_2	N.E.P	
		N	E	A			N	E	A		
	Sub path										
R3	22.5 × 22.5 cm					11.25 × 11.25 cm					
		N	E	A			N	E	A		
	N.E.P	H_2	H_0	H_1	H_3	H_1	H_0	H_2	H_3	N.E.P	
		N	E	A			N	E	A		
	Sub water channel										

Soil Analysis

Fertility of soil was determined by extracting soil samples before sowing using standard methods, soil fertility status evaluation is presented in the Table below:

Table 2 Soil Analysis

Parameter	Values	Units
Soil type	Sandy loam soil	
EC	0.35	dSm^{-1}
pH	8.23	
Exchangeable Na	0.86	$me100g^{-1}$
Organic Matter	0.9	%
Nitrogen	0.77	%
Phosphorus	125	Ppm
Exchangeable K	109	Ppm

Crop Husbandry

Seedbed thoroughly prepared using tractor mounted plough for two to three times and followed by planking. The soil was prepared and leveled and optimum soil moisture conditions as per treatments. The rice variety Basmati-515 was drilled in 22.5 cm spaced rows and in other treatment

11.25 cm spaced rows at seed rate of 29 kg ha-1 on June 27, 2018. Fertilizer was applied with dose of N (135 kg per hectare), K (61 kg per hectare) and P (88 kg per hectare) in all plots. Whole of the phosphorus, potash and one third of nitrogen were applied at the time of sowing. Two third of nitrogen was applied in equal splits, one at the time of tillering while the other at panicle initiation. All others operations were kept uniform for treatments.

Plant Protection Measures

Application of pre emergence herbicides was done within 24 hours after sowing and post emergence herbicides application was made 15 days after sowing according to treatment plan. Application of herbicides was done manually using knap sack sprayer. There was no critical invasion of insect pest and diseases.

Observations/Data

Data regarding weed and crop parameters were taken according to standard procedure.

Weeds

1. Total weed density at 15, 30 and 45 DAS (m-2)
2. Weed fresh weight at harvesting (g m-2)
3. Weed dry weight (g m-2)

Rice

a) Agronomic traits

1. Height of plant (cm)
2. Total number of tillers (m-2)
3. Fertile tillers (m-2)
4. Non-fertile tillers (m-2)
5. Length of panicle (cm)
6. Number of branches per panicle
7. Number of kernels per panicle
8. 1000-kernel weight (g)
9. Biological yield (t ha-1)
10. Straw yield (t ha-1)
11. Paddy yield (t ha-1)
12. Harvest index

Procedure for recoding data

Data regarding weed biomass, density and yield attributes of rice were recorded by standard procedures as prescribed under.

Weeds

a) Weed density (m-2) at 15, 30 and 45 DAS: Weeds density was recorded from a randomly placed quadrate. Weeds were removed from the soil surface and individual counts of weeds were made from each quadrate after 15, 30 and 45 days after sowing. Then the averages were taken and recorded in the observation book.

b) Weed fresh weight (g m^{-2}) at harvesting: Weeds were harvested before harvesting the crop and put in Kraft paper bags. Sample of weeds taken from the field were weighted with digital balance and fresh weight was recorded.

c) Weed dry weight (g m^{-2}): Weeds were individually harvested and put in Kraft paper bags. Sample of weeds taken from field were sun dried for three to five days and then placed in an oven till a constant weight achieved. Digital balanced was used to record weed dry weight.

Rice

Agronomic traits:

a) Height of plant (cm): Ten rice plants for each plot were randomly selected at maturity from each plot and their height was measured from soil surface to the final growing point with a measuring tape and average was calculated.

b) Total number of tillers (m^{-2}): Number of tillers were counted from three different places in each plot at physical maturity. The average per unit area (m-2) was computed.

c) Fertile tillers (m^{-2}): Panicle bearing tillers were counted at random from three different places in each plot at the maturity. Then their averages were calculated.

d) Non-fertile tillers (m^{-2}): Tillers having no panicle were counted from three randomly selected sites in each plot at the maturity and average was computed.

e) Length of Panicle (cm): Ten rice plants were selected randomly and their panicle length was measured with a measuring tape and average was computed.

f) Number of branches per panicle: From each plot ten panicle of primary tillers were randomly collected at harvest. Number of branches per panicle were counted and average was calculated.

g) Number of kernels per panicle: From each plot ten panicles were randomly harvested. Their kernels were manually threshed and calculated. Then their average was recorded.

h) 1000-Kernel weight (g): The 1000-kernel weight of normal kernels was recorded thrice in grams using electrical balance and the average of the three repetitions was recorded.

Results and Discussion

The parameters under consideration during the research period were explained and illustrated with the tables thoroughly.

They were as follow

Parameters for weeds

Abundance of weeds affected the rice yield severely. Data for total number of weeds was recorded at 15, 30 and 45 days after sowing. Weed community of experimental site comprised of weeds like purple nutsedge (Cyperusrotundus L.), Jungle rice (Echenochloacolona L.), Horse purslane (Trianthemaportulacastrum L.), Aligator weed

(Altirnantheraphiloxiroides L.) and Crowfoot grass (Dactylocteneumaegypteum L.). Data on density of weed and weeds fresh and dry weight are presented and discussed in the below sections.

Weeds density (m-2) at 15 DAS

Information given in Table 3 about total density of weeds at 15 days after sowing indicated that total density of weed was significantly ($p \leq 0.05$) influenced by various row spacing. Significantly lower weed density (58.00 m^{-2}) was observed in narrow row spacing (11.25 cm) as compared to that (69.66 m^{-2}) observed in wider row spacing (22.5 m^{-2}) at 15 DAS. All herbicide treatments also depicted a significant influence on total density of weed at 15 DAS (Table 3). Lower weed density (32.67 m^{-2}) was observed in Butachlor as @) 118.61 g a.i. ha-1 pre-emergence which was statistically at similar with Bispyribac Sodium @ 26.7 g a.i. ha-1 + Bensulfurin Methyl @ 17.8 g a.i. ha-1 as post-emergence (34.00 m^{-2}) and the higher weeds density (106.67 m^{-2}) was observed in control treatment where no herbicide treatment was applied.

A statistically non-significant interaction of row spacing and herbicide treatments was recorded in present study. Lower weeds density shows that herbicide treatments was effective and reduced the weed emergence. Similar results were reported by Khaliq et al. (2014).

Effect of herbicides and row spacing on weed density (m^{-2}) in direct seeded rice at 15 days after sowing

Table 3 Analysis of Variance

Source	DF	SS	MS	F
R	2	185.3	92.67	
F1	1	816.7	816.67	1225.00**
Error R × F1	2	1.3	0.67	
F2	3	24156.7	8052.22	255.18**
F1 × F2	3	44.7	14.89	0.47 ns
Error R × F1 × F2	12	378.7	31.56	
Total	23	25583.3		

** = highly significant, ns = non-significant

Table 4 Individual comparison of Treatment Means

Treatment	Herbicide Application				
Row Spacing	Control	Butachlor(Pre-Emergence)	Butachlor+ Bispyribac Sodium + Bensulfurin Methyl(Pre+Post)	Bispyribac Sodium + Bensulfurin Methyl(Post-emergence)	Mean
22.5 cm	114.67	37.33	88.00	38.67	69.667 A
11.25 cm	98.67	28.00	76.00	29.33	58.000 B
Mean	106.67 A	32.67 C	82.00 B	34.00 C	

Purple nutsedge density (m^{-2}) at 15 DAS

All herbicide treatments significantly affected the density of purple nutsedge at 15 days after sowing (Table 5). The Minimum purple nutsedge density was found in Bispyribac Sodium @ 26.7 g a.i. ha-1 (3.06 m^{-2}) which was statistically at par with Butachlor @) 118.61 g a.i. ha-1 and consecutively followed by Bispyribac Sodium @ 26.7 g a.i. ha-1 and Butachlor @) 118.61 g a.i. ha-1 where density of purple nutsedge was observed (3.81 m^{-2} and 3.20 m^{-2}) respectively. The higher density of purple nutsedge was recorded in treatment where no herbicide was used (45.31 m^{-2}). The Purple nutsedge density at two different row spacing was found non-significant.

The Interactive effect of herbicide treatments with different row spacing was found statistically non-significant in this study (Table 4.2). The results are in accordance with Mann et al. (2007) in which they concluded that a mixture of two post emergence herbicide like 2,4D and ethoxysulfuron gives good results to control all kind of weeds viz., broad leaf weeds, grasses and sedges. Khaliq et al. (2011) also stated the good results by using mixture of two herbicides.

Density of jungle rice (m^{-2}) at 15 DAS

Rice crop planted at two distinctive row spacing depicted a significant influence on density of Jungle rice at 15 DAS. Different herbicide treatments significantly influence the Jungle rice density at 15 DAS. A statistically significant ($p \leq 0.05$) interactive impact of herbicide treatments with two different row spacing was found in this study. All herbicide treatments demonstrated a significant decrease in jungle rice density at both row spacing at 15 DAS as compared to their respective control treatments. The lower jungle rice density was observed in Bispyribac Sodium @ 26.7 g a.i. ha-1 + Bensulfurin Methyl @ 17.8 g a.i. ha-1 as post-emergence (1.90 m^{-2}) which was statistically at par with Butachlor @) 118.61 g a.i. ha-1 (2.40 m^{-2}) under narrow row spacing.

These results are in accordance with Gopal et al. (2010) in which they concluded that a mixture of two post emergence herbicide like 2,4D and ethoxysulfuron gives better results to control all types of weeds viz., broad leaf weeds, grasses and sedges. Similar findings were also reported by Phuong et al. (2005).

Table 5: Influence of different herbicide treatments on purple nutsedge density in direct seeded rice at different row spacing at 15 Days after sowing: Analysis of Variance

Source	DF	SS	MS	F
R	2	8.21	4.10	
F1	1	41.08	41.08	13.45 ns
Error R × F1	2	6.11	3.06	
F2	3	7923.13	2641.04	651.28 **
F1 × F2	3	26.21	8.74	2.15 ns
Error R × F1 × F2	12	48.66	4.06	
Total	23	8053.40		

** = Highly significant, ns = non-significant

Table 6: Individual comparison of Treatment Means

Treatment	Herbicide Application				
Row Spacing	Control	Butachlor(Pre-Emergence)	Butachlor+ Bispyribac Sodium + Bensulfurin Methyl(Pre+Post)	Bispyribac Sodium + Bensulfurin Methyl(Post-emergence)	Mean
22.5 cm	48.400	4.067	4.200	3.967	15.158
11.25	42.233	2.333	3.433	2.167	12.542
Mean	45.317 A	3.200 B	3.817 B	3.067 B	

Means not sharing the same latter differ significantly at (p≤0.05) by LSD test LSD value for Herbicide Application = 2.5332

Crowfoot grass density (m-2) at 15 DAS

Data recorded at 15 days after sowing indicated that crowfoot grass density was significant (p≤0.05) at distinctive row spacing. All herbicide treatments significantly reduced the crowfoot density at 15 DAS table 7. A statistically significant interactive (p≤0.05) effect of two row spacing was observed with various herbicide treatments in this study. The minimum density of crowfoot grass was recorded in Bispyribac Sodium @ 26.7 g a.i. ha-1 + Bensulfurin Methyl @ 17.8 g a.i. ha-1 as post-emergence (1.33 m-2) which was statistically at par with Butachlor @) 118.61 g a.i. ha-1 (1.46 m-2) under narrow row spacing.

The results are in accordance with Pathak et al. (2011) in which they concluded that a combination of two post emergence herbicide like 2,4D and ethoxysulfuron gives good results to control all types of weeds viz., broad leaf weeds, grasses and sedges. Farooq et al. (2011) also reported the better results by applying mixture of two herbicides.

Alligator weed density (m-2) at 15 DAS

Different row spacing caused a significant (p≤0.05) reduction in alligator weed density at 15 DAS. Wider row (22.5 cm) spacing gave maximum alligator weed density (2.00 m-2) while at narrow row spacing (11.25 cm) presented minimum alligator weed density (1.54 m-2). Alligator weed density showed a significant decrease by all herbicide treatments at 15 DAS. The highest weed density was observed in control treatment while minimum alligator weed density was recorded in Butachlor @) 118.61 g a.i. ha-1 as pre-emergence (1.03 m-2) which was statistically at par with Bispyribac Sodium @ 26.7 g a.i. ha-1 and Butachlor @) 118.61 g a.i. ha-1 consecutively followed by Bispyribac Sodium @ 26.7 g a.i. ha-1 (1.08 m-2 and 1.30m-2), respectively. A statistically non-significant (p≤0.05) interactive influence of two row spacing with different herbicide treatments was observed in this study.

Same results were also mentioned by Mann et al. (2007). Mahajan et al. (2009) also mentioned a superior control of broad leaves weeds and sedges with sequential application of pretilachlor and metsulfuron.

Table 7: Influence of different herbicide treatments on crowfoot grass density at 15 DAS in direct seeded rice at different row spacing

Analysis of Variance

Source	DF	SS	MS	F
R	2	0.750	0.3750	
F1	1	17.510	17.5104	102.00 **
Error R × F1	2	0.343	0.1717	
F2	3	290.355	96.7849	138.81 **
F1 × F2	3	8.291	2.7638	3.96 *
Error R × F1 × F2	12	8.367	0.6972	
Total	23	325.616		

** = highly significant, * = significant

Table 8: Individual comparison of Treatment Means

Treatment	Herbicide Application				
Row Spacing	Control	Butachlor(Pre-Emergence)	Butachlor+ Bispyribac Sodium + Bensulfurin Methyl(Pre+Post)	Bispyribac Sodium + Bensulfurin Methyl(Post-emergence)	Mean
22.5 cm	12.133 a	2.600 de	4.633 c	1.900 de	5.3167 A
11.25	8.467 b	1.467 e	3.167 d	1.333 e	3.6083 B
Mean	10.300 A	2.033 C	3.900 B	1.617 C	

Means not sharing the same latter differ significantly at (p≤0.05) by LSD test

LSD value for Row Spacing = 0.7278
LSD value for Herbicide Application = 1.0504
LSD value for Row Spacing × Herbicide Application = 1.4855

Conclusion

The general conclusion for present study is that paddy yield among various treatments is related to effective herbicide and row spacing. Research data suggested that there is a considerable scope to exploit the yield potential of direct seeded rice using row spacing and controlling weed population. It is concluded that herbicide treatment Bispyribac Sodium @ 26.7 g a.i. ha-1 + Bensulfurin Methyl @ 17.8 g a.i. ha-1 as post-emergence against weed control gave maximum yield under narrow row spacing (11.25 cm) in direct seeded rice.

A field experiment was conducted to determine the effect of weed management in direct seeded rice under different row spacing during Kharif, 2018 at Agronomic Research Area, University of Agriculture, Faisalabad. Four Herbicide treatments, H0) No herbicide H1) Butachlor @) 118.61 g a.i. ha-1 at pre emergence stage H2) Butachlor @) 118.61 g a.i. ha-1 + Bispyribac Sodium + Bensulfurin Methyl @ 26.7 g a.i. ha-1 + 17.8 g a.i. ha-1 at pre emergence and post emergence stage H3) Bispyribac Sodium + Bensulfurin Methyl @ 26.7 g a.i. ha-1 + 17.8 g a.i. ha-1 at post emergence stage and two row spacing 11.25 cm and 22.5 cm were used. Randomized complete block design (RCBD) with split plot arrangement with a net plot size of 3 m × 2.25 m. Basmati-515, a promising rice variety was directly sown on 27 June 2018 using hand drill with a seed rate at 29 kg per hectare.

To fulfil the requirement of nutrients, fertilizer at 135 kg N, 88 kg P and 61 kg K ha-1 were applied. Half of the total dose of nitrogen and full dose of phosphorous and potash was used as a baseline dose at planting, while the remaining dose of nitrogen in two equal doses was applied at tillering (30 days after sowing) and early panicles (65 days after sowing). The crop was irrigated as and when required to meet consumptive use of water. The experiment was replicated thrice in a randomized complete block design under split plot arrangement. Data related to the weed density (15, 30 and 45 DAS) and yield components of rice were recorded by following standard procedure and statistically analyzed by following Fisher's analysis of variance techniques. Probability level of least significant difference test (LSD) at 5% will be employed to relate the treatment mean. The most important findings are summarized below.

I recommend that if we use Bispyribac Sodium @ 26.7 g a.i. ha-1 + Bensulfurin Methyl @ 17.8 g a.i. ha-1 as post-emergence herbicide with narrow row spacing (11.25 cm) then we can get maximum paddy yield in direct seeded rice.

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