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EXCEPTIONAL PRODUCTION OF AEROBIC RICE BY ROW SPACING AND WEED MANAGEMENT PRACTICES

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ABSTRACT

A study was conducted at Agronomic Research Area, University of Agriculture Faisalabad, Pakistan during the year 2013 to investigate the row spacing effect as a weed management approach and its effect on rice performance (cv. Super Basmati). The experiment was executed in RCBD, and plantation was made at triplicate spacing level in each row by parallel width viz. 15, 22.5 and 30cm. Plots were divided into weedy check, and mechanical control was made for weed i.e. hand pulling, hoeing and pre- as well as post-emergence herbicide application in a one-unit plot (pendimethalin and bis-pyribac sodium respectively). Maximum reduction in weed density (86%) and more dry weight (79%) was recorded in control plots. Among the planting methods, row spacing of 15 cm produced higher yield (3.24 t ha^{-1}) similarly weed free plot yielded higher (4.12 t ha^{-1}) than other weed management practices. Among herbicides Pendimetatin as a pre-emergence, and "Bis-pyribac sodium" as a post-emergence yielded better (3.69 (t ha^{-1}) yield.

KEYWORDS: Row spacing; handling pulling; Pendimethalin; Bis-pyribac sodium; paddy yield; Pakistan.

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INTRODUCTION

Rice is one of the chief global staple foods and 90% of total production comes from Asia. It is grown in 114 countries, and 42% calories of food consumption come from this commodity. In Pakistan, 7.4 M tons of rice is produced annually from an area of 2.89 million hectares, (Govt. of Pakistan, 2017-18).

Rice is cultivated based on nursery plantation and then transplanting it or through direct seeding; a faster plantation technique. The first method requires raising of nursery. The nursery raising techniques include wet bed, dry bed, dapog and mat methods. But their extent is decreasing, as these are losing edge over nursery management and transplanting labor requirements (Bouman *et al*., 2007). Further, Vorosmarty *et al*. (2000) reported that rice areas are hot and transpire large amount of water, so increasing costs of fuel for ponding water with tubewell, do not left it economically favorable. The shortage of electricity and changing patterns of hot climate has also lowered the water table in Pakistan. Therefore, due to water shortage irrespective to usual production systems, rice could become uneconomic. Hence to safeguard future as well as community need rice, production through aerobic cultivation would be optimal. But an appropriate weed management strategy is necessary for successful adoption specially in Asia, where farmers, are not much technical to control weeds or establishment and further consequences of herbicide resistance. There are problems and opportunities for direct seeding and some farmers are successfully growing since many years. Rice cultivation is the single largest land use for food. But, earlier, Jayadeva *et al*. (2011) found severe weed infestation resulting in complete crop failure in comparison to other rice production system. Almost similar results have been reported by Mishra and Singh (2007) wherein paddy yield weed based losses in aerobic rice ranged from 15 to 20% on an average and surged to 50% or even 100%, when no control measures were implemented.

Rao *et al*. (2007) observed that in Pakistan, aerobic rice has become popular across the world, yet in Pakistan it has not attained popularity due to flaws in effective management strategies. According to various weed eradication measures, weed control through manual ways is although effective but it is getting difficult due to labor shortage, increase in wages and its dependency on weather conditions. Further, manual weeding is discouraging due to hot climatic conditions unfavorable to human values in the 21st century and large time required to clean up the field. Mechanical weeding is almost universally practiced and changed new shapes of implements with time. So, direct seeded rice will also need the row spacing impacts study, to

further recommend, as mechanical weeding choice is not avoidable and herbicide application might not give complete solutions. Hussain *et al*. (2008) acknowledged that most of the studies considered chemical weed control most effective method of weed management. Pendimethalin and Benthiocarb prevent grassy and broad-leaved weed species, respectively. It is some well-known fact that, use of a single particular herbicide rarely gives the satisfactory control of weeds in aerobic rice. Use of narrow spacing in direct seeded rice might be yield efficient and might provide suitable conditions for the weed uprising issue. Chauhan and Johnson (2011) observed that upto 30% reduction was recorded by 15-18 and 25-30cm spacing. Further Bhagirath *et al*. (2011) observed that 30cm spaced rows method of rice sowing caused the reduction in yield while increase in biomass of weeds relating with 15 and 10-20-10cm spaced rows method.

As the modern agriculture emphasizes on goal-oriented productivity, sustainability and economic viability of the system, hence, an approach to evaluate a weed management strategy with objective of cost-effectiveness and easy to manage with little or no adverse effects on ecosystem, is essentially required. However, unfortunately, information on weed management practices through aerobic cultivation method on various row spacing is scanty. So in this study the efficiency of different weeds control practices was evaluated for aerobic rice at different row spacing under the Faisalabad ecological circumstances.

MATERIALS AND METHODS

Experimental area

This study was conducted at Faisalabad, Agriculture University research site, during summer season of 2013. Soil analysis for studying the properties of soil was conducted. The selective attributes were i.e. pH of saturated soil paste (8.1) and total soluble salts (0.40 dSm^{-1}). The organic matter was 0.9%, total N 0.061%, available phosphorus 9 ppm and potassium 104 ppm. Features of Faisalabad region are like arid successions and have 200mm annual rainfall on average.

Research experiment

The experiments were conducted in 3.6m x 6.0m (18 m^2) plot size for each treatment. Layout system was RCBD. Ploughing and planking of soil in triplicate was made three times to achieve the pulverized soil and further according to the treatments. Crop was sown on June 26, 2013 with the seed rate of 75 kg ha^{-1} for aerobic rice. Seed of Super Basmati fine rice cultivar was drilled in 15, 22.5 and 30 cm spaced rows. NPK dose was applied at the rate 140, 90 and 70 kg per hector, respectively. Phosphorus and potassium applications were made at the land preparation, in a single application, nitrogen applications were made triplicated splits – "half" nitrogen was applied at land preparation but leftover was applied by duplicated splits (tillering stage irrigation time and at panicle instigation point).

Herbicides (pendimethalin and bis-pyribac sodium) were used in the study. Stomp 455 CS (pendimethalin) was used as a pre-emergence, @ 900 g a.i. per hector. Bis-pyribac sodium (Nominee 100 SC) was used @ 30 g a.i. per hector, as early post emergence. Both herbicides were applied with T-jet nozzle fitted in the Knapsack hand sprayer and their applications were made after 15 days of sowing. The second weed control procedure adopted was hoeing at 10, 20 and 30 days after planting the crop. Monitoring and applications of free weed were accomplished weekly as control treatments for comparison with other management practices. Hand pulling was practiced at regular intervals to uproot weeds in weed free plots.

Weed density as well as dry weight was calculated after 45 and 60 days of sowing. The sample area consisted of quadrates from each experimental plot. The quadrates were randomly a Weeds' dry weight was taken by cutting them at ground level, then these were washed with distilled water, dried under sunlight, later dried out at for 45 hours, and then weighing was done. Number of dynamic tillers per m^2 of rice crop were recorded by 6 rows of each plot, multiplied by total number of rows and then converted in (m^{-2}). Data on yield contributing parameters were recorded randomly from 20 selected plants, taken separately plot wise and on average also. Harvesting was made by making bundles in respective plot, biological yield was recorded; wherein threshing was made to determine paddy yield outcomes and for conversion on hectare basis.

Fisher's analysis technique and LSD (least significance difference) @ α 0.05 to differentiate among treatment means were used for analysis of data as statistical tool (Steel *et al*., 1997).

RESULTS AND DISCUSSION

Weed growth

Weeds were suppressed by all treatments and it was reduced to average 0.25 m^{-2} at both 45 and 60 days after sowing (DAS) as compared with control (weedy check) plots. Maximum decrease in weed density (100%) over control was obtained under weed free condition at all three row spacing. Pendimethalin and then bis-pyribac sodium were relatively more efficient and reduced the density by more than 86%, when cultivation was made at 15 cm row spacing. Density

of weeds was reduced by more than 83% and 81% among the plots planted at 30 cm and 22.5 cm distance with application of pendimethalin and bis-pyribac sodium. Hoeing practiced plots also reduced weed density to a significant level with 82% reduction at 15 cm row spacing, 80% and 79% suppression of total weeds in that plots sown at 22.5 and 30 cm distance, respectively.

Bhagirath *et al*. (2011); Chauhan *et al*. (2011) and Jayadeva *et al*. (2011) acknowledged that being an obnoxious plantation in any crop fields, weeds compete for sources use and resultantly these cause reduction in yield as well as value additions. According to various weed eradication measures, weed control through manual ways is although effective but it is getting difficult due to labor shortage, increase in wages and its dependency on weather conditions. Further manual weeding is discouraging due to hot climatic conditions unfavorable to human values in the 21st century and large time required to clean up the field. Mechanical weeding is almost universally practiced and changed new shapes of implements with time. So, cosmopolitan, it is recommended that their fair measures may be accomplished that should be easier and also environment friendly. It is further to accord that their long lasting control is much dire for mandatory additions toward yield and crop productions. Accordingly, present module was a step for the objective and experimental data was as follow: the most dominant weeds on the study site were *Echinochloa crus-galli, Cyperus rotundus, Cyperus iria, Trianthema portulacastrum, Dactyloctenium aegyptium, Echinochloa colona* and *Elusine indica.*

Significant reduction in dry weight of all weed species was observed for all applications over control subversions. After maximum reduction 100% in dry weight by weed free treatment, chemical control (pendimethalin + bis-pryibac sodium) was found to be most effective regarding lowering of weeds' dry weight. They reduced dry weight of weeds in aerobic rice up to 79% (15 cm), 76% (22.5cm) and 75% (30cm) spacing. Pendimethalin that belongs to dinitroaniline group of herbicides, works as a mitotic poison. Darren and Stephen (2006) acknowledged that it disrupts the cell division kills germinating seeds rather than seedings due to interference with microtubule assembly. Bis-pyribac sodium (family of pyri-midinyloxy benzoic) inhibit acetolactate synthase enzyme amongst the prone plants, as it retards the synthesis of chain amino acids branches. In the same context, Mahajan *et al*. (2009) reported similar results with regard to analogous applications. Among the non-chemical means of control, hoeing also significantly decreased various weed species dry weight in total.

Rice yield components

Rice cultivation is the single largest land use for food. Paddy yield and other agronomic attributes were observed the significant influence of all weed control practices (Table 1). Quite a large number of dynamic tillers (346 m^{-2}) for weed free plots were recorded. Pendimethalin followed by bis-pyribac and Na (sodium) was next more effective treatment with 333 dynamic tillers m^{-2} and without chemical control (hoeing) also performed better than weedy check plots. Variable row spacing also significantly affected dynamic tillers of aerobic rice. At narrow distance i.e. 15 cm 301 dynamic tillers per meter square were recorded which was at par with 22.5 cm (294 m^{-2})and 30 cm (286 m^{-2}). Bis-pyribac sodium accounted for maximum Kernels (82.88 per panicle), 1000-Kernal weight (7.5 g) and paddy yield (3.69 t ha^{-1}. The plots where hoeing was practiced as a weed management practice, also produced more kernels, 1000-kernel weight and paddy yield than weedy check plots. Highest paddy yield among different row spacings was attained at narrow spacing of 15 cm (3.24 t ha^{-1}), compared with wider rows 22.5 cm (3.01 t h^{-1}) and 30cm (2.88 t h^{-1}).

Table 1. Influence of weed management practices and row spacing on yield attributes of aerobic rice

Treatments	Productive tillers/m^2	kernels/ panicle	1000-kernel weight(g)	Yield (t ha^{-1})
Row spacing				
15cm	301 a	77.50ns	17.40 a	3.24 a
22.5 cm	294 a	74.50ns	17.25 b	3.01 b
30 cm	286 b	72.75ns	17.19 b	2.88 c
LSD< 0.05 probability 7.31	7.31	4.19	0.10	0.07
Weed management practices				
W_0: Weedy check	176 b	79.88 c	16.56 b	1.05 b
W_1: Weed free	346 a	87.33 a	17.92 a	4.12 a
W_2: Hoeing 10,20,30 DAS	319 c	79.55 b	17.12 c	3.32 c
W_3: Pendimethalin+bispyridac sodium	333c	82.88 ab	17.50 b	3.69 b
LSD<0.05 probability				

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CONTRIBUTION OF AUTHORS

S. No.	Author name	Contribution	Signature
1.	Riaz Ahmad	Planned and conducted the research	
2.	Mahmood Ahmad Randhawa	Being agronomist evaluated the research data for conclusions	
3.	Rashid Ahmad	Worked as research project committee member	
4.	Muazim Ali	Conducted field experiment to compile the thesis manuscript for the award of degree