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Influence of Stubble Height and Nitrogen Fertilizer Level on Seed Yield and Quality in KRH-4 Hybrid Rice Seed Production

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ABSTRACT

A field experiment was carried out during *rabi* 2016 and 2017 at the Agricultural Research Station, Malagi, UAS, Dharwad to study the influence of stubble height and nitrogen fertilizer level on ratoon seed yield in KRH-4 hybrid rice seed production. The experiment consisted of two factors. Factor one was the stubble height which included 3 cutting heights namely H₁: (15 cm A line and 15 cm R line), H₂: (15 cm A line and 20 cm R line) and H₃: (20 cm A line and 20 cm R line). Factor two was the nitrogen fertilizer levels *viz.*, F₁: (25% N of main crop), F₂: (50% N of main crop), F₃: (75% N of main crop) and F₄: (100% N of main crop) and the treatment combinations were replicated thrice. The results revealed that among the stubble heights H₃ recorded the highest regeneration percentage (98.89 % and 98.67 % in 2016 and 2017 respectively), highest plant height (45.54 cm and 46.54 cm in 2016 and 2017 respectively), whereas the highest seed set (8.47% and 8.68% in 2016 and 2017 respectively) and seed yield per hectare (375 kg and 425 kg in 2016 and 2017 respectively) recorded by H₂. Among the nitrogen levels F₄ recorded the highest regeneration (97.49% and 97.53% in 2016 and 2017 respectively) and highest plant height (44.50 cm and 45.61 cm in 2016 and 2017 respectively) whereas the F₃ recorded highest seed yield per hectare (395 kg and 450 kg in 2016 and 2017 respectively). Among the combinations H₂F₃ recorded the highest seed yield per hectare (449 kg and 502 kg in 2016 and 2017 respectively) due to effective synchrony of flowering between the parental lines. The study indicated that stubble height at H₂:(15 cm A line and 20 cm R line) together with nitrogen fertilizer level of F₃: (75% N of main crop) is ideal in achieving the better synchrony of flowering as well as better regeneration of ratoon to get higher seed yield in KRH-4 hybrid rice.

Keywords

Stubble height,
Ratooning,
Nitrogen, Hybrid

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Introduction

Rice (*Oryza sativa* L.) is the staple food for nearly fifty per cent of the world's population. Rice ratooning is the production of a second rice crop from the stubble left behind after the

main-crop harvest. The ratoon crop develops by regenerating rice tillers from nodal buds of the stubble that was left behind after the first seasonal rice harvest. The practice of ratooning can be followed by the farmers for the purpose of on farm seed production which

ensures cent per cent genetic purity in seed production activity as the ratoons are generated vegetatively. Grain yield of the ratoon crop is generally one-third of the yield realized in the first, or main, crop (Turner and Jund, 1993). Main-crop harvest heights are cultivar dependent and generally range between 40 and 45 cm above ground level. Lower harvest heights leaving stubble of 20–25 cm are currently recommended in Texas as a potential ratoon yield enhancement strategy when the main crop is harvested before August 15 (Tarpley *et al.*, 2008). The advantage of rice ratooning is that in areas where rice is the main crop, a double crop of rice can be grown for additional returns. The ratoon crop matures earlier and requires less labor and water inputs (Reddy *et al.*, 1979). Rice ratooning offers special scope for increasing production without expanding land area, particularly where moisture and growing season are inadequate for planting a second crop of rice. The practice of ratooning in hybrid rice ensures the cent per cent of genetic purity in hybrid rice seed production as the ratooning involves the vegetative propagation of parental lines through the left over stubbles. Seed production from the ratoon crop may thus be possible. Planting value and stability of ratoon crop seed are worth studying to determine the seed production potential. In case of scarcity of parental seeds and human resource F₁ seed production can be made possible with small alterations in agronomic practices to obtain considerable quantity of F₁ seeds within short span of time with least effort. This practice also reduces burden of rouging, weeding, isolation maintenance which have been taken care of during main crop only. Hence the effort was made to realize the importance of technique.

Materials and Methods

The field experiment was carried out at the Agricultural Research Station Malagi, UAS,

Dharwad during *rabi* 2016 and 2017 to standardize the technique of hybrid rice seed production through ratooning of parental lines in KRH-4 hybrid rice. The experiment was laid out in randomized block design with 2 factors *viz.*, factor one consisted of the height of stubble cutting (H₁): 15 cm A line and 15 cm R line, (H₂): 15 cm A line and 20 cm R line, (H₃): 20 cm A line and 20 cm R line and factor two was the nitrogen fertilizer levels. (N₁): 25% N of main crop RDF, (N₂): 50% N of main crop RDF, (N₃): 75% N of main crop RDF, (N₄): 100% N of main crop RDF and replicated thrice. The resultant seed quality attributes were examined in the laboratory of Department of Seed Science and Technology, College of Agriculture, UAS, Dharwad. The parental seeds, CRMS 32-A (male sterile line) and MSN 36-R (Restorer line) of KRH-4 hybrid rice were collected from the Zonal Agricultural Research Station, Mandya. The ratooning (stubble cutting) of parental lines treatments were imposed at harvest maturity stage and the nitrogen fertilizer treatments were imposed immediately after the main crop harvest in each plots as per the treatments. The five randomly selected and tagged plants from the net plot were used to record the observations. Observations on plant height (cm), regeneration percentage, number of tillers and yield parameters like number of productive tillers, panicle length (cm), seed set (%) and seed yield plant⁻¹ (g) were recorded. The data recorded were subjected to the statistical analysis as per Panse and Sukhatme.

Results and Discussion

Studies on influence of stubble height and nitrogen levels exhibited the significant variations on growth, flowering and yield parameters in KRH-4 hybrid seed production by ratooning of parental lines. Among the treatments of height of stubble cutting, the higher stubble heights (H₃): 20 cm in A line and 20 cm in R line recorded the significantly

higher growth parameters like regeneration percentage (98.89 % and 98.67 % in 2016 and 2017 respectively), highest plant height (45.54 cm and 46.54 cm in 2016 and 2017 respectively), least number of days to 50 per cent flowering (42.75 and 43.92 days in 2016 and 2017 respectively), highest number of tillers (7.31 and 8.57 in 2016 and 2017 respectively), similarly among the yield parameters, the higher number of productive tillers (5.08 and 6.30 in 2016 and 2017 respectively) was noticed with H₃, whereas higher seed set per cent (8.47 % and 8.68 % in 2016 and 2017 respectively) and seed yield per hectare (375 kg and 425 kg in 2016 and 2017 respectively) were registered with stubble height H₃.

The nitrogen levels imparted the remarkable variations on growth, flowering and yield parameters. Among the treatments of nitrogen levels, the nitrogen dosage of 100% of the main crop (F₄) registered the significantly higher growth parameters like regeneration percentage (97.49 % and 97.53 % in 2016 and 2017 respectively), highest plant height (44.50 cm and 45.61 cm in 2016 and 2017 respectively), whereas the least number of days to 50 per cent flowering (42.78 and 44.00 days in 2016 and 2017 respectively) was observed in the plants given with the 75% nitrogen of the main crop (F₃), similarly the nitrogen dose (F₃): 75 per cent nitrogen of main crop recorded the highest number of tillers (7.43 and 8.72 in 2016 and 2017 respectively), the higher number of productive tillers (5.08 and 6.30 in 2016 and 2017 respectively), seed set per cent (8.37 % and 8.63 % in 2016 and 2017 respectively) and seed yield per hectare (395 kg and 450 kg in 2016 and 2017 respectively).

The interaction effects were found non-significant for the regeneration percentage, number of tillers and seed set percent however the treatment combination of H₃F₄

recorded significantly highest plant height (46.17 cm and 46.83 cm in 2016 and 2017 respectively), H₃F₃ interaction took significantly least number of days for 50 per cent flowering (42.33 and 43.67 days in 2016 and 2017 respectively), whereas the treatment combination of H₂F₃ registered the highest seed yield per hectare (449 kg and 502 kg in 2016 and 2017 respectively).

Though the genotypic difference exists for the growth, performance and ratooning ability, the success of ratoon crop also depends on the agronomic practices like height of cutting, time of cutting, water and fertilizer management with care of plant protection. So in the present investigation also the ratooning practices like height of cutting and nitrogen levels vitally influence the ratoon growth and performance. The cutting height of parental lines significantly influenced the growth parameters. Among the treatments, the cutting height H₃: 20 cm in A line and 20 cm in R line recorded the highest regeneration per cent, highest plant height, least number of days 50 per cent flowering and highest number tillers compared to other stubble cutting heights. Wide variation exists among rice cultivars in their genetic potential for ratooning and yield levels. On an average, ratoon rice can give a yield roughly equivalent to 40 per cent that of the main crop, with 40 per cent reduction in crop duration. The increase in the plant height and number of tillers as well as earliness in the flowering is mainly because of higher carbohydrates that remain in the stubbles and roots (Mahadevappa and Yogeesh, 1988) in longer stubbles after the harvest of the main crop and rapid senescence of leaves in the shorter cutting heights of stubbles. Bahar and Datta (1977) observed 15-20 cm as the optimum cutting height above ground. The present findings are similar with the reports of Mortaza *et al.*, (2011) in rice; Petroudi *et al.*, (2011) in rice.

Among the level of nitrogen fertilizers, application of 100 per cent nitrogen of main crop RDF (F₄) recorded the significantly highest regeneration per cent, accordingly highest plant height, whereas F₃ recorded the higher number of tillers, least number of days to 50 % flowering. The higher dosage of nitrogen fertilizer increased N metabolism, delayed leaf senescence and promoted germination of dormant buds. Although ratoon tiller development is determined by genotype and a number of management and environmental factors, Chauhan *et al.*, (1985) and Ichii (1984) showed the effectiveness of nitrogen element in promoting development and growth of ratoon tillers. However the higher dose of nitrogen promotes the vegetative growth and delays the flowering. Similar results were also reported by Ali *et al.*, (2011) in rice and Endris and Alemayehu (2014) in rice.

Ratooning in rice offers special scope for boosting the production without expanding land area, particularly where moisture and growing season are inadequate for planting a second crop of rice. The ratoon yield varies 26 % to 350 % of the main crop, but on an average the ratoon yield roughly equivalent to 40 % that of the main crop depending upon the management practices (Chauhan, 1988). In the present study also the ratooning practices in hybrid rice seed production exigently influenced the ratoon yield and yield parameters.

The yield attributes such as number of productive tillers, seed set per cent and seed yield per hectare were found to be significant for the cutting height. Though the cutting height H₃: 20 cm in A line and 20 cm in R line recorded the highest number of productive tillers, the cutting height H₂: 15 cm in A line and 20 cm in R line registered higher seed set per cent, seed yield per plant and highest seed yield per hectare. This might

be due to the better synchrony of flowering between parental ratoons ensuring the effective crossing, higher seed set and seed yield compared to other cutting heights. The height of cutting affects the days to panicle emergence and days to flowering (Mahadevappa and Yogeesh, 1988; Santos *et al.*, 2003) as the synchrony of parental lines is the key for success in hybrid seed production the differential cutting height of 15 cm in the seed parent and 20 cm in the pollen parent facilitated the better synchrony together with optimum height for the better regeneration. Application of 75% of nitrogen of main crop registered the higher yield parameters compared to other doses of nitrogen. Availability of nitrogen to the left over stubbles just after removing main crop plant tops is important in harnessing the reserve carbohydrates accumulated in stem bases, and eventually in the better growth and development of the ratoon plant.

The higher doses of nitrogen negatively affect the mobilization of carbohydrate reserves of ratoon rice causing delay in the duration for flowering, maturity and weakening of the plants which may adversely affect the performance and yield of the ratoon rice. Similar results were given by Evatt and Beachell (1960) who recommended that application of 75 per cent nitrogen of main crop as the optimum nitrogen dosage for higher yield of ratoon. The present research findings are in agreement with the findings of Hiroshi and Satoshi (2008) in rice and Ali *et al.*, (2011). The significantly increased yield in H₂F₃ might be due to the effective synchrony achieved with differential cutting heights of parental lines (Mahadevappa and Yogeesh, 1988) as well as the increased yield attributing characters in the ratoon plants imposed with cutting height of 15 cm in A line and 20 cm in R line together with optimum dosage on nitrogen fertilizer of 75 per cent of main crop (Table 1–4).

Table.1 Influence of stubble height and nitrogen application on regeneration per cent and plant height in seed parent (CRMS 32-A) of KRH-4 hybrid rice

Treatments	Regeneration per cent (2016)				Regeneration per cent (2017)				Plant height (cm) 2016				Plant height (cm) 2017			
	H ₁	H ₂	H ₃	Mean	H ₁	H ₂	H ₃	Mean	H ₁	H ₂	H ₃	Mean	H ₁	H ₂	H ₃	Mean
F₁	91.98	93.70	97.78	94.49	91.11	92.59	97.28	93.66	41.17	41.50	45.17	42.61	41.83	42.33	46.33	43.50
F₂	93.83	94.69	98.40	95.64	94.07	94.94	98.02	95.68	41.83	42.17	45.33	43.11	43.33	43.73	46.33	44.47
F₃	94.81	96.42	100.00	97.08	95.43	95.68	99.88	97.00	43.17	43.17	45.50	43.94	44.50	44.67	46.67	45.28
F₄	96.05	97.04	99.38	97.49	96.30	96.79	99.51	97.53	43.83	43.50	46.17	44.50	45.00	45.00	46.83	45.61
Mean	94.17	95.46	98.89		94.23	95.00	98.67		42.50	42.58	45.54		43.67	43.93	46.54	
	S. Em. ±		CD (0.05)		S. Em. ±		CD (0.05)		S. Em. ±		CD (0.05)		S. Em. ±		CD (0.05)	
F	0.68		2.00		0.65		1.92		0.15		0.45		0.21		0.61	
H	0.59		1.73		0.57		1.66		0.13		0.39		0.18		0.53	
F × H	1.18		NS		1.13		NS		0.27		0.78		0.36		1.06	

Table.2 Influence of stubble height and nitrogen application on total tillers and productive tillers in seed parent (CRMS 32-A) of KRH-4 hybrid rice

Treatments	Total tillers (2016)				Total tillers (2017)				Productive tillers (2016)				Productive tillers (2017)			
	H ₁	H ₂	H ₃	Mean	H ₁	H ₂	H ₃	Mean	H ₁	H ₂	H ₃	Mean	H ₁	H ₂	H ₃	Mean
F₁	5.37	5.40	6.43	5.73	6.50	6.60	7.57	6.89	3.53	3.53	4.33	3.80	4.67	4.73	5.53	4.98
F₂	5.97	6.00	7.00	6.32	7.10	7.23	8.13	7.49	4.10	4.20	4.93	4.41	5.23	5.20	6.20	5.54
F₃	7.13	7.17	8.00	7.43	8.37	8.43	9.37	8.72	5.07	5.17	5.67	5.30	6.33	6.43	6.80	6.52
F₄	6.70	6.80	7.80	7.10	8.03	8.20	9.20	8.48	4.40	4.60	5.40	4.80	5.67	5.83	6.67	6.06
Mean	6.29	6.34	7.31		7.50	7.62	8.57		4.28	4.38	5.08		5.48	5.55	6.30	
	S. Em. ±		CD (0.05)		S. Em. ±		CD (0.05)		S. Em. ±		CD (0.05)		S. Em. ±		CD (0.05)	
F	0.04		0.11		0.07		0.20		0.13		0.38		0.11		0.33	
H	0.03		0.09		0.06		0.18		0.11		0.33		0.10		0.28	
F × H	0.06		NS		0.12		NS		0.22		NS		0.19		NS	

F: Nitrogen levels

F₁: 25% N of main crop
 F₂: 50% N of main crop
 F₃: 75% N of main crop
 F₄: 100% N of main crop
 NS: Non-significant

H: Height of cutting

H₁: 15 cm A line and 15 cm R line
 H₂: 15 cm A line and 20 cm R line
 H₃: 20 cm A line and 20 cm R line

Table.3 Influence of stubble height and nitrogen application on days to 50% flowering and seed set per cent in seed parent (CRMS 32-A) of KRH-4 hybrid rice

Treatments	Days to 50% flowering (2016)				Days to 50% flowering (2017)				Seed set per cent 2016				Seed set per cent 2017			
	H ₁	H ₂	H ₃	Mean	H ₁	H ₂	H ₃	Mean	H ₁	H ₂	H ₃	Mean	H ₁	H ₂	H ₃	Mean
F ₁	45.00	44.67	43.00	44.22	46.33	46.00	44.33	45.56	7.06	7.84	7.24	7.38	7.32	7.97	7.33	7.54
F ₂	44.67	43.33	43.00	43.67	46.00	44.67	43.67	44.78	7.57	8.18	7.71	7.82	7.75	8.37	7.87	8.00
F ₃	43.00	43.00	42.33	42.78	44.33	44.00	43.67	44.00	7.98	9.00	8.13	8.37	8.14	9.33	8.42	8.63
F ₄	43.33	43.00	42.67	43.00	44.67	44.33	44.00	44.33	7.73	8.86	8.12	8.24	7.94	9.04	8.30	8.43
Mean	44.00	43.50	42.75		45.33	44.75	43.92		7.59	8.47	7.80		7.79	8.68	7.98	
	S. Em. ±		CD (0.05)		S. Em. ±		CD (0.05)		S. Em. ±		CD (0.05)		S. Em. ±		CD (0.05)	
F	0.15		0.44		0.14		0.41		0.07		0.21		0.12		0.35	
H	0.13		0.38		0.12		0.35		0.06		0.18		0.10		0.30	
F × H	0.26		0.77		0.24		0.71		0.12		NS		0.21		NS	

Table.4 Influence of stubble height and nitrogen application on F1 seed yield per plant and F1 seed yield per ha in KRH-4 hybrid rice seed production

Treatments	Seed yield/plant (g) 2016				Seed yield/plant (g) 2017				Seed yield/ha (kg) 2016				Seed yield/ha (kg) 2017			
	H ₁	H ₂	H ₃	Mean	H ₁	H ₂	H ₃	Mean	H ₁	H ₂	H ₃	Mean	H ₁	H ₂	H ₃	Mean
F ₁	2.69	3.04	2.73	2.82	3.00	3.37	3.01	3.13	278	302	284	288	330	352	332	338
F ₂	2.83	3.15	3.00	2.99	3.15	3.43	3.30	3.29	299	321	307	309	349	369	359	359
F ₃	3.19	3.62	3.24	3.35	3.50	3.96	3.57	3.68	355	449	381	395	417	502	430	450
F ₄	3.06	3.43	3.10	3.20	3.37	3.71	3.38	3.49	355	430	378	388	411	477	425	438
Mean	2.94	3.31	3.02		3.26	3.62	3.32		322	375	337		377	425	387	
	S. Em. ±		CD (0.05)		S. Em. ±		CD (0.05)		S. Em. ±		CD (0.05)		S. Em. ±		CD (0.05)	
F	0.02		0.05		0.02		0.05		5.93		17.40		5.84		17.13	
H	0.02		0.05		0.01		0.04		5.14		15.06		5.06		14.83	
F × H	0.03		0.09		0.03		0.09		10.27		30.13		10.11		29.66	

F: Nitrogen levels

F₁: 25% N of main crop
 F₂: 50% N of main crop
 F₃: 75% N of main crop
 F₄: 100% N of main crop
 NS: Non-significant

H: Height of cutting

H₁: 15 cm A line and 15 cm R line
 H₂: 15 cm A line and 20 cm R line
 H₃: 20 cm A line and 20 cm R line

The improved yield attributing characters such as productive tillers and higher seed set due to optimum dosage of nitrogen level (75 % of main crop) accorded for the higher yields in ratoon (Ganguli and Ralwani 1954). The present findings are in agreement with the findings of Evatt and Beachell (1960) in rice; Votong (1975) in rice.

In conclusion, the present investigation inferred that the practice of ratooning by cutting the stubbles at the height of 15 cm in female parent and 20 cm in male parent of KRH-4 hybrid rice together with application of 75% nitrogen dosage of main crop RDF is ideal to get higher seed yield.

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