JOURNAL OF PURE AND APPLIED MICROBIOLOGY, March 2017. Vol. **11**(1), p. 335-342

Evaluation of Rice Varieties against Multiple Diseases Under Middle IGP of Bihar

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http://dx.doi.org/10.22207/JPAM.11.1.42

(Received: 17 December 2016; accepted: 20 January 2017)

An investigation was carried out to evaluate the susceptibility of rice cultivation to major field diseases like brown spot, sheath blight and bacterial leaf blight under middle Indo Gangetic Plain. The disease incidence and disease severity were observed at three different growth stages namely flowering, milk and maturity in *boro* seasons during 2015-16. The incidence of brown spot ranged from 8.93 to 17.83%, 16.67 to 25.67% and 18.33 to 28.33% at flowering, milk and maturity stages, respectively. The severity of brown spot in grade (0-9 scale) ranged from 5.13 to 10.33, 9.33 to 20.00 and 11.57 to 22.67, respectively at flowering, milk and maturity stages. The incidence of sheath blight of paddy ranged from 7. 03 to 16.50%, 13.13 to 22.67% and 19.67 to 35.67% at flowering, milk and maturity stages, respectively. The severity of sheath blight in grade (0-9 scale) ranged from 4.00 to 8.60, 8.33 to 13.93 and 18.33 to 34.33, respectively at flowering, milk and maturity stages. The incidence of bacterial leaf blight ranged from 5.00 to 14.00%, 11.43 to 21.00% and 17.00 to 34.00% at flowering, milk and maturity stages, respectively. The severity of bacterial leaf blight in grade (0-9 scale) ranged from 2.00 to 8.00%, 6.33 to 12.05% and 14.47 to 20.17%, respectively at flowering, milk and maturity stages. Among the varieties, the highest incidence and severity of Brown spot was recorded on Rajendra Bhagawati whereas it was lowest on 27P31 at all growth stages. In the case of Sheath blight, highest incidence and severity was recorded on Sambha Mahsuri whereas it was the lowest on CRL 193. Beside this in the case of Bacterial leaf blight, the highest incidence and severity was recorded on Kranti whereas the lowest was recorded on CRL 193. In general, it was observed that the incidence and severity of diseases increased gradually from flowering to maturity stage and the genotypes with the minimum incidence and severity of diseases gave the maximum yield.

Keywords: Rice, *boro*, BLB, brown spot and sheath blight.

Rice (*Oryza sativa* L.) is a major food crop of India. It is cultivated in an area of 43.95 million hectare with total production of 106.54 million tonnes and productivity of 2.42 t/ha. In Bihar, total area under rice is 3.26 million hectare and production is 8.24 million tonnes with an average productivity 2.52 t/ha (Directorate of Economics and Statistics, Govt. of Bihar, 2015). '*Boro*' a term of Bengal origin refers to special rice cultivation in low land pockets during the months of November - May taking advantage of the residual water in field after harvest of *kharif* rice. The farmers innovated this rice cultivation with short duration photo period insensitive varieties to supplement a poor *kharif* harvest. The fact that *boro* rice gives much higher yields than *kharif* rice is mainly

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attributed to higher solar radiation and lower night temperatures throughout the crop growth in winter and favourable temperature during ripening. Generally *boro* rice crop is affected by more than 10 diseases and certain diseases are more common on hybrid rice varieties than on conventional varieties. Among the different diseases brown spot, sheath blight, blast, stem rot and bacterial leaf blight are considered important in various parts of rice growing areas of the world. Sheath blight is an important soil borne disease caused by *Rhizoctonia solani* that can cause up to 25% yield loss (Kumar *et al.*, 2009). Bacterial leaf blight is caused by *Xanthomonas oryzae* occurs mostly during the wet season and in some areas of Asia, which can reduce crop yield by up to 50% (Latif *et al.*, 2011). Brown spot of rice caused by *Helminthosporium oryzae* can reduce crop yield by up to 40%. However, rice genotypes may vary in their response to disease tolerance. Hence, the present experiment was undertaken to evaluate the performance of 30 rice genotype against three major rice diseases during *boro* season.

MATERIALS AND METHODS

The experiment was conducted with 30 rice genotypes (Table 1) in a randomized complete block design (RCBD) with three replicates at the ICAR Research Complex for Eastern Region Patna (25°30'N latitude, 85°15'E longitude and 52 m above mean sea level), Bihar during 2015-16 *boro* season. The climate of the experimental site is humid sub-tropical in nature characterized by the monsoon season from late June to late September and chilly winter nights and foggy or sunny days from November to February. Rice nursery was seeded on 06 December 2016. Sixty days old seedlings were uprooted from the seedbed very carefully and then transplanted in the main field with row to row spacing of 20 cm and plant to plant spacing of 15 cm. The crop was irrigated as per need on regular basis and fertilizers were applied @ 120, 50 and 50 kg ha^{-1} N, P_2O_5 and K_2O, respectively.

Assessment of the disease incidence

Each plot was visited on regular basis for recording observations. The disease incidence was recorded at three different growth stages of the plant *viz*., flowering, milk and maturity stage. Data were recorded visually by observing the symptoms.

Sixteen plants were randomly selected from each unit plot and the following parameters were considered for data collection.

Number of tillers / plants

Number diseased tillers / plants

Percent leaf area diseased (LAD)

Disease incidence was calculated by the following formula (Rajput and Bartaria, 1995):

Disease incidence = Number of diseased tillers/ Total number of inspected tillers x 100

Assessment of the disease severity

Sixteen plants from each unit plot were randomly selected and tagged for grading the severity of disease. The severity of three diseases *viz*. brown spot, sheath blight and bacterial leaf blight was recorded as per following IRRI recommended grading scale (Standard Evaluation System for Rice, 2002). The disease severity was recorded at flowering, milk and maturity stages of the crop. The grade of different diseases is presented in Table 2.

The crop was harvested on the maturity of the individual genotypes. The observations on growth parameters, yield and yield attributes were also recorded.

Isolation and identification of causal organism

The leaves from the diseased plants were collected from the field and cut into small pieces along with healthy portion. Cut pieces were sterilized by the surface disinfectants e.g. 0.1% mercuric chloride for 30 seconds. After sterilization the cut pieces were washed three times with sterile water. The cut pieces were then placed on sterile blotter paper to remove excess water. The cut pieces were then placed on the Potato Dextrose Agar plate. The plate were labelled and placed in the incubation chamber for 7 days at 25 + 2°C. After 7 days of incubation, the fungi grown on culture media. A portion of culture was taken on slide and observed under microscope and identified the pathogenic fungi *i.e. Helminthosporium oryzae*, *Rhizoctonia solani*, with the help of relevant literature (Mew and Gonzales, 2002; Barnet and Hunter, 1972). In bacterial leaf blight causal organism *Xanthomonas oryzae* isolated on nutrient Agar media. A portion of culture was taken by inoculating needle on another Potato Dextrose

Agar and nutrient Agar media plates. A small portion from the subculture was inoculated to another Potato Dextrose Agar and nutrient Agar plate for pure culture. The pathogen, thus purified, was kept in refrigerator for future use. All these operations were done aseptically in the laminar air flow chamber.

Analysis of data

The data on different characters were subjected to estimates of ANOVA (analysis of variance) by using statistical software OPSTAT.

Table 1. Detailed information of the rice varieties in the experiment

S No.	Name of varieties	Source of collection
1	Arize Prima	Bayer Crop Science Pvt. Ltd.
2	Nayanmuni	ICAR RCER Patna
3	Parijat	ICAR RCER Patna
4	Gutraj	Farmers
5	27P31	Farmers
6	Gautam	RAU PUSA
7	Silky	Farmers
8	Annada	ICAR RCER Patna
9	IET 4094	Farmers Katihar
10	RCPR 29	ICAR RCER Patna
11	Prabhat	RAU PUSA
12	RCPR 32	ICAR RCER Patna
13	Mali 101N	Farmer Katihar
14	Pusa Sugandh 5	IARI PUSA
15	Sahabhagi Dhan	RAU PUSA
16	IR 64	Local Market
17	Kranti	BISA PUSA
18	PNR 381	IARI PUSA
19	Rajendra Bhagawati	RAU PUSA
20	Naveen	ICAR RCER Patna
21	Arize 6129	Bayer Crop Science Pvt. Ltd.
22	Chandrama	ICAR RCER Patna
23	CRL 193	ICAR RCER Patna
24	Pusa Basmati 1509	BISA PUSA
25	RCPR 31	ICAR RCER Patna
26	Arize 6444 Gold	Bayer Crop Science Pvt. Ltd.
27	Swarna Shreya	ICAR RCER Patna
28	Arize Tez	Bayer Crop Science Pvt. Ltd.
29	Jaymati	ICAR RCER Patna
30	Sambha Mahsuri	ICAR RCER Patna

RESULTS AND DISCUSSION

Evaluation of rice varieties against disease incidence and severity

It was observed that under field conditions, the incidence and severity of brown spot disease were fairly significant. The incidence of brown spot ranged from 8.93 to 17.83%, 16.67 to 25.67% and 18.33 to 28.33% at flowering, milk and maturity stages, respectively. The severity of brown spot in grade (0-9 scale) ranged from 5.13 to 10.33, 9.33 to 20.00 and 11.57 to 22.67, respectively at flowering, milk and maturity stages (Table 3). At all the three growth stages, the highest disease incidence and disease severity was recorded in Rajendra Bhagawati whereas the least value was observed in 27P31. Rashed (2001), also reported that the incidence and severity of brown spot were observed 30.75 to 62.75% and 25.25 to 47.50%, respectively at 50 days after transplanting on the hybrids line 321H. The incidence and severity varied from 40.50 to 80% and 45 to 77%, respectively at 70 days after transplanting on the hybrids line

Table 2. Disease severity scale of brown leaf spot, sheath blight and bacterial leaf blight

Name of diseases	Scale
Brown Spot	1 = No incidence
	2 = Less than 1%
	3 = 1-3%
	4 = 4-5%
	5 = 11-15%
	6 = 16-25%
	7 = 26-50%
	8 = 51-75%
	9 = 76-100%
Sheath Blight	0 = No infection observed
	1 = Lesions limited to lower 20% of the plant height
	3 = 20-30%
	5 = 31-45%
	7 = 46-65%
	9 = More than 65%
Bacterial leaf blight	0 = no lesion
	1 = 1-5% lesion area
	3 = 6-12% lesion area
	5 = 13-25% lesion area
	7 = 26-50% lesion area
	9 = 51-100% lesion area

321H. Saifulla (1994) reported that mean brown spot severity ranged from 23.0 to 36.5% in IR9924-124 and IR9924-14.

The incidence of sheath blight ranged from 7. 03 to 16.50%, 13.13 to 22.67% and 19.67 to 35.67% at flowering, milk and maturity stages, respectively. The severity of sheath blight in grade (0-9 scale) ranged from 4.00 to 8.60, 8.33 to 13.93 and 18.33 to 34.33, respectively at flowering, milk and maturity stages (Table 4). In all growth stages, the highest incidence and severity was recorded on Sambha Mahsuri whereas the lowest incidence and severity was observed on CRL 193. The similar result was also reported by Alam (2007), who observed the maximum infection index at soft dough stage and minimum infection index at maximum tillering stage. Mosaddeque *et al.* (2008) also found highest disease severity (5.18) of sheath blight on BR-111 and lowest severity (0.50) on resistant line (Accession No. 08R).

The incidence of bacterial leaf blight ranged from 5.00 to 14.00%, 11.43 to 21.00% and 17.00 to 34.00% at flowering, milk and maturity stages, respectively. The severity of bacterial leaf blight in grade (0-9 scale) ranged from 2.00 to 8.00, 6.33 to 12.05 and 14.47 to 20.17, respectively at

Table 3. Disease incidence and disease severity of brown spot of paddy in different boro rice varieties

Name of varieties	Disease incidence (%)			Disease severity (%)		
	Flowering stage	Milk stage	Maturity stage	Flowering stage	Milk stage	Maturity stage
Arize Prima	12.00	18.00	20.00	5.67	12.33	13.33
Nayanmuni	13.00	19.67	21.67	5.67	11.67	12.67
Parijat	11.00	17.00	19.00	5.93	10.90	11.60
Gutraj	11.07	20.67	22.33	5.33	11.17	12.20
27P31	8.93	16.67	18.33	5.13	9.33	11.57
Gautam	12.20	21.87	23.53	7.67	12.17	13.50
Silky	11.37	17.80	20.00	6.87	14.53	15.67
Annada	11.57	17.33	19.00	5.73	10.57	15.20
IET 4094	13.13	19.90	21.57	7.00	12.00	13.00
RCPR 29	16.97	22.20	23.67	8.67	15.00	16.33
Prabhat	13.00	21.67	23.33	9.10	13.33	15.00
RCPR 32	11.20	19.67	21.33	9.00	16.33	17.67
Mali 101N	11.60	18.33	20.00	8.67	14.00	15.33
Pusa Sugandh 5	11.00	20.00	21.67	7.17	11.33	12.67
Sahabhagi Dhan	10.67	19.67	21.33	8.00	16.33	17.67
IR 64	11.33	19.33	21.67	8.87	12.40	13.73
Kranti	13.67	21.80	24.00	9.60	14.20	15.53
PNR 381	11.33	19.67	21.67	7.67	11.67	13.00
Rajendra Bhagawati	17.83	25.67	28.33	10.33	20.00	22.67
Naveen	13.17	21.33	23.33	7.33	12.47	13.47
Arize 6129	9.17	18.33	20.33	6.67	13.27	14.33
Chandrama	9.77	20.00	20.67	6.00	14.00	15.33
CRL 193	9.03	18.67	20.67	6.67	11.00	12.00
Pusa Basmati 1509	10.67	18.00	20.33	7.00	12.00	13.33
RCPR 31	10.33	19.00	21.00	6.33	15.00	16.00
Arize 6444 Gold	9.00	17.33	20.00	6.67	11.00	12.00
Swarna Shreya	10.17	17.20	19.20	5.67	13.33	14.00
Arize Tez	9.83	18.60	20.33	5.67	13.87	14.67
Jaymati	11.00	18.47	20.67	5.00	10.00	12.67
Sambha Mahsuri	15.00	24.67	27.33	8.47	15.43	16.43
SE (m)	1.44	1.67	1.41	0.99	1.57	1.51
$LSD_{(0.05)}$	4.10	4.73	4.00	2.81	4.47	4.29

flowering, milk and maturity stage (Table 5). In all growth stages, the highest incidence and severity was recorded on rice cultivation 'Kranti' whereas the lowest incidence and severity of bacterial leaf blight was recorded on 'CRL 193'. These finding were supported by Akhtar *et al.*, (2003) who found that BLB disease of rice prompted by *Xanthomonas oryzae* pv. *oryzae* has created a serious situation in all provinces of Pakistan *viz*., Punjab, Khyber Pakhtukhwa, Sindh, Baluchistan including Pakistan occupied Kashmir.

Grain yield and yield attributes

Plant height ranged from 76.8 to 118.3cm. The highest plant height (118.3 cm) was recorded in Jaymati and lowest (76.8cm) in RCPR 29. Number of tillers/hill ranged from 8.8 to 34.5. Maximum number of tillers was recorded in Arize Prima (34.5) and the lowest number of tillers was recorded in Annada (8.8). Number of panicle/hill ranged from 6.3 to 29.1. It was highest (34.5) in Arize Prima and lowest (6.3) in Annada. Weight of biomass/plant ranged from 23.6 to 88.4g. it was highest in Arize

Table 4. Disease incidence and disease severity of sheath blight of paddy in different boro rice varieties

Name of varieties	Disease incidence (%)			Disease severity (%)		
	Flowering stage	Milk stage	Maturity stage	Flowering stage	Milk stage	Maturity stage
Arize Prima	10.33	16.33	25.00	5.00	11.00	24.00
Nayanmuni	11.33	17.33	27.00	5.00	10.33	25.67
Parijat	9.33	15.33	22.33	5.27	9.57	21.67
Gutraj	9.40	17.27	21.67	4.47	9.83	20.67
27P31	7.27	14.00	19.00	4.67	12.73	18.67
Gautam	10.53	20.20	23.00	7.00	11.10	21.67
Silky	9.53	16.13	22.67	6.20	13.00	21.67
Annada	9.90	15.67	21.00	5.07	9.57	20.33
IET 4094	11.37	17.90	25.33	6.33	11.00	24.33
RCPR 29	15.23	20.20	32.33	8.00	13.67	30.67
Prabhat	11.33	18.33	24.33	9.67	12.00	22.67
RCPR 32	9.67	16.43	24.00	8.33	14.67	22.67
Mali 101N	9.93	15.60	25.67	8.00	12.67	24.00
Pusa Sugandh 5	9.33	15.73	26.00	6.50	9.67	25.00
Sahabhagi Dhan	9.07	15.47	21.60	7.33	14.67	20.60
IR 64	9.57	17.00	20.67	7.87	10.90	20.00
Kranti	13.33	21.00	33.67	8.00	17.33	32.67
PNR 381	9.67	15.33	21.00	6.67	10.67	19.67
Rajendra Bhagawati	12.00	18.63	29.00	7.80	13.10	28.00
Naveen	11.50	18.50	24.67	6.33	10.90	23.67
Arize 6129	7.33	14.17	21.33	5.67	12.27	20.67
Chandrama	8.23	15.73	21.00	5.33	12.33	20.00
CRL 193	7.03	13.13	19.67	4.00	8.33	18.33
Pusa Basmati 1509	9.00	16.50	23.00	6.33	10.67	21.67
RCPR 31	8.67	14.33	22.53	5.33	13.67	21.53
Arize 6444 Gold	7.33	13.30	20.33	5.33	9.00	19.00
Swarna Shreya	8.50	14.47	22.80	5.00	12.00	21.80
Arize Tez	8.17	14.03	20.80	5.00	7.33	19.47
Jaymati	7.33	14.47	19.70	5.00	9.00	18.70
Sambha Mahsuri	16.50	22.67	35.67	8.60	13.93	34.33
SE (m)	1.12	1.49	1.71	1.09	1.48	1.43
$LSD_{(0.05)}$	3.19	4.24	4.85	3.10	4.21	4.05

6129 (88.4g) and the lowest in in Pusa Sugandh 5 (23.6 g). Grain weight/plant ranged from 11.3 to 45.1g. It was highest in Arize 6129 (45.1g) and the lowest in Pusa Sugandh-5 (11.3g) The highest grain yield was observed in Arize 6444 Gold (7.62 t/ ha) and the lowest in Rajendra Bhagawati (3.70 t/ ha). The present findings aresupported by Rai *et al.,* (2003) who reported that maximum disease incidence and severity at maturity stage cause drastical yield loss.

CONCLUSIONS

Based on above findings it was observed that all the thirty rice varieties were susceptible to brown spot, sheath blight and bacterial leaf blight disease. In all growth stages, the highest incidence and severity of brown spot was recorded on Rajendra Bhagawati whereas the lowest incidence and severity was observed on 27P31. For sheath blight, the highest incidence and severity was recorded on Sambha Mahsuri whereas the lowest

Table 5. Disease incidence and disease severity of bacterial leaf blight

Name of varieties	Disease Incidence (%)			Disease severity (%)		
	Flowering stage	Milk stage	Maturity stage	Flowering stage	Milk stage	Maturity stage
Arize Prima	9.00	15.00	22.00	4.00	9.33	15.00
Nayanmuni	10.00	16.00	24.00	4.00	9.00	16.00
Parijat	8.00	14.00	20.00	3.80	8.23	14.00
Gutraj	7.90	15.57	21.00	3.47	8.43	14.47
27P31	6.10	12.00	17.10	3.00	10.70	13.45
Gautam	9.50	15.20	21.00	5.00	9.77	16.30
Silky	8.37	14.93	20.00	4.80	9.60	17.53
Annada	8.47	14.00	19.00	4.30	8.70	15.43
IET 4094	9.73	16.47	23.00	5.00	9.67	17.37
RCPR 29	11.00	20.17	30.00	7.00	11.00	18.50
Prabhat	10.00	16.00	22.00	7.13	12.00	20.00
RCPR 32	8.73	14.97	21.00	7.00	12.00	19.53
Mali 101N	8.33	14.27	23.00	6.67	11.40	19.92
Pusa Sugandh 5	8.00	14.07	24.00	5.17	10.00	17.97
Sahabhagi Dhan	7.53	13.80	19.77	6.00	10.00	18.70
IR 64	8.57	14.53	20.00	6.50	10.43	18.87
Kranti	14.00	21.00	34.00	8.00	12.05	20.17
PNR 381	8.33	14.00	20.00	5.00	9.67	19.07
Rajendra Bhagawati	15.17	17.33	27.00	7.80	11.87	19.83
Naveen	10.17	16.50	22.00	4.67	9.33	17.63
Arize 6129	6.40	12.43	18.00	4.33	8.53	18.53
Chandrama	7.00	13.63	19.83	4.00	8.40	19.23
CRL 193	5.00	11.43	17.00	2.00	6.33	14.47
Pusa Basmati 1509	8.00	14.43	19.67	4.67	9.00	19.47
RCPR 31	7.00	13.00	19.87	4.00	8.00	19.60
Arize 6444 Gold	6.00	11.97	18.00	4.00	7.33	19.60
Swarna Shreya	7.50	13.40	21.13	3.00	8.00	15.47
Arize Tez	6.50	12.80	18.47	3.00	7.00	15.67
Jaymati	6.00	12.73	18.37	3.33	7.00	15.57
Sambha Mahsuri	12.00	19.33	31.67	6.00	10.33	18.33
SE (m)	0.79	1.43	1.55	0.86	1.18	1.38
$LSD_{(0.05)}$	2.24	4.05	4.40	2.45	3.33	3.93

Table 6. Effect of boro rice varieties on plant growth and yield contributing characters

Genotypes	Plant height (cm)	Number of tillers/hill	Number of panicles/hill	Biomass/ plant (g)	Grain weight /plant(g)	Grain yield (t/ha)
Arize Prima	104.9	34.5	29.1	77.2	39.4	4.21
Nayanmuni	87.8	24.5	20.1	71.1	39.0	4.04
Parijat	78.2	21.8	17.6	62.0	31.0	5.03
Gutraj	77.7	23.1	20.1	67.3	38.3	6.19
27P31	83.9	16.3	12.5	61.7	28.3	6.44
Gautam (check-2)	81.7	23.4	16.7	52.9	29.8	4.86
Silky	90.8	13.6	11.5	54.8	30.2	6.72
Annada	101.1	8.8	6.3	54.9	27.4	6.78
IET 4094	78.3	14.9	14.1	32.2	17.0	5.11
RCPR 29	76.8	21.2	19.9	51.3	24.6	3.79
Prabhat	76.9	16.9	14.0	36.3	18.6	4.30
RCPR 32	89.7	13.9	11.9	58.9	30.4	5.48
Mali 101N	96.2	19.3	14.8	62.9	33.3	4.00
Pusa Sugandh 5	76.3	18.3	16.1	23.6	11.3	4.05
Sahabhagi Dhan	91.5	24.3	15.9	81.6	42.0	6.78
IR 64 (check-1)	80.2	23.8	19.0	58.4	30.9	5.56
Kranti	78.0	15.2	12.1	47.2	24.5	4.46
PNR 381	85.8	15.3	15.0	62.4	31.7	6.19
Rajendra Bhagawati	92.1	24.6	16.4	72.9	39.2	3.70
Naveen	98.6	16.4	13.7	61.3	34.9	3.96
Arize 6129	94.7	19.3	15.1	88.4	45.1	6.95
Chandrama	99.1	19.2	14.5	83.2	42.0	5.14
CRL 193	89.9	14.6	10.6	73.5	30.7	7.45
Pusa Basmati 1509	90.7	14.8	12.7	66.9	32.6	5.88
RCPR 31	91.0	23.2	15.1	53.3	33.5	6.91
Arize 6444 Gold	87.9	16.4	14.5	61.6	39.0	7.62
Swarna Shreya	88.5	22.5	21.4	70.8	32.9	5.69
Arize Tez	87.6	16.3	11.5	56.7	31.5	6.55
Jaymati	118.3	18.5	13.1	76.9	36.0	5.16
Sambha Mahsuri	95.1	30.0	16.5	77.0	32.5	3.90
SE (m)	1.86	2.22	1.87	6.74	2.21	0.31
$LSD_{(0.05)}$	5.29	6.29	5.31	19.13	6.27	0.90

incidence and severity was observed in CRL193. In case of bacterial leaf blight, the highest incidence and severity was recorded on Kranti whereas the lowest incidence and severity of bacterial leaf blight was recorded on CRL193. The findings indicate that minimum incidence and severity resulted in maximum grain yield. It was also observed that there was gradual increase in disease incidence and severity from flowering stage to maturity stage.

ACKNOWLEDGEMENTS

The authors are grateful to the National Innovations in Climate Resilient Agriculture (NICRA) for providing financial support to do this research. The authors also acknowledge to ICAR-Research Complex for Eastern Region Patna for providing research facilities.

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