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Studies on Impact of Different Seed Rates and Spacings against Insect Pests in Direct Seeded Rice

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ABSTRACT

A field experiment entitled "Studies on impact of different seed rate and spacing against insect pests in direct seeded rice" was conducted at Agriculture College Farm Bapatla during *kharif*, 2022. Rice seeds were sown directly in the field with 11 treatments (T_1 at 8kg acre^{-1} seed rate, 30x10cm spacing, T_2 at 12kg acre^{-1} seed rate, 30x10cm spacing, T_3 at 16kg acre^{-1} seed rate, 30x10cm spacing, T_4 at 8kg acre^{-1} seed rate, 40x10cm spacing, T_5 at 12kg acre^{-1} seed rate, 40x10cm spacing, T_6 at 16kg acre^{-1} seed rate, 40x10cm spacing, T_7 at 8kg acre^{-1} seed rate, 45x10cm spacing, T_8 at 12kg acre^{-1} seed rate, 45x10cm spacing, T_9 at 16kg acre^{-1} seed rate, 45x10cm spacing, T_{10}-broadcasting and T_{11}-transplanting with 20x15cm spacing) to study the impact of different seed rates, spacings against insect pests in direct seeded rice. Among 11 treatments T_4 (8kg acre^{-1} seed rate and 40x10cm spacing) was found to be the best treatment when compared to broadcasting and transplanting treatments based on mean per cent damage (6.13) of rice leaf folder *Cnaphalocrocis medinalis* and mean population (1.55) of rice BPH *Nilaparvata lugens*. The major insect pests identified during the crop season were rice leaf folder and Brown plant hopper. The mean per cent damage of leaf folder in different seed rates and spacings along with transplanting and broadcasting treatments ranged from 6.13 (T_4 at 8kg acre^{-1} seed rate, 40x10cm spacing) to 12.56 (T_{10}- broadcasting) per cent. The mean population damage of BPH ranged from 1.55 (T_4 at 8kg acre^{-1} seed rate 40x10cm spacing) to 2.33 (T_{10}- broadcasting). Results revealed that broadcasted treatment recorded the highest infestation because of closer spacing and higher seed rate. Yield at different seed rate and spacing was more in T_4 8kg acre^{-1} seed rate 40x10cm spacing with 6672 kg ha^{-1} and very low yield of 5032 was observed in T_{10} (broadcasting).

Keywords: *Direct Seeded Rice, Leaf folder, BPH, Seed rate and Spacing*

Rice (*Oryza sativa* L.) is a staple food for over half of the world's population (IRRI, 2006). Rice is the third most common agricultural crop in the world, after sugarcane and maize (FAO, 2017). Andhra Pradesh stood in third place in terms of rice production with 22 lakh hectares area during *kharif* and *rabi* seasons and 128.95 lakh tonnes production in India. Andhra Pradesh is a leading rice producer with a production of 12% of total rice produced in the country.

Rice is traditionally grown by transplanting method. Transplating method is followed and still being followed from many years. Input costs are high, *viz*. labour costs have risen by 100 per cent, chemical fertilizers and pesticides by 45 per cent, seed costs by 33 per cent and tillage operations by 35-40 per cent transplanting method (Chandrasekhar *et al*., 2013). Deteriorating soil health demands some alternative establishment methods to sustain productivity of rice as well as natural resources. Because of all these reasons many of the farmers are shifting their planting method from transplanting to Direct Seeded Rice (DSR).

In Direct Seeded Rice method, the seeds are sown directly in prepared field. Direct Seeded Rice method does not require maintenance of nursery and transplanting of seedlings. The DSR demonstrated its superiority in terms of significant improvement in productivity with higher system net returns, increased water use efficiency and fertilizer use efficiency (Kumar and Ladha, 2011). More number of panicles, increased panicle length, more number of grains per panicle have been observed in Direct Seeded Rice.

The major insect pests attacking rice are rice leaf folder, *Cnaphalocrocis medinalis* (Guenee), brown planthopper, *Nilaparvata lugens* (Stal),

Treatment Details

Treatment	Seed rate (kg/acre)	Spacing (cm)
T_1	8	30x10
T_2	12	30x10
T_3	16	30x10
T_4	8	40x10
T_5	12	40x10
T_6	16	40x10
T_7	8	45x10
T_8	12	45x10
T_9	16	45x10
T_{10} (Broadcasting)	24-30	NA
T_{11} (Transplanting)	20-25	20x15

whitebacked planthopper, *Sogatella furcifera* (Horvath) and yellow stem borer, *Scirpophaga incertulas* (Walker). The loss due to yellow stem borer was ranged from 3 to 65 per cent (Muralidharan and Pasalu, 2005) and leaf folder was reported to the extent of 5 to 39 per cent (Shanmugam *et al.*, 2006). A change from transplanting to direct seeding may affect the status of various pests. The main factors that influence pest status are exposure of very young seedlings to pests, longer plant duration in the field and increasing plant density. This study describes possible changes in pest status in direct seeded rice fields.

MATERIAL AND METHODS

The rice variety BPT 5204 (Samba Mahsuri) developed at Agricultural College, Bapatla, under ANGRAU was evaluated to study the impact of different seed rates and spacings against insect pests in direct seeded rice during *kharif*, 2022 at Agricultural College Farm, Bapatla. The experiment was laid out in a simple Randomized Block Design (RBD) with 11 treatments including of checks broadcasting and transplanting treatments and each replicated thrice. The seeds were directly sown in plot size of 5 x 5m and was marked by using markers. To achieve a homogenous plant population, gap filling was performed 25 days after sowing. Crop was grown as per the recommendations of ANGRAU.

No plant protection measures were taken to create optimum conditions for pest multiplication. Data on leaf folder damage and population of plant hopper were recorded from 45 days after sowing at weekly interval from 5 randomly selected hills from each replication. To calculate per cent leaf folder damage total number of leaves and total number of infested leaves per hill were counted. The per cent leaf folder damage was calculated by using the formula given below

Leaf folder per cent damage =

$$\left(\frac{\text{Number of damaged leaves per hill}}{\text{Total numberof leaves per hill}}\right) 100$$

The data obtained from various treatments was transformed to the corresponding square root transformation values and subjected to ANOVA. The yield data was collected separately and subjected to statistical analysis (Gomez and Gomez, 1984) to test the significance of mean yield in different treatments.

RESULTS AND DISCUSSION

The mean per cent damage caused by leaf folder ranged from 6.13 to 12.56 per cent (Table 1). The lowest per cent damage (6.13) was observed in T_4 8kg acre^{-1} seed rate and 40x10cm spacing when compared to checks T_{10}-broadcasting (12.56) and T_{11}- transplanting (11.94). The results indicated that broadcasted and transplanted plots recorded the highest infestation of leaf folder compared to the other three other treatments of seed rate and spacing. Among all the treatments T_4 (8kg acre^{-1} seed rate and

40x10cm spacing) has recorded the lowest leaf folder infestation levels in Direct Seeded Rice (DSR). According to Stout *et al*. (2009) the pest infestation is more in higher plant densities with closer spacing. Pest infestation was lower in higher spacing (30x30cm) and the highest infestation was observed in closer spacing (14x14cm). This might be the reason for higher pest incidence in transplanted crop with closer spacing (20x15cm).

The mean population of BPH ranged from 1.55 to 2.33 (Table 2). The lowest population (1.55) was observed in T_4 (8kg acre^{-1} seed rate with 40x10cm spacing) when compared to checks T_{10} (broadcasting) (2.33) and T_{11}(transplanting) (2.01). The results are indicated that broadcasted and transplanted plots recorded the highest infestation of BPH compared to the other three different seed rates and spacings treatments. Among all the treatments T_4 (8kg acre^{-1} seed rate and 40x10cm spacing) has recorded the lowest BPH infestation levels in Direct Seeded Rice (DSR). In the case of transplanting, the surrounding direct sown crop may have reached the end of their vulnerable growth stages, and the entire pest will be feeding or confined to the transplanted crop (Rani and Pillai, 2013). According to Stout *et al*, (2009) the pest infestation was more in higher plant densities with closer spacing.

Yield (kg ha^{-1})

As the experiment was conducted without plant protection measures the yield data collected at different seed rates and spacings under DSR ranged from 5032 kg ha^{-1} to 6672 kg ha^{-1} (Table 3). The highest yield (6672 kg ha$^{-1)}$ was recorded in T_4@ 8kg acre^{-1} seed rate with 40x10cm spacing followed by 6576 kg ha^{-1} in T_8 (seed rate 12kg acre^{-1}, 45x10cm spacing), 6144 kg ha^{-1} in T_9 (seed rate 16kg acre^{-1} 45x10cm spacing), 6136 kg ha^{-1} in T_6 (seed rate 16kg acre^{-1}, 40x10cm spacing), 6048 kg ha^{-1} in T_2 (seed rate 12kg acre^{-1}, 30x10cm spacing), 5960 kg ha^{-1} in T_5 (seed rate 12kg acre^{-1}, 40x10cm spacing), 5912 kg ha^{-1} in T_7(seed rate 8kg acre^{-1}, 45x10cm spacing), 5776 kg ha^{-1} in T_1 (seed rate 8kg acre^{-1}, 30x10cm spacing), 6576 kg ha^{-1} in T_8 (seed 12kg acre^{-1}, 45x10cm spacing), 5472 kg ha^{-1} in T_3 (seed rate 16kg acre^{-1}, 30x10cm spacing), 5128 kg ha^{-1} in T_{11} which was transplanted with 20x15cm spacing and the lowest yield was recorded in T_{10} which was broadcasted. The results are in accordance with Mitchell *et al.* (2004) who also reported that the higher yields were recorded in direct seeded rice than in transplanted rice.

Among 11 treatments of three different seed rates (8kg acre^{-1}, 12kg acre^{-1}, 16kg acre^{-1}), three different spacing (30x10cm, 40x10cm and 45x10cm), broadcasting and transplanting (20x15cm spacing), T_4 (8kg acre^{-1} seed rate and 40x10cm spacing) was found to be the best treatment when compared to other treatments based on mean per cent damage (6.13) of rice leaf folder *Cnaphalocrocis medinalis* and mean population (1.55) of rice BPH *Nilaparvata lugens*.

The results also revealed that maintaining proper spacing and seed rate leads to the less pest occurrence in the crop. Among all the treatments, T_4 sown at 8kg acre^{-1} seed rate and 40x10cm spacing has recorded less pest infestation due to maintenance of proper seed rate and spacing whereas T_{10} which was broadcasted has recorded the highest pest infestation due to non-maintenance of spacing.

The highest yield (6672 kg ha^{-1}) was recorded in T_4 (8kg acre^{-1} seed rate and 40x10cm spacing) due to less pest population and the lowest yield (5032 kg ha^{-1}) was recorded in T_{10} (broadcasted) due to higher pest incidence.

LITERATURE CITED

Chandrasekhar R C, Jitendranath S and Murthy T G K 2013. Resource optimization in rice through direct seeding by drum seeder. *International Journal of Agriculture and Food Science Technology*. 4(3): 239-246.

FAO 2017. *Crops*. 7 March 2017. http:// www.fao.org/faostat/en#data/QC.

Gomez K A and Gomez A A 1984. *Statistical procedures for Agricultural Research*, 2nd Edition. IRRI, Phillippines. 12: 680.

IRRI 2006. Bringing hope, improving lives: Strategic Plan 2007–2015. Manila. 61.

Kumar V and Ladha J K 2011. Direct seeding of rice: recent developments and future research needs. *Advances in Agronomy*.111: 297-413.

Mitchell J, Fukai S and Basnayake J 2004. Grain yield of direct seeded and transplanted rice in rainfed lowlands of South East Asia. In *Proceedings of 4th International Crop Science Congress* (26).

Table 1. Impact of different seed rates and spacing against leaf folder *C.medinalis* in DSR under field conditions during *kharif*, 2022-23

S. No.	Treatments	per cent leaf damage at							MEAN
		45 DAS 1st week	2nd week	3rd week	4th week	5th week	6th week	7th week	
1	T1: 8 kg acre^{-1}, 30x10cm spacing	5.13 (2.48)^{g}	6.20 (2.68)^{gh}	7.40 (2.90)^{e}	8.53 (3.09)^{ef}	7.97 (2.99)^{e}	6.93 (2.82)^{b}	3.10 (2.02)^{a}	6.48 (2.73)^{f}
2	T2: 12 kg acre^{-1}, 30x10cm spacing	7.33 (2.89)^{e}	8.27 (3.04)^{e}	8.93 (3.15)^{d}	9.67 (3.27)^{de}	8.07 (3.01)^{cde}	7.00 (2.83)^{b}	2.33 (1.82)^{bc}	7.37 (2.89)^{e}
3	T3: 16 kg acre^{-1}, 30x10cm spacing	11.47 (3.53)^{c}	12.47 (3.67)^{c}	14.00 (3.87)^{b}	15.47(4.06)^{b}	10.07(3.33)^{ab}	9.33 (3.21)^{a}	2.83 (1.96)^{ab}	10.81 (3.43)^{b}
4	T4: 8 kg acre^{-1}, 40x10cm spacing	4.67 (2.38)^{g}	5.80 (2.61)^{gh}	6.80 (2.79)^{e}	7.67 (2.94)^{f}	7.80 (2.97)^{de}	6.50 (2.74)^{b}	2.23 (1.80)^{a}	6.13 (2.67)^{f}
5	T5: 12 kg acre^{-1}, 40x10cm spacing	6.47 (2.73)^{f}	7.47 (2.91)^{f}	8.93 (3.15)^{d}	10.73(3.42)^{cd}	9.43 (3.23)^{bcd}	8.13 (3.02)^{ab}	2.83 (1.96)^{ab}	7.71 (2.95)^{e}
6	T6: 16 kg acre^{-1}, 40x10cm spacing	10.47 (3.39)^{d}	11.47 (3.53)^{d}	13.13(3.76)^{b}	14.33(3.92)^{b}	9.47 (3.24)^{bc}	9.40 (3.22)^{a}	2.60 (1.90)^{abc}	10.13 (3.33)^{c}
7	T7: 8 kg acre^{-1}, 45x10cm spacing	5.20 (2.49)^{g}	5.93 (2.63)^{h}	7.27 (2.88)^{e}	8.47 (3.08)^{ef}	8.30 (3.05)^{cde}	7.93 (2.99)^{ab}	2.77 (1.94)^{abc}	6.46 (2.73)^{f}
8	T8: 12 kg acre^{-1}, 45x10cm spacing	7.47 (2.91)^{e}	8.60 (3.10)^{e}	10.07(3.33)^{c}	11.67(3.56)^{c}	9.37 (3.22)^{bcd}	8.87 (3.14)^{a}	2.40 (1.84)^{a}	8.45 (3.07)^{d}
9	T9: 16 kg acre^{-1}, 45x10cm spacing	5.67 (2.58)^{f}	7.00 (2.83)^{fg}	8.60 (3.10)^{d}	9.67 (3.27)^{de}	8.97 (3.16)^{bcde}	7.87 (2.98)^{ab}	2.73 (1.93)^{abc}	7.22 (2.86)^{e}
10	T10: Broadcasting	13.80(3.85)^{b}	14.33(3.92)^{b}	15.67(4.08)^{a}	17.27 (4.27)^{a}	11.03 (3.47)^{a}	9.23 (3.20)^{a}	3.10 (2.02)^{c}	12.56 (3.68)^{a}
11	T11: Transplanting, 20x15cm spacing	15.53 (4.07)^{a}	15.27 (4.03)^{a}	16.2 (4.15)^{a}	18.00 (4.36)^{a}	11.13(3.48)^{a}	9.43 (3.23)^{a}	3.13 (2.04)^{bc}	11.94 (3.59)^{a}
	SEm±	0.29	0.27	0.3	0.55	0.51	0.61	0.19	0.23
	Fcal	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig
	CD (P= 0.05)	0.85	0.79	0.9	1.62	1.5	1.79	0.58	0.67
	CV%	5.9	4.93	4.95	7.95	9.51	12.73	12.35	4.57

Figures in parenthesis are square root transformed values

Mean with same letter are not significantly different at 5 % level by Duncan's Multiple Range test

Table 2. Impact of different seed rates and spacing on rice BPH *N.lugens* damage in DSR under field conditions during *kharif*, 2022-23

S. No.	Treatments	BPH (no/hill) at							MEAN
		45 DAS 1st week	2nd week	3rd week	4th week	5th week	6th week	7th week	
1	T_1: 8 kg acre^{-1}, 30x10cm spacing	2.07 (1.75)^{a}	2.40 (1.84)^{b}	2.40 (1.84)^{b}	2.47 (1.86)^{bc}	1.73 (1.65)^{ab}	1.48 (1.57)^{a}	0.61 (1.27)^{bc}	1.94 (1.71)^{bc}
2	T_2: 12 kg acre^{-1}, 30x10cm spacing	2.13 (1.77)^{b}	2.07 (1.75)^{cd}	2.27 (1.81)^{bc}	2.30 (1.82)^{cd}	1.50 (1.58)^{bcd}	1.55 (1.60)^{a}	0.51 (1.23)^{cd}	1.81 (1.67)^{cde}
3	T_3: 16 kg acre^{-1}, 30x10cm spacing	2.20 (1.79)^{b}	2.00 (1.73)^{cd}	2.33 (1.82)^{bc}	2.27 (1.81)^{cd}	1.57 (1.60)^{abcd}	1.37(1.54)^{abc}	0.41 (1.19)^{de}	1.71 (1.64)^{def}
4	T_4: 8 kg acre^{-1}, 40x10cm spacing	2.00 (1.73)^{a}	1.93 (1.71)^{a}	2.13 (1.77)^{a}	1.67 (1.63)^{f}	1.33 (1.53)^{d}	1.06 (1.44)^{c}	0.34 (1.16)^{e}	1.55 (1.59)^{f}
5	T_5: 12 kg acre^{-1}, 40x10cm spacing	2.70 (1.92)^{a}	2.27 (1.81)^{bc}	2.35 (1.83)^{b}	2.50 (1.87)^{bc}	1.70 (1.64)^{abc}	1.20 (1.48)^{bc}	0.61 (1.27)^{a}	1.85 (1.68)^{b}
6	T_6: 16 kg acre^{-1}, 40x10cm spacing	2.43 (1.85)^{b}	2.13 (1.77)^{bcd}	2.27 (1.81)^{bc}	1.93 (1.71)^{def}	1.37 (1.54)^{bcd}	1.37(1.54)^{abc}	0.65 (1.28)^{ab}	1.69 (1.64)^{def}
7	T_7: 8 kg acre^{-1}, 45x10cm spacing	2.22 (1.79)^{b}	2.20 (1.79)^{bcd}	2.33 (1.82)^{bc}	1.87 (1.69)^{ef}	1.50 (1.58)^{bcd}	1.47 (1.57)^{ab}	0.71 (1.31)^{ab}	1.75 (1.65)^{de}
8	T_8: 12 kg acre^{-1}, 45x10cm spacing	2.03 (1.74)^{b}	2.07 (1.75)^{cd}	2.40 (1.84)^{b}	2.07 (1.75)^{f}	1.57 (1.60)^{abcd}	1.40 (1.55)^{ab}	0.38 (1.17)^{e}	1.66 (1.63)^{ef}
9	T_9: 16 kg acre^{-1}, 45x10cm spacing	2.23 (1.80)^{b}	2.07 (1.82)^{d}	2.50 (1.87)^{c}	1.93 (1.71)^{def}	1.37 (1.54)^{bcd}	1.47 (1.57)^{ab}	0.53 (1.24)^{c}	1.58 (1.60)^{f}
10	T_{10}: Broadcasting	2.73 (1.93)^{b}	2.50 (1.87)^{cd}	2.53 (1.88)^{bc}	3.30 (2.07)^{a}	1.87 (1.69)^{a}	1.63 (1.62)^{a}	0.77 (1.33)^{a}	2.33 (1.82)^{a}
11	T_{11}: Transplanting, 20x15cm spacing	2.60 (1.90)^{b}	2.77 (1.94)^{cd}	3.63 (2.15)^{bc}	2.83 (1.96)^{b}	1.87 (1.69)^{a}	1.63 (1.62)^{a}	0.77 (1.33)^{a}	2.01 (1.73)^{b}
	SEm±	0.1	0.11	0.14	0.14	0.12	0.11	0.04	0.05
	Fcal	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig
	CD (P= 0.05)	0.31	0.33	0.41	0.4	0.37	0.31	0.12	0.16
	CV%	8.03	8.95	9.88	10.28	13.5	12.94	12.32	5.25

Figures in parenthesis are square root transformed values

Mean with same letter are not significantly different at 5 % level by Duncan's Multiple Range test

Table 3 Yield from different seed rates and spacing under DSR during *kharif*, 2022-23.

Treatments	Yield (kg ha^{-1})
T_1: 8 kg acre^{-1}, 30x10cm spacing	5776
T_2: 12 kg acre^{-1}, 30x10cm spacing	6048
T_3: 16 kg acre^{-1}, 30x10cm spacing	5472
T_4: 8 kg acre^{-1}, 40x10cm spacing	6672
T_5: 12 kg acre^{-1}, 40x10cm spacing	5960
T_6: 16 kg acre^{-1}, 40x10cm spacing	6136
T_7: 8 kg acre^{-1}, 45x10cm spacing	5912
T_8: 12 kg acre^{-1}, 45x10cm spacing	6576
T_9: 16 kg acre^{-1}, 45x10cm spacing	6144
T_{10}: Broadcasting	5032
T_{11}: Transplanting, 20x15cm spacing	5128
SEm±	161.34
CD (P= 0.05)	475.96
CV (%)	14.21

Muralidharan K and Pasalu I C 2005. "Crop losses in rice ecosystems due to Gall Midge," *Indian Journal of Plant Protection*, 33(1): 11-16.

Rani S T and Pillai R 2013. Seasonal and varietal influence on pest and disease incidence in rice. *Plant Archives*. 12: 201-204.

Shanmugam T R, Sendhil R and Thirumalvalavan V 2006. "Quantification and prioritization of constraints causing yield loss in rice in India," *Agricultura Tropica et Subtropica*, 39: 194–201.

Stout M J, Harrell D, Tindall KV and Bond J 2009. Impacts of seeding rate on interactions between rice and rice water weevils. *Journal of Economic Entomology* 102(5): 1837-1845.

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