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Incidence of rice yellow stem borer on transplanted and Direct seeded rice

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Abstract
A field investigation on the incidence of yellow stem borer, *Scirpophaga incertulas* Walker, on rice under different methods of crop establishment was carried out on five varieties, GR-11, NAUR-1, GNR-3, GNR-26 and GNR-8, during kharif 2025 at the College Farm, N.M. College of Agriculture, Navsari Agricultural University, Navsari. Dead heart and moth catch commenced at 21 DAT/S and peaked at 49 DAT/S, direct seeded rice (DSR) recording significantly higher dead heart and moth catch than transplanted rice (TPR) at every stage, working out to nearly 1.3 to 1.4 times that of TPR at the peak. NAUR-1 was ranked the most tolerant variety and GR-11 the most susceptible, based on the combined performance of dead heart, white ear head and moth catch. Spider and coccinellid populations were unaffected by method of crop establishment or variety. Transplanted rice recorded significantly higher grain yield than direct seeded rice in every variety, whereas the benefit-cost ratio was considerably higher under DSR (2.14 to 2.95) than under TPR (1.62 to 2.16), owing to the saving in cost of cultivation. NAUR-1 secured the first rank on the basis of combined yield and economic performance, followed by GNR-3, GNR-26 and GNR-8, with GR-11 ranking last.

Keywords: *Scirpophaga incertulas*, direct seeded rice, transplanted rice, varietal tolerance, dead heart, white ear head

Introduction
Since most species are phytophagous, they represent an economically important group of hemipteran pests. *Nezara viridula* also called stink bug is one of the most important pentatomid insect pests in the world. It shows severe infestation on various leguminous crops. *N. viridula* has been recorded from many mostly herbaceous, annual plant Rice is the food for more than half the people on the planet and it plays a big role, in keeping food safe and helping families earn money in many parts of Asia. In India, the old way of planting rice is called transplanting. This method uses a lot of water and a lot of people to work. These things have become more expensive and harder to get in recent years. Using much nitrogen fertilizer and many chemicals in this way has made the bug problem worse instead of helping it. (Anonymous, 2010) [1].

It is this combination of rising cost and dwindling water supply that has pushed farmers in irrigated and assured or high-rainfall tracts toward direct seeding instead of puddled transplanting; the technique asks far less of the farmer in terms of inputs, which is why it has caught on so quickly, particularly among growers at the tail end of a canal system who cannot always count on getting water when they need it (Edirisinghe and Bambaradeniya, 2006) [5].

More than a hundred insect species are known to feed on the rice plant at one stage or another, and roughly twenty of these do enough damage to matter economically (Pathak and Khan, 1994) [10]; taken together, this insect pressure is widely regarded as the single biggest obstacle standing between a rice crop and its full yield potential (Rai *et al.*, 2000) [11]. Yellow stem borer (*Scirpophaga incertulas* Walker), Rice leaf folder (*Cnaphalocrocis medinalis* Guenee), brown planthopper (*Nilaparvata lugens* Stal) and white-backed planthopper (*Sogatella furcifera* Horvath) are counted among the more damaging of these insects. Field-level estimates put yellow stem borer damage anywhere between 3 and 65 per cent depending on the season and location (Muralidharan and Pasalu, 2005) [8].

Figures from other rice-growing tracts of Asia go even higher, with yellow stem borer alone blamed for losses of up to 87 per cent in some cases; the insect attacks the crop twice over, once in the vegetative phase, where it kills the growing shoot and produces the symptom known as dead heart, and again after panicle initiation, where the resulting damage shows up as an unfilled, bleached panicle called white ear head (Deka and Barthakur, 2010; Pallavi and Sharanabasappa, 2017) [4, 9].

Keeping the above facts in view, the present investigation was undertaken to study the incidence of yellow stem borer on five rice varieties, namely GR-11, NAUR-1, GNR-3, GNR-26 and GNR-8, under transplanted and direct seeded methods of planting, along with the associated natural enemies and the resulting grain yield and economics.

Materials and Methods
1. Location and Experimental Design
The field trial was conducted during kharif 2025 at the College Farm, N.M. College of Agriculture, Navsari Agricultural University (20° 55' N, 72° 54' E), Navsari, Gujarat, India. The trial was laid out in a Factorial Randomised Block Design with three replications. Two factors were tested together: five rice varieties (GR-11, NAUR-1, GNR-3, GNR-26 and GNR-8) as one factor and two methods of crop establishment, transplanted rice (TPR) and direct seeded rice (DSR), as the other, giving ten treatment combinations per replication.

Seedling age was kept comparable between the two establishment methods by sowing the DSR plots and the TPR nursery on the same date. 21-day-old seedlings were then transplanted into puddled soil in the TPR plots, while the DSR plots were left to grow from the directly sown seed without any transplanting operation. Both sets of plots received the same recommended dose of fertiliser, the same irrigation schedule apart from the puddling requirement of TPR, and the same intercultural operations, so that any difference recorded between the two systems could be attributed to the method of establishment rather than to an unrelated agronomic factor. No insecticide or other plant protection measure directed at yellow stem borer was applied at any stage, so that the pest could build up naturally and be recorded without interference.

2. Recording of observations

Twenty-five hills were selected at random in each plot for recording dead heart and white ear head. Observations were taken at weekly intervals starting from 21 days after transplanting or sowing (DAT/S) and continuing up to 70 DAT/S, corresponding to the 34th through 41st standard meteorological week of the season. Per cent dead heart and white ear head were worked out using the formula given by Chakraborty (2011) [3], and the values were arcsine-transformed before analysis, as is standard practice for percentage data of this kind.

$$\text{Per cent stem borer incidence} = \frac{\text{Number of dead heart/white ears}}{\text{Total number of tillers/panicles}} \times 100$$

Adult moth activity was recorded separately using a standard insect sweep net, five sweeps being taken per plot at the same weekly intervals used for the larval symptoms. The number of moths caught was expressed as moths per five sweeps and square-root ($\sqrt{x + 0.5}$) transformed prior to statistical analysis. Spiders and coccinellids, the two predator groups most commonly encountered in the crop during the survey, were counted on the same twenty-five hills used for the pest observations, so that predator and pest data could be compared directly on a per-hill basis.

Grain and straw yield were recorded separately from each plot at harvest and converted to a tonnes-per-hectare basis. Cost of cultivation was worked out for each establishment method based on the actual operations carried out, including nursery raising, puddling and transplanting labour for TPR, which DSR does not require. Gross and net returns were calculated using the prevailing local price of grain and straw, and the benefit-cost ratio was derived from the net return relative to the cost of cultivation.

3. Statistical analysis

All data were analysed by analysis of variance appropriate to the factorial randomised block design used in the trial. Treatment means were compared using Duncan's New Multiple Range Test at the five per cent level of probability. The main effects of establishment method and variety, along with their interaction, were tested separately at every weekly observation and again on the season-long pooled means.

Results and Discussion

1. Dead heart incidence

Dead heart commenced at 21 DAT/S and increased gradually week after week in all five varieties under both TPR and DSR, reaching its peak at 49 DAT/S, after which it declined till harvest (Table 1). Among the varieties, NAUR-1 recorded the significantly lowest dead heart at almost every stage and remained statistically at par with GNR-3, whereas GR-11 recorded the significantly highest dead heart throughout the crop growth period, marking it out as the most susceptible variety; GNR-26 and GNR-8 showed an intermediate reaction. At the peak week, dead heart in GR-11 worked out to 10.36 per cent under TPR and 14.13 per cent under DSR, while NAUR-1 recorded only 7.60 per cent under TPR and 10.34 per cent under DSR.

Between the two methods, DSR recorded significantly higher dead heart than TPR at every stage of observation for all the varieties, the gap being widest around the peak infestation week, when dead heart in DSR worked out to nearly 1.3 to 1.4 times that recorded in TPR. The method × variety interaction remained non-significant throughout the season, indicating that the two factors acted independently. This finding is inagreement with Ashrith *et al.* (2016) [2], who also recorded higher yellow stem borer damage in direct seeded rice than in transplanted rice at Raichur, and with Kumar *et al.* (2019) [7], who reported that the stem borer population built up both earlier and in larger numbers under direct seeding. A likely explanation is that the direct seeded crop stands closer together from the very start, without the check that transplanting places on the seedlings, so there is more continuous plant tissue available for the moth to lay eggs on and for the young larvae to move between tillers once they hatch. Transplanting, by contrast, sets the crop back for a short period right after the seedlings are pulled and reset, and this brief disruption in canopy growth may reduce the window during which the pest can establish itself as easily.

2. Adult Moth Catch

The adult moth population, recorded through sweep net catches, also increased steadily up to 49 DAT/S, the peak moth activity period, and declined thereafter (Table 2). NAUR-1 supported the lowest moth population at nearly every stage of sampling and generally remained at par with GNR-3, whereas GR-11 attracted the maximum number of moths right through the season, confirming the same order of varietal susceptibility already noticed for dead heart. At the seasonal peak, moth catch in GR-11 reached 4.67 per five sweeps under TPR and 6.59 under DSR.

DSR consistently recorded a higher moth catch than TPR for all the varieties and at all stages of observation, the difference being most pronounced during the peak activity period, while the method × variety interaction remained non-significant throughout the season. Kamboj *et al.* (2025) [6] similarly reported that establishment method significantly influenced insect abundance in basmati rice, a denser and more continuous canopy under DSR likely offering more shelter and oviposition surface to the moth than the transplanted crop.

3. White ear head at harvest and season-long comparative performance

NAUR-1 recorded the lowest white ear head under both TPR (6.65%) and DSR (8.29%), while GR-11 recorded the highest under both systems (9.57% under TPR and 12.53% under DSR). GNR-3, GNR-26 and GNR-8 fell in between in that order, and DSR again produced significantly more damage than TPR for every variety without exception (Table 3).

When the weekly figures were pooled over the whole season, NAUR-1 came out most tolerant, followed by GNR-3, then GNR-26 and GNR-8 roughly together, and GR-11 last, and this order held under both TPR and DSR.

This general pattern is consistent with Ashrith *et al.* (2016) [2], who also recorded higher yellow stem borer damage in direct seeded rice than in transplanted rice. It also fits with the common understanding that a variety showing less larval survival early in the season, when dead heart is formed, usually goes on to support fewer breeding moths later, which in turn produces less white ear head once the crop reaches the reproductive stage.

4. Natural enemies

Spiders and coccinellids, the two predator groups recorded through the season, both built up gradually from the first observation at 21 DAT/S, reached their highest numbers around 63 DAT/S, and then dropped off a little as the crop moved toward harvest. This pattern was seen in both TPR and DSR plots and across all five varieties (Tables 4 and 5).

The mean spider population ranged from 0.71 to 0.91 per hill under TPR and from 0.58 to 0.74 per hill under DSR, while the mean coccinellid population ranged from 0.57 to 0.71 per hill under TPR and from 0.47 to 0.62 per hill under DSR, being comparatively higher in NAUR-1 and lower in GR-11 among the varieties under both the methods. The effect of method of crop establishment and the method × variety interaction on the population of both natural enemies remained non-significant throughout the season, indicating that the natural enemy complex was largely unaffected by the method of crop establishment or the variety grown.

5. Yield and economics

With respect to yield, TPR recorded significantly higher grain yield than DSR in every variety, the reduction under direct seeding working out to nearly 18 to 22 per cent depending upon the variety, whereas straw yield did not differ significantly between the two methods (Table 6). Under both TPR and DSR, NAUR-1 recorded the highest grain yield (3.95 t/ha under TPR), followed by GNR-3, GNR-26 and GNR-8, while GR-11 recorded the significantly lowest yield. Cost of cultivation was higher under TPR (₹ 57,855/ha) than under DSR (₹ 34,740/ha) for every variety; despite the lower yield realised, the benefit-cost ratio worked out considerably higher under DSR, ranging from 2.14 in GR-11 to 2.95 in NAUR-1, than under TPR, which ranged from 1.62 in GR-11 to 2.16 in NAUR-1. On the basis of combined yield and economic performance, NAUR-1 secured the first rank, followed by GNR-3, GNR-26 and GNR-8, with GR-11 ranking last, which is the exact reverse of its rank in pest susceptibility.

Table 1: Incidence of rice yellow stem borer dead heart in transplanted and direct seeded rice for various varieties at different standard meteorological weeks

Variety	Dead heart (%)															
	21 DAT/S (34 SMW)		28 DAT/S (35 SMW)		35 DAT/S (36 SMW)		42 DAT/S (37 SMW)		49 DAT/S (38 SMW)		56 DAT/S (39 SMW)		63 DAT/S (40 SMW)		70 DAT/S (41 SMW)	
	TPR	DSR	TPR	DSR	TPR	DSR	TPR	DSR	TPR	DSR	TPR	DSR	TPR	DSR	TPR	DSR
GR-11	4.59 (12.33)^{b}	6.03 (14.17)^{b}	6.31 (14.52)^{b}	8.41 (16.84)^{b}	7.84 (16.20)^{b}	10.60 (19.00)^{b}	9.53 (17.96)^{b}	12.02 (20.22)^{b}	10.36 (18.75)^{b}	14.13 (22.07)^{b}	9.66 (18.08)^{b}	13.33 (21.39)^{b}	8.72 (17.16)^{b}	12.48 (20.67)^{b}	7.38 (15.68)^{b}	10.39 (18.79)^{b}
NAUR-1	3.21 (10.32)^{a}	4.40 (12.11)^{a}	4.48 (12.20)^{a}	5.74 (13.84)^{a}	5.27 (13.22)^{a}	7.76 (16.17)^{a}	6.21 (14.40)^{a}	9.35 (17.78)^{a}	7.60 (15.89)^{a}	10.34 (18.75)^{a}	6.49 (14.69)^{a}	9.75 (18.13)^{a}	5.82 (13.96)^{a}	8.54 (16.97)^{a}	4.66 (12.42)^{a}	7.39 (15.74)^{a}
GNR-3	3.83 (11.26)^{ab}	4.76 (12.60)^{ab}	4.96 (12.79)^{ab}	6.55 (14.81)^{ab}	5.90 (13.97)^{ab}	8.36 (16.77)^{a}	7.09 (15.39)^{ab}	10.21 (18.62)^{ab}	8.45 (16.84)^{ab}	11.73 (19.98)^{ab}	7.09 (15.41)^{ab}	10.95 (19.24)^{ab}	6.43 (14.64)^{ab}	9.12 (17.52)^{ab}	5.41 (13.43)^{ab}	8.17 (16.58)^{a}
GNR-26	4.16 (11.75)^{ab}	4.83 (12.68)^{ab}	5.23 (13.20)^{ab}	7.02 (15.33)^{ab}	6.26 (14.40)^{ab}	8.58 (17.01)^{a}	7.36 (15.72)^{ab}	10.56 (18.89)^{ab}	8.84 (17.30)^{ab}	12.26 (20.46)^{ab}	7.39 (15.73)^{ab}	11.48 (19.76)^{ab}	6.71 (15.02)^{ab}	9.73 (18.06)^{ab}	5.92 (14.06)^{ab}	8.56 (16.98)^{ab}
GNR-8	4.43 (12.09)^{ab}	5.36 (13.36)^{ab}	5.77 (13.88)^{b}	7.57 (15.93)^{ab}	6.84 (15.14)^{ab}	9.49 (17.89)^{ab}	8.09 (16.50)^{ab}	11.31 (19.60)^{ab}	9.34 (17.75)^{ab}	13.19 (21.29)^{ab}	8.11 (16.53)^{ab}	12.10 (20.33)^{ab}	7.64 (16.02)^{b}	11.35 (19.68)^{ab}	6.62 (14.90)^{ab}	9.55 (17.98)^{ab}
S. Em ± M	0.26		0.32		0.40		0.42		0.43		0.43		0.34		0.39	
V	0.41		0.50		0.63		0.66		0.67		0.69		0.53		0.61	
M x V	0.58		0.71		0.89		0.66		0.95		0.97		0.76		0.87	
CD @ 5% M	0.77		0.94		1.19		1.25		1.26		1.29		1.00		1.15	
V	1.22		1.49		1.87		1.97		2.00		2.04		1.59		1.82	
M x V	NS		NS		NS		NS		NS		NS		NS		NS	
CV (%)	8.21		8.59		9.67		9.29		8.71		9.38		8.37		8.87	

Note: Figures in the parentheses are arcsine transformed values and those outside are original values. Means followed by same letter(s) in a column do not differ significantly by DNMRT (p=0.05). M = Method, V = Variety, NS = Non-significant, DAT/S = Days after transplanting/ sowing, SMW = Standard meteorological week, TPR= Transplanted rice, DSR = Direct seeded rice.

Table 2: Rice yellow stem borer catches by sweep net at weekly intervals for various varieties in transplanted and direct seeded rice

Variety	No. of moths/5 sweeps at different DAT/S															
	21 DAT/S (34 SMW)		28 DAT/S (35 SMW)		35 DAT/S (36 SMW)		42 DAT/S (37 SMW)		49 DAT/S (38 SMW)		56 DAT/S (39 SMW)		63 DAT/S (40 SMW)		70 DAT/S (41 SMW)	
	TPR	DSR	TPR	DSR	TPR	DSR	TPR	DSR	TPR	DSR	TPR	DSR	TPR	DSR	TPR	DSR
GR-11	1.90 (1.44)^{b}	2.69 (1.78)^{c}	2.50 (1.73)^{b}	2.95 (1.85)^{b}	3.02 (1.86)^{b}	4.09 (2.14)^{b}	3.57 (2.01)^{b}	5.44 (2.43)^{c}	4.67 (2.27)^{c}	6.59 (2.66)^{c}	3.95 (2.10)^{b}	5.05 (2.35)^{b}	3.32 (1.95)^{b}	4.59 (2.25)^{c}	2.23 (1.63)^{c}	3.14 (1.90)^{c}
NAUR-1	0.90 (1.14)^{a}	1.57 (1.44)^{abc}	1.15 (1.27)^{a}	1.71 (1.48)^{a}	1.28 (1.33)^{a}	2.09 (1.60)^{a}	1.94 (1.55)^{a}	2.60 (1.74)^{a}	2.51 (1.71)^{a}	3.42 (1.98)^{a}	1.83 (1.52)^{a}	2.48 (1.71)^{a}	1.44 (1.38)^{a}	1.98 (1.57)^{a}	0.74 (1.10)^{a}	1.18 (1.29)^{a}

GNR-3	0.83 (1.13)^{a}	0.76 (1.09)^{a}	1.44 (1.37)^{a}	2.17 (1.61)^{ab}	2.06 (1.58)^{ab}	2.55 (1.74)^{ab}	2.35 (1.69)^{ab}	3.32 (1.94)^{ab}	3.04 (1.88)^{ab}	4.47 (2.23)^{ab}	2.32 (1.68)^{ab}	2.82 (1.80)^{a}	1.88 (1.53)^{ab}	2.52 (1.73)^{ab}	1.21 (1.31)^{ab}	1.78 (1.50)^{ab}
GNR-26	1.05 (1.23)^{ab}	1.12 (1.27)^{ab}	1.88 (1.54)^{ab}	2.33 (1.68)^{ab}	2.25 (1.66)^{ab}	2.70 (1.76)^{ab}	2.51 (1.73)^{ab}	3.96 (2.11)^{abc}	3.40 (1.97)^{abc}	5.06 (2.35)^{bc}	2.80 (1.81)^{ab}	3.40 (1.97)^{ab}	2.32 (1.67)^{ab}	3.25 (1.94)^{abc}	1.47 (1.39)^{abc}	2.21 (1.64)^{bc}
GNR-8	1.33 (1.35)^{ab}	2.09 (1.61)^{bc}	1.95 (1.56)^{ab}	2.42 (1.70)^{ab}	2.73 (1.80)^{b}	3.13 (1.89)^{ab}	3.43 (1.98)^{b}	4.33 (2.19)^{ab}	4.12 (2.15)^{ab}	5.61 (2.47)^{bc}	3.29 (1.93)^{ab}	4.35 (2.19)^{ab}	2.74 (1.79)^{ab}	3.94 (2.06)^{bc}	1.82 (1.52)^{bc}	2.73 (1.79)^{bc}
S. Em ±M	0.06		0.05		0.05		0.05		0.05		0.07		0.10		0.05	
V	0.09		0.08		0.08		0.08		0.08		0.11		0.07		0.07	
M x V	0.13		0.11		0.13		0.11		0.66		0.11		0.15		0.10	
CD @5% M	0.17		0.15		0.15		0.15		0.15		0.20		0.31		0.13	
V	0.27		0.23		0.24		0.24		0.24		0.32		0.20		0.21	
M x V	NS		NS		NS		NS		NS		NS		NS		NS	
CV (%)	16.65		12.05		13.54		10.39		9.12		13.97		14.56		11.56	

Note: Figures in the parentheses are square root √ (x + 0.5) transformed values and those outside are original values. Means followed by same letter(s) in a column do not differ significantly by DNMRT (p=0.05). M = Method, V = Variety, NS = Non-significant, DAT/S = Days after transplanting/ sowing, SMW = Standard meteorological week, TPR= Transplanted rice, DSR = Direct seeded rice

Table 3: Comparative mean incidence of rice yellow stem borer across varieties and cultivation methods

Variety	Mean (pooled) dead heart (%)		White ear head (%) at harvest		Mean (pooled) moth catch		Rank
	TPR	DSR	TPR	DSR	TPR	DSR	
GR-11	8.05 (16.34)^{b}	10.92 (19.14)^{b}	9.57 (17.99)^{b}	12.53 (20.69)^{b}	3.14 (1.87)^{b}	4.31 (2.17)^{b}	5
NAUR-1	5.47 (13.39)^{a}	7.91 (16.19)^{a}	6.65 (14.81)^{a}	8.29 (16.71)^{a}	1.49 (1.38)^{a}	2.13 (1.60)^{a}	1
GNR-3	6.14 (14.22)^{ab}	8.73 (17.02)^{ab}	7.44 (15.81)^{ab}	9.47 (17.87)^{ab}	1.89 (1.52)^{ab}	2.55 (1.71)^{a}	2
GNR-26	6.48 (14.65)^{ab}	9.13 (17.40)^{ab}	7.72 (16.10)^{ab}	10.39 (18.79)^{ab}	2.21 (1.62)^{ab}	3.00 (1.84)^{ab}	3
GNR-8	7.10 (15.35)^{ab}	9.99 (18.26)^{ab}	8.23 (16.66)^{ab}	11.33 (19.62)^{ab}	2.68 (1.76)^{ab}	3.58 (1.99)^{ab}	4
S. Em ± M	0.13		0.41		0.02		-
V	0.21		0.65		0.03		-
M x V	0.29		0.92		0.04		-
CD @ 5% M	0.37		1.23		0.05		-
V	0.58		1.94		0.09		-
M x V	NS		NS		NS		-

Note: Figures in parentheses are arcsine/square root transformed values, as applicable and those outside are original values. M Method, V = Variety, NS = Non-significant, TPR= Transplanted rice, DSR = Direct seeded rice.

Conclusion

The dead heart incidence and adult moth catch of yellow stem borer commenced at 21 DAT/S, built up progressively to a seasonal peak at 49 DAT/S, and declined thereafter till harvest in all five varieties tested under both transplanted and direct seeded conditions. Among the varieties, NAUR-1 and GNR-3 were comparatively tolerant, GR-11 was the most susceptible, and GNR-26 and GNR-8 showed an intermediate reaction, this same order holding good for dead heart, moth catch and white ear head alike. Direct seeded rice consistently recorded higher pest incidence than transplanted rice, and transplanted rice, in turn, recorded significantly higher grain yield than direct seeded rice in every variety. Despite the lower yield and higher pest damage recorded under direct seeding, the benefit-cost ratio of DSR was superior to that of TPR on account of the considerable saving in cost of cultivation, and NAUR-1 secured the best overall rank on the basis of combined yield and economic performance under both methods, being the exact reverse of its rank in pest susceptibility. The population of the natural enemies, viz., spiders and coccinellids, built up progressively through the season under both methods and remained largely uninfluenced by the method of crop establishment or the variety grown, indicating that the natural enemy complex was not adversely affected by direct seeding.

Table 4: Occurrence of spiders in transplanted and direct seeded rice

Variety	Spiders/Hill																	
	21 DAT/S (34 SMW)		28 DAT/S (35 SMW)		35 DAT/S (36 SMW)		42 DAT/S (37 SMW)		49 DAT/S (38 SMW)		56 DAT/S (39 SMW)		63 DAT/S (40 SMW)		70 DAT/S (41 SMW)		Mean incidence	
	TPR	DSR	TPR	DSR	TPR	DSR	TPR	DSR	TPR	DSR	TPR	DSR	TPR	DSR	TPR	DSR	TPR	DSR
GR-11	0.25 (0.87)	0.24 (0.86)	0.35 (0.92)	0.25 (0.86)	0.36 (0.93)	0.32 (0.90)	0.56 (1.03)	0.45 (0.98)	0.82 (1.15)	0.69 (1.07)	1.03 (1.24)	0.87 (1.17)	1.26 (1.33)	1.02 (1.23)	1.08 (1.26)	0.87 (1.17)	0.71 (1.06)	0.58 (1.03)
NAUR-1	0.32 (0.91)	0.27 (0.88)	0.43 (0.96)	0.28 (0.88)	0.53 (1.01)	0.46 (0.98)	0.89 (1.18)	0.63 (1.06)	0.97 (1.21)	0.80 (1.14)	1.28 (1.33)	1.13 (1.27)	1.47 (1.40)	1.23 (1.31)	1.12 (1.27)	1.18 (1.29)	0.91 (1.17)	0.74 (1.10)
GNR-3	0.35	0.26	0.38	0.31	0.54	0.40	0.71	0.66	0.86	0.70	1.21	1.08	1.38	1.13	1.21	0.95	0.83 (1.14)	0.68 (1.07)

	(0.92)	(0.87)	(0.92)	(0.90)	(1.02)	(0.95)	(1.10)	(1.07)	(1.16)	(1.09)	(1.31)	(1.26)	(1.37)	(1.28)	(1.31)	(1.20)		
GNR-26	0.29 (0.89)	0.20 (0.83)	0.35 (0.92)	0.25 (0.86)	0.46 (0.98)	0.36 (0.93)	0.63 (1.06)	0.51 (1.00)	0.90 (1.18)	0.72 (1.10)	1.13 (1.27)	0.92 (1.19)	1.36 (1.36)	1.26 (1.33)	1.47 (1.39)	1.14 (1.28)	0.82 (1.13)	0.67 (1.06)
GNR-8	0.26 (0.87)	0.29 (0.89)	0.32 (0.90)	0.30 (0.89)	0.41 (0.95)	0.33 (0.91)	0.62 (1.05)	0.53 (1.01)	0.86 (1.17)	0.75 (1.12)	1.08 (1.25)	0.97 (1.21)	1.22 (1.31)	1.09 (1.26)	1.05 (1.25)	0.94 (1.20)	0.73 (1.09)	0.64 (1.06)
CD @ 5%	NS		NS		NS		NS		NS		NS		NS		NS		-	

Table 5: Occurrence of coccinellids in transplanted and direct seeded rice

Variety	Coccinellids/hill																	
	21 DAT/S (34 SMW)		**28 DAT/S (35 SMW)**		**35 DAT/S (36 SMW)**		**42 DAT/S (37 SMW)**		**49 DAT/S (38 SMW)**		**56 DAT/S (39 SMW)**		**63 DAT/S (40 SMW)**		**70 DAT/S (41 SMW)**		**Mean incidence**	
	TPR	**DSR**	**TPR**	**DSR**	**TPR**	**DSR**	**TPR**	**DSR**	**TPR**	**DSR**	**TPR**	**DSR**	**TPR**	**DSR**	**TPR**	**DSR**	**TPR**	**DSR**
GR-11	0.18 (0.82)	0.12 (0.79)	0.25 (0.87)	0.18 (0.82)	0.32 (0.91)	0.24 (0.86)	0.45 (0.97)	0.37 (0.93)	0.59 (1.04)	0.45 (0.97)	0.82 (1.15)	0.68 (1.09)	1.03 (1.24)	0.94 (1.20)	0.94 (1.20)	0.85 (1.16)	0.57 (1.02)	0.47 (0.97)
NAUR-1	0.22 (0.85)	0.14 (0.80)	0.32 (0.91)	0.21 (0.84)	0.41 (0.95)	0.29 (0.89)	0.62 (1.06)	0.58 (1.04)	0.88 (1.17)	0.75 (1.12)	1.02 (1.23)	0.97 (1.21)	1.15 (1.28)	1.08 (1.26)	1.06 (1.25)	0.97 (1.21)	0.71 (1.09)	0.62 (1.04)
GNR-3	0.19 (0.83)	0.12 (0.79)	0.33 (0.91)	0.19 (0.83)	0.35 (0.92)	0.32 (0.91)	0.54 (1.02)	0.45 (0.97)	0.75 (1.12)	0.67 (1.08)	0.92 (1.19)	0.84 (1.16)	1.14 (1.28)	1.02 (1.23)	1.03 (1.24)	0.92 (1.19)	0.66 (1.06)	0.59 (1.03)
GNR-26	0.14 (0.80)	0.11 (0.78)	0.26 (0.87)	0.23 (0.85)	0.39 (0.94)	0.33 (0.91)	0.57 (1.03)	0.61 (1.05)	0.71 (1.10)	0.58 (1.04)	0.84 (1.16)	0.78 (1.13)	1.05 (1.24)	0.96 (1.21)	0.97 (1.21)	0.94 (1.20)	0.62 (1.05)	0.57 (1.02)
GNR-8	0.19 (0.83)	0.15 (0.81)	0.23 (0.85)	0.21 (0.84)	0.34 (0.92)	0.28 (0.88)	0.52 (1.01)	0.41 (0.95)	0.65 (1.07)	0.52 (1.01)	0.76 (1.12)	0.64 (1.07)	1.10 (1.26)	1.21 (1.31)	0.92 (1.19)	1.07 (1.25)	0.59 (1.03)	0.56 (1.01)
CD @ 5%	NS		NS		NS		NS		NS		NS		NS		NS		-	

Note: Figures in the parentheses are square root √ (x + 0.5) transformed values and those outside are original values.

Table 6: Yield and economics of rice varieties under transplanted and direct seeded rice

Variety	Transplanted rice					Direct seeded rice				
	Yield (T/ha)		Gross returns	Cost of cultivation	B:C ratio	Yield (T/ha)		Gross returns	Cost of cultivation	B:C ratio
	Grain	Straw				Grain	Straw			
GR-11	2.74[c]	5.07	93,850	57,855	1.62	2.03[c]	4.75	74,500	34,740	2.14
NAUR-1	3.95[a]	5.22	1,24,850	57,855	2.16	3.15[a]	4.81	1,02,800	34,740	2.95
GNR-3	3.72[a]	5.13	1,18,650	57,855	2.05	3.05[a]	4.85	1,00,500	34,740	2.89
GNR-26	3.32[b]	5.18	1,08,900	57,855	1.88	2.56[b]	4.88	88,400	34,740	2.54
GNR-8	3.13[bc]	5.29	1,04,700	57,855	1.81	2.22[bc]	4.92	80,100	34,740	2.31
S. Em ± M	0.07	0.09	-	-	-	0.07	0.09	-	-	-
V	0.10	0.14	-	-	-	0.10	0.14	-	-	-
M x V	0.15	0.20	-	-	-	0.15	0.20	-	-	-
CD @ 5% M	0.19	NS	-	-	-	0.19	NS	-	-	-
V	0.31	0.26	-	-	-	0.31	0.26	-	-	-
M x V	NS	NS	-	-	-	NS	NS	-	-	-
CV (%)	8.12	6.82	-	-	-	8.12	6.82	-	-	-

Note: Grain price: ₹ 25/kg; Straw price: ₹ 5/kg. Means followed by same letter(s) in a column do not differ significantly by DNMRT (p=0.05), NS=non-significant, B:C ratio= Benefit: Cost ratio.

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