Agro-management for high yield in hybrid rice seed production

M.P. Pandey, S.R. Dhua, A.K. Gupta and B.K. Pal

Central Rice Research Institute
CUTTACK (Orissa) 753 006, India

Introduction

- Adoption of hybrid rice technology is constrained in India by inadequate availability of quality seeds and its higher cost.
- Available technology is capable of producing 1.5-2.0 t ha^{-1} hybrid seed yield (Pandey *et. al.* 1996).
- Reports indicate low seeding rate promots tillering and seeding vigour in rice -tolerate stresses and transplanting shock.
- Continuous availability of optimum NPK-enhanced root dry wt. and grain yield/ha.
- Studies in China suggest refinement in agro-techniques of the seed and pollen parents in hybrid seed production can maximize yield (Peng *et. al.*1998).
- However, no research data in India is available on the refinement of agro techniques of hybrid rice seed production to enhance further the seed yield.

Objectives

The main objectives are:

1. Study the effect of nursery management factors on seedling growth related traits,
2. Study the tillering pattern of seed and pollen parents, and
3. Study the effect of factors of management of parental lines of hybrids in the nursery and field on seed yield and related traits

Experimental site

- All the experiments were taken during wet season at the experiment station of G.B.Pant University of Agriculture & Technology, Pantnagar, India
- It is located at Himalyan foot hills in Uttarakhand State at 29°N latitude and 79.3°E longitude and at an altitude of 243.8 m above Mean Sea Level
- The climate is humid sub-tropical and the temperature ranges between 28 to 41° C during crop season (June-October).

Materials

- Comprised of parental lines of two early maturing and high yielding hybrids i.e.
  Pant Sankar Dhan 1 (PSD 1) and
  Pant Sankar Dhan 3 (PSD 3)
- Both are released for commercial cultivation under irrigated and transplanted conditions in the plains of North-West India.
- Both the hybrids share a common female parent i.e. WA based Cytoplasmic male sterile line, UPRI 95-17A.
- Days to flowering after seeding
  UPRI 95-17A, CMS line - 100days
  UPRI 92-133R, the restorer of PSD 1 - 95days
  UPRI 93-287R, the restorer of PSD 3 - 94days
- **Testing years/season**: Two experiments on hybrid seed production with each of the hybrids (PSD 1 and PSD 3) were conducted during wet season

Contd./-

- **Staggered seeding of parents** for synchronization

- Single seeding of seed parent and three seedings at 2d interval for respective restorer was done done in the nursery

- Respective restorers were staggered sown on three dates at two-days interval to get synchronized flowering between parents.

-The first seeding of restorer coincided with the seeding date of seed parent.

•Nursery raising

-Seedbeds of size 2.0 m x 1.0 m for restorer and 4.0 m x 1.2 m for seed parent for each treatment

-Fertilizer/plot: 1.0 kg N, 0.6 kg P and 0.4 kg K per 100 m^2 area (PSD1) applied

-Adopted all standard cultural practices and plant protection measures

-All practices to promote out crossing were adopted in field

Materials and Methods-III

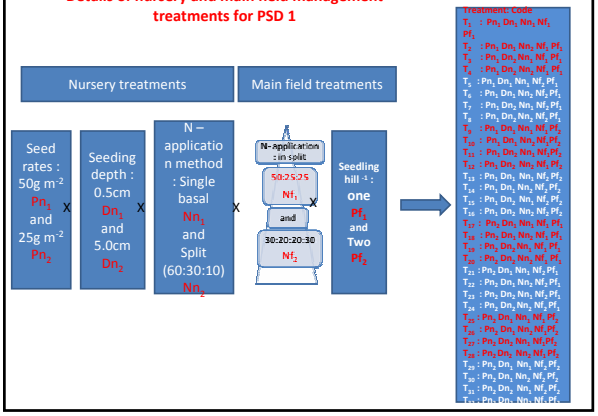
Factors and levels of nursery management

No. of treatments: PSD1: 8 PSD3: 24

Factors of management	PSD 1		PSD 3	
	No. of levels	Levels	No. of levels	Levels
Seed rate	2	25g and 50g/m^2	3	15g, 25g and 50g/m^2
Depth of seeding	2	0.5cm and 5.0cm	2	0.5 and 5.0cm
N-dose	1	100Kg/ha	2	100Kg/ha &150Kg/ha
N- application method	2	All basal and Split(60:30:10)	2	All basal and Split(60:30:10)

Materials and Methods-IV

Details of nursery and main field management treatments for PSD 1



Materials and Methods-V

Details of nursery management treatments with PSD 3

Treatment (code)	Nursery management treatments			
	Seed rate (g/m^2)	Seeding depth (cm)	Nitrogen dose (Kg/ha)	Nitrogen application method
Vn$_1$ (Standard control)	50	5.00	100	Single, basal
Vn$_2$ (Improved control)	25	5.00	100	Split (60:30:10)
Vn$_3$	25	5.00	100	Single, basal
Vn$_4$	25	0.50	100	Split (60:30:10)
Vn$_5$	15	5.00	150	Split (60:30:10)
Vn$_6$	25	5.00	150	Split (60:30:10)

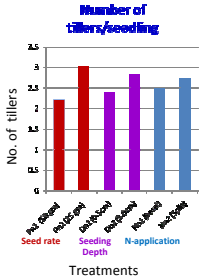
Selected nursery and main field management treatments for PSD-3

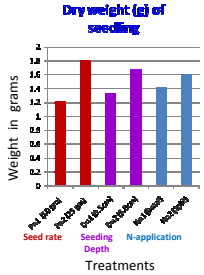
Field Management treatments (Code)	Nursery treatments			Main field	
	Seed rate (g m^{-2})	Seedling depth (cm)	Nitrogen dose (Kg ha^{-1}) and method of application	Nitrogen dose (Kg ha^{-1})	No. of seedling hill^{-1} transplanted
V$_1$(Standard Control)	50	5.0	100,basal	120, 3 split	2
V$_2$ (Improved Control)	25	5.0	100, Split	150, 4 Split	2
V$_3$	25	5.0	100, Split	150, 4 Split	1
V$_4$	25	5.0	100, Split	180, 4 Split	2
V$_5$	25	5.0	100, Split	180, 4 Split	1
V$_6$	25	5.0	100,basal	150, 4 Split	2
V$_7$	25	0.5	100, Split	150, 4 Split	2
V$_8$	15	5.0	150, Split	180, 4 Split	2
V$_9$	15	5.0	150, Split	210, 4 Split	1
V$_{10}$	15	5.0	150, Split	210, 4 Split	2
V$_{11}$	25	5.0	150, Split	180, 4 Split	2
V$_{12}$	25	5.0	150, Split	210, 4 Split	1

Experimental Results

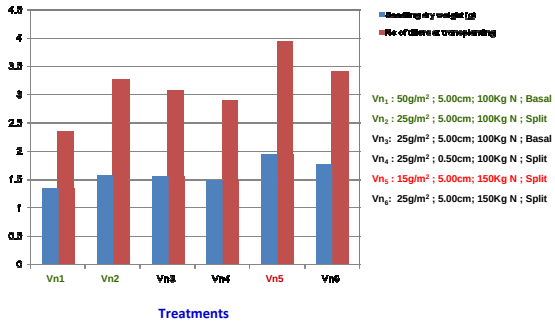
Effect of individual nursery treatments on seedling growth of tillers/ seedling of the seed parent of PSD 1 (Pooled data)

Characters studied: Shoot length, root length, seedling height, tillers (#) per seedling and seeding dry weight



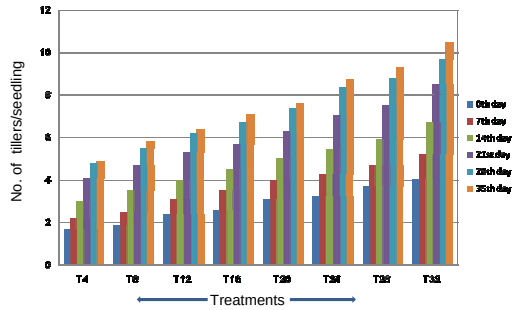


Effect of nursery treatments on seedling growth of the restorer parent of PSD 3 (Pooled season data)



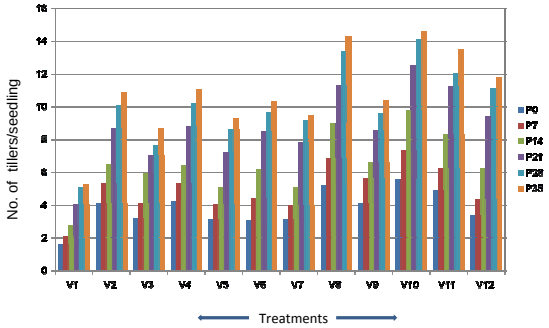
Vn$_1$: 50g/m^2 ; 5.00cm; 100Kg N ; Basal
Vn$_2$: 25g/m^2 ; 5.00cm; 100Kg N ; Split
Vn$_3$: 25g/m^2 ; 5.00cm; 100Kg N ; Basal
Vn$_4$: 25g/m^2 ; 0.50cm; 100Kg N ; Split
Vn$_5$: 15g/m^2 ; 5.00cm; 150Kg N ; Split
Vn$_6$: 25g/m^2 ; 5.00cm; 150Kg N ; Split

Effect of agro management treatments on pattern of tiller development in seed parent of PSD 1 (Pooled data)

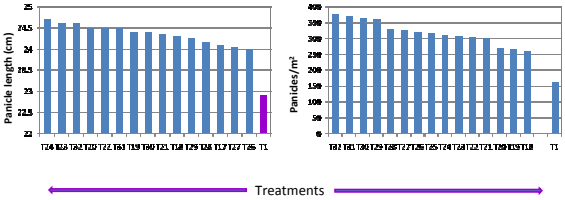


All the treatments attained maximum tiller development rate between 7th-28th day with peak between 14th and 21st day after transplanting

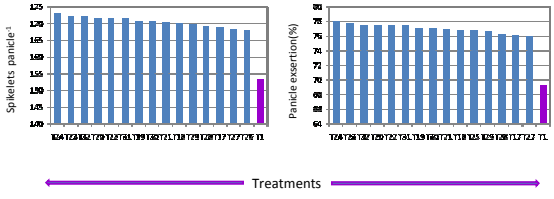
Effect of agro management treatments on pattern of tiller development in seed parent of PSD-3 (Pooled data)



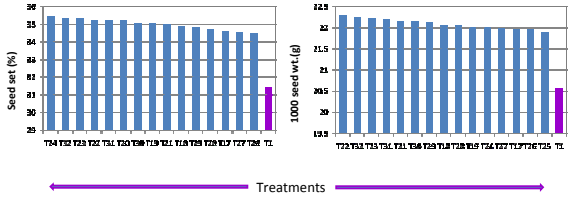
Effect of top treatments for Panicle length (cm) and Panicles /m² of seed parent of PSD 1 (Pooled data)



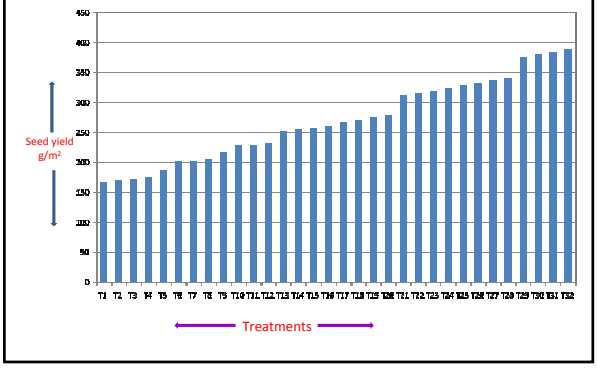
Effect of top treatments for Spikelets/panicle and Panicles exsertion (%) of seed parent of PSD 1 (Pooled data)



Effect of top treatments for Seed set (%) and 1000 seed wt. (g) of seed parent of PSD 1 (Pooled data)

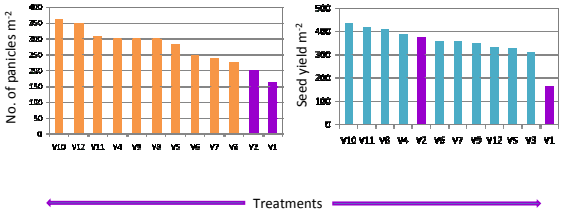


Seed yield (g)/m² of seed parent for different treatments of PSD 1 (Pooled data)



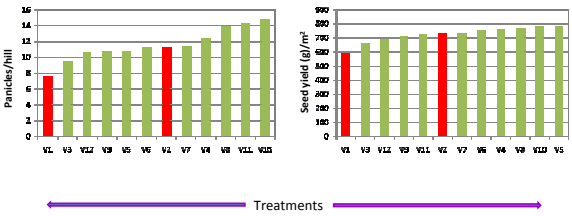
Mean effect of treatments on panicles/hill and seed yield (g)/m² for the seed parent of PSD-3

(Pooled mean)



Mean effect of treatments on panicles/hill and seed yield (g)/m² for the restorer parent of PSD-3

(Pooled mean)



Best three management treatments for individual characters in the seed and restorer parents of hybrids (Pooled data)

Hybrid	Parent	Treatment ranking	Plant height	Tillers /hill	Panicles /m²	Panicle length	Spikelets /panicle	Panicle exsertion	Seed set %	1000 Seed wt.	Seed yield/m²
PSD 1	Seed	I	T_{24}	T_{32}	T_{32}	T_{24}	T_{24}	T_{24}	T_{24}	T_{22}	T_{32}
		II	T_{23}	T_{31}	T_{31}	T_{32}/ T_{23}	T_{32}	T_{23}	T_{32}	T_{32}	T_{31}
		III	T_{22}	T_{30}	T_{30}	T_{31}/ T_{22}	T_{23}	T_{32}	T_{23}	T_{23}	T_{30}
	Restorer	I	T_{16}	T_{16}	T_{16}	T_{16}	-	-	-	-	T_{16}
		II	T_{15}	T_{15}	T_{15}	T_{15}	-	-	-	-	T_{15}
		III	T_{14}	T_{14}	T_{14}/ T_{12}	T_{14}/ T_{13}	-	-	-	-	T_{14}
PSD 3	Seed	I	V_9	V_{10}	V_{10}	V_{12}	V_{10}	V_{12}	V_{10}	V_{12}	V_{10}
		II	V_8	V_8	V_{12}	V_9	V_{11}	V_5	V_8	V_9	V_{11}
		III	V_{11}	V_{11}	V_{11}	V_5	V_8	V_3	V_{11}	V_8	V_8
	Restorer	I	V_9	V_{10}	V_{10}	V_{10}/ V_8	-	-	-	-	V_5 / V_{10}
		II	V_6	V_{11}	V_{11}	V_7	-	-	-	-	V_8
		III	V_5	V_8	V_8	V_4	-	-	-	-	V_6

Summary

1.Effect of nursery management on seedling parameters

•Four nursery management treatments (seed rate, seeding depth, N-dosase and N application method in nursery) revealed highly significant effect on various seedling parameters in parental lines of both the hybrids.

•Sparse seeding combined with deep seed placement and split applications of higher nitrogen dose encouraged development of robust and multi tillered seedlings as compared to controls (Vn_5 and Vn_6 for PSD 3). The responses were identical in both the hybrids, which are of almost similar maturity duration (early-mid early).

2. Effect of nursery management on rate of tiller development

•Studied the rate of tiller development of different treatments up to 35 DAT at 7 d interval. At 35 DAT, crop was vary close to PI stage.

•Treatments producing multi tillered and rebust seedlings (Vn_5 and Vn_6 in PSD3 on transplanting under high fertilizer (210-180 kg N/ha) with more splits (V_{10}, V_8 and V_{11} in PSD 3) in main field produced about 3 times higher tillers/seedling (13-15) as compared to control (5).

•The rate of tiller development over period of time showed normal curve with peak between 14 to 21 DAT declining thereafter at 28 DAT and it was no or very little between 28-25 DAT

•It has implication for early fertilizer application in field for inducing maximum tillering and panicles/m² area for higher yield.

3. Effect on seed yield and other related traits

•Pooled analysis of variance revealed significant variances over years for two hybrids due to agro-management treatments, years and interaction between years x management treatments.

Some of the management treatments higher hybrid seed yield in both the hybrids

(a) With PSD 1

The agro-management treatment were T_{32}, T_{31}, T_{30} and T_{28}. Treatments T_{32} and T_{30}. Combined nursery management of sparse seed rate (25g), deep seeding and three split application of N with main field management of planting of two seedlings $hill^{-1}$ and more split (4) application of nitrogen in the main field (T_{32}) produced higher no. of productive panicles/m² area. It is reflected into maximum hybrid seed yield of 3.9 t ha^{-1}

Higher seed yield may have been due to enhanced pollen load of male parent resulting into higher seed rate. The seed parent produced 291.3 million spikelets/ha. It resulted into higher seed set percentage.

(b) With PSD 3

Results explicitly show that further refinement of the best management technique in PSD-1 by a) reduction in the seeding rate (15g m^{-2}), b) increase in N application (100 vs 150Kg ha^{-1}) in the nursery and c) higher application of N (100 kg vs 180 and 210 kg N) in four split dosage in the main field, to give higher hybrid seed yield. It is evident with treatment V_{10} with maximum hybrid seed yield of 4.33t ha^{-1}

(c) Restorer parents

•The restorer parents of the hybrids also yield 7.5 t/ha in the treatment T_{32} for PSD-1 and 7.81 t/ha in the treatment V_{10} for PSD-3.

•High yielding capability of the top agro-management technique was accomplished due to significantly high panicle number hill^{-1} resulting from planting of vigorous and multi tillered seedlings with higher nitrogen dose to induce more synchronous tillering, higher number of spikelets per panicle, better panicle exsertion and seed set percent.

Conclusion

1.Study demonstrates much greater scope for enhancement of yield in hybrid seed production by judicious management of the agro-technology.

2.Since, results are based on relativity smaller plot size, further testing at multi-location sites in larger plots would help in hybrid specific recommendations for achieving higher yield of the hybrid seeds.

3.Agro-management technology would help in reducing the cost of hybrid seed facilitating large scale adoption of hybrid technology by the farmers in the country.

Thank you