

Optimization of Ground Cover by Green Manure Cover Crops before No-Till Direct Seeded and Mechanically Transplanted Rice in Rice-Wheat Cropping System

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Abstract

Two field experiments were conducted during *kharif* of 2009, to optimize ground cover by green manure cover crops before taking no-till direct seeded basmati rice and mechanical transplanted coarse grain rice. The treatments included three cover crops (*Sesbania*, mungbean and cowpea) with two seed rates (X and 2X) along with check (without cover crop) under no-till after wheat harvest. The X seed rates for *Sesbania*, mungbean and cowpea were 30, 20 and 50 kg/ha, respectively. Farmers' field trails on the issue in question were also conducted at three locations. Weed infestation until cover crops were knocked down, was significantly reduced due to growing of cover crops as compared to plots where no cover crop was included. Minimum density and dry weight of weeds was recorded with *Sesbania* at 60 kg/ha seed rate which was superior to all other treatments. This could be due to ample ground cover and heavy biomass production by *Sesbania*. In general biomass production among green manure cover crops was followed the sequence of *Sesbania*>cowpea>mungbean. Due to lower cost of seed, *Sesbania* at 60 kg/ha was realized more economical than other cover crops. Infestation of *Echinochloa* sp. in rice was lowest in the plots where *Sesbania* was taken as preceding cover crop and it was superior to other two cover crops. There was no infestation of sedges in rice in the plots where cover crops were grown but there was infestation of sedges in check plots. There was no significant impact of different cover crops on the yield and yield attributed of rice; however, to attain higher returns, inclusion of green manure cover crops on long-term basis could be more meaningful.

Key words : Ground cover, Green manure cover crops, No-till direct seeded, Transplanted rice, Rice-wheat cropping system.

In most of the South Asia, common practice of establishing rice in the rice-wheat systems is through puddling followed by transplanting. Puddling help in reducing water losses through percolation and controlling weeds by water stagnation in rice fields. But besides being costly, cumbersome and time consuming it results in degradation of soil and other natural resources and subsequently poses difficulties in seedbed preparation for succeeding wheat crop in rotation. Breaking of soil aggregates, alteration of particle orientation and development of hard pan at a depth of 10—40 cm, increase in bulk density and soil compaction (1), impediment in root growth of wheat due to formation of hard pan in rice crop (2), labor scarcity and drudgery among women workers (3) are some of the other disadvantages associated with

puddle transplant rice (PTR). Looking into these problems particularly receding ground water and increasing labor cost, there is need for replacing this traditional practice of rice cultivation with alternate establishment methods like direct seeding and mechanized transplanting without puddling or under no-till system. Beneficial effects of zero tillage in wheat are well established but it will be more interesting to look into its remunerative effects not only in wheat but in rice-wheat cropping system as a whole. Mechanical transplanting of rice (MTPR) and direct seeding of rice (DSR) may be cost-effective and can give higher net returns because production costs are lower (4). As deterioration of soil fertility is a major cause of concern in rice-wheat system, the intervention in the form of green manuring through *Sesbania*, mungbean or

Table 1. Effect of different cover crops and their seed rate on green manure biomass production, weeds infestation in cover crop and yield and yield attributes of no-till DSR at Karnal.

Cover crop	Seed (kg/ha)	Green manure biomass (g/m ²)		Density of weeds (No./m ²)	Dry weight of weeds (g/m ²)	Plant height (cm)	Effective tillers/m ²	Panicle length (cm)	Grain yield (kg/ha)
		Fresh weight	Dry weight						
<i>Sesbania</i>	30	592.2	98.3	5.12 (25.3)	8.5	100.9	97.0	20.7	1575
<i>Sesbania</i>	60	850.5	131.4	3.40 (10.7)	2.1	101.0	98.3	21.6	1750
Mungbean	20	669.2	105.2	7.68 (58.7)	5.8	103.3	96.2	21.1	1492
Mungbean	40	794.2	120.3	5.88 (34.0)	4.1	102.8	95.5	20.9	1533
Cowpea	50	671.6	116.0	5.08 (25.3)	5.0	101.7	94.5	21.4	1523
Cowpea	100	785.9	130.2	4.02 (15.3)	2.4	103.1	97.3	20.9	1554
No cover crop	–	0.0	0.0	9.22 (84.0)	32.3	100.6	94.2	20.1	1474
CD 5%		80.7	14.4	1.22	3.6	NS	NS	NS	NS

cowpea after wheat harvest may be instrumental in improving soil fertility, and discouraging weed infestation in succeeding crop of rice under no-till. Hence, this study was undertaken to optimize the ground cover by different green manure cover crops before mechanically transplanted and direct seeded rice under no-till system.

Methods

Experiment I : Cover Crops Before No-Till Direct Seeded Rice

A field experiment was conducted at CCS Haryana Agricultural University Regional Research Station, Karnal during *kharif* of 2009. The treatments included three cover crops (*Sesbania*, mungbean and cowpea) with two seed rates (X and 2X) along with check (with-

out cover crop) under no-till after wheat harvest. The X seed rates for *Sesbania*, mungbean and cowpea were 30, 20 and 50 kg/ha, respectively. The treatments were laid out in randomized block design with three replicates. Sowing of cover crops was accomplished with zero-till seed-cum-fertilizer drill on 26 May 2009 at a row spacing of 18 cm. The cover crops were knocked down by spraying 2, 4-DE 0.5 kg/ha on 23 June *fb* application of paraquat 24SL 0.5% solution on 26 June to kill the pre-emerged weeds. Basmati rice cultivar CSR30 was sown with no-till drill on 27 June 2009 at row to row spacing of 20 cm using seed rate of 25 kg/ha. Seed was also treated with 25 g carbendazim in 25 liter of water solution for 24 hours. Fertilizers were applied as in main crop according to recommended package of practices by the state university. The gross and net plot size was 12.5 m × 6.5 m and 8.0

Table 2. Effect of different cover crops and their seed rate on green manure biomass production and weed infestation before and after mechanized transplanting of rice in no-till system at Karnal.

Cover crop	Seed (kg/ha)	Biomass of cover crop (g/m ²)		Weed infestation before rice crop		Weed infestation in rice crop at 25 DAS				Dry weight (g/m ²)
		Fresh weight	Dry weight	Density (No./m ²)	Dry weight (g/m ²)	Density (No./m ²)		Total weeds	Dry weight (g/m ²)	
					<i>Echinochloa</i>	Other grassy weeds	Sedges			
<i>Sesbania</i>	30	1501	197.3	3.32 (10.7)	1.4	1.82 (2.7)	5.35 (28.0)	1.00 (0.0)	5.60 (30.7)	5.0
<i>Sesbania</i>	60	1853	240.4	2.95 (8.0)	0.9	1.41 (1.3)	4.84 (22.7)	1.00 (0.0)	4.96 (24.0)	3.1
Mungbean	20	1191	179.6	8.15 (66.7)	4.2	8.05 (64.0)	3.95 (14.7)	1.00 (0.0)	8.91 (78.7)	11.0
Mungbean	40	1367	194.2	7.16 (50.7)	2.9	7.36 (53.3)	3.58 (12.0)	1.00 (0.0)	8.14 (65.3)	8.0
Cowpea	50	1445	191.1	9.21 (84.0)	5.1	7.21 (52.0)	6.00 (36.0)	1.00 (0.0)	9.32 (88.0)	8.7
Cowpea	100	1571	214.5	7.67 (58.0)	3.3	6.58 (42.7)	4.82 (22.7)	1.00 (0.0)	8.12 (65.3)	6.9
No cover crop		0	0.0	10.68 (113.3)	7.3	6.82 (46.7)	4.42 (18.7)	5.87 (34.7)	9.98 (100.0)	26.1
CD 5%		325	41.0	1.41	2.0	1.34	1.35	0.91	0.91	3.7

Table 3. Effect of different cover crops on yield and yield attributes of mechanized transplanted rice in no-till system at Karnal.

Cover crop	Seed (kg/ha)	Effec-			Grain yield (kg/ha)
		Plant height (cm)	tive tillers/m ²	Panicle length (cm)	
<i>Sesbania</i>	30	90.1	58.2	19.9	4442
<i>Sesbania</i>	60	90.5	56.3	19.7	4781
Mungbean	20	89.9	53.7	20.1	4320
Mungbean	40	90.0	61.3	19.8	4582
Cowpea	50	90.4	59.2	20.3	4141
Cowpea	100	90.1	53.2	19.9	4550
No cover crop		90.1	60.2	20.1	4294
CD 5%		NS	NS	NS	NS

m × 6.0 m, respectively. Bispyribac 25 g/ha was applied at 25 DAS followed by one hand weeding at 50 DAS for managing weeds in the rice crop. Data on biomass accumulation by green manure crops and weed infestation (density and dry weight) were recorded at 25 DAS (1 day before 2, 4-DE application). Yield and yield attributes of crop were recorded at harvest. Crop was harvest on 9 November 2009.

Experiment II : Cover Crops Before Mechanically Transplanted Rice in No-Till

A field experiment was conducted at CCS Haryana Agricultural University Regional Research Station, Karnal during *kharif* of 2009. The treatment included three cover crops (*Sesbania*, mungbean and cowpea) with two seed rates (X and 2X) along with check (without cover crop) under no-till after wheat harvest. The X seed for *Sesbania*, mungbean and cowpea were 30, 20 and 50 kg/ha, respectively. The treatments were laid out in randomized block design with three replicates. Sowing of cover crops was accomplished with zero-till seed-cum-fertilizer drill on 23 May 2009 at a row spacing of 18 cm. The cover crops were knocked down by spraying 2, 4-DE 0.5 kg/ha on 27 June (35 DAS) followed by application of paraquat 24SL 0.5% solution on 01 July to kill the pre-emerged weeds. Twenty days old seedlings (mat type nursery) of rice cultivar HKR47 were transplanted with paddy transplanter on 04 July 2009 keeping a spacing of 21 × 17 cm. The crop was raised with all other recommended package of practices of transplanted rice. Bispyribac

Table 4. Effect of different cover crops on green manure biomass production and weed infestation after 30 days under no-till system before machine transplanting of rice in Karnal (Location-1).

Cover crop	Seed (kg/ha)	Biomass of green manure (g/m ²)		Dry weight of weeds (g/m ²)
		Fresh weight	Dry weight	
<i>Sesbania</i>	30	1116	163.1	0.8
Mungbean	30	588	99.4	0.8
Cowpea	50	751	103.2	0
No cover crop		0	0	79

25 g/ha was applied at 25 DAT followed by one hand weeding at 50 DAT for managing weeds in the crop. The gross and net plot size was 10.0 × 7.5 m and 8.0 × 6.5 m, respectively. Data on biomass accumulation by green manure crops were recorded at 34 DAS (1 day before 2, 4-DE application). Density and dry weight of weeds were also recorded at 34 DAS in cover crops and 25 DAT (before spray of bispyrivbac) in rice. Yield and yield attributes of crop were recorded at harvest. Crop was harvested on 29 October 2009.

Farmers' Field Trials on Cover Crops Before Mechanically Transplanted Rice

Unreplicated farmers' field trials were also conducted at village Rambha in district Karnal (Location-1), Antawa (Location.2) and Talakaur (Location-3) in district Yamuna Nagar during *kharif* of 2009. The treatments included three cover crops viz. *Sesbania*, mungbean and cowpea at seed rate of 30, 30 and 50 kg/ha, respectively compared with check (no cover crop) at Location-1, and 45, 30 and 75 kg/ha, respectively at Location-2 and 3. The plot size was 0.1 ha under each treatment at all locations, under no-till after wheat harvest. Sowing of cover crops was accomplished with zero-till seed-cum-fertilizer drill on 21 May 2009 at location-1 and 30 May 2009 at location-2 and 3 keeping a row spacing of 18 cm. The cover crops were knocked down by spraying 2, 4-DE 0.5 kg/ha at 30—35 DAS followed by application of paraquat 24SL 0.5% solution at 35—40 DAS to kill the pre-emerged weeds. Twenty days old seedlings (mat type nursery) of rice cultivar PR114 were transplanted with paddy transplanter on 03 July at loca-

Table 5. Effect of different cover crops on grain yield of rice under no-till in Yamuna Nagar (Locations 2 and 3).

Treatments	Fresh weight (g/m ²)		Dry weight (g/m ²)		Grain yield (q/ha)	
	Loca- tion- 2	Loca- tion- 3	Loca- tion- 2	Loca- tion- 3	Loca- tion- 2	Loca- tion- 3
	<i>Sesbania fb</i> ZT-MTPR	1090	1000	155	145	76.0
Mungbean <i>fb</i> ZT-MTPR	550	495	95	83	75.0	73.5
Cowpea <i>fb</i> ZT-MTPR	695	565	101	87	75.5	74.5
No cover crop <i>fb</i> ZT-MTPR	–	–	–	–	75.0	73.3
No cover crop <i>fb</i> PTR	–	–	–	–	71.0	70.5
No cover crop <i>fb</i> unpuddle MTPR	–	–	–	–	–	73.5

tion-1, 14 July at location-2 and 15 July 2009 at location-3 keeping a spacing of 21 × 17 cm. The crop was raised with all other recommended package of practices of transplanted rice. Data on biomass accumulation by green manure crops were recorded at one day before 2, 4-DE application. Yield and yield attributes of crop were recorded at harvest.

Results and Discussion

Cover Crops Before No-Till Direct Seeded Rice

The maximum biomass production among green manure cover crops was recorded by *Sesbania* at 60 kg/ha seed rate, which was at par with 2X seed rates of mungbean (40 kg/ha) and cowpea (100 kg/ha) (Table 1). There was significant increase in biomass of each cover crop and decrease in weed infestation with increasing seed rate. Minimum density and dry weight of weeds was recorded with *Sesbania* at 60 kg/ha seed rate which was superior to all other treatments except cowpea at 100 kg/ha seed rate. Weed infestation, in general, was significantly reduced due to growing of cover crops as compared to plots where no cover crop was included.

There was no significant impact of different cover crops on the yield and yield attributed of rice, however, the maximum grain yield (1,750 kg/ha) was recorded in the plots with *Sesbania* as cover crop at 60

kg/ha. The minimum grain yield of rice was recorded in the plots without green manure crops (Table 1).

Cover Crops Before Mechanically Transplanted Rice in No-Till

The maximum biomass production among green manure cover crops was recorded by *Sesbania* at 60 kg/ha seed rate, which was superior to all other treatments of cover crops except cowpea at 100 kg/ha (Table 2). There was increase in biomass of each cover crop with increasing seed rate however the differences were more pronounced in case of *Sesbania*. Minimum density and dry weight of weeds before rice transplanting was recorded with *Sesbania* at 60 kg/ha seed rate which was superior to all other treatments except its lower seed rate. Weed infestation, in general, was significantly reduced due to growing of cover crops as compared to plots where no cover crop was included. Increasing seed rates of cover crops resulted into decrease infestation of weeds before rice planting however the differences were not always significant.

Infestation of *Echinochloa* in rice was lowest in the plots where *Sesbania* was taken as preceding cover crop and it was superior to other two cover crops (Table 2). Carry over effect of mungbean and cowpea on infestation of *Echinochloa* in rice was not visible and these were as good as check plots (without cover crops). Infestation of other grassy weeds (*Leptochloa* and *Eragrostis*) in rice was lowest in the plots where mungbean was grown as preceding cover crop and it was superior to other two cover crops. Carry over effect of *Sesbania* and cowpea on infestation of other grassy weeds in rice was not visible and these were as good as check plots (without cover crops). There was no infestation of sedges in rice in the plots where cover crops were grown but there was infestation of sedges in check plots (35/m²). Overall density and dry weight of total weeds in rice was significantly less in the plots where *Sesbania* was grown at X or 2X seed rate and it was superior to other two cover crops. Impact of mungbean and cowpea on density of weeds in rice was less pronounced as compare to dry weight of total weeds.

There was no significant impact of different cover crops on the yield and yield attributed of rice, however, the maximum grain yield (4781 kg/ha) was re-

corded in the plots with *Sesbania* as cover crop at 60 kg/ha (Table 3).

The farmers' field trials indicated that maximum biomass production among green manure cover crops was recorded by *Sesbania fb* cowpea and mungbean at all locations (Tables 4 and 5). At location-1, weed infestation was significantly reduced due to growing of cover crops as compared to plots where no cover crop was included (Table 4).

There was no significant impact of different cover crops on grain yield of rice at location-2 and 3 (Table 5). But compared to manually transplanted rice under puddle condition (conventional), the grain yield of rice was about 3—4 q/ha higher with mechanical transplanting under zero tillage. Grain yield of rice at location-2 could not be recorded.

Conclusion

Among different green manure cover crops before no-till DSR and MTPR in rice-wheat system, *Sesbania* with seed rate of 60 kg/ha was realized most suitable in terms of biomass production and culminating weed infestation during growth period of cover crops and also in succeeding rice crop. Impact of growing *Sesbania* on long-term basis as green manure crop on weed dynamics, and its beneficial effects in terms of improved soil health, micro-flora and grain yield in

rice-wheat cropping system has been well documented (5). Due to lower cost of seed, *Sesbania* would also be more economical than other cover crops. However, to attain higher returns, inclusion of green manure cover crops on long-term basis could be more meaningful.

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