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Effect of bed planting systems and mulching on yield and economics of soybean and wheat in Soybean-Wheat cropping system under water stress condition in dry areas of Punjab

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ABSTRACT

An experiment was conducted at Ludhiana, during *Kharif* and *Rabi* season on loamy sand soil consisting of twelve treatment combination arranged in split plot design and replicated three times with three bed planting, *viz.*, Fresh bed (FB), Permanent bed (PB) and Alternate bed (FB/PB) in main plot two crop residue management *viz*., residue incorporation/ mulching (R) and no incorporation / no mulching (R_0) and two seed rate/ nitrogen level *viz*., 75 kg ha^{-1} (S_{100}) and 93.75 kg ha^{-1} (S_{125}) / 90 kg N ha^{-1} (N_{90}) and 120 kg N ha^{-1} (N_{120}) in sub plot. In soybean treatment, R recorded significantly higher grain (22.60 q ha^{-1}) and straw (44.50 q ha^{-1}) yield as compared to R_0. FB/ PB recorded highest grain (22.60 q ha^{-1}) and straw (43.90 q ha^{-1}) yield followed by PB (21.40 q ha^{-1}) and FB (21.20 q ha^{-1}). S_{125} recorded higher grain (22.30 q ha^{-1}) and straw (44.80 q ha^{-1}) yield then S_{100}. Highest gross return (Rs ha^{-1}), Net return (Rs ha^{-1}), and B:C ratio was also obtained under FB/PB, R and S_{125} treatment as compared to other treatment . In wheat treatment FB recorded highest grain (41.40 q ha^{-1}) and straw (53.60 q ha^{-1}) then FB/PB and PB. R treatment recorded higher grain (41.10 q ha^{-1}) and straw (53.30 q ha^{-1}) yield then R_0. N_{120} treatment recorded higher grain (41.20 q ha^{-1}) and straw (53.30 q ha^{-1}) yield. Highest net return (Rs 29442.20 ha^{-1}) and B:C ratio (2.05) was obtained under PB then FB and FB/PB. R_0 treatment recorded higher net return (Rs 30873.86 ha^{-1}) and B: C ratio (2.15) then R treatment. N_{120} treatment recorded higher net return (Rs 29402.56 ha^{-1}) and B:C ratio (2.0) under water stress condition in dry areas.

KEYWORDS

Fresh Bed, Permanent Bed, Mulching, Yield, Net Return, B: C Ratio

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The bed planting system is found to be potential resource conservation technology which can play a big role to save the scarce natural resources like land and water (25%) and is gaining importance due to number of advantages like better irrigation management, better crop establishment, better light penetration within crop canopy, improve fertilizer use efficiency and reduces crop lodging. The combination of permanent beds and straw as stubble produced higher yield of wheat and increased soil quality by increasing soil microbial carbon than conventional with straw removed or incorporated (Limon *et al.* 2000). Similarly, nitrogen requirement may vary under bed planting as nutrients are collected along the soil under the seeding zone at the time of bed preparation. Moreover, leaching losses of nitrogen fertilizer are minimal in beds as irrigation is applied in furrows. Mulches keep the soil surface cool, wetter and mellower for longer period which may enhance the root and shoot growth of crops. Soil strength decreases with application of crop residue whereas infiltration rate, soil microbial biomass and carbon increase. Hence the present investigation made to find bed plantings, crop residue management and seed rates/nitrogen levels for maximization of the productivity of soybean- wheat system under water stress condition in dry areas of Punjab, India.

MATERIALS AND METHODS

The field trial was conducted with soybean (var. SL 525) wheat (var. PBW 343) system was carried out at the Research Farm, Department of Agronomy, Punjab Agricultural University, Ludhiana, Punjab during kharif and rabi season. The soil of the experimental field was loamy sand in textural, alkaline (pH 8.2) in reaction with low organic carbon (0.33%) content and analyzing low in available N (131.7 kg ha^{-1}), P_2O_5 (13.8 kg ha^{-1}) and K_2O (228.5 kg ha^{-1}). However, twelve treatment combinations arranged in split plot design replicated three times with three bed plantings [Fresh beds (FB),

Permanent beds (PB) and Alternate beds (FB/PB)] in main plots, two crop residue management [Residue incorporation/mulching (R) and No incorporation/No mulching (Ro) and two seed rates/nitrogen levels, 75 kg ha^{-1} (S_{100}) and 93.75 kg ha^{-1} (S_{125})/ 90 kg N ha^{-1} (N_{90}) and 120 kg N ha^{-1} (N_{120})] in sub plots. Sowing of seed was done by drilling (wheat) and manually (Soybean) by using with tractor drawn bed maker-cum planter. Distance of 67.5 cm between centre to centre of bed was the bed size including 37.5 cm bed top and 30 cm furrow. Two rows / bed of each crop were sown as per treatments. Incorporation of *in-situ* available or at 5 t ha^{-1} chopped to about four inch size crop residue was done in fresh beds while the same *in-situ* available crop residue or at 5 t ha^{-1} crop residue was used as mulch in permanent beds. Conventional tillage (one offset disc harrowing followed by two runs of cultivators and planking) was done for preparation of seed bed in fresh beds followed by simultaneous sowing using tractor drawn bed maker-cum planter. While the beds of previous year were not disturbed in permanent beds and only reshaping of the beds was done prior to the sowing of soybean as well as wheat. The seed rate was 75 and 93.5 kg ha^{-1} in soybean (var. SL 525) as per treatment for recommended and 25% higher than recommended seed rate and it was 75 kg ha^{-1} in wheat (var. PBW 343). The seed was treated with captan and bavistin at 3.0 g and 2.5 g kg^{-1} seed of soybean and wheat respectively. Two rows per bed of each crop were sown. In soybean the recommended fertilizer dose of 30 kg N and 80 kg P_2O_5 in the form of urea and single super phosphate and 10 tonnes FYM ha^{-1} was applied before sowing *i.e.* before bed making and before reshaping of permanent beds. While in wheat two levels of 90 kg and 120 kg N ha^{-1} as per treatment and 60 kg P_2O_5 and 30 kg K_2O ha^{-1} were applied in the form of urea, single super phosphate and muriate of potash at the time of bed making/ bed reshaping/ sowing the crop.

RESULTS AND DISCUSSION

Effect of Bed Plantings

Among bed planting FB, crop tended to record higher seed and straw yield of soybean than PB but both are were on par among them being non significant statistically. The better crop yield under fresh beds may be due to higher PAR interception leading to better crop growth besides higher number of pods per plant and higher 100 seed weight. Among bed plantings FB planted crop recoded higher grain yield of wheat 41.4 q ha^{-1} than PB 40.6 q ha^{-1} but both were on par statistically that may be due to greater PAR interception coupled with higher number of grains per ear (Table 1). FB planted crop recoded higher grain yield of wheat than PB was also observed by (Brar *et al.* 2004) in earlier studies. FB planted crop produced higher straw yield of wheat 53.6 q ha^{-1} than PB and FB/PB which was 52.4 q ha^{-1} and 52.8 q ha^{-1} but statistically all were on par. FB planted crop produced higher straw yield of wheat than PB and FB/PB were also reported by (Bhardwaj *et al.* 2004) in their earlier studies. The gross return, net return and B:C ratio was higher under FB/PB which followed by PB and FB (Table 2) in both soybean and wheat. The higher net return was attributed to the higher grain yield with lower cost of cultivation.

Effect of Crop Residue Management/Mulching

The data (Table 1) recorded the crop produced significantly higher seed yield of soybean 22.6 q ha^{-1} under mulching/incorporation (R) treatment compared to 20.8 q ha^{-1} obtained from non-mulching/ no of incorporation (R_0) treatment due to higher number of pods per plant and 100 seed weight. The data (Table 1) recorded the higher grain yield of wheat (41.1 q ha^{-1}) was obtained in residue incorporation (R) treatment than non residue incorporation (R_0) treatment (40.9 q ha^{-1}) due to cumulative effect of better growth and development of the crop. The residue incorporation (R) treatments produced higher straw yield than non residue incorporation (Ro) treatments which was 53.3 q ha^{-1} and 52.6 q ha^{-1} respectively. The gross return, net return and B:C ratio was higher under residue incorporation/mulching treatment than no-incorporation/non-mulching treatment (Table 2) in both soybean and wheat. The higher net return was attributed to the higher grain yield.

Effect of Seed Rates in Soybean

The data (Table 1) showed crop sown with higher seed rate tended to produce higher seed yield than normal seed rates but both were on par statistically which may be due to better crop growth and yield attributing characters. Higher seed yield

Table 1. Yield of soybean and wheat as affected by bed planting, mulching and seed rate / nitrogen level in soybean –wheat system

Treatment	Soybean				Wheat			
	Cost of cultivation (Rs/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	B:C ratio	Cost of cultivation (Rs/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	B:C ratio
Bed Planting								
Fresh bed	28265.80	50389.17	22123.37	1.58	29265.80	58312.00	29046.20	1.99
Permanent bed	26765.80	50150.18	24084.37	1.68	27765.80	57208.00	29442.20	2.05
Alternate bed	28265.80	53661.16	25395.37	1.69	29265.80	57888.00	28622.20	1.97
SE (d)	---	355.66	395.75	0.06	----	329.33	255.20	0.06
CD (p = 0.05)	---	1052.00	1175.00	NS	----	982.00	752.00	NS
Crop Residue Management								
Incorporation/ Mulching	33099.13	53753.00	20653.87	1.62	30765.80	57965.66	27199.86	1.88
No incorporation/ No mulching	29099.13	49514.00	20414.87	1.70	26765.80	57639.66	30873.86	2.15
SE (d)	----	311.00	208.00	0.03	----	285.00	198.00	0.03
CD (p = 0.05)	----	915.00	615.00	NS	----	842.00	585.00	NS
Seed Rate								
Recommended	30817.88	50183.00	19365.12	1.62	28584.53	57255.66	28671.13	2.00
125 % of recommended	31380.38	53084.00	21704.00	1.69	28947.10	58349.66	29402.56	2.01
SE (d)	----	265.66	165.98	0.02	----	155.66	111.00	0.03
CD (p = 0.05)	----	786.00	485.95	NS	----	452.00	315.00	NS

Table 2. Economics of soybean and wheat as affected by bed planting, mulching and seed rate/nitrogen level on quality parameters of soybean and wheat in soybean – wheat system

Treatment	Yield of Soybean		Yield of Wheat	
	Grain yield (q/ha)	Straw yield (q/ha)	Grain yield (q/ha)	Straw yield (q/ha)
Bed Planting				
Fresh bed	21.20	43.10	41.40	53.60
Permanent bed	21.40	42.40	40.60	52.40
Alternate bed	22.60	43.90	41.10	52.80
SE (d)	0.52	0.55	0.69	0.73
CD (P = 0.05)	NS	NS	NS	NS
Crop Residue Management				
Incorporation/ Mulching	22.60	44.50	41.10	53.30
No incorporation/ No mulching	20.80	41.80	40.90	52.60
SE (d)	0.45	0.68	0.51	0.53
CD (P = 0.05)	1.22	1.94	NS	NS
Seed Rate/Nitrogen Level				
Recommended /N_{90}	21.10	41.50	40.80	52.60
125 % of recommended/ N_{120}	22.30	44.80	41.20	53.30
SE (d)	0.25	0.68	0.48	0.44
CD (P = 0.05)	NS	1.94	NS	NS

with higher seed rate was obtained by Rajput and Shrivastava (1999) in their earlier studies. The significantly more straw yield was obtained from the crop under higher seed rate (S_{125}) than normal seed rate (S_{100}) that may be due to higher light interception. Gross return, net return and B:C ratio was higher under higher seed rate than normal seed rate (Table 2). The significantly higher net return was attributed due to the higher grain yield under S_{125}.

Effect of Nitrogen Levels in Wheat

The data (Table 1) showed that higher grain yield of 41.2 q ha^{-1} was obtained under the application of 120 kg N ha^{-1} (N_{120}) than 40.8 q ha^{-1} under 90 kg of applied N ha^{-1} (N_{90}) but both N levels were on par statistically. The tendency of higher yield under higher N dose may be the result of better crop growth and yield attributing characters. Although the more straw yield was obtained under 120 kg of applied N ha^{-1} (N_{120}) than 90 kg ha^{-1} (N_{90}) which was 53.3 q ha^{-1} and 52.6 q ha^{-1} respectively. Gross return, net return and B: C ratio was higher under N_{120} than N_{90} treatment (Table 2). The significantly higher net return was attributed due to the higher grain yield under N_{120}.

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