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Bioefficacy of herbicides in relation to sowing methods in wheat

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ABSTRACT

A field experiment was conducted at Ludhiana during 2009-10 and 2010-11, study the effect of sowing methods and herbicides on weed dynamics and productivity of wheat (*Triticum aestivum* L.). Sowing methods, *viz*. bed planting, zero till, conventional till and stubbled sowing did not influence densities and dry matter accumulation of narrow- and broad-leaved weeds. Averaged over two seasons, bed planting, zero till and conventional till sowing methods recorded similar wheat grain yield and were statistically superior to stubbed sowing. Wheat grain yield under bed planting, zero till and conventional till methods was 25.4, 46.2 and 40.8% higher as compared to stubbled sowing. Among weed control, post-emergence application of carfentrazone + sulfosulfuron 45 g, metsulfuron + sulfosulfuron 30 g and fenoxaprop-p-ethyl + metribuzin 275 g/ha recorded complete control of all the narrow- and broad-leaved weeds. Mesosulfuron + iodosulfuron 12 g, sulfosulfuron 25 g, pinoxaden 50 g and clodinafop 60 g/ha recorded effective control of narrow-leaved weeds only. All these herbicidal treatments, except fenoxaprop-p-ethyl + metribuzin 275 g/ha, recorded significantly higher wheat grain yield as compared to unsprayed control. Fenoxaprop-p-ethyl + metribuzin was phototoxic to wheat plants and wheat grain yield was at par to weedy check.

Key words: Chemical control, Herbicides, Tillage, Weed dynamics, Wheat

Wheat is the most widely grown winter cereal and is the backbone of food security in India. The productivity and economic gains of wheat are reducing consistently. Excessive tillage and soil degradation limit the wheat productivity particularly under rice-wheat cropping system (Hobbs *et al*. 1997). Severe weed infestation is another formidable factor (Pandey *et al*. 2006). Yield reduction due to weeds in wheat vary from 15-50%, depending upon the weed density and type of weed flora (Jat *et al*. 2003). Selective herbicides effectively control weeds in wheat. However, continuous use of same herbicide or herbicide having similar mode of action results in weed flora shifts and evolution of resistance in weeds. Thus, their judicious use is important for getting long-term benefits. In this context, integrated use of herbicides with other weed control tools may help in solving the problems of weed shift and herbicide resistance. Tillage and establishment method are effective tools which, if used in integration with herbicides, can help in diverting the competition in favour of wheat.

Zero tillage (ZT) technology in wheat has already proven its worth in the rice-wheat cropping system and is being followed on nearly 2.1 million ha area of Indo-Gangetic plains of India (Yadav *et al.* 2009). It saves time and energy. Zero till seeding with Happy Seeder machine combines the stubble mulching and seed drilling functions into one machine and suppresses the weeds. The raised bed planting of wheat permits use of mechanical hoeing with tractor and encounters lesser population and dry weight of weeds as compared to conventionally flat sown wheat (Dhillon *et al*. 2005). Altering tillage practices change, weed seed depth in the soil which play a major role in weed species shifts and affects the efficacy of control practice. Hence, the current study was undertaken to find out the effect of tillage and herbicides on weed dynamics and productivity of wheat in rice-wheat system.

MATERIALS AND METHODS

A field experiment was conducted at Punjab Agricultural University, Ludhiana during *Rabi* 2009-10 and 2010-11. The experiment field was sandy loam, normal in reaction and low in organic carbon (0.31%), low in available N (225.8 kg/ha) and medium in available P (16.9 kg/ha) and K (128.9 kg/ha). The experiment was laid out in a split-plot design with sowing methods in main plot and weed control treatments in subplots. In 2009-10, four methods of sowing (stubbled, zero tillage (ZT), bed sowing (BS) and conventional tillage (CT) and seven weed

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control treatments, *viz.* pinoxaden 50 g, sulfosulfuron + metsulfuron 30 g + surfactant, mesosulfuron + iodosulfuron 12 g + surfactant, sulfosulfuron 25 g + surfactant, fenoxaprop-p-ethyl + metribuzin 275 g, carfentrazone + sulfosulfuron 45 g/ha + surfactant and unsprayed control were evaluated. In 2010-11, three methods of sowing (stubbled, ZT and CT) and six weed control treatments, *viz.* sulfosulfuron 25 g + surfactant, clodinafop 60 g, sulfosulfuron + metsulfuron 30 g + surfactant, mesosulfuron + iodosulfuron 12 g + surfactant, fenoxaprop-p-ethyl + metribuzin 275 g, carfentrazone + sulfosulfuron 45 g/ha + surfactant and unsprayed control were evaluated. Wheat cv '*PBW 550*' was seeded on 26 November 2009 and 30 November 2010 with tractor drawn wheat seeding drills as per treatment using 100 kg seed/ha. Recommended doses of N (125 kg/ha), P (27.5 kg P_2O_5/ha) and K (25 kg K_2O/ha) were applied through urea, diammonium phosphate and muriate of potash, respectively. Whole of phosphorous and potassium and half of N were applied at sowing and remaining N was applied with first irrigation. The wheat crop was sown after raising non-experimental crop of rice by managing rice straw for stubbled sowing treatments. Sowing of wheat in standing stubbles was done with 'Happy-seeder'. In zero tillage, the crop was directly sown in the field with zero-till drill. In bed planting, the field was prepared as per conventional tillage technique followed by preparation of beds with bed planter which were 67.5 cm wide (37.5 cm bed top and 30 cm furrow) and sowing of wheat was done in two rows 20 cm apart on the bed top. Ordinary drill was used for sowing of wheat in CT treatment. Herbicides were applied as post-emergence (after first irrigation) 30 days after sowing at their respective doses as per treatment. Spraying was done with the help of knapsack sprayer fitted with flat-fan nozzle using 250 liter of water/ha. Population and dry matter of both narrow- and broad-leaved weeds was taken from a quadrate measuring 30 x 30 cm, at harvest. Weed data were subjected to square root transformation before statistical analysis.

RESULTS AND DISCUSSION

Weed

Weed flora varied in both seasons. In 2009-10, narrow-leaved weeds and in 2010-11 broad-leaved weeds dominated. *Phalaris minor* (55%), *Avena ludoviciana* (5%) among grasses and *Chenopodium album,* (12%), *Medicago denticulata* (11%), *Rumex dentatus* (6%), *Trigonella polycerata* (2%), *Melilotus indica/Melilotus alba* (2%), *Rumex spinosus* (1%) and *Anagallis arvensis* (2%) among broad-leaved were major weeds in the experimental field.

Sowing methods did not influence densities and dry matter accumulation of narrow and broad-leaved weeds during both the years (Table 1 and 2). Among weed control treatments, carfentrazone + sulfosulfuron 45 g, metsulfuron + sulfosulfruon 30 g and fenoxaprop-p-ethyl + metribuzin 275 g/ha recorded complete control of all the narrow and broad-leaved weeds during both the years. Weed control efficacy under these treatments varied from 93 to 100%. Mesosulfuron + iodosulfuron 12 g and sulfosulfuron 25 g/ha recorded effective control of narrow-leaved weeds during both the years, however, their performance against broad-leaved weeds was relatively poor during 2009-10. Pinoxaden 50 g and clodinafop 60 g/ha recorded effective control of narrow-leaved weeds only as these are basically grass herbicides. Weed control efficacy varied from 58 to 63%.

Crop

During 2009-10, wheat plants planted on bed, recorded significantly longer panicles as compared to stubbled sowing. ZT and CT were also at par with bed planting (Table 1 and 2). During 2010-11, ZT recorded taller plants having longer panicles and higher number of effective tillers and was statistically better over stubbled sowing method. Among weed control treatments, all the herbicidal treatments except fenoxaprop-p-ethyl + metribuzin 275 g/ha recorded significantly taller plants as compared to unsprayed control. Fenoxaprop-p-ethyl + metribuzin was phytotoxic to wheat plants and reduced the plant height during both the years though the crop recovered after 25 days, the effective tillers were significantly reduced even as compared to unsprayed control during 2010-11. Carfentrazone + sulfosulfuron 45 g, metsulfuron + sulfosulfuron 30 g and mesosulfuron + iodosulfuron 12 g/ha recorded significantly taller plants having longer panicles during both the years as compared to unsprayed control. The effective tillers were significantly lower under pinoxaden 50 g and clodinafop 60 g and sulfosulfuron 25 g/ha as compared to the above treatments. Toxicity of metribuzin on wheat plants particularly at higher doses had been reported earlier (Pandey *et al.* 2002, Singh *et al.* 2004).

Averaged over two years, bed planting, zero till and conventional till sowing method recorded similar wheat grain yield and were statistically superior to stubbed sowing method. Wheat grain yield under bed planting, ZT and CT were 25.4, 46.2 and 40.8% higher as compared to stubbled sowing method (Table 1 and 2). All the herbicides, except fenoxaprop-p-ethyl + metribuzin 275 g/ha, during 2010-11 gave significantly higher grain yield as

Table 1. Effect of sowing method and weed control on weed dry matter, growth and grain yield of wheat during 2009-10

Treatment	Dose (g/ha)	Effect on weeds					Effect on crop			
		PNW	PBW	DNW	DBW	WCE	PH	ET	PL	GY
Sowing method										
Stubbled	-	1.14 (0.35)	1.07 (0.15)	149.2	123.2	-	55.2	37.5	9.1	3.23
Zero tillage (ZT)	-	1.14 (0.33)	1.07 (0.15)	161.2	121.0	-	56.2	46.3	9.3	3.78
Bed planting (BP)	-	1.07 (0.17)	1.09 (0.18)	132.5	125.4	-	58.8	56.3	9.5	4.05
Conventional tillage (CT)	-	1.10 (0.24)	1.09 (0.22)	139.2	125.4	-	54.6	48.5	9.4	3.47
LSD (P=0.05)	-	NS	NS	NS	NS	-	NS	NS	0.3	0.59
Weed control										
Pinoxaden	50	1.26 (0.61)	1.23 (0.50)	201.6	169.5	51.0	56.3	44.2	8.7	3.55
Sulfosulfuron + metsulfuron	30	1.00 (0.00)	1.00 (0.00)	0	0	100.0	57.3	48.8	9.8	3.94
Mesosulfuron + iodosulfuron	12	1.09 (0.21)	1.00 (0.00)	127.6	0	89.2	57.4	51.6	9.2	3.71
Sulfosulfuron	25	1.06 (0.15)	1.00 (0.00)	117.8	0	93.9	58.1	48	9.8	3.86
Fenoxaprop-p-ethyl + metribuzin	275	1.05 (0.13)	1.00 (0.00)	116.6	0	94.7	54.8	47.7	9.7	3.68
Carfentrazone + sulfosulfuron	45	1.02 (0.05)	1.00 (0.00)	108.1	0	97.5	57.5	50.5	9.8	4.09
Unsprayed control	-	1.40 (0.96)	1.33 (0.77)	334.9	219.0	-	51.9	35.5	7.8	2.46
LSD (P=0.05)	-	0.08	0.03	23.4	25.0	-	2.9	6	0.4	0.44

*Values given in parentheses are original values

PNW - Population of narrow-leaved weeds (no./m^2), PBW - Population of broad-leaved weeds (no./m^2), DNW - Dry matter of narrow-leaved weeds (kg/ha), DBW - Dry matter of broad-leaved weeds (kg/ha), WCE - Weed control efficiency (%), PH - Plant height (cm), ET - Effective Tillers (no./mrl), PL - Panicle length (cm), GY - Grain yield (t/ha)

Table 2. Effect of sowing method and weed control on weed dry matter, growth and grain yield of wheat during 2010-11

Treatment	Weeds					Wheat			
	PNW	PBW	DNW	DBW	WE	PH	ET	PL	GY
Sowing method									
Conventional tillage (CT)	1.5 (2.9)	2.2 (7.9)	58.0	127.0	-	65.9	55.8	10.0	3.45
Zero tillage (ZT)	1.7 (3.7)	3.2 (15.7)	74.1	251.5	-	65.9	58.2	10.2	3.55
Stubbled	1.8 (4.6)	3.5 (20.8)	93.3	333.3	-	59.4	44.4	9.8	2.43
LSD (p=0.05)	NS	NS	NS	NS	-	3.1	4.0	0.3	0.37
Weed control									
Sulfosulfuron	1.0 (0.0)	3.6 (15.4)	0	247.1	76.4	65.7	56.4	10.2	3.50
Clodinafop	1.4 (2.5)	4.3 (24.3)	49.2	389.2	58.2	65.9	49.1	10.1	3.38
Sulfosulfuron + metsulfuron	1.0 (0.0)	1.0 (0.0)	0	0	100.0	66.7	60.7	10.3	3.63
Mesosulfuron + iodosulfuron	1.9 (4.9)	2.6 (14.6)	99.5	234.1	68.2	63.2	59.4	9.8	3.41
Fenoxaprop-p-ethyl + metribuzin	1.0 (0.0)	1.0 (0.0)	0	0	100.0	52.3	36.9	9.4	2.19
Carfentrazone + sulfosulfuron	1.0 (0.0)	1.8 (7.3)	0	117.3	88.8	68.9	62.7	10.4	3.72
Unsprayed control	4.4 (18.8)	6.4 (42.0)	376.6	672.3	-	63.3	44.3	9.9	2.17
LSD (P=0.05)	0.9	2.1	132.0	273.0	-	4.7	5.1	0.5	0.54

*Original values are in parentheses

compared to unsprayed control. Averaged over two years, the increase in wheat grain yield with herbicides varied from 80.2 to 59.9% as compared to unsprayed plot. Effective control of narrow and broad-leaved weeds with herbicides increased the number of effective tillers and the wheat plant produced longer panicles and the wheat yield increased. Though fenoxaprop + metribuzin recorded complete control of all the weeds during both the years, its phototoxicity to wheat plants reduced the grain yield. Higher broad-leaved weed pressure reduced the wheat grain yield in pinoxaden treatment. Efficacy of above herbicides in wheat crop has been reported earlier (Dhillon *et al*. 2005, Singh 2007). The interaction effects between methods of sowing and weed control treatments for grain yield were non-significant. The lower wheat grain yields during both the years were attributed to late sowing and attack of yellow rust.

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