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RESEARCH NOTE

Weed management in zero-till wheat grown after greengram

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ABSTRACT

An experiment was conducted on zero-till (ZT) wheat grown after greengram at Jhansi during 2019-20. Broad-leaved weeds dominated (90-95%) the field, with limited occurrence of grassy weeds (5-10%). Weed density was higher under conventional tillage (CT) than ZT. Wheat grain yield was the highest under ZT, but there was no effect of greengram residue along with ZT. Pre-emergence application (PE) of pendimethalin followed by (*fb*) post-emergence application (PoE) of sulfosulfuron provided effective control of weeds, and improved weed control efficiency (88.2–90.5%). Herbicidal efficiency index also was maximum with pendimethalin PE *fb* sulfosulfuron PoE. The improved profitability with enhanced productivity of wheat can be achieved with ZT with application of glyphosate before sowing wheat after greengram and usage of sulfosulfuron PoE for controlling weeds. The greengram residues along with ZT may prove beneficial in the long-run.

Keywords: Greengram, Sulfosulfuron, Weed management, Wheat, Zero tillage

Wheat (*Triticum aestivum* L. emend Fiori & Paol.) is predominantly grown in sequence with greengram (*Vigna radiata* (L.) R. Wilczek), blackgram (*Vigna mungo* (L.) Hepper), sesame (*Sesamum indicum* L.) or groundnut (*Arachis hypogaea* L.) in the Bundelkhand region. The acreage under wheat has increased over time at the cost of traditional pulse and oilseed crops due to availability of irrigation in most areas (Yadav 2021). The late sowing of wheat from the end of November up to the beginning of January, broadcast sowing of seed, weed infestation, inadequate fertilization and low varietal replacement rate are responsible for low yields (~3 t/ha) in the Bundelkhand region (Sharma *et al.* 2020). Conventional tillage involving repeated ploughing of the land also leads to delayed sowing. Zero tillage is known to advance sowing of wheat (Sharma 2021), and influences weed infestations significantly (Saharawat *et al.* 2010). Zero tillage along with residue retention led to higher wheat yields over conventional tillage in north-western India (Brar and Walia 2007, Kumar *et al.* 2017). The pre-emergence application (PE) of pendimethalin and post-emergence application (PoE) of 2,4-D, metsulfuron, sulfosulfuron, pinoxaden and clodinafop or their mixtures are recommended for weed control in wheat (Dawson *et al.* 2008, Manhas 2017). However, information is scanty on the efficacy of recommended herbicides to manage weeds in zero tillage wheat grown after greengram in the Bundelkhand region. Hence, this study was conducted to assess the effect of tillage and weed management practices on wheat productivity and profitability.

An experiment was conducted during 2019–20 at the research farm of Rani Lakshmi Bai Central Agricultural University, Jhansi on loamy soil, low in organic C (0.47%) and available N (255 kg/ha), and medium in available P (17 kg/ha) and K (245 kg/ha). A uniform crop of greengram was grown during *Kharif* (rainy) season (mid-July to mid-October), after which the experimental wheat was grown in *Rabi* (winter) season (third week of November 2019 to early April 2020) with a total of twelve treatment combinations involving three tillage practices, *viz.* conventional tillage (CT) (3 ploughings with harrow and cultivator), zero tillage (ZT) (no ploughing), and ZT + greengram residue 3 t/ha retention (ZT+R); and four weed management practices, *viz.* pendimethalin PE 1.0 kg/ha, pendimethalin PE followed by (*fb*) sulfosulfuron PoE 25 g/ha, pendimethalin *fb* hand weeding (HW) at 30 days after sowing (DAS), and unweeded control. A randomized block design with 3 replications was used with plot size of 45 m^2.

Wheat cv. HI 1544 was sown on 19 November, 2019 with Happy Seeder using seed rate of 100 kg/ha at 20 cm row spacing. In all the ZT plots, glyphosate 1.0 kg/ha was sprayed before sowing. Application of 50 kg N/ha along with 25.8 kg P and 32.2 kg K/ha

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was done as basal placement with seed drill, and 50 kg N/ha was applied as top dressing after first irrigation. Besides a pre-sowing irrigation, three irrigations were given at 21, 54 and 86 DAS. Harvesting was done on 3 April 2020 (134 DAS). Observations were recorded on species-wise weed density and tillering of wheat at 30 days interval. Wheat yield was recorded from net plot area of 20 m^2, and various efficiency indices were worked out as per standard procedures.

Effect on weeds

The major dominant weeds in the experimental field included: *Medicago denticulata, Anagallis arvensis, Melilotus alba, Coronopus didymus, Spergula arvensis, Cynodon dactylon* and *Cyperus rotundus* **(Table 1)**. *M. denticulata* and *A. arvensis* emerged at the early stages of crop (30 DAS), while the other species *M. alba, C. didymus* and *S. arvensis* appeared at the later stages of crop growth. Perennial grassy weeds like *C. dactylon* and sedges like *C. rotundus* occurred in lesser density. Total weed density was maximum at 30 DAS and decreased at 60 and 90 DAS **(Table 2)**. ZT+R showed significantly lower weed density than ZT alone, both of which were superior to CT. The highest weed density under CT was possibly due to intensive ploughing of the land, bringing weed seeds from lower soil layers to the surface and also improving their germinability due to exposure to light and temperature (Shyam *et al.* 2009). However, the weed seeds lying near the surface under ZT emerged in the first flush and there was no emergence from the seeds lying below the surface layer (Brar and Walia 2009). These initial findings are in contrast to the conventional opinion of increased weed infestations under ZT systems.

At 60 DAS, weed density decreased drastically with sulfosulfuron PoE and HW at 30 DAS **(Table 2)**. A similar trend was observed at 90 DAS, with superior weed control by sulfosulfuron PoE than HW. Weed density with pendimethalin PE remained on par with unweeded control at all the sampling intervals as pendimethalin was a grassy weed killer and did not have effect on the broad-leaved species in the field (Chhokar *et al.* 2012). This suggests that the choice of herbicide for weed control should be based on the predominating weed flora. Sulfosulfuron PoE has been recommended for the control of isoproturon-resistant *Phalaris minor* (Kumar *et al.* 2007, Chhokar *et al.* 2012), and it was also found effective to control the broad-leaved weeds in the present study.

Effect on wheat

Emergence of wheat was equal under ZT and CT, and higher than ZT+R **(Table 2)**. Normally, the emergence of seeds is similar irrespective of tillage if sowing is done in optimum soil moisture at the desired soil depth using a well-calibrated seed drill. Rice residue load of 5.0–7.5 t/ha had no adverse effect on germination of ZT wheat (Chhokar *et al.* 2009, Kumar *et al.* 2013), but greengram residue 3 t/ha was fibrous and also not well dried, which

Table 1. Relative dominance (%) of weed species in unweeded check at different growth intervals of wheat

Days after wheat seeding (DAS)	*Medicago denticulata*	*Melilotus alba*	*Anagallis arvensis*	*Coronopus didymus*	*Spergula arvensis*	*Cynodon dactylon*	*Cyperus rotundus*
30	75.5	3.6	9.8	0.0	0.0	2.1	8.8
60	52.0	16.0	7.8	6.1	13.1	2.2	2.3
90	43.8	7.7	28.9	6.3	7.6	2.5	2.7

Table 2. Effect of tillage and weed management on weed density and crop growth at different stages of wheat

Treatment	Weed density (no./m^2)			Wheat emergence count at 15 DAS (no./m^2)	Tillers/m^2			Plant height at maturity (cm)
	30 DAS	60 DAS	90 DAS		30 DAS	60 DAS	90 DAS	
Tillage								
ZT	261.0	170.1	166.6	147.0	221.6	462.0	365.4	108.3
ZT+R	240.0	96.9	89.8	136.1	208.7	456.6	358.7	107.6
CT	307.1	219.5	208.8	149.7	235.0	450.0	350.8	107.9
LSD (p=0.05)	24.0	14.2	13.4	8.6	18.6	NS	NS	NS
Weed management								
Pendimethalin PE	268.5	265.4	248.2	144.3	216.6	427.7	323.8	108.1
Pendimethalin PE *fb* sulfosulfuron PoE	266.8	32.1	34.6	146.5	222.7	504.3	416.6	107.4
Pendimethalin PE *fb* HW	259.0	75.5	81.4	144.1	226.1	483.3	382.7	108.3
Unweeded control	283.2	275.6	256.1	142.3	221.7	409.4	310.0	107.6
LSD (p=0.05)	NS	10.7	9.1	NS	NS	31.6	23.7	NS

*PE = pre-emergence application, PoE = post-emergence application, HW = hand weeding, ZT = zero tillage, CT = conventional tillage, R = residue retention, *fb* = followed by

intermingled with the tines of Happy Seeder and blocked the pores occasionally during sowing. Number of tillers/m^2 at 30 DAS was also significantly lower under ZT+R than ZT and CT but recovered in later stages, resulting in non-significant differences among tillage treatments at 60 and 90 DAS. The wheat crop under ZT+R looked less vigorous for about a month but the growth picked up after first irrigation and top dressing of N fertilizer.

There was no effect on tillers/m^2 at 30 DAS due to weed management treatments **(Table 2)**. However, at 60 and 90 DAS, pendimethalin PE *fb* sulfosulfuron PoE was the best followed by pendimethalin PE *fb* HW, both of which were significantly superior to pendimethalin PE and unweeded check, which remained at par with each other. Tillering improved after 30 DAS when weeds were controlled by sulfosulfuron PoE or HW. Nonetheless, the differences in plant height at maturity remained non-significant with tillage and weed management practices.

Mean grain yield of wheat was the highest under ZT and on par with ZT+R, but was significantly higher than CT **(Table 3)**. Similarly, pendimethalin PE *fb* sulfusulfuron PoE was significantly superior to pendimethalin PE *fb* HW, both of which were vastly superior to pendimethalin PE alone and unweeded control. The mean loss in wheat grain yield due to weeds was 17.7%. Interaction data revealed that the highest grain yield was obtained with pendimethalin PE *fb* sulfosulfuron PoE under ZT. This suggests that ZT should be accompanied with efficient weed control for achieving higher wheat productivity. The greengram residue effect was not observed in the first year of experimentation but it is likely to prove beneficial in the long-run due to improvement in soil fertility besides moisture conservation and weed control (Kumar *et al.* 2017). Straw yield was not influenced significantly with tillage, but pendimethalin PE *fb* sulfosulfuron PoE or HW was superior in increasing wheat straw yield over pendimethalin PE alone and unweeded control.

Effect on efficiency indices

Harvest index was relatively higher under ZT than CT, and with pendimethalin PE *fb* sulfosulfuron PoE or HW compared with pendimethalin PE alone and unweeded control **(Table 3)**. Weed control efficiency (WCE) based on weed density was very low (0.8–4.9%) with pendimethalin PE alone, but improved (to 88.2–90.5%) when sulfosulfuron PoE was sprayed at 30 DAS. However, HW failed to provide complete control of the weeds, especially those along the crop rows and thus resulted in lower WCE (59.2–80.2%). Herbicidal efficiency index (HEI), which is the ratio of percent increase in grain yield and percent weed weight in the treatment, was maximum (1.85–2.10) with pendimethalin PE *fb* sulfosulfuron PoE at 30 DAS. This suggests that pendimethalin PE *fb* sulfosulfuron PoE was the best treatment to control all weeds effectively leading to higher grain yield, which resulted in increased HI, WCE and HEI. ZT with or without residue was superior to CT in improving the efficiency indices.

Economics

The highest net B:C was obtained under ZT, which decreased when greengram residue was also applied along with ZT due to its inclusion in the cost of cultivation and no increase in yield **(Table 3)**. However, both these treatments were superior to CT. The highest returns were under pendimethalin PE *fb* sulfosulfuron PoE, and superior to pendimethalin PE *fb* HW.

Table 3. Effect of tillage and weed management on wheat yield, B:C ratio, weed control efficiency and herbicidal efficiency index

Treatment	Grain yield (t/ha)	Straw yield (t/ha)	Harvest index (%)	Net B:C ratio	Weed control efficiency (%)	Herbicidal efficiency index
Tillage						
ZT	4.64	6.43	41.8	2.18	52.1	0.83
ZT+R	4.46	6.34	41.1	1.81	56.4	0.97
CT	4.22	6.16	40.6	1.61	51.5	0.84
LSD (p=0.05)	0.29	NS	-	-	-	-
Weed management						
Pendimethalin PE	4.12	6.04	40.5	1.72	3.2	0.015
Pendimethalin PE *fb* sulfosulfuron PoE	4.92	6.71	42.2	2.07	89.0	1.95
Pendimethalin PE *fb* HW	4.66	6.50	41.7	1.78	67.9	0.68
Unweeded control	4.05	5.99	40.3	1.88	-	-
LSD (p=0.05)	0.12	0.19	-	-	-	-

PE = pre-emergence application, PoE = post-emergence application, HW = hand weeding, ZT = Zero tillage, CT = conventional tillage, R = residue retention, *fb* = followed by

It was concluded that improved productivity and profitability of wheat can be achieved by growing wheat under zero tillage after greengram with application of glyphosate before sowing and pendimethalin PE *fb* sulfosulfuron as post-emergence for controlling weeds, in the Bundelkhand region.

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