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RESEARCH NOTE

Bio-efficacy of herbicide admixtures against composite weed flora in wheat under three methods of wheat seeding

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ABSTRACT

The field experiment was conducted with an objective to assess the bio-efficacy of herbicide admixtures against composite weed flora in wheat (*Triticum aestivum*) under three methods of wheat seeding. It was conducted at Students' Research Farm, Khalsa College, Amritsar during *Rabi* season of 2020-21 in split-plot design, replicated thrice, with three methods of sowing, *viz.* conventional tillage, super seeder and happy seeder in main plots and seven weed management treatments in sub-plots, *viz*. pinoxaden + clodinafop, fenoxaprop + metribuzin, metsulfuron-methyl + carfentrazone-ethyl + NIS, pendimethalin *fb* pinoxaden + metsulfuron-methyl, isoproturon + 2,4-D, weed free and weedy. Among the different methods of wheat seeding, greater weed density and biomass was observed in happy seeder sown wheat than the super seeder sown wheat, while the maximum weed density and biomass was observed in wheat sown with conventional tillage. Super seeder sown wheat recorded highest grain and straw yields as well as net return and B:C ratio. Among the various weed control treatments, pre-emergence application (PE) within 2 days after wheat sowing (DAS) of pendimethalin 900 g/ha followed by (*fb*) post-emergence application (PoE) at 35 DAS of pinoxaden + metsulfuron-methyl 60 g/ha enhanced of growth, yield and benefit cost ratio of wheat which was at par with weed free, pinoxaden + clodinafop-propargyl 70 g/ha PoE and fenoxaprop + metribuzin 110 g/ha and significantly better than metsulfuron-methyl 4 g/ha + carfentrazone-ethyl 25 g/ha (PoE), isoproturon 750 g/ha + 2,4-D 500 g/ha PoE as compared to weedy check. Pendimethalin 900 g/ha PE *fb* pinoxaden + metsulfuron-methyl 60 g/ha PoE recorded the maximum wheat grain (5.42 t/ha), net returns (Rs. 87373/-) and B:C ratio (2.04).

Keywords: Herbicide, Happy seeder, Methods of seeding, Pinoxaden + metsulfuron-methyl, Super seeder, Tillage, Weed management, Wheat

Wheat (*Triticum aestivum* L.) is a *Rabi* season crop which covers large area in world. In Punjab, the total area under wheat cultivation was 35.30 lakh hectares during 2020-21 with production of 171.8 lakh tonnes and an average yield of 4.87 t/ha (Anon 2021). Excessive tillage is used in the traditional method of wheat establishment, which involves greater time and energy (Tripathi *et al.* 2002). After transplanted rice is harvested, the seeding of wheat is typically postponed since conventional systems require extensive tillage to prepare the seed bed. This results in reduced crop duration, equivalent to an extent of 1.0-1.5% yield loss/hectare/day (Gathala *et al.* 2011).

A number of biotic and abiotic factors directly affect wheat crop productivity. Of them, weed infestation is the most limiting biological limitation. The yield losses of wheat vary between 17-30% annually (Rao and Chauhan 2015). Weed problem is one of the major barriers responsible for low productivity of wheat as weeds competes with the crop for moisture, nutrients, space, light etc. Wheat is infested by both grass and broad-leaved weeds. The dominant weeds noted in wheat field are *Phalaris minor*, *Rumex dentatus*, *Rumex spinosus*, *Chenopodium album*, *Anagallis arvensis, Avena fatua, Convolvulus arvensis, Euphorbia helioscopia* and *Cannabis sativa*. *Phalaris minor* is one of the very serious weeds in wheat and sometimes almost 100% crop losses have been reported by Singh and Singh (2005). Due to increased soil strength, the no-till wheat system under the rice wheat system decreased the infestation of *Phalaris minor*, but it increased the infestation of broad-leaved weeds such as *Medicago denticulate*, *Malva parviflora*, and *Rumex dentatus*. Hence, the use of herbicides could be the only way to check the weeds and improve the wheat yields. Weed management with herbicide usage increased grain yield as compared to weedy and hand weeding treatments (Amin *et al.* 2008). Combination of herbicides that manage both grassy and broad-leaved weeds was better than their sole application for

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weed control in wheat (Shahzad *et al.* 2016). Pre-mixed broad-spectrum herbicide is cost-effective against complex weed flora (Patel *et al.* 2017). In this study, the efficacy of combination of tank-mix or as pre-mix pre- and post- emergence herbicide were evaluated in sequence for managing weeds to attain higher growth and yield of wheat, under different methods of wheat establishment.

The field study was carried out during *Rabi* season of year 2020-2021 at Khalsa College, Amritsar (Location 31.63°E and 74.87°N, 234 meters above mean sea-level). A split plot design with three replications was used. The main plot treatments comprised of three sowing methods, *viz.* conventional tillage, super seeder and happy seeder whereas, treatments in sub plots include: post-emergence application (PoE) of pinoxaden + clodinafop-propargyl 70 g/ha; fenoxaprop + metribuzin 110 g/ha PoE; metsulfuron-methyl 4 g/ha + carfentrazone-ethyl 25 g/ha PoE + non-ionic surfactant (NIS); pre-emergence application (PE) of pendimethalin 900 g/ha followed by (*fb)* pinoxaden + metsulfuron-methyl 60 g/ha PoE; isoproturon 750 g/ha + 2,4-D 500 g/ha PoE; weed free and weedy check. The wheat variety "Unnat PBW343" was sown and recommended doses of fertilizers were applied. Pre-emergence application of herbicide was done with flood-jet nozzle by using a spray volume of 500 l/ha and post-emergence herbicides were sprayed with flat-fan nozzle using a spray volume of 375 l/ha. The pre-emergence application of herbicides was done within 2 days after sowing (DAS) and post-emergence herbicides were sprayed at 35 DAS Weedy check plots remained infested with native weeds till harvest. Observation on weed density and dry matter accumulation (weed biomass) were recorded using quadrat of 30 cm × 30 cm placed randomly at 4 places in each plot at 30, 60 and 90 days after herbicide application. Total number of weeds falling inside each quadrat were counted and cut at ground level for collecting weed biomass data. The sample were first dried in sun and after that oven dried at constant temperature 65 ^{0}C. The dried samples were weighed and expressed as weed biomass (g/m^2). Data on weeds were subjected to square-roots transformation to normalize their distribution. The grain yield recorded in kg/plot was finally converted into grain yield kg/ha and then into q/ha. The pair comparison of treatment mean was done using LSD value 5% level of significance.

Weed density

The weed density was not affected by wheat establishment methods (**Table 1**). However, amongst the weed management treatments, weed density was minimum with pendimethalin *fb* pinoxaden + metsulfuron followed by pinoxaden + clodinafop-propargyl, fenoxaprop + metribuzin, metsulfuron-methyl + carfentrazone-ethyl + NIS and isoproturon + 2,4-D. The percentage decrease in weed density, at wheat harvest, caused by weed management treatments was 93.46 %, 93.07%, 87.83%, 97.59%, 76.74% and 100% with pinoxaden + clodinafop-propargyl, fenoxaprop + metribuzin, metsulfuron-

Table 1. Effect of wheat seeding methods and weed management treatments on weed density and biomass of narrow-leaved weeds and broad-leaved weeds

Treatment	Weed density (no./m^2) (Narrow-leaved weeds) at 60 DAS	Weed density (no./m^2) (Broad-leaved weeds) at 60 DAS	Weed biomass (q/ha) (Narrow-leaved weeds)	Weed biomass (q/ha) Broad-leaved weeds)	Weed control efficiency (%)
Wheat seeding methods					
Conventional tillage	7.47(70.80)	4.18(20.88)	1.86(2.96)	1.84(3.01)	-
Super seeder	7.30(68.03)	3.86(18.08)	1.74(2.46)	1.83(2.95)	-
Happy seeder	6.72(60.56)	4.63(25.23)	1.62(1.96)	1.86(3.07)	-
LSD (p=0.05)	NS	NS	NS	NS	
Weed management treatment					
Pinoxaden + clodinafop-propargyl 70 g/ha PoE	7.30(53.49)	4.32(18.6)	1.74(2.20)	1.76(2.18)	91.82
Fenoxaprop + metribuzin 110 g/ha PoE	7.37(54.6)	4.40(19.39)	1.80(2.32)	1.80(2.32)	91.30
Metsulfuron-methyl 4 g/ha + carfentrazone-ethyl 25 g/ha PoE + non-ionic surfactant (NIS)	8.32(69.75)	4.23(17.86)	1.85(2.53)	1.72(2.03)	87.89
Pendimethalin 900 g/ha PE *fb* pinoxaden + metsulfuron-methyl 60 g/ha PoE	3.29(10.75)	3.08(9.15)	1.04(0.09)	1.009(0.02)	96.77
Isoproturon 750 g/ha + 2,4-D 500 g/ha PoE	11.53(132.05)	4.77(22.86)	1.96(2.98)	2.66(6.34)	76.55
Weed free	1(0)	1(0)	1(0)	1(0)	100
Weedy	13.84(194.53)	7.75(61.94)	2.79(7.13)	2.97(8.18)	0
LSD (p=0.05)	0.72	0.57	0.21	0.25	-

The original data in parentheses was subjected to $\sqrt{x+0.5}$ transformation; PE = pre-emergence treatment; PoE = post-emergence treatment; DAS = days after seeding

methyl + NIS, pendimethalin *fb* pinoxaden + metsulfuron-methyl, isoproturon + 2,4-D and weed free, when compared with weedy check.

Weed biomass

Pendimethalin *fb* pinoxaden + metsulfuron-methyl recorded the lowest weed biomass of narrow and broad-leaved weeds, followed by pinoxaden + clodinafop, fenoxaprop + metribuzin, metsulfuron-methyl + carfentrazone-ethyl + NIS, isoproturon + 2,4-D and treatment at 60 DAS. The percentage decrease in weed biomass at wheat harvest was 87.44%, 82.35%, 76.57%, 99.30%, 29.42% and 100% with pinoxaden + clodinafop, fenoxaprop + metribuzin, metsulfuron-methyl + carfentrazone-ethyl + NIS, pendimethalin *fb* pinoxaden + metsulfuron-methyl, isoproturon + 2,4-D and weed free, respectively when compared with weedy check. The results are in conformity with Rana *et al.* 2017.

Wheat yield

Wheat seeding methods and herbicides treatments showed a remarkable effect on grain yield (Table 2.). Among sowing methods of wheat, super seeder sown wheat produced the highest grain yield, which was much higher than conventional tillage but statistically at par with happy seeder. However, the grain yield with wheat super seeder (4.77 t/ha) and happy seeder (4.28 t/ha) sown wheat differed significantly. According to Chhokar *et al.* (2007), surface retention of rice residue at 5.0 and 7.5 t/ha decreased weed biomass in wheat by 23.4- 30.3 and 35.5- 44.1%, respectively.

Weed free had the highest wheat grain and straw yield and it was significantly at par with pendimethalin *fb* pinoxaden + metsulfuron-methyl, pinoxaden + clodinafop and fenoxaprop + metribuzin and was significantly higher than other herbicide treatments. Walia *et al.* (2000) reported that metsulfuron-methyl enhanced wheat grain yield by 43.3 and 36.7% over weedy control. The wheat yield with isoproturon + 2,4-D and weedy check was significantly at par with each other. The wheat yield with fenoxaprop + metribuzin and metsulfuron + carfentrazone-ethyl + NIS was also significantly at par with each other. The weedy check produced the lowest grain yield. The percentage increase in grain yield of pinoxaden + clodinafop, fenoxaprop + metribuzin, metsulfuron-methyl + carfentrazone-ethyl + NIS, pendimethalin *fb* pinoxaden + metsulfuron-methyl, isoproturon + 2,4-D and weed free when compared with weedy check was 45.51%, 44.90%, 40.30%, 48.86%, 13.78% and 49.66%, respectively. Among the different weed control treatments weed free had the highest straw yield and it was significantly at par with pendimethalin *fb* pinoxaden + metsulfuron-methyl, pinoxaden + clodinafop and fenoxaprop + metribuzin, which were significantly higher than metsulfuron-methyl + carfentrazone-ethyl + NIS, isoproturon + 2,4-D and weedy check.

Economics

The economics of wheat production in terms of gross and net returns and benefit cost ratio were calculated to examine the economic feasibility and viability of the various treatments under investigation.

Table 2. Effect of wheat seeding methods and weed management treatments on wheat grain and straw yield, harvest index, total cost of production, net returns and benefit: cost ratio of wheat

Treatment	Grain yield (t/ha)	Straw yield (t/ha)	Harvest index (%)	Total cost of production (Rs./ha)	Net returns (Rs./ha)	B:C ratio
Wheat seeding methods						
Conventional tillage	4.65	6.82	40.52	47554	66467	2.39
Super seeder	4.77	7.16	40.01	39958	77696	2.94
Happy seeder	4.28	6.24	40.70	38708	66213	2.71
LSD (p=0.05)	0.38	0.52				
Weed control treatment						
Pinoxaden + clodinafop-propargyl 70 g/ha PoE	5.09	7.44	40.77	42055	79204	1.88
Fenoxaprop + metribuzin 110 g/ha PoE	5.03	7.30	40.90	41805	78091	1.86
Metsulfuron-methyl 4 g/ha + carfentrazone-ethyl 25 g/ha PoE + non-ionic surfactant (NIS)	4.65	6.65	41.36	41830	68069	1.62
Pendimethalin 900 g/ha PE *fb* pinoxaden + metsulfuron-methyl 60 g/ha PoE	5.42	8.11	40.24	42630	87373	2.04
Isoproturon 750 g/ha + 2,4-D 500 g/ha PoE	3.22	4.95	39.39	41330	34952	0.84
Weed free	5.51	8.30	40.08	44930	87412	1.94
Weedy	2.77	4.31	39.13	39930	55724	1.48
LSD (p=0.05)	0.45	0.73				

PE = pre-emergence treatment; PoE = post-emergence treatment; DAS = days after seeding

Among different sowing methods, super-seeder sown wheat recorded highest net returns (Rs.77696/ ha) and similar results were also reported by Bishnoi *et al. (*2024). Among the various weed control practices weed free recorded highest net returns. Among different weed control treatments weed free recorded highest net returns.

Conclusion

It may be concluded that the higher wheat grain yield can be obtained with wheat seeding using super-seeder and weed management by pendimethalin 900 g/ha PE *fb* pinoxaden + metsulfuron-methyl 60 g/ha PoE for controlling complex weed flora in wheat and to increase wheat productivity.

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