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Impact of Wheat Establishment Methods and Weed Management Practices on Weed Flora, Yield and Nutrient Uptake of Wheat in Rice-wheat Cropping System

MOHAN SINGH[1], OMBIR SINGH[2] AND ROHITASAV SINGH[1]

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ABSTRACT

A field experiment was conducted at the Crop Research Centre of Govind Ballabh Pant University of Agriculture and Technology Pantnagar, Udham Singh Nagar for during continuous two years to study the weed flora, yield and nutrient uptake of wheat (*Triticum aestivum* L.) under different wheat establishment methods in main plots and seven weed management in sub plots. *Phalaris minor* was the most dominant weed at 60 DAS contributed 55.0 per cent of total weed population. *Melilotus indica* was the major non grassy weeds in wheat which contributed 11 per cent to total weed population during respective years. Sowing of wheat with zero tillage significantly reduced the *Phalaris minor* density as compared to conventionally tilled wheat after transplanted rice, 60 per cent *Phalaris minor* emerged from 0-3 cm in reduced and conventional tillage where as in zero tillage after transplanted rice there was 55 per cent emergence from 0-3 cm layer.The highest grain yield was obtained in two hand weedings done at 30 and 60 DAS and was at par with Isoproturon 1.0 kg ha^{-1} + Metsulfuron methyl 4 g ha^{-1} at 30 DAS and Clodinafop – Propargyl 60 g ha^{-1} at 30 DAS fb. Metsulfuron methyl 4 g ha^{-1} at 37 DAS. Zero tillage resulted in significantly higher uptake of NPK by wheat plants as compared to conventional tillage, whereas reduced tillage recorded minimum NPK, which was significantly lower over the other treatments of wheat establishment methods.

KEYWORDS

Zero tillage, Wheat establishment methods, grain yield, bulk density, infiltration rate

INTRODUCTION

Rice-wheat is one of the main cropping systems and occupies nearly 14 million hectares of land extending across the Indo-Gangetic Plain (IGP) and 10.5 million hectares area in India. The major challenge facing the IGP's rice-wheat cropping system is to sustain long-term productivity. This system has a pivotal role in the food security and livelihoods of millions of farmers and workers of populous countries such as India. The adoption of resource conservation technologies, such as zero tilled wheat sowing, is considered essential to maintain the productivity of the rice-wheat cropping system (Singh *et al*., 2010). Zero tillage with previous crop residue retention results in water saving. It also saves the soil from formation of large cracks and also avoids sub-soil compaction (Jat *et al*., 2008). Conventional tillage practices followed by farmers for raising wheat after rice, involve higher use of machines, labour and energy as it is done to change the low permeability soil structure created for rice to well aerated structure for wheat. Weeds are the major problem in irrigated wheat. Many research workers have reported the predominance of *Phalaris minor*, *Avena fatua* among the monocots, *Chenopodium album*, *Melilotus indica* among the dicot weeds in wheat field (Yadav *et al*., 2005 and Chahel *et al*., 2002). However, with the use of suitable herbicides or adoption of integrated approach of weed control, the weeds problem in wheat could be managed effectively and economically (Shrama *et al*., 2005) and cost of weed control in wheat could partially or completely decreases . The introduction of dwarf wheat cultivars appears to have created a greater grassy weed problem like *Phalaris minor* and *Avena* spp. throughout the wheat growing areas in the country. It is probably due to the fact that the dwarf wheat varieties with short stature and erect leaf orientation, permit more light penetration through the canopy and being highly responsive to fertilizer and irrigation are less competitive against weeds than the traditional tall cultivars. Different herbicides have been tested for controlling weeds,out of these, isoproturon was introduced as the most effective and economical herbicide for control of *Phalaris minor* and some broad leaf weeds but continuous use of isoproturon has resulted in development of resistance in *Phalaris minor* in some parts of country (Walia and Singh, 2005). Clodinafoppropargyl, sulfosulfuron and fenoxaprop-p-ethyl, post emergence herbicides had been found promising against grassy weeds particularly resistant bio-types of *Phalaris minor*.

MATERIALS AND METHODS

An investigation was carried out at the Crop Research Centre of Govind Ballabh Pant University of Agriculture and Technology Pantnagar, Udham Singh Nagar during continuous two years. The Crop Research Center is located at 29^{0}N latitude, 79.3^{0}E longitude and at an altitude of 243.8 meters above mean sea level and lies in the tarai belt of Shivalik range of Himalayan foot hills. The experimental site was sandy loam in texture having alkaline reaction (7.9 pH). The soils was medium in available N (265 kg N/ha) and rich in available P (37.5 kg/ha) and medium in K (264.45 kg/ha). The field experiments was consisted of 21 treatments combinations imposed to wheat crop, comprising three wheat establishment methods i.e. Zero tillage (sowing with zero till ferti-seed drill), Reduced tillage (3 harrowing fb planking) and Conventional tillage (6-7 harrowing fb planking) in main plots and seven weed management practices (i) Isoproturon 1.0 kg ha^{-1} at 30 DAS, (ii) Clodinafop – propargyl 60 g ha^{-1} at 30 DAS, (iii) Metsulfuron methyl 4 g ha^{-1} at 30 DAS, (iv) Isoproturon 1.0 kg ha^{-1} + Metsulfuron methyl 4 g ha^{-1} at 30 DAS, (v). Clodinafop – Propargyl 60 g ha^{-1} at 30 DAS fb. Metsulfuron methyl 4 g ha^{-1} at 37 DAS

[1]Department of Agronomy, G.B. Pant Univ. of Agric. & Tech., Pantnagar-U.S. Nagar, Uttarakhand, India
[2]Department of Agronomy, Ch. Chhotu Ram (P.G.) College, Muzaffarnagar, U.P., India
*Corresponding Author Email: omvir2007@rediffmail.com

(vi).Hand weedings at 30 & 50 DAS (vii). Weedy (control)in sub plots, replicated thrice in a split plot design. Recommended levels of 150 kg N; 60 kg P_2O_5, 40 kg K_2O and 25 kg $ZnSO_4$/ha will be applied in wheat crop. Field was prepared as per the given in the treatment i.e. reduced tillage (3 harrowing) and conventional tillage (6 harrowing) followed by one roller and then finally field was leveled. But in case of zero tillage, wheat was sown directly without any tillage operation. Wheat variety "PBW 343" with 100 kg ha^{-1} seed rate was sown in the rows, 20 cm apart. In the zero tillage treatment the seeds were sown by Pant zero-till ferti-seed drill and in reduced and conventional system the seeds were sown manually. The isoproturon and clodinafop-propargyl were applied at 30 days after sowing (DAS), while metsulfuron methyl at 7 days after spray of clodinafoppropargyl in wheat crop. Data on grain and straw yields of wheat were recorded as per the standard procedures. The nutrient uptake (NPK) were estimated from both seed and stover separately during both the years and its uptake were estimated with the help of total seed and stover yield multiply with respective nutrient content.

RESULTS AND DISCUSSION

i. Weed population and density

In the experimental field 13 weed species (3 grassy, 9 non grassy and 1- sedge) were recorded during *rabi* season (Table 1). The relative contribution of grasses to total weed population in terms of density was higher at all the stages of crop growth. *Phalaris minor* was the most dominant weed at 60 DAS contributed 55.0 per cent of total weed population (Fig. 1). *Melilotus indica* was the major non grassy weeds in wheat which contributed 11 per cent to total weed population during respective years. *The* population of *Chenopodium album* was more while *Medicago denticulate* emerged as second most

Table 1: Weed density, crop weed competition index and yield of wheat as influenced by different treatments

Treatments	Total weed population / m^2		Total weed dry matter/ m^2		Seed yield (q/ha)		Straw yield (q/ha)		Weed crop competition index	
	Ist year	IInd year	Ist year	IInd year	Ist year	IInd year	Ist year	IInd year	Ist year	IInd year
Wheat establishments methods										
Zero tillage	9.07	8.84	4.49	4.30	46.13	46.55	68.14	68.74	9.35	10.73
	98.29	92.71	21.97	20.47						
Reduced tillage	10.49	10.20	6.27	6.14	40.44	40.97	61.48	61.90	9.64	9.65
	128.43	123.57	41.91	40.14						
Conventional tillage	11.18	10.94	7.34	7.19	44.44	45.11	66.42	66.89	8.66	8.59
	146.43	140.14	57.29	55.26						
S.Em. ±	0.120	0.149	0.074	0.082	0.132	0.137	0.382	0.353	0.08	0.09
CD at 5%	0.342	0.427	0.213	0.235	0.456	0.472	1.317	1.215	0.28	0.32
Weed Management practices in wheat										
Isoproturon 1.0 kg ha^{-1} at 30 DAS	10.90	10.68	6.54	6.36	43.88	44.45	65.09	65.88	8.79	9.17
	119.33	114.67	43.64	41.59						
Clodinafop – propargyl 60 g ha^{-1} at 30 DAS	11.04	10.80	6.63	6.48	45.77	46.37	69.11	69.40	4.85	5.24
	123.00	117.67	45.43	43.62						
Metsulfuron methyl 4 g ha^{-1} at 30 DAS	10.97	10.72	6.42	6.25	43.98	44.45	65.98	66.62	8.53	9.10
	120.67	115.67	42.31	40.15						
Isoproturon 1.0 kg ha^{-1} + Metsulfuron methyl 4 g ha^{-1} at 30 DAS	8.51	8.19	5.20	5.01	47.54	48.31	71.80	72.36	1.16	1.27
	72.67	67.33	27.91	26.14						
Clodinafop – Propargyl 60 g ha^{-1} at 30 DAS fb. Metsulfuron methyl 4 g ha^{-1} at 37 DAS	8.15	7.95	5.17	4.95	46.72	47.39	71.17	71.26	2.83	3.09
	66.67	63.33	27.85	25.65						
Hand weeding at 30 & 50 DAS	3.23	3.08	3.07	2.94	48.10	48.94	72.71	73.23	0.00	0.00
	10.00	9.00	9.28	8.43						
Weedy (control)	18.91	18.53	9.22	9.14	29.70	29.54	41.55	42.17	38.35	39.72
	358.33	344.00	86.32	84.79						
S.Em. ±	0.183	0.228	0.114	0.125	0.660	0.674	0.990	0.916	0.47	0.51
CD at 5%	0.522	0.652	0.325	0.359	1.871	1.954	2.807	2.599	2.23	2.54

dominant non grassy weeds. Mishra *et al.* (2005) also reported *P. minor, Melilotus spp.* and *Chenopodium album* as the dominant weeds of wheat in rice-wheat cropping system. Density of total weeds recorded lower under zero tillage as compared to the conventional tillage. Reduced tillage also recorded lower weed density than conventional tillage but it was higher than zero tillage. Sinha and Singh (2005) were also observed the similar trend in this regard. Findings were further confirmed by Prasad *et al.* (2005), who noticed lower density of total weeds in zero tillage in comparison to conventional tillage.

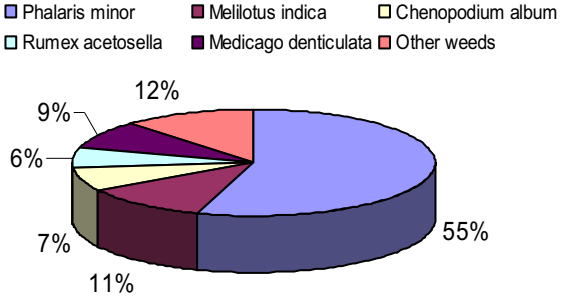

Fig.1: weed flora in wheat crop under rice –wheat cropping system

Sowing of wheat with zero tillage significantly reduced the *Phalaris minor* density as compared to conventionally tilled wheat after transplanted rice, 60 per cent *Phalaris minor* emerged from 0-3 cm in reduced and conventional tillage where as in zero tillage after transplanted rice there was 55 per cent emergence from 0-3 cm layer. The weed density and dry matter of all the individual weeds were recorded higher in conventional tillage as compared to zero tillage at 60 stage, except *Rumex acetosella* and *Medicago denticulata*. Mishra *et al.* (2005) at Jabalpur also noticed reduction in population of *Phalaris minor* and *Chenopodium album*in zero tillage. This reduction might be due to the fact that puddling of rice placed previous season seeds of *Phalaris minor* and *C. album* in the deeper layers of the soil, which could not emerge in the absence of solar radiation under zero tilled wheat.

Yaduraju and Mishra (2007) also reported lower density of *Phalaris minor* under zero tilled wheat. The weed density and dry matter of *Medicago denticulata*, *Rumex acetosella* and other weed species were recorded lower under Isoproturon 1.0 kg ha^{-1} + Metsulfuron methyl 4 g ha^{-1} at 30 DAS and Clodinafop – Propargyl 60 g ha^{-1} at 30 DAS fb. Metsulfuron methyl 4 g ha^{-1} at 37 DAS at 60, 90 and 120 DAS stage during both the years. However, *M. indica* and *C. album* were fully controlled by these herbicides. The weed control efficiency of Isoproturon 1.0 kg ha^{-1} + Metsulfuron methyl 4 g ha^{-1} at 30 DAS and Clodinafop – Propargyl 60 g ha^{-1} at 30 DAS fb. Metsulfuron methyl 4 g ha^{-1} at 37 DAS was better than isoproturon , Metsulfuron methyl and Clodinafop – Propargyl alone because of broader spectrum of this chemical combination. Chopra and Chopra (2005) also confirmed the superiority of clodinafop over isoproturon in controlling the grasses especially resistant bio-types of *Phalaris minor.* Walia and Singh (2005) reported better efficacy of metsulfuron methyl against broad leaf weeds.

The poor efficacy of herbicides under conventional tillage was owing to extended period of weed emergence as it provides better environment for emergence of weeds in different flushes. Among the wheat establishment methods weed crop competition index was maximum in case of zero tillage in IInd year and during Ist year under reduced tillage. However, conventional tillage recorded minimum value of weed crop competition index during both the years. Among the weed management practices, the highest weed crop competition index was recorded in weedy check. Excluding two hand weedings, weed crop competition index was observed minimum under Isoproturon 1.0 kg ha^{-1} + Metsulfuron methyl 4 g ha^{-1} at 30 DAS in comparison to Clodinafop – Propargyl 60 g ha^{-1} at 30 DAS fb. Metsulfuron methyl 4 g ha^{-1} at 37 DAS which was significantly differs during both years.

Wheat establishment method significant effect on number of shoot m^{-2} dry matter and plant height during both the year of experimentation. However, days taken to anthesis as well as maturity does not influenced at statistical level of significance due to method of wheat establishment. Sowing of wheat with zero tillage proved significantly superior in respect number of shoots, dry matter production as well as plant height over reduced and conventional method of tillage during both the year. All the growth and development parameters given in the Table 2 were affected remarkably by used management.

ii. Growth and Development

practices during both years. The significant highest number of shoot of tallest height was recorded under the treatment of *chlodinafop-propargyl* 60g ha^{-1}, metsulfuron methyl 14gha^{-1}during both years over there treatments. However, the lowest value in this regards were noticed in weedy parts, where none of the methods to control the weeds were followed.

iii. Yield performance

Wheat establishment methods caused significant effect on the grain yield during both the years. The zero tilled wheat yielded 12.35 and 3.66 per cent higher over reduced and conventional tillage during I^{st} year, respectively. The respective increase during II^{nd} year was 11.99 and 3.09 per cent. The marked increase in grain yield in above treatments might be due to overall improvement on yield attributes. The straw yield was higher under zero tillage during both the years. There was an increase of 9.7 and 9.95 per cent over reduced tillage and 2.52 and 2.69 per cent over conventional tillage during I^{st} year and II^{nd} year, respectively.

Wheat yield was affected remarkably by the weeds and recorded 62.0 and 65.7 per cent reduction in the yield in uncontrolled weeds during I^{st} year and IInd year, respectively as compared to crop given two hand weedings at 30 and 50 DAS (Table 3). This finding was supported by Chopra *et al.* (1999) and Singh *et al.* (1997) who stated that uncontrolled weeds caused 30-60 per cent reduction in the grain yield of wheat. Kumar (1993) and Meena (1996) at Pantnagar also reported 31.8 to 54.2 per cent reduction in wheat yield due to weeds. All the weed management practices produced significantly higher grain yield than weedy check. The highest grain yield was obtained in two hand weedings done at 30 and 60 DAS and was at par with Isoproturon 1.0 kg ha^{-1} + Metsulfuron methyl 4 g ha^{-1} at 30 DAS and Clodinafop –

Table 2: Growth and development in wheat as influenced by various treatments

Treatments	Number of shoots m^{-2} at 120days		Dry matter accumulation g/m^2 at120days		Plant height cm at 120days		Days to anthesis		Days of Maturity	
	Ist year	II nd year	Ist year	II nd year	Ist year	II nd year	Ist year	II nd year	Ist year	II nd year
Wheat establishments methods										
Zero tillage	165.6	168.3	1175.5	1189.3	87.62	89.46	93.1	93.5	140.7	142.5
Reduced tillage	158.9	160.3	1072.3	1085.9	83.33	85.96	93.8	94.5	141.4	143.4
Conventional tillage	157.3	158.4	1057.5	1072.4	81.26	83.79	93.2	93.8	141.3	143.5
S.Em. ±	0.94	0.87	7.07	8.04	0.963	0.982	0.49	0.30	0.158	0.69
CD at 5%	3.24	2.99	24.35	27.69	3.317	3.382	NS	NS	NS	NS
Weed management practices in wheat										
Isoproturon 10 kg ha^{-1} at 30 DAS	157.0	158.7	1076.8	1087.1	82.67	84.27	93.3	91.6	140.0	141.4
Clodinafop– propargyl 60 g ha^{-1} at 30 DAS	154.3	155.7	1081.5	1094.0	83.33	85.43	93.7	94.2	139.8	142.8
Metsulfuron methyl 4 g ha^{-1} at 30 DAS	157.0	159.0	1085.9	1099.3	81.37	83.83	92.2	92.7	140.5	142.0
Isoproturon 1.0 kg ha^{-1} + Metsulfuron methyl 4 g ha^{-1} at 30 DAS	166.3	168.3	1159.2	1175.8	87.67	90.13	94.9	95.9	144.2	146.0
Clodinafop– Propargyl 60 g ha^{-1} at 30 DAS fb. Metsulfuron methyl 4 g ha^{-1} at 37 DAS	168.0	171.0	1108.0	1123.0	85.40	87.57	93.6	94.4	140.8	141.6
Hand weeding at 30 & 50 DAS	175.7	175.7	1189.2	1202.7	90.83	93.43	95.2	95.7	145.8	147.9
Weedy (control)	145.7	148.0	1011.9	1029.1	77.30	80.13	92.5	93.2	136.7	140.2
S.Em. ±	2.07	2.35	14.90	12.52	1.216	1.167	1.19	1.29	1.97	2.07
CD at 5%	5.87	6.67	42.26	35.51	3.448	3.309	NS	NS	NS	NS

Propargyl 60 g ha^{-1} at 30 DAS fb. Metsulfuron methyl 4 g ha^{-1} at 37 DAS. Bharat and Karchroo (2007) also reported superiority of tank mixing of clodinafop + metsulfuron methyl over isoproturon alone in broadening the spectrum of weed control and increasing yield. The herbicide application significantly increased the grain and biomass yield due to reduction in weed density and weed dry weight. That's why there would be less crop weed competition for space, light,

Table 3: Grain yield and nutrient (NPK) uptake in wheat as influenced by various treatments

Treatments	Nitrogen uptake (kg/ha)		Phosphorus uptake (kg/ha)		Potassium uptake (kg/ha)	
	I^{st} year	II^{nd} year	I^{st} year	II^{nd} year	I^{st} year	II^{nd} year
Wheat establishments methods						
Zero tillage	102.68	103.86	13.45	13.60	121.75	122.94
Reduced tillage	93.31	95.02	12.03	12.29	109.66	110.56
Conventional tillage	100.66	102.14	13.11	13.39	118.98	119.99
S.Em. ±	0.64	0.66	0.06	0.06	1.00	0.90
CD at 5%	2.18	2.26	0.19	0.22	3.46	3.11
Weed management practices in wheat						
Isoproturon 1.0 kg ha^{-1} at 30 DAS	97.32	98.92	12.93	13 .12	116.27	117.77
Clodinafop – propargyl 60 g ha^{-1} at 30 DAS	107.45	108.98	13.80	13.96	123.55	124.03
Metsulfuron methyl 4 g ha^{-1} at 30 DAS	99.68	100.95	13.16	13.40	118.28	119.27
Isoproturon 1.0 kg ha^{-1} + Metsulfuron methyl 4 g ha^{-1} at 30 DAS	107.81	109. 67	13.89	14.27	128.16	129.49
Clodinafop – Propargyl 60 g ha^{-1} at 30 DAS fb. Metsulfuron methyl 4 g ha^{-1} at 37 DAS	107.25	108.64	13.86	14.12	126.59	127.29
Hand weeding at 30 & 50 DAS	114.18	116.15	14.21	14.53	129.71	131.00
Weedy (control)	58.48	59.04	8.2 2	8.28	75.02	75.95
S.Em. ±	1.11	1.19	0.19	0.19	1.73	1.76
CD at 5%	3.14	3.37	0.54	0.55	4.91	4.99

moisture and nutrient etc which resulted in better crop establishment, reduced tiller mortality and ultimately increase in the grain and biomass yield. The straw yield was highest under hand weeding twice followed by Isoproturon 1.0 kg ha^{-1} + Metsulfuron methyl 4 g ha^{-1} at 30 DAS and Clodinafop – Propargyl 60 g ha^{-1} at 30 DAS fb. Metsulfuron methyl 4 g ha^{-1} at 37 DAS during both the years, but, these are significantly higher over the weedy condition during both the years.

Nitrogen uptake (kg/ha)

The uptake of nutrient in wheat crop was significantly influenced by wheat establishment methods. Zero tillage resulted in significantly higher uptake of NPK by wheat plants as compared to conventional tillage, whereas reduced tillage recorded minimum NPK, which was significantly lower over the other treatments of wheat establishment methods. The trend was found similar in both the years of study. Increase in uptake under zero tillage may be due to an increased grain and straw yield of wheat and increasing nitrogen content. The similar result was reported by Kumar *et al.* (2004). The amount of NPK removal was significantly influenced by weed management practice. The maximum uptake of nutrients was observed under two hand weedings done at 30 and 50 DAS which was significantly higher than Isoproturon 1.0 kg ha^{-1} + Metsulfuron methyl 4 g ha^{-1} at 30 DAS and Clodinafop – Propargyl 60 g ha^{-1} at 30 DAS fb. Metsulfuron methyl 4 g ha^{-1} at 37 DAS during both the years. This is obvious because the biomass production increased due to these weed management practice over weedy check. Increase in NPK uptake under various weed control methods was also reported by Jain *et al.*(2007) and Rahman and Mukahrjee (2010).

CONCLUSION

It was concluded that most dominant grassy weeds flora was *Phalaris minor* (*55.0* per cent), whereas major non grassy weed was *Melilotus indica* in wheat cop. In case nutrient uptake, Zero tilled whet recorded higher uptake of NPK.

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