Journal of Crop and Weed 4(2) : 33-37(2008)

Effect of herbicides on weeds and soil microbes in wheat under *Terai* agro-ecological region of West Bengal

S. RAHAMAN AND P.K. MUKHERJEE

Department of Agronomy,
Uttar Banga Krishi Viswavidyalaya,
Pundibari–736165, Cooch Behar, West Bengal, India

ABSTRACT

A field experiment was conducted during *rabi* season of 2005-06 and 2006-07 at instructional farm of Uttar Banga Krishi Viswavidyalaya to find out the effective and ecologically suitable herbicides in wheat (Sonalika) grown under different tillage systems. The dominant weeds were *Polygonum pensylvanicum, Polygonum orientale*, *Polygonum persicaria, Stellaria media, Oldenthnadia diffusa, Spilanthes paniculata, Hydrocotyl renunculoides, Physalis minima* and *Eclipta alba* (broadleaved weeds) and *Cynodon dactylon*, *Setaria glauca* and *Digitaria sanguinalis* (grasses). Among the herbicides, pendimethalin 0.50 kg ha^{-1} in conventional tillage showed highest weed control efficiency (82.2% and 77.42%) in both the years. The treatment 2,4-D 0.50 kg ha^{-1}at 35 DAS found effective in controlling weeds in first year of the experiment. However, isoproturon became ineffective in controlling weed especially broadleaved. Among the herbicides highest yield was recorded in pendimethalin (22.4 q/ha and 26.7 q/ha) under conventional tillage and it was statistically at par with complete weed-free situation (23.04 q/ha and 27.19 q/ha) during both the years. Timely sowing of the crop during second year increased yield of wheat. Highest net return was obtained in 2,4-D 0.50 kg ha^{-1} at 35 DAS (Rs.5921/-) in conventional tillage system in first year and pendimethalin 0.50 kg ha^{-1} (Rs. 9111/-) in second year. However, poor yield of wheat in second year was due to shifting of weed flora triggered by 2,4-D application. Pendimethalin 0.50 kg ha^{-1} in conventional tillage at initial stage showed antagonistic effect on soil microbes. Isoproturon showed little growth promoting activity in terms of increasing height of wheat. Performance of wheat was comparatively higher in conventional tillage than zero tillage.

Key words: Conventional tillage, isoproturon, pendimethalin, weed flora, zero tillage

Like rice, wheat is a most important food grain crop in India. However, farmers of *Terai* region of West Bengal usually keep 60% of total cultivable land fallow during winter season due to late harvesting of preceding rice crop (*kharif* rice) and high residual soil moisture because of high rainfall during monsoon and thus resulted in severe weed pressure during winter season. Profuse growth of several weeds with high invasive capacity coupled with poor fertility status often becomes limiting factor in crop cultivation. Aggressive growth of the weeds especially broadleaved like *Polygonum* spp*, Stellaria media, Oldenlandia diffusa, Leucas indica* etc. with high invasion potential becomes an important constraint in crop cultivation during *rabi* season. Therefore, proper weed management is essential to make the cropping economical. Effective weed control enhances grain yield of wheat by 40.6% (Dixit and Bhan, 1997). Among the herbicides isoproturon and pendimethalin are being used for the last two decades in wheat (Walia *et al.,* 1998; Chopra *et al.,* 2001). The broadleaved weeds can, however, be controlled effectively with the application of 2,4-D (Singh and Singh, 2002), however, it could also lead to shifting of weed flora. Soil, on application of herbicides also show some antagonistic effect on soil microbes (Ashraf and Sen, 1981). Keeping these views in mind, present experiment was conducted on wheat after *kharif* rice with objectives to identify suitable herbicide(s) with the dose(s) in different tillage systems that could be used successfully in integrated weed management practices.

MATERIAL AND METHODS

The experiment was carried out during *rabi* seasons of 2005-06 and 2006-07 in the farm of Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar. The experiment consisting 8 treatments, viz (T_1) zero tillage + weedy, (T_2) zero tillage + 2,4-D 0.50 kg/ha, (T_3) zero tillage + glyphosate 1.00 kg/ha followed by 2,4-D 0.50 kg/ha, (T_4) conventional tillage + 2,4-D 0.50 kg/ha, (T_5) conventional tillage + isoproturon 0.70 kg/ha, (T_6) conventional tillage + pendimethalin 0.50 kg/ha, (T_7) conventional tillage + weedy and (T_6) conventional tillage + complete weed free were laid out in Randomized Complete Block Design (RCBD) with three replication in the plots having individual plot size of 15 X 3 m^2. The soil was sandy loam in texture with pH 5.34-5.8, 0.75% organic carbon and low in available nitrogen (94.75 kg/ha), medium in available phosphorus (16.35 kg/ha), low available potassium (76.9 kg/ha).

Wheat variety "Sonalika" was sown 22.5 cm apart on 10 December 2005 and 15 November 2006 and harvest on 3rd April 2006 and 7th April 2007 during two years of experimentation. The crop was fertilized with 120 kg N/ha + 60 kg P_2O_5/ha and 60 kg K_2O/ ha. Half dose of nitrogen and full dose of phosphorus and potassium as basal in the form of urea, single super phosphate and murate of potash at the time of sowing and remaining nitrogen was top dressed after first irrigation. Glyphosate was applied as pre-plant desiccators 10 days before sowing and 2,4-D was applied as postemergence at 32 DAS, whereas pendimethalin and isoproturon was applied as pre-emergence with knapsack sprayer fitted with flood jet nozzles using 550 litre/ha. The density and dry weight of weeds were recorded using quadrate (0.50 m^2) placed randomly at 2 places in each plot and expressed as number and g/m^2, respectively. Weed data were subjected to square root transformation (v X +0.5) before statistical analysis. The data on weed density and dry weight were recorded at 40 and 60 days after sowing (DAS). Data on weed density were pooled species-wise. For microbial population counting, rhizosphere soil samples from three different locations were collected in each replication of the treatments. After that these soil samples were mixed together and dried properly for final processing. Jensen's medium and Modified king's medium were used for growing *Azotobacter* and *Fluorescence pseudomonas,* respectively.

RESULT AND DISCUSSIONS

Weed flora

The major weed flora observed in experimental plots at 40 and 60 days after sowing were different in different tillage systems. However, major weeds species were *Polygonum pensylvanicum, Polygonum orientale, Polygonum persicaria, Stellaria media, Oldenlandia diffusa, Spilanthes paniculata, Hydrocotyl renunculoides, Physalis minima* and *Eclipta alba* among the broadleaved and *Cynodon dactylon*, *Setaria glauca, Digitaria sanguinalis* among the grassy weeds.

Herbicidal treatments significantly influenced *Polygonum* population and other weeds at 40 and 60 DAS in both the years. Among the treatments, pendimethalin treated plots in both the years showed lowest *Polygonum* population (5.1 and 6.3 at 40 DAS and 15.3 and 16.6 at 60 DAS) and other weeds. This finding was also similar in 2,4-D treated plots in conventional tillage system only in first year. However, in second year 2,4-D application triggered shifting of weed flora from *Polygonum* to *Physalis minima* and reemergence of *Stellaria media* resulting in aggressive of these weeds. The lowest weed dry weight was found in pendimethalin treated plots (2.47 g/m^2 and 2.59 g/m^2 in first and 4.81g/m^2 and 5.62 g/ m^2 in second year, respectively, at both stages) leading to highest weed control efficiency of 88.8-90.0% in first year and 82.2%- 77.42% in second year (Table 1). In first year 2,4-D showed desirable value of weed control efficiency (71.60%), however, in second year poor weed control efficiency (15.85%) was obtained in 2,4-D treated plots mainly because of shifting of weed flora.

Results on weed persistence index at different growth stages revealed that pendimethalin recorded lowest value during first year, however, in second year the value was slightly higher at 60 DAS indicating emergence of weeds at or before this growth stage of wheat. Another treatment isoproturon recorded comparatively higher value resulting from continuous persistence of weeds at higher level through out the growth stages of wheat as compared to pendimethalin. Results on herbicide efficiency index revealed that the pendimethalin registered highest value at both the years of experimentation reflecting its highest killing potential of weeds without having phytotoxic effect on wheat. Value of this treatment obtained in second year (317.89) was lower than that of first year (383.82) because of emergence of weeds (*Hydrocotyl renunculoides*) in second year at this stage resulting from shifting of weed flora due to its continuous application (Table 3). Similar trend was noticed in 2,4-D in conventional tillage system (T_4) (206.72 and 33.72 in 2005-06 and 2006-07, respectively) and glyphosate + 2,4-D 0.5 in zero tillage system (T_3) (213.03 and 80.41 in 2005-06 and 2006-07, respectively) in which marked difference on the values of herbicide efficiency index between first year and second year of experimentation was observed and that could be due to shifting of weed flora for their continuous application.

Effect on crop

Among the treatments isoproturon showed synergistic effect to the limited extent on crop growth in term of increasing plant height. At initial growth stages up to 65 DAS isoproturon treated plot showed highest plant height (59.72 and 59.81 cm) (Table 2) in both the year which was even higher than the complete weed free situation (59.21 and 59.45 cm). After that stages plant height did not differ

Table 1. Effect of treatments on weed flora, weed dry weight (g/m²) and weed control efficiency (%).

Treatments	Weed flora (No.)								Weed dry weight (g/m²)				Weed control efficiency (%)			
	Polygonum sp.				Other than *Polygonum* sp											
	40 DAS		80 DAS		40 DAS		80 DAS		40 DAS		80DAS		40 DAS		80DAS	
	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07
T_1	13.1 (171.0)	10.5 (110.0)	13.9 (194.4)	11.6 (135.0)	14.9 (233.4)	17.2 (295.4)	16.8 (280.0)	19.1 (363.7)	7.56 (56.37)	8.04 (63.18)	15.86 (249.95)	11.13 (122.60)	-	-	-	-
T_2	11.9 (141.0)	10.4 (107.0)	12.9 (166.7)	11.3 (126.0)	12.8 (163.4)	15.4 (235.4)	14.3 (203.7)	15.3 (233.4)	5.80 (32.43)	7.51 (55.57)	10.37 (103.30)	10.09 (100.84)	42.63	12.02	58.61	17.75
T_3	10.2 (105.0)	13.9 (195.0)	10.9 (120.0)	14.6 (212.0)	9.1 (81.4)	10.2 (102.7)	11.2 (124.4)	12.8 (162.7)	3.83 (13.74)	4.12 (16.05)	8.54 (71.40)	8.71 (74.96)	71.30	74.59	59.60	38.85
T_4	6.0 (36.0)	17.0 (287.7)	7.3 (52.4)	15.9 (254.7)	6.1 (36.7)	7.6 (56.7)	5.7 (32.0)	8.7 (75.0)	6.49 (41.10)	7.22 (46.28)	6.03 (35.06)	10.72 (113.63)	10.70	23.48	71.60	15.85
T_5	11.6 (133.7)	12.2 (147.7)	12.8 (163.4)	13.2 (172.3)	6.4 (41.4)	7.8 (61.4)	6.1 (37.4)	8.6 (73.4)	4.38 (17.98)	4.54 (19.65)	8.90 (77.66)	10.17 (102.07)	60.90	67.51	37.10	24.42
T_6	5.1 (25.7)	15.3 (232.0)	6.3 (39.0)	16.6 (274.4)	5.4 (28.8)	6.3 (38.7)	6.2 (38.7)	7.2 (52.0)	2.47 (5.12)	2.59 (5.67)	4.81 (21.80)	5.62 (30.48)	88.90	90.62	82.20	77.42
T_7	16.0 (255.4)	17.9 (318.4)	17.1 (291.7)	18.9 (355.6)	4.8 (23.0)	6.0 (36.0)	7.2 (51.7)	9.1 (81.4)	6.86 (46.02)	7.81 (60.50)	11.22 (123.46)	11.70 (135.03)	-	-	-	-
T_8	0.7 (0.5)	0.7 (0.5)	0.7 (0.5)	0.7 (0.5)	0.7 (0.5)	0.7 (0.5)	0.7 (0.5)	0.7 (0.5)	0.7 (0.5)	0.7 (0.5)	0.7 (0.5)	0.7 (0.5)	100	100	100	100
LSD (P= 0.05)	**0.63**	**0.61**	**0.61**	**1.06**	**0.40**	**0.23**	**0.35**	**2.3**	**0.408**	**0.451**	**0.701**	**0.551**	-	-	-	-

Table 2. Effect of treatments on crop height (cm) at different growth stages of crop:

Treatments	Crop height (cm)									
	25DAS		45DAS		65DAS		85DAS		At harvest	
	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07
T_1	17.91	17.89	36.12	36.22	53.64	53.69	68.34	68.42	78.89	78.88
T_2	17.98	17.99	36.98	36.99	53.89	53.98	69.87	69.89	80.21	80.23
T_3	19.24	19.28	37.54	37.58	54.85	54.69	70.12	70.11	81.34	81.15
T_4	19.61	19.64	37.25	37.31	58.86	55.32	72.94	71.25	83.35	82.25
T_5	20.89	20.99	38.99	39.12	59.72	59.81	72.36	72.41	83.94	84.12
T_6	18.41	18.54	36.99	37.12	58.22	58.29	72.26	72.29	83.75	84.01
T_7	19.25	19.29	37.12	37.24	54.25	54.92	69.89	69.95	79.89	80.12
T_8	20.15	20.29	38.62	38.76	59.21	59.45	72.41	72.46	83.99	84.19
LSD (P = 0.05)	**2.38**	**2.00**	**1.69**	**1.71**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

T_1 : ZT + Weedy, T_2 : ZT + 2,4- D, T_3: ZT + glyphosate + 2,4-D, T_4: CT + 2,4-D, T_5: CT + isoproturon, T_7 : CT + pendimethalin, T_8 : CT + weedy, T_8 : CT + completeweed free, ZT- Zero tillage, CT- Conventional tillage, DAS- Days after sowing, Data transformed to $\sqrt{X + 0.5}$, figures in parentheses indicate original values.

Table 3: Effect of treatments on weed persistency index (%), herbicide efficiency index (%), pest (weed) control index (%), biological yield and economics of wheat crop

Treatments	Weed persistence index (%)				Herbicide efficiency index (%)		Straw yield (q/ha)		Grain yield (2/ha)		Net profit (Rs)	
	40 DAS		80 DAS									
	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07
T_1	1.00	1.00	1.00	1.0	-	-	27.26	28.25	10.33	11.41	-1161.00	-292.00
T_2	0.36	0.56	0.48	0.80	61.38	14.10	29.84	29.45	13.38	12.84	482.00	-282.00
T_3	0.08	0.09	0.20	0.42	213.03	80.41	38.25	37.89	18.93	18.27	3675.00	3158.00
T_4	0.27	0.31	0.13	0.72	206.72	33.72	41.26	37.51	21.95	18.24	5921.00	2931.00
T_5	0.28	0.35	0.59	0.70	66.18	40.39	40.12	39.56	19.40	18.96	3934.00	3571.00
T_6	0.01	0.02	0.08	0.18	383.82	317.89	42.12	45.42	22.40	26.75	5650.00	9111.00
T_7	1.00	1.00	1.00	1.00	-	-	29.59	31.21	13.66	14.21	-200.00	311.00
T_8	-	-	-	-	-	-	42.69	46.11	23.04	27.19	1121.00	4440.00
LSD (P= 0.05)	**-**	**-**	**-**	**-**	**-**	**-**	**4.12**	**2.50**	**1.10**	**1.19**	**-**	**-**

Table 4: Effect of treatments on soil microbial population (no. /g of soil)

Treatments	*Pseudomonas fluorescence*				*Azotobacter*			
	Initial	20DAS	40DAS	At Harvest	Initial	20DAS	40DAS	At Harvest
T_1	7.952 (9×10^7)	7.845 (7×10^7)	8.956 (9×10^8)	8.593 (4×10^8)	7.842 (7×10^7)	7.725 (5×10^7)	8.785 (6×10^8)	8.999 (9×10^8)
T_2	7.952 (9×10^7)	7.800 (6×10^7)	8.560 (4×10^8)	8.521 (3×10^8)	7.901 (7×10^7)	7.667 (5×10^7)	8.778 (6×10^8)	8.933 (9×10^8)
T_3	7.952 (9×10^7)	7.593 (4×10^7)	8.768 (4×10^8)	8.518 (3×10^8)	7.859 (7×10^7)	7.593 (4×10^7)	8.612 (4×10^8)	8.952 (9×10^8)
T_4	8.397 (25×10^7)	7.774 (6×10^7)	8.675 (5×10^8)	9.078 (12×10^8)	8.040 (11×10^7)	7.842 (7×10^7)	8.608 (4×10^8)	8.901 (8×10^8)
T_5	8.398 (25×10^7)	8.287 (20×10^7)	8.746 (6×10^8)	9.113 (13×10^8)	8.158 (11×10^7)	7.774 (6×10^7)	8.726 (5×10^8)	8.952 (9×10^8)
T_6	8.397 (25×10^7)	8.255 (18×10^7)	8.775 (6×10^8)	9.165 (14×10^8)	8.040 (11×10^7)	7.619 (4×10^7)	8.683 (5×10^8)	8.999 (10×10^8)
T_7	8.398 (25×10^7)	7.774 (6×10^7)	8.635 (4×10^8)	9.052 (11×10^8)	8.025 (11×10^7)	7.842 (7×10^7)	8.598 (4×10^8)	8.901 (8×10^8)
T_8	8.392 (25×10^7)	8.359 (23×10^7)	8.969 (9×10^8)	9.175 (14×10^8)	8.052 (11×10^7)	7.901 (8×10^7)	8.788 (6×10^8)	8.999 (10×10^8)
LSD (P = 0.05)	**0.068**	**0.139**	**0.347**	**0.068**	**0.324**	**0.149**	**0.043**	**0.095**

T_1: ZT + Weedy, T_2: ZT + 2,4- D, T_3: ZT + glyphosate + 2,4-D, T_4: CT + 2,4-D, T_5: CT + isoproturon, T_6: CT + pendimethalin, T_7: CT + weedy, T_8: CT + completeweed free, ZT- Zero tillage, CT- Conventional tillage, DAS- Days after sowing, Data transformed to v X + 0.5, figures in parentheses indicate original values.

significantly from other treatments. Pendimethalin caused growth retardation of wheat at the initial phase and wheat recovered completely without having any effect on its yield performance. Among the herbicidal treatments pendimethalin 0.5 kg/ha recorded highest grain yield (22.40 and 26.75 q/ha) in both the year and it became at par with complete weed free situation (23.04 and 27.19 q/ha) (Table 3). Similar finding was also reported by Paradkar *et al.* (2003). Shifting of weeds against 2,4-D application in second year reduced yield performance significantly (18.24 q/ha) which otherwise became statistically at par (21.95 q/ha) with weed-free condition (23.04 q/ha) and pendimethalin treated plots (26.75q/ha) in first year. In first year highest net return was found in CT + 2,4-D treated plot (Rs. 5921/-) and CT + pendimethalin (Rs. 9111/-) in second year, respectively. Under zero tillage system Gyphosate+2,4-D treatment became effective in controlling weeds in first year, however, it was not reflected on yield performance of wheat mainly because of inadequate crop establishment under zero tillage.

Effect on microbes

The beneficial microbes such as *Pseudomonas fluorescence* and *Azotobacter* population were highest in complete weed free situation at different stages crop (23 X 10^7, 9 X 10^8, 14 X 10^8 of *Pseudomonas fluorescence* and 8 X 10^7, 6 X 10^8, 10 X 10^8 of *Azotobacter* at 20 DAS, 40 DAS and at harvest, respectively) (Table 4). Pendimethalin at the dose of 0.50 kg/ha showed inhibitory effect on *Azotobacter* to the limited extent at the initial phase of crop growth, however, it recovered well at 40 DAS onwards. Other herbicides tested in conventional tillage and zero tillage system did not have any significant inhibitory effect on growth of these microbes in comparison to complete weed free condition.

REFERENCES

Ashraf, N. and Sen, D. N. 1981. Effect of herbicides on soil microbial activity in Indian arid zone; Abst. *Ann. Conf. Indian Soc.Weed Sci.*

Chopra, N., Singh, H., Tripathi, H. P. Chopra, N. K.,Chopra, N. and Singh, H. 2001. Performance of metsulfuron methyl and pendimethalin alone and their mixtures with isoproturon on weed control in wheat (*Triticum aestivum*) seed crop. *Indian J. Agro.* **46** (2): 239-45.

Dixit, A. and Bhan, V. M. 1997. Weed control efficiency of isoproturon applied at different concentration and its combination with 2,4-D in wheat. *Indian J. Weed Sci.* **29**: 11-14.

Paradkar, V. K., Thakur, S. K. and Tiwari, J. P. 2003. Productivity and economic viability as influenced by herbicides in irrigated wheat in Satpura Plateau. *J.Soils and Crops.* **13** : 22-24.

Singh, Govindra and Singh, Mahendra. 2002. Bio-efficacy of metsulfuronmethyl in combination with isoproturon for control of grassy and non grassy weeds in wheat. *Indian J. Weed Sci.* **34** : 9-12.

Walia, U. S., Brar, L. S. and Dhaliwal, B. K. 1998. Performance of clodinafop and fenoxaprop – p- ethyl for the control of *Phalaris minor* in wheat. *Indian J. Weed Sci.* **30** : 48-50.