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Effect of Herbicides and Tillage on Weed Flora in Wheat (*Triticum aestivum* L.) at *Terai* Agro-Ecological Region of West Bengal

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The irrigated wheat (*Triticum aestivum* L.) is infested with several broad-leaved weeds which create competitive stress resulting in yield losses varying from 10-70% depending upon their density (Singh *et al*., 1996). Therefore, proper management of weeds is essential to get its higher yield. Several herbicides have been found effective and among them isoproturon is being used for last two decades for controlling weeds especially grasses in wheat (Mishra *et al*., 2005), although it has not been found excellent against all broad-leaved weeds (Kushwaha and Singh, 2000). The broad-leaved weeds can; however, be controlled effectively with the application of 2,4-D. Continuous and improper use of these herbicides resulted in shifting of weed flora in terms of herbicide resistant weed biotypes (Malik and Singh, 1995). *Terai* region of West Bengal has a characteristic feature of high rainfall and micronutrient deficiency in soil leading to aggressive growth of weeds especially broad-leaved during crop season. High weed pressure of broad-leaved weed during winter season becomes a constraint in crop cultivation. An experiment was conducted with an objective to study the effect of herbicide on weed flora in wheat grown under different tillage systems.

Field experiment was carried out during two consecutive **rabi** (winter) seasons of 2005-06 and 2006-07 in the farm of Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar (26°19'86"N latitude and 89°23'53" E longitude). The soil was sandy loam in texture having a pH 5.34-5.8 and 0.75% organic carbon, low in available nitrogen (94.75 kg/ha), medium in available phosphorus (16.35 kg/ha) and low in available potassium (76.9 kg/ha). The treatments comprising (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 fb 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 replicated thrice in randomized block design (RBD). Wheat variety "Sonalika" was used in the experiment. The crop was sown in row of 22.5 cm apart on 10 December in 1st year and 15 November in 2nd year. The crop was fertilized with 120 kg nitrogen/ha, 60 kg Phosphorus/ha and 60 kg potassium/ha. Weed count was made on 60 DAS, whereas weed dry biomass was recorded at 40, 60 and 80 DAS from the area enclosed by a quadrate of 0.25 m^2 randomly selected at two places in each plot. Weed data were subjected to square root transformation ($\sqrt{X+0.5}$) before statistical analysis. Weed index (WI), weed persistency index (WPI) and weed control efficiency (WCE) were calculated by using following formulae :

$$\text{WI (\%)} = \frac{\text{Grain yield in weed free plot} - \text{Grain yield in treated plot}}{\text{Grain yield in weed free plot}} \times 100$$

$$\text{WPI (\%)} = \frac{\text{Dry weight of weeds in treated plot}}{\text{Dry weight of weeds in control plot}} \times \frac{\text{Weed count in control plot}}{\text{Weed count in treated plot}}$$

$$\text{WCE (\%)} = \frac{\text{Dry weight of weeds in control plot (weedy)} - \text{Dry matter in treated plot}}{\text{Dry weight of weed in control plot (weedy)}} \times 100$$

Effect on Weeds

The weedy field was dominated by naturally occurring highly aggressive broad-leaved weeds viz., *Polygonum pensylvenicum, Polygonum orientale, Polygonum persicaria, Stellaria media, Stellaria aquatica, Oldenlandia diffusa* and *Spilanthes paniculata* in first year; however, *O. diffusa* and *S. paniculata* were completely absent during second year especially in zero tillage weedy plots due to early sowing of wheat as these weeds generally appear at later phase of the winter season. Among the grasses *C. dactylon*, *Setaria glauca* and *Digitaria sanguinalis* became dominant during both the years.

All the treatments significantly reduced the density and dry weight of weeds compared to weedy plots. The summed dominant ratio (SDR) and important value index (IVI) of weeds at 60 days after sowing revealed that *Polygonum* and *Stellaria* were most effectively controlled by the application of 2,4-D and pendimethalin during first year of experimentation (Table 1). Application of these herbicides in same plot during second year resulted in occurrence of *Physalis minima* and reemergence of *S. media* in 2,4-D treated plots, whereas *Hydrocotyl ranunculoides* and *Eclipta alba* were in pendimethalin treated plots. The weed flora like *O. diffusa* and *S. paniculata* were completely absent in second year.

The weed flora was dominated by several species of *Polygonum* having higher competitive ability and damaging potential than other broad-leaved weeds. Therefore, the weed control efficiency of the herbicides was mainly influenced by their ability to control *Polygonum*. Among the chemical treatments, pendimethain has recorded lowest weed dry weight at 40, 60 and 80 DAS in both the years followed by conventional tillage+2,4-D in first year of the experimentation. Isoproturon had completely failed to reduce the weed dry weight because of its poor efficacy against broad-leaved weeds; however, a growth promoting activity on wheat in terms of sharp increase in height at active growth phase was observed. Among the herbicides, pendimethalin recorded highest weed control efficiency (>80%) (Singh and Singh, 2004),

Table 1. Effect of herbicides and tillage treatments on important value index (IVI) and summed dominant ratio (SDR) of individual weeds at 60 DAS

Treatment	*Polygonum* spp.				*Stellaria media*				*Spilanthes paniculata*		*Oldenandia diffusa*		*Physalis minima*	
	2005-06		2006-07		2005-06		2006-07		Only 2005-06		Only 2005-06		Only 2006-07	
	IVI	SDR	IVI	SDR	IVI	SDR	IVI	SDR	IVI	SDR	IVI	SDR	IVI	SDR
Z+Weedy (T_1)	28.9	14.4	24.3	12.1	25.5	12.7	27.5	13.8	26.5	13.3	25.9	12.97	-	-
ZT+2,4- D (T_2)	30.0	15.0	24.9	12.5	25.1	12.5	35.3	17.6	30.3	15.16	26.3	13.15	19.3	9.67
ZT+Glyphosate+2,4-D (T_3)	35.6	17.8	28.7	14.4	26.6	13.3	44.5	22.3	31.3	15.6	26.57	13.3	34.2	17.1
CT+2,4-D (T_4)	45.5	22.7	20.2	10.1	48.4	24.2	74.1	37.0	-	-	-	-	29.9	14.9
CT+Isoproturon (T_5)	89.4	44.7	84.7	42.3	29.8	14.9	32.1	16.0	-	-	-	-	8.32	4.2
CT+Pendimethalin (T_6)	31.8	15.9	18.9	9.5	49.4	24.7	20.1	10.0	-	-	-	-	-	-
CT+Weedy (T_7)	67.3	33.6	54.2	27.1	70.2	35.1	62.9	31.5	31.7	15.8	-	-	-	-

Contd.

Table 1 contd.

Treatment	*Hydrocotyl ranunculoides*		*Eclipta alba*		*Cynodon dactylon*				Other gassy weeds			
	Only 2006-07		Only 2006-07		2005-06		2006-07		2005-06		2006-07	
	IVI	SDR	IVI	SDR	IVI	SDR	IVI	SDR	IVI	SDR	IVI	SDR
Z+Weedy (T_1)	-	-	-	-	57.5	28.7	66.3	33.1	37.4	18.7	42.8	21.41
ZT+2,4-D (T_2)	23.3	11.63	-	-	44.9	22.5	48.5	24.2	44.9	22.5	46.2	23.12
ZT+Glyphosate+2,4-D (T_3)	20.4	10.2	-	-	31.3	15.7	31.3	15.6	50.5	25.2	42.7	21.4
CT+2,4-D (T_4)	17.5	8.73	-	-	24.7	13.9	30.6	15.3	77.3	38.6	25.6	12.8
CT+Isoproturon (T_5)	-	-	-	-	32.3	16.2	35.6	17.8	48.3	24.1	38.7	19.4
CT+Pendimethalin (T_6)	85.2	42.6	39.1	19.6	36.2	18.1	12.5	6.3	78.6	39.3	24.1	12.1
CT+Weedy (T_7)	-	-	-	-	-	-	23.5	11.8	30.7	15.3	32.5	16.3

DAS–Days after sowing, ZT–Zero tillage, CT–Conventional tillage.

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Table 2. Effect of herbicides and tillage treatments on weed dry weight, weed control efficiency, straw yield, grain yield, weed index and weed persistency index

Treatment	Weed dry weight (g/m^2)						Weed control efficiency (%)						Straw yield (q/ha)		Grain yield (q/ha)		Weed index (%)		Weed persistency index (%) at 60 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
	40 DAS	60 DAS	80 DAS	40 DAS	60 DAS	80 DAS	40 DAS	60 DAS	80 DAS	40 DAS	60 DAS	80 DAS								
T_1	7.56 (56.37)	10.19 (103.17)	15.86 (249.95)	8.04 (63.18)	9.71 (92.5)	11.13 (122.6)	-	-	-	-	-	-	27.26	28.25	10.33	11.41	55.16	58.04	1.00	1.00
T_2	5.8 (32.43)	7.66 (59.56)	10.37 (103.3)	7.51 (55.57)	8.91 (78.24)	10.09 (100.84)	42.63	42.2	58.61	12.02	15.39	17.75	29.84	29.45	13.38	12.84	41.93	52.78	0.46	0.64
T_3	3.83 (13.74)	5.54 (29.66)	8.54 (71.4)	4.12 (16.05)	6.37 (39.36)	8.71 (74.96)	71.3	71.1	59.6	74.59	57.42	38.85	38.25	37.89	18.93	18.27	17.84	32.81	0.16	0.24
T_4	6.49 (41.10)	5.02 (24.3)	6.03 (35.06)	7.22 (46.28)	8.65 (73.36)	10.72 (113.63)	10.7	71.3	71.6	23.48	24.05	15.85	41.26	37.51	21.95	18.24	4.73	32.92	0.11	0.65
T_5	4.38 (17.98)	7.37 (52.92)	8.9 (77.66)	4.54 (19.65)	7.79 (59.38)	10.17 (102.07)	60.9	37.5	37.1	67.51	38.53	24.42	40.12	39.56	19.4	18.96	15.8	30.27	0.54	0.57
T_6	2.47 (5.12)	3.83 (13.62)	4.81 (21.8)	2.59 (5.67)	4.38 (18.2)	5.62 (30.48)	88.9	83.9	82.2	90.62	81.15	77.42	42.12	45.42	22.4	26.75	2.78	1.62	0.04	0.13
T_7	6.86 (46.02)	9.28 (84.72)	11.22 (123.46)	7.81 (60.5)	9.89 (96.6)	11.7 (135.03)	-	-	-	-	-	-	29.59	31.21	13.66	14.21	40.71	47.74	1.00	1.00
T_8	0.7 (0)	0.7 (0)	0.7 (0)	0.7 (0)	0.7 (0)	0.7 (0)	100	100	100	100	100	100	42.69	46.11	23.04	27.19	-	-	-	-
LSd (P=0.05)	0.408	0.396	0.701	0.451	0.449	0.551						4.12	2.50	1.10	1.19					

Treatment details in materials and methods, DAS–Days after sowing, ZT–Zero tillage, CT–Conventional tillage.
Data transformed to $\sqrt{X+0.5}$. Figures in parentheses indicate original values.

lowest weed index, lowest weed persistence index in first year. In second year, weed control efficiency of pendimethalin (>77%) was slightly lower because of the emergence of *E. alba* and *H. ranunculoides* (Table 2). 2,4-D in conventional tillage caused desirable weed control efficiency (70-75%) during first year of experimentation; however, in second year it had poor weed control efficiency because of occurrence of *P. minima* and reemergence of *S. media.*

Effect on Crop

Among the herbicidal treatments, pendimethalin has recorded highest value of grain yield (22.4 and 26.7 q/ha) which was statistically at par with complete weed free situation (23.04 and 27.19 q/ha) during both the years in conventional tillage. Under zero tillage, herbicidal treatment of glyphosate followed by 2,4-D was found effective in controlling weeds; however, yield was significantly lower than pendimethalin treated plots.

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