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Bioassay study of pendimethalin in wheat-*Polygonum* association 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

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Chemical methods of weed control through herbicide play a vital role as a cost effective tool in integrated weed management programme and are being widely practice in the present day agriculture. The terai agro-ecological zone has a typical sub-tropical humid climate with high annual rainfall (more than 3000mm) along with high relative humidity resulting in luxuriant growth of the weeds, which often become obnoxious. Nevertheless, the soils in this region developed under the influence of high rainfall and intense leaching condition are coarse in texture and become multiple nutrient deficient. Profuse growth of several weeds with high invasive capacity coupled with poor fertility status often became limiting factor in crop cultivation. Non-selective action of pendimethalin and its phytotoxicity on wheat observed in field condition under terai agro-ecological region led to evaluate the dose of pendimethalin that become safe for use as pre-emergence treatment in wheat for controlling *Polygonum*. The bioassay experiment has been planned with the objective to determine dose and degree of selectivity of pendimethalin through the measurement of selectivity index. This technique usually lead to identify the herbicides that are safe for a crop in terms of phytotoxicity and growth reduction by making relationship between different herbicidal doses and per cent growth reduction of plants (Tag *et al.*, 1981).

A field experiment was carried out during the *rabi* season of 2007 and 2008 at the research farm of Uttar Banga Krishi Viswavidyalaya located at Pundibari, Cooch Behar, W.B. The soil of the experimental site was sandy loam with pH 5.34-5.8, organic carbon 0.45%, available N 112.80 kg ha^{-1}, available phosphorus 16.35 kg ha^{-1} and available potash 76.9 kg ha^{-1}. The locally cultivated wheat variety "Sonalika" was considered in the experiment. In wheat pendimethalin @ of 0.00, 0.20, 0.30, 0.40, 0.50, 0.60, 0.70, 0.80, 1.00, 1.20, and 1.40 kg ha^{-1} and in case weeds (*Polygonum*) pendimethalin @ of 0.00, 0.10, 0.20, 0.30, 0.40, 0.50, 0.60, 0.70, 0.80, 1.10 and1.20 kg ha^{-1} were considered for the field experiment in a plot size of 2 m^2 area. Both wheat and weed plant samples were taken at 20 and 40 days after sowing (DAS) from 20 cm × 20 cm sample area. Visual observations were made daily to recognize the changes in growth behavior of the plants and appearance of phytotoxic symptom owing to herbicidal toxicity on plant at different dosages. Biological response of plants to herbicides was determined through measuring the fresh weight of the plants grown in different herbicides treated plots and per cent growth inhibition of plant was calculated by comparing the fresh weight of herbicide treated plant with healthy plant from untreated plot. The per cent growth inhibition values obtained at different herbicidal doses both in case of wheat and weed were transformed to probit values and plotted against log values of the doses (Table 1, 2 and 3). A straight line was obtained through computation of regression equation ($Y = Mx + C$ where, Y = Probit value, M = regression coefficient, x = log dose and C = constant) reflecting response of plants at different doses of herbicides. Selectivity index (S.I.) value was calculated by formula S.I. = Maximum dose tolerated by the crop/minimum dose required to control the weeds. Maximum dose of herbicide tolerated by wheat crop was equal to the dose that caused 10% growth reduction of wheat at initial stage and minimum dose required to control the weeds (*Polygonum*) was equal to the dose that resulted in 80% growth reduction of weed or 80% weed control efficiency. S.I. value >1 is always desirable to get selective control over weeds without any lethal effect on crop plant. The proportional increase of plant response in terms of growth reduction to herbicide dose led to identify the level at which the plant produced 50% response which is known as GR_{50} (dose that causes 50% growth reduction) or ED_{50} (equivalent dose for 50% response). GR_{50} values show relative sensitivity of crops to herbicides (Nel *et al.*, 1995).

Weed flora

Weed flora of the experiment comprised different species of *Polygonum* like *P. persicaria* L., *P. pensylvanicum* L., *P. oriental* L. and *P. odoratum* L.

Phytotoxicity and selectivity index of herbicide

The phytotoxic effect to the wheat plant was manifested with characteristic yellowing and necrotic symptom which appeared within 8-10 DAS in newly emerged seedling. Appearance of yellowing and necrotic symptom was followed by death of seeding within 12-15 DAS. Selectivity index value of pendimethalin for wheat-*Polygonum* association were 1.06 and 1.03 at 20 DAS during 2007 and 2008, respectively in which GR_{10} values of wheat were 0.516 and 0.505 kg/ha and GR_{80} values of weed (*Polygonum*) were 0.488 and 0.491 kg ha^{-1} during 2007 and 2008, respectively. At 40 DAS selectivity index values were 1.08 and 1.1 in which GR_{10} values of wheat were 0.544 and 0.553 kg ha^{-1} and GR_{80} values of weed (*Polygonum*) were 0.506 and 0.503 kg ha^{-1} during 2007 and 2008, respectively.

Short communication

E-mail: sefauragro@gmail.com

Table 1: Dose of herbicide (kg ha^{-1}), corresponding logarithmic dose of herbicide, dry weight of wheat (g) influenced by different dosages of herbicide, per cent growth inhibition of wheat and its corresponding probit value at 20 DAS and 40 DAS

Dose of herbicide (kg ha^{-1})	Log dose (X)	Dry weight (g)				Growth inhibition (%)				Probit value (Y)			
		20 DAS		40 DAS		20 DAS		40 DAS		20 DAS		40 DAS	
		2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008
0.0	0.000	2.2000	2.1700	12.3000	12.1000	-	-	-	-	-	-	-	-
0.2	-0.669	2.1758	2.1417	12.1647	11.9669	1.10	1.30	1.10	1.10	2.7006	2.7897	2.7006	2.7006
0.3	-0.523	2.1340	2.1049	12.0048	11.8459	3.00	3.00	2.40	2.10	3.1192	3.1192	3.0226	2.9665
0.4	-0.398	2.0988	2.0701	11.9802	11.5676	4.60	4.60	2.60	4.40	3.3151	3.3151	3.0500	3.2940
0.5	-0.301	2.0944	2.0376	11.9310	11.5434	4.80	6.10	3.00	4.60	3.3354	3.4536	3.1192	3.3151
0.6	-0.222	2.0020	1.9725	11.7342	11.3619	9.00	9.10	4.60	6.1	3.6592	3.6654	3.3151	3.4536
0.7	-0.155	1.9910	1.9530	11.1807	10.9989	9.50	10.00	9.10	9.10	3.6894	3.7184	3.6654	3.6654
0.8	-0.097	1.8964	1.8792	10.6518	10.8900	13.8	13.40	13.40	10.00	3.9107	3.8923	3.8923	3.7184
1.0	0.000	1.0780	1.085	6.2853	7.0059	51.0	50.00	48.90	42.10	5.0251	5.0000	4.9724	4.8007
1.2	0.079	0.9196	0.8180	5.3874	5.2030	58.20	62.30	56.20	57.00	5.2070	5.3134	5.1558	5.1764
1.4	0.146	0.4092	0.4053	2.8659	3.4606	81.40	81.32	76.70	71.40	5.8927	5.8901	5.7290	5.5651

Table 2: Dose of herbicide (kg/ha), corresponding logarithmic dose of herbicide, dry weight of *Polygonum* (g) influenced by different doses of herbicide, per cent growth inhibition of *Polygonum* and its corresponding probit value at 20 DAS and 40 DAS

Dose of herbicide (kg ha^{-1})	Log dose (X)	Dry weight (g)				Growth inhibition (%)				Probit value (Y)			
		20 DAS		40 DAS		20 DAS		40 DAS		20 DAS		40 DAS	
		2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008
0.0	0.000	1.7400	1.6800	4.4200	4.1200	-	-	-	-	-	-	-	-
0.1	-1.000	1.4007	1.3120	3.5581	3.3166	19.50	21.90	19.50	19.50	4.1404	4.2244	4.1404	4.1404
0.2	-0.699	1.1240	1.0852	2.8951	2.6986	35.40	35.40	34.50	34.50	4.6255	4.6255	4.6011	4.6011
0.3	-0.523	0.8891	0.8500	2.2586	2.1053	48.90	49.40	48.90	48.90	4.9724	4.9850	4.9724	4.9724
0.4	-0.398	0.5742	0.4569	1.5028	1.2154	67.00	72.80	66.00	70.50	5.4399	5.6068	5.4125	5.5388
0.5	-0.301	0.3236	0.4418	0.8707	1.0959	81.40	73.70	80.30	73.40	5.8927	5.6250	5.8542	5.6250
0.6	-0.222	0.2836	0.2184	0.7425	0.5397	83.70	87.00	83.20	86.90	5.9822	6.1264	5.9621	6.1217
0.7	-0.155	0.1426	0.1814	0.4773	0.4449	91.80	89.20	89.20	89.20	6.3917	6.2372	6.2372	6.2372
0.8	-0.097	0.1200	0.1344	0.3624	0.3378	93.10	92.00	91.80	91.80	6.4833	6.4051	6.3917	6.3917
1.0	-0.000	0.0904	0.0772	0.2607	0.2018	94.80	95.40	94.10	95.10	6.6258	6.6646	6.5632	6.6546
1.2	0.079	0.0189	0.0191	0.0503	0.0770	98.91	98.86	98.86	98.13	7.2938	7.2766	7.2766	7.0814

Table 3: Regression equation between probit value and logarithmic dose of herbicide, r^2 value, GR_{10} value of wheat, GR_{50} value of wheat and *Polygonum*, GR_{80} value of *Polygonum* and selectivity index

	Wheat at 20 DAS		*Polygonum* at 20 DAS		Wheat at 40 DAS		*Polygonum* at 40 DAS	
	2007	**2008**	**2007**	**2008**	**2007**	**2008**	**2007**	**2008**
Regression equation	Y=3.6561X + 4.7678	Y=3.6136X + 4.789	Y=2.8964X + 6.7452	Y=2.7946X + 6.7044	Y=3.6744X+ 4.6886	Y=3.4241X + 4.5983	Y=2.8273X + 6.6787	Y=2.7795X + 6.6581
R^2 value	0.8592	0.8550	0.9628	0.9551	0.8407	0.8578	0.9606	0.9720
GR_{10} values (kg ha^{-1})	0.5160	0.5050	-	-	0.5440	0.5530	-	-
GR_{50} values (kg ha^{-1}))	1.1570	1.1440	0.2500	0.2460	1.2150	1.3090	0.2540	0.2530
GR_{80} values (kg ha^{-1}))	-	-	0.4880	0.4910	-	-	0.5060	0.5030
Selectivity Index	S.I.= 0.516/0.488 = 1.057 (for 2007)				S.I.= 0.544/0.506 =1.075 (for 2007)			
	S.I.= 0.505/0.491 = 1.028 (for 2008)				S.I.= 0.553/0.503 =1.099 (for 2008)			

S.I. value >1 ensured selectivity of pendimethalin in wheat-*Polygonum* association to achieve 80% weed control efficiency with the dose ranging from 0.49 to 0.51 kg/ha. Maintaining S.I. value >1 up to 40 DAS indicated persistence of pendimethalin in soil at least for the period of 40 DAS for controlling weed (*Polygonum*) in wheat. Therefore it might be concluded that the pendimethalin 0.5 kg/ha could be effective to achieve > 80% weed control efficiency of weed in wheat without showing any phytotoxic to wheat under terai agro-ecological region of West Bengal and it could help the poor farmers to reap maximum benefit by saving their crop from severs crop-weed competition.

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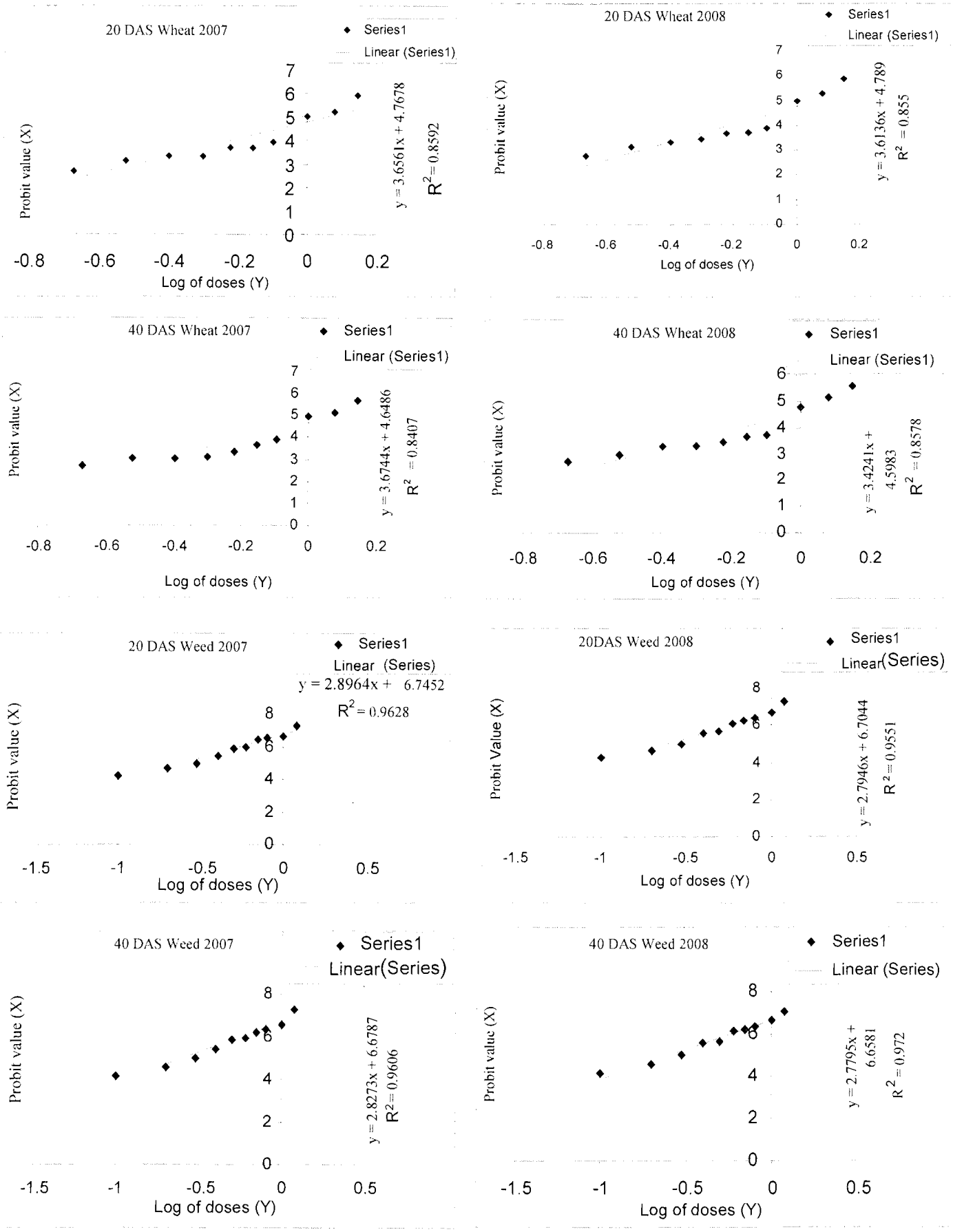

Fig. Relationship between probit value of growth reduction (X axis) of wheat and weed (*Polygonum*) and logarithmic doses of herbicide (pendimethalin) (Y axis)