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Herbicide economy with surfactants to control weeds in wheat (*Triticum aestivum*)

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ABSTRACT

A field experiment was conducted during 1987–88 and 1988–89 to economize the dose of isoproturon and methabenzthiazuron with surfactants for the control of weeds in wheat (*Triticum aestivum* L. emend. Fiori & Paol.). There were 28 treatment combinations of 2 herbicides (isoproturon and methabenzthiazuron), 3 doses [50% of the recommended, 75% of the recommended and recommended (1.5 kg/ha)] and unweeded check in main plots; and 4 surfactants [no surfactant, Selwet (0.5% V/V), Triton x-100 (0.1% V/V) and Teepol (0.5% V/V)] in subplots with 3 replications. Methabenzthiazuron was found superior to isoproturon in controlling the weeds. Surfactants increased the efficacy of both herbicides in controlling *Lolium temulentum* L. and other weeds. All the herbicides at 50% of the recommended dose in combination with Selwet and Teepol surfactants and 75% of the recommended dose with Selwet being staistically at par gave significantly higher grain yield than recommended dose without surfactant. The recommended dose with surfactant caused phytotoxic effect to the crop.

Herbicide activity depends on efficient uptake into plants, which in turn is dependent on good spray retention, wetting and spreading on plant surfaces (Sharma and Vanden Born, 1970). High cost of presently recommended broad-spectrum herbicides restrict their use by small and marginal farmers. The addition of surfactants improve herbicidal efficacy possibly by altering solubility relationships and cuticle retention and penetration of the cuticle (Var Valkenbury, 1982) and thus may help in reducing the recommended dose of costly herbicides.

Hence the present field study was conducted to economize the dose of isoproturon and methabenzthiazuron with surfactants to control weeds in wheat (*Triticum aestivum* L. emend. Fiori & Paol.).

METERIALS AND METHODS

A field experiment was conducted in split-plot design with 3 replications at experimental farm, Palampur, during the winter season (*rabi*) of 1987–88 and 1988–89. Seven treatment combinations consisted of 2 herbicides [H_1, isoproturon; and H_2, methabenzthiazuron each at 3 doses, i.e. D_1 50% of recommended; D_2, 75% of the recommended; and D_3, recommended dose (1.5 kg/ha) and 1 unweeded check (H_0)] in main plots and 4 surfactants, viz. S_0, no surfactant; S_1, Selwet-E 0.5%; S_2, Triton x-100 0.1% v/v.; S_3, Teepol 0.5 v/v in subplot. Each of the surfactants was applied after tank mixing with the herbicides. The soil of experimental field was silty clay-loam in texture and acidic (pH 5.5.) in reaction. The soil was low in available nitrogen, medium in available phosphorus and high in available potassium. 'Sonalika' wheat was sown on 15 November using the recommended package of practices. Herbicides were

Table 1. Effect of weed-control treatments on weed counts (number/m^2) and weed dry matter (g/m^2) in wheat field

Treatment	Weed count				Weed dry matter			
	Lolium		Other weeds		Lolium		Other weeds	
	1987–88	1988–89	1987–88	1988–89	1987–88	1988–89	1987–88	1988–89
Unweeded	8.73 (76.0)	9.0 (80.87)	14.95 (223.5)	15.58 (242.69)	71.83	76.43	129.17	140.23
Chemical control	5.29 (30.4)	5.70 (32.54)	7.35 (61.8)	9.70 (94.10)	38.84	41.57	53.84	59.19
CD (P = 0.05)	0.67	0.95	0.72	1.23	1.55	2.25	5.42	8.22
Herbicide								
Isoproturon	5.21 (28.7)	5.53 (30.64)	7.69 (66.0)	8.62 (74.26)	39.67	42.35	54.76	61.61
Methabenzthiazuron	5.38 (32.2)	5.93 (35.17)	7.02 (57.6)	7.85 (61.67)	38.02	41.53	53.02	56.77
CD (P = 0.05)	NS	NS	0.55	0.75	1.17	0.65	NS	2.47
Dose								
50% of R	6.82 (46.7)	7.04 (49.63)	9.81 (96.6)	10.15 (103.03)	44.94	47.76	68.06	72.59
75% of R	5.23 (28.0)	5.53 (30.56)	8.44 (72.2)	8.88 (78.95)	38.71	42.25	51.76	56.13
R	3.84 (16.7)	4.25 (18.03)	3.81 (16.7)	4.35 (18.95)	32.88	35.50	41.85	47.50
CD (P = 0.05)	0.62	0.98	0.67	1.02	1.44	2.67	5.02	7.10

R, Recommended dose

Values given in the parentheses are the means of original values

sprayed with Maruyama power sprayer using 600 litres water/ha at 30 days after sowing. Data on weed counts and weed dry matter were recorded by throwing 50 cm x 50 cm quadrat at random in each plot. The data of weed counts were analysed after subjecting the original data to square-root transformation. The data recorded on yield and yield-contributing characters were analysed.

RESULTS AND DISCUSSION

The major weeds of the experimental field were *Phalaris minor* Retz., *Avena fatua* L., *Lolium temulentum* L., and broad-leaf weeds were *Vicia sativa* L. and *Anagallis arvensis* L.), constituting 57.2–61.2, 16.7–18.5 and 20.3–26.1% of the total weed flora respectively. Except broad-leaf weeds, all other weeds were higher during the second year.

Effect on weeds

The herbicides decreased the population and dry matter of *Lolium temulentum* and other weeds significantly from the unweeded check, during both the years (Table 1). However, methabenzthiazuron was significantly superior to isoproturon in reducing the population and dry matter of weeds. But differences were not significant in influencing the count of *Lolium temulentum* during both years and dry matter of other weeds during

Table 2. Interaction effect of herbicides, their doses and surfactants on dry-matter accumulation (g/m^2) of weeds (except *Lolium)* at harvest in wheat

Treatment	Surfactant							
	No surfactant		Selwet-E		Triton x-100		Teepol	
	1987–88	1988–89	1987–88	1988–89	1987–88	1988–89	1987–88	1988–89
Herbicide x dose								
$H_1 D_1$	84.47	90.27	61.63	67.85	64.10	70.52	61.63	67.43
$H_1 D_2$	61.43	68.25	49.10	55.25	49.17	56.10	52.07	59.50
$H_1 D_3$	47.57	55.43	41.87	49.34	40.10	48.85	43.97	50.57
$H_2 D_1$	82.93	87.53	61.93	65.27	61.97	65.33	65.80	66.57
$H_2 D_2$	61.93	67.57	44.93	49.43	46.33	51.23	49.13	52.43
$H_2 D_3$	46.00	50.87	38.10	41.53	36.77	39.93	40.40	43.50
CD (P = 0.05)								
					1987–88		*1988–89*	
2 surfactants means at same herbicide x dose					2.45		3.15	
2 herbicides x doses means at same or different surfactants					7.41		9.53	

H_1, Isoproturon; H_2, methabenzthiazuron; D_1, 50% recommended dose of herbicide; D_2, 75% recommended dose of herbicide; D_3, recommended dose of herbicides

1987–88. These results are in conformity with those of Angiras and Modgal (1981). Increasing doses of herbicides decreased the population and dry matter of weeds significantly.

Data on interaction effect of herbicides, their doses and surfactants on dry matter of weeds other than *Lolium* at harvests revealed that in each of the herbicide and dose combinations, surfactants reduced the dry matter of other weeds significantly compared with their combinations without surfactants (Table 2). Both the herbicides at their recommended dose in combination with any of the surfactants reduced the dry matter of other weeds to a significantly lowest level in comparison to without surfactants and combination of remaining herbicides, their doses with and without surfactants. The results indicated that owing to use of any of the surfactants, the herbicide doses could be reduced by 25% from each of the higher dose of herbicide without surfactants. The increased efficacy of herbicides in the presence of surfactants may be attributed to combined polar and non-polar properties in the same molecule which provide compatibility in aquous and lipoidal phases and thus increased the penetration by reducing surface tension of herbicide solutions (Foy and Smith, 1969). The result confirms the findings of Pujol *et al.* (1984), who also reported 20% reduction in herbicide dose by the use of surfactants in controlling *Lolium* spp. in vegetable crops.

Effect on crop

All the herbicides increased the yield-

Table 3. Effect of treatments on yield and yield-contributing characters of wheat

Treatment	Effective tillers/ m^2		Spike length (cm)		Spikelets/ spike		Grains/ spike		1,000-grain weight (g)		Grain yield (kg/ha)	
	1987–88	1988–89	1987–88	1988–89	1987–88	1988–89	1987–88	1988–89	1987–88	1988–89	1987–88	1988–89
Unweeded check vs herbicide												
Unweeded check	345.6	330.5	9.92	9.90	17.11	17.21	36.83	36.53	38.82	36.50	2,135	1,965
Chemical weed control	399.1	387.8	11.34	11.00	23.27	23.25	48.74	48.62	44.67	43.95	4,552	3,034
CD (P = 0.05)	11.9	11.0	0.32	0.44	0.94	1.02	1.64	1.84	1.16	1.20	594	484
Herbicide												
Isoproturon	400.0	390.5	11.36	11.10	23.44	23.50	49.30	49.00	44.23	44.00	4,406	2,920
Methabenzthiazuron	398.3	385.2	11.32	10.90	22.91	23.00	48.27	48.24	45.11	43.90	4,697	3,148
CD (P = 0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Dose												
50% of R	397.2	387.5	11.01	10.45	22.62	23.00	47.22	47.45	45.17	44.95	4,864	3,241
75% of R	426.5	405.2	11.59	11.50	24.27	24.00	51.01	50.80	44.93	43.75	4,760	3,173
R	373.7	370.7	11.42	11.05	22.72	22.75	47.99	46.50	43.89	43.15	4,031	2,688
CD (P = 0.05)	11.0	10.5	0.30	0.46	0.87	0.84	1.52	1.50	1.08	1.02	550	345

R, Recommended dose

contributing characters significantly over the unweeded check (Table 3). Both herbicides did not differ significantly in influencing the yield atrributes. Increase in dose of herbicides up to 75% of the recommended dose significantly increased all the yield-contributing characters.

Interaction of herbicide doses and surfactants indicated that 50 and 75% of the recommended doses of the herbicides with use of sufactants increased all the yield attributes significantly over without surfactant. This is attributed to reduced crop-weed competition, which might have resulted in better formation of sink and translocation of photosynthates to the sink. At recommended dose of herbicides, surfactants reduced the number of effective tillers significantly. It showed that surfactants when mixed with recommended dose caused phytotoxicity to tillers.

Table 4. Interaction effect of surfactants and doses of herbicides on grain yield (kg/ha) of wheat

Dose	Surfactant			
	Without surfactant	Selwet E	Triton-x-100	Teepol
	1987–88			
50% of R	3,778	5,278	5,088	5,313
75% of R	3,900	5,508	4,748	4,883
R	4,583	3,805	3,996	3,741
	1988–89			
50% of R	2,512	3,519	3,392	3,542
75% of R	2,600	3,672	3,106	3,256
R	3,056	2,537	2,664	2,494
CD (P = 0.05)			*1987–88*	*1988–89*
2 surfactants means at same dose			681	682
2 doses at same or different surfactants			688	689

Herbicides being statistically alike increased the grain yield significantly over the unweeded check (Table 3). It is attributed to effective weed control and increase in yield-contributing characters owing to application of herbicides. On an average, weeds in unweeded check caused 53 and 46.8% reduction in the grain yield of wheat from the best treatment. Increase in dose of herbicides beyond 75% of recommended dose caused phytotoxicity and reduced the yield-contributing characters, thereby resulting in significant reduction in grain yield.

The use of surfactants with 50 and 75% of the recommended doses of herbicide increased the grain yield significantly over no surfactant (Table 4). All the surfactants were statistically at par in affecting the grain yield. Although use of surfactants with recommended dose of herbicides reduced the dry matter of weeds and weed counts significantly (Table 2), but because of their phytotoxic effects on yield attributes, the grain yield reduced significantly over no herbicide.

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