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Effect of fertilizer and weed management on nutrient economy and yield of wheat (*Triticum aestivum*)

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ABSTRACT

A field experiment was conducted during the winter (*rabi*) season of 1996–97 and 1997–98 to study the effect of fertilizer levels and weed management on nutrient economy and yield of wheat (*Triticum aestivum* L. emend. Fiori & Paol.). Fertilizer rate of 160, 80 and 60 kg N, P and K/ha recorded significantly higher yield attributes, i.e. tillers/m row length, ear length, grains/ear and grain yield, but failed to achieve significant increase in net return over 120, 60 and 40 kg N, P and K/ha which accrued the maximum benefit : cost ratio. Among the weed-management practices, though hand-weeding resulted in significantly higher yield attributes and grain yield than 2, 4-D and mixture of isoproturon and 2, 4-D, the differences in net returns were non-significant. Weed control through herbicides recorded significantly higher benefit : cost ratio than hand-weeding. The yield obtained at lower levels of fertilizer with effective control of weeds was at par with the yield obtained even at the highest level of fertilizer (160, 80 and 60 kg N, P and K/ha) under weedy check. Fertilizer levels recorded significantly higher weed count and weed dry biomass than no fertilizer treatment. Among the weed-control treatments, minimum weed dry biomass and higher weed-control efficiency were recorded in hand-weeded plot. The herbicides tested were equally effective in controlling the weeds and providing the grain yield.

Key words : Wheat, Nutrient economy, Herbicides, Yield

With the adoption of high-yielding dwarf wheat varieties, weed infestation with complex flora has become a serious problem in the wheat-growing areas of the country. *Phalaris minor (retz.)* Pers. and *Avena ludoviciana* L. have emerged as serious grassy weeds of wheat crop. Since last 15 years, isoproturon was intensively used for controlling these weeds at farmers' fields (*Gupta et al.,* 1990). Though 2, 4-D provided excellent control of broad-leaf weeds, it has the problem of developmental deformities in wheat (Balyan *et al.,* 1990). In order to control broad-leaf weeds along with the grasses, application of isoproturon in combination with 2, 4-D may help control the complex weed flora in wheat. Therefore the present investigation was conducted to find out the efficacy of tank mixture of isoproturon and 2, 4-D for the

control of the complex weed flora and to explore the possibility of economizing fertilizer use through weed-management practices.

MATERIALS AND METHODS

A field experiment was conducted at Research Farm of Rajendra Agricultural University, Pusa (Samastipur), during the winter (*rabi*) season of 1996–97 and 1997–98. The soil was clay loam in texture and calcareous in nature, low in organic carbon (0.37%), available nitrogen (223.6 kg/ha), P (17.2 kg/ha) and K (117.0 kg/ha), with pH 7.9. The experiment was laid out in split-plot design, comprising 4 levels of fertilizer [F_0, $N_0 P_0 K_0$ (0, 0 and 0 kg NPK/ha); F_1, $N_{80} P_{40} K_{20}$; F_2, $N_{120} P_{60} K_{40}$; F_3, $N_{160} P_{180} K_{40}$] in main plots and 5 weed-control treatments [W_0, weedy check, W_1, hand-weeding (30 days after sowing); W_2, isoproturon @ 1.0 kg/ha (post-emergence); W_3, 2,4–D @ 0.8 kg/ha (post-emergence); W_4, isoproturon @ 0.5 kg + 2,4–D 0.125 kg (post-emergence)] in sub- plots and was replicated thrice. Wheat variety 'UP 262' was sown in rows 20 cm apart on 12 and 10 December in 1996 and 1997 respectively. Full dose of P_2O_5 and K_2O and half dose of N were applied basal and remaining N was top-dressed in 2 equal splits, i.e. one-fourth after first irrigation and rest one-fourth after second irrigation. The crop received 3 uniform irrigations. Weed counts and weed dry weight were recorded at harvest from an area enclosed in a quadrate of 0.25 m^2 randomly selected at 2 places in each plot. Weed data were subjected to square-root transformation ($\sqrt{X + 0.5}$) before statistical analysis. Post-emergence application of isoproturon and 2, 4-D was done 30 days after sowing, using the Knapsack sprayer fitted with flat-fan nozzle.

RESULTS AND DISCUSSION

Weed

Among the broad leaved weeds, *Chenopodium album* L., *Oxalis corniculata* L., *Convolvulus arvensis* L., *Lipia nudiflora* Mich, *Melilotus indica* L., *Launea pinnatifida* L., *Cannabis sativa* L., *Nicotiana plumbginifolia* L. *and Spergula arvensis* L. predominantly infested the crop field. Among the grassy weeds, *Phalaris minor* (L.) Retz., *Avena ludoviciana* L. and *Cynodon dactylon* (L.) Pers. and that of sedges *Cyperus rotundus* L. were found to infest the crop.

Fertilizer levels recorded significantly higher weed count and weed dry biomass than no fertilizer in both the years (Table 2). But different levels of fertilizers were at par for weed count. However, weed dry biomass significantly increased with increasing fertilizer levels except during second year, where significant increase was observed up to N_{120}, P_{60}, K_{40} only. All weed-control treatments significantly reduced the weed count and weed dry biomass than weedy check. Among the weed-control treatments, isoproturon recorded the minimum weed count and was at par with other herbicidal treatments. Although herbicidal weed-control treatments recorded significantly lower weed count than hand-weeding, the weed dry biomass recorded in the hand-weeded plot was significantly lower than herbicidal treatments. Lower weed dry biomass in hand-weeded plot was due to slower pace

Table 1. Effect of fertilizer levels and weed-management practices on yield-attributing characters and yield of wheat

Treatment	Plant height (cm) at harvest		Effective tillers/m row length		Ear length (cm)		Grains/ ear		Test weight (g)		Grain yield (q/ha)		Straw yield (q/ha)	
	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2
Fertilizer														
F_0	71.45	72.26	39.58	44.04	7.33	7.47	26.40	28.26	39.75	40.23	18.08	20.78	26.88	30.78
F_1	81.07	83.40	56.00	62.91	9.40	9.60	37.60	39.21	43.18	43.92	29.98	33.34	43.08	47.83
F_2	84.46	86.80	64.38	70.50	9.94	10.08	42.68	44.0	45.0	45.62	37.39	40.32	52.98	56.98
F_3	86.74	88.21	67.65	73.63	10.24	10.36	46.32	47.33	45.73	46.19	40.28	42.43	56.77	59.57
CD (P=0.05)	3.00	3.20	3.10	2.84	0.28	0.26	2.40	2.27	0.9	0.84	1.76	2.06	2.87	3.10
Weed control														
W_0	77.47	80.52	46.78	50.61	7.72	7.83	31.32	33.34	41.11	41.50	24.10	26.42	34.97	38.19
W_1	83.38	84.64	62.08	68.26	9.80	9.95	41.70	42.93	44.29	44.89	34.92	37.84	49.38	53.47
W_2	81.83	83.50	59.75	66.05	9.61	9.78	39.92	41.22	43.97	44.61	33.40	36.46	47.58	51.87
W_3	81.23	82.79	58.53	65.10	9.53	9.70	39.36	40.74	43.87	44.50	32.64	35.53	46.67	50.67
W_4	80.75	81.91	57.37	63.83	9.46	9.62	38.95	40.28	43.83	44.45	32.10	34.84	46.03	49.76
CD (P=0.05)	2.68	2.81	2.41	2.29	0.24	0.21	2.04	1.90	0.74	0.67	1.52	1.67	2.44	2.71

Y_1, 1996–97; Y_2, 1997–98
Details of treatments are given in text

of growth of first flush of weeds 30 days after sowing and thereafter emergence of new flushes of weeds could not attain full growth under shade of crop plant. On the other hand, the surviving weeds after herbicidal treatments had better growth and greater dry-matter accumulation. Higher weed-control efficiency was also associated with hand weeding.

Growth, yield attributes and yield of crop

Plant height increased with increasing fertilizer levels but significant increase was recorded up to N_{120}, P_{60}, K_{40} only. Among the weed-control treatments, although hand-weeding recorded the maximum plant height but it was at par with herbicidal treatments and all weed-control treatments significantly surpassed the weedy check in both the years. The yield-attributing characters, i.e. tillers/m row length, ear length, grains/ear except test weight, increased significantly with increasing fertilizer levels and recorded the maximum values at N_{120}, P_{60}, K_{40}. The harvest index also significantly increased up to N_{120}, P_{60}, K_{40}. Weed-control treatments recorded significantly higher values of yield indices than weedy check. Maximum values of these indices were recorded in hand-weeded plot which was found to be at par with isoproturon but significantly higher than 2, 4-D and mixture of isoproturon and 2,4-D except the test weight. Test weight recorded in hand-weeded plot was at par with 2, 4-D and mixture of isoproturon and 2, 4-D. The values of these indices recorded in herbicidal treatments were at par among themselves. Hand-weeding also recorded higher harvest index and was at par with herbicidal treatments except in the first year, when 2, 4-D and mixture of isoproturon and 2,4-D recorded significantly lower value than hand-weeding.

Grain yield increased significantly with increasing fertilizer levels and was the maximum at higher level of NPK. Similar trend was also found in straw yield except in the second year, where significant increase was noticed up to N_{120}, P_{60}, K_{40} only. The increase in grain and straw yields might be due to adequate quantities and balanced proportions of plant nutrients supplied to the crop as per need resulting in favourable increase in yield-attributing characters which ultimately resulted in an increase in economic yield. Pandey and Agarwal (1991) also reported that highest grain and straw yield of wheat with the application of N_{120}, P_{60}, K_{40}.

Weed-control treatments resulted in significantly higher grain and straw yields than weedy check. Hand-weeding although recorded maximum grain and straw yields, it was on a par with isoproturon and significantly higher than 2,4-D and isoproturon + 2,4-D. Isoproturon, 2,4-D and isoproturon + 2,4-D were at par with each other for grain and straw yields. The results confirm the findings of Singh and Ghos (1992). Lower weed population under these treatments reduced the crop-weed competition and the plants had not to face either nutrient and moisture stress due to heavy weed infestation.

The interaction between fertilizer levels and weed-control measures was significant (Table 3). During both the years, yield obtained at N_{80}, P_{40}, K_{20} was at par with the

Table 2. Effect of fertilizer levels and weed-management practices on weeds and economics of wheat

Treatment	Harvest index (%)		Net return (Rs/ha)		Benefit : cost ratio		Weeds/m^2 at harvest		Weed dry weight (g/m^2 at harvest		Weed-control efficiency (%)	
	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2
Fertilizer												
F_0	40.21	40.30	4,068.97	5,880.59	0.50	0.72	12.68 (172.43)	11.85 (152.4)	6.57 (42.71)	5.85 (33.69)		
F_1	41.04	41.07	10,492.55	12,731.90	1.10	1.33	13.35 (188.69)	12.62 (170.49)	7.99 (63.33)	7.49 (55.62)		
F_2	41.37	41.44	14,580.61	16,519.39	1.41	1.60	13.69 (197.68)	13.05 (181.21)	8.43 (70.50)	8.00 (63.48)		
F_3	41.50	41.60	15,681.81	17,090.39	1.40	1.53	13.91 (203.89)	13.23 (185.91)	8.75 (76.0)	8.25 (67.58)		
CD (P=0.05)	0.31	0.36	1,251.30	1,135.92	0.13	0.10	0.66	0.61	0.24	0.31		
Weed control												
W_0	40.8	40.89	6,943.41	8,485.80	0.72	0.88	19.94 (397.84)	19.38 (376.22)	12.02 (144.05)	11.70 (136.28)		
W_1	41.42	41.44	12,277.40	14,218.63	1.08	1.26	12.65 (159.73)	11.80 (139.09)	6.07 (36.35)	5.45 (29.15)	74.77	78.61
W_2	41.25	41.28	12,542.5	14,573.19	1.24	1.46	11.30 (127.63)	10.49 (109.93)	6.65 (43.7)	5.97 (35.02)	69.66	74.30
W_3	41.16	41.22	12,357.9	14,280.18	1.27	1.48	11.47 (131.48)	10.74 (115.51)	6.77 (45.36)	6.12 (36.99)	68.51	72.86
W_4	41.09	41.18	11,909.97	13,720.03	1.21	1.40	11.69 (136.67)	11.03 (121.82)	6.84 (46.23)	6.21 (38.02)	67.91	72.91
CD (P=0.05)	0.24	0.30	1,005.49	920.74	0.10	0.08	0.51	0.48	0.21	0.25		

Figures in parentheses indicate original values
Y_1, 1996–97; Y_2, 1997–98

Table 3. Interaction effect of fertilizer levels and weed-management practices on yield of wheat (q/ha)

Treatment	Fertilizer levels							
	1997–98				1997–98			
	F_0	F_1	F_2	F_3	F_0	F_1	F_2	F_3
Weed management								
W_0	12.56	22.33	28.17	33.33	14.49	24.00	31.43	35.77
W_1	20.56	32.95	41.25	44.92	23.78	37.42	44.07	46.07
W_2	19.67	31.33	39.53	43.08	22.45	34.84	43.30	45.23
W_3	18.95	31.89	39.42	40.31	22.05	35.68	41.73	42.67
W_4	18.67	31.39	38.58	39.75	21.12	34.75	41.07	42.40
CD (P=0.05)	2.97				3.14			

Y_1, 1996–97; Y_2, 1997–98

yield obtained at N_{160}, P_{80}, K_{60} under weedy check. Thus, fertilizer use could be minimized with efficient weed-control practices. The increase in grain yield under efficient weed control with increasing levels of fertilizer was owing to reduced depletion of nutrients by weeds and concomitant increase in nutrient uptake by crop plants ultimately resulting in marked improvements in the yield-attributing characters (Rathi and Tiwari, 1981).

Economics

Net return increased with increasing levels of fertilizer, but significant increase was observed only up to N_{120}, P_{60}, K_{40}. Further increase in fertilizer level failed to produce significant effect on net return. Likewise, benefit : cost ratio also significantly increased up to N_{120}, P_{60}, K_{40}, and further increase in fertilizer level reduced the benefit : cost ratio. Weed-control treatments significantly increased the net return and benefit : cost ratio over the weedy check. Isoproturon recorded the maximum net return, followed by 2,4-D, hand-weeding and isoproturon + 2,4-D, but the differences among the treatments were non-significant. However, maximum benefit : cost ratio was noticed in 2,4-D treated plots, followed by isoproturon and isoproturon + 2,4-D. These were found at par among themselves but significantly superior to hand-weeding.

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