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Efficacy of different herbicides and fertility levels on weed dynamics and yield of wheat (*Triticum aestivum* L.) in S-E Rajasthan

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Abstract

A field experiment was conducted during *rabi* 2023-24 and *rabi* 2024-25 at Research Farm, Agricultural Research Station, Kota. The experiment was laid out in split plot design comprising eight weed control treatments in main plots and three fertility levels in sub-plots. Results showed that two hand weeding at 30 & 45 DAS, tank mix of pyroxasulfone 85% WG @ 127.5 g a.i./ha + metsulfuron methyl 20% WP @ 4 g a.i./ha and pinoxaden 5.1% EC @ 45 g a.i./ha + metsulfuron methyl 20% WP @ 4 g a.i./ha resulted in better weed control of monocot, dicot weeds and sedges as compared to other treatments and weedy check. On pooled basis, these treatments significantly reduced weed density and weed dry matter at 45, 90 DAS and at harvest of total monocot, dicot weeds and sedges as compared to weedy check. Two hand weeding at 30 & 45 DAS resulted in highest weed control efficiency of total weeds at 45, 90 DAS and at harvest (96.46%, 87.94% and 85.29%), followed by pyroxasulfone 85% WG @ 127.5 g a.i./ha + metsulfuron methyl 20% WP @ 4 g a.i./ha (89.94%, 83.04% and 78.91%) and pinoxaden 5.1% EC @ 45 g a.i./ha + metsulfuron methyl 20% WP @ 4 g a.i./ha (88.06%, 82.52% and 78.12%) which were at par with each other. On pooled basis, two hand weeding at 30 and 45 DAS, pyroxasulfone 85% WG @ 127.5 g a.i./ha + metsulfuron methyl 20% WP @ 4 g a.i./ha and pinoxaden 5.1% EC @ 45 g a.i./ha + metsulfuron methyl 20% WP @ 4 g a.i./ha as post-emergence at 35 DAS resulted significantly higher grain yield (59.47, 56.19 and 55.57 q/ha, respectively) and straw yield (79.91, 76.86 and 72.63 q/ha, respectively). Fertility level of 125% and 150% NPK were at par and significantly resulted higher growth parameters and yields as compared to 100% NPK.

Keywords: Herbicides, fertility, weed control efficiency and yield

Introduction

Wheat (*Triticum aestivum* L.) is major cereal crop worldwide after rice. In India it is second most important crop which is grown in area of about 32.8 million ha and production of 1117.9 million ton. Wheat infestation has become serious threat in production of wheat causing yield reduction upto. Wheat is infested with both grassy and broad-leaved weeds viz. *Phalaris minor*, *Avena fatua*, *Cyperus rotundus*, *Cynodon dactylon* and broad leaved weeds i.e. *Chenopodium album*, *Chenopodium murale*, *Fumaria parviflora*, *Melilotus indica*, *Anagallis arvensis*, *Cirsium arvense*, *Lathyrus aphaca*, *Convolvulus arvensis* and *Vicia hirsute* etc., depending upon the adopted agronomic practices, soil types, weed control techniques and cropping system followed. Weeds pose great menace majorly in irrigated wheat where frequent irrigations promote fast growing of weeds. Hence, proper weed management is required for the weed control and sustainable production of wheat. Herbicides are the potent tools to control the weed flora in wheat. Since, cultural methods of weed control are difficult to adopt due to high cost and unavailability of labour. Herbicides like 2,4-D and isoproturon have been continuously used in wheat since many times, but they either control grassy or broad-leaved weeds. *Phalaris minor* has developed multiple resistance against isoproturon and *Avena fatua* to clodinafop. In order to overcome this problem herbicide mixtures can prove to be better option as they allow broad spectrum of weed control. Apart from weed control measures, nutrient management also plays an important role in enhancing the productivity of wheat. Studies showed that continuous use

of recommended dose of fertilizers, there's no any significant increase in productivity of wheat. Thus, it is essential to promote the use of appropriate combination and levels of NPK to enhance wheat yield. Fertility levels also affect the weeds and crop weed interference. Efficient nutrient management can improve crop growth and production allowing them to compete with the weeds. Therefore, there need to be synergy between weed and nutrient management. For this efficient use of newer herbicide mixtures and optimum fertility levels need to be evaluated for sustainable production of wheat crop.

Methodology

A field experiment was conducted for two years at Research farm, ARS, Ummedganj, Kota (Agriculture University, Kota) during *rabi* 2023-24 and *rabi* 2024-25. Split plot design was used for laying out the experiment with three replications. Treatments consisted of eight weed control measures in main plot (W1: Weedy check, W2: Two hand weeding at 30 & 45 DAS, W3: 2,4-D (ester) @ 500 g a.i./ha, W4: Isoproturon @ 1.25 kg a.i./ha, W5: Clodinafop propargyl 15% + metsulfuron methyl 1% WP @ 52 g a.i./ha, W6: Mesosulfuron methyl 3% @ 12 g a.i./ha + iodosulfuron 0.6% WG 2.4 g a.i./ha @ 400 g/ha, W7: Pinoxaden 5.1% EC @ 45 g a.i./ha + metsulfuron methyl 20% WP @ 4 g a.i./ha and W8: Pyroxasulfone 85% WG @ 127.5 g a.i./ha + metsulfuron methyl 20% WP @ 4 g a.i./ha) as post-emergence at 30-35 DAS and three fertility levels in sub-plot (F1: 100% RDF, F2: 125% RDF and F3: 150% RDF). All the herbicides were sprayed using the knapsack sprayer fitted with flat-fan nozzle with a spray volume of 500 l/ha water. The fertilizer treatments were applied as basal dose of urea, SSP and MOP and top dressing of urea. The variety of test crop used was Raj 4079 with seed rate of 100 kg/ha. Weeds were counted using the 0.5 m² quadrat. Weed control efficiency was calculated using the following formula:

$$\text{WCE \%} = \frac{X - Y}{X}$$

where, X – weed dry matter in control plot
Y – weed dry matter in treated plot

Results

Effect on weed density

A perusal of data presented in Table 1 indicate that on pooled basis the weed density at 45, 90 DAS and at harvest of total monocots, dicots and sedges was significantly affected by different weed control treatments. Two hand weeding at 30 and 45 DAS resulted in minimum weed density of all weed flora (3.03/m² at 45 DAS, 6.04/m² at 90 DAS and 6.41/m² at harvest). This may be due to the strategic interruption of weed life cycle during the critical period of crop-weed competition in wheat. Two hand weeding eliminates the initial weed flush and at later stages wheat being the fast-growing crop suppress the weeds by smothering effect. The single herbicides like isoproturon and 2,4-D effectively controlled either grassy or broad-leaved weeds, respectively. While herbicide mixtures provide broad spectrum of weed control controlling all type of weed flora. Among herbicide mixtures, tank mix application of pyroxasulfone 85% WG @ 127.5 g a.i./ha + metsulfuron methyl 20% WP @ 4 g a.i./ha resulted in significantly lower weed density (60.9/m² at 45 DAS, 8.22/m² at 90 DAS and 8.25/m² at harvest), which was comparable to pinoxaden 5.1% EC @ 45 g a.i./ha + metsulfuron methyl 20% WP @ 4 g a.i./ha (6.65/m² at 45 DAS, 8.37/m² at 90 DAS and 8.44/m² at harvest), and were significant to other

treatments and weedy check. Maximum weed density of monocots, dicot weeds and sedges was observed in weedy check, at all stages (13.88/m² at 45 DAS, 14.77/m² at 90 DAS and 14.58/m² at harvest). However, density of weeds was not affected due to different fertility levels. Similar findings were reported by Pisal *et al.* (2013) ^[8], Gupta *et al.* (2019) ^[3] and Bagri *et al.* (2023) ^[1].

Effect on weed dry matter

The data presented in Table 2 shows that on pooled basis, two hand weeding at 30 and 45 DAS resulted in minimum weed dry matter at 45, 90 DAS and at harvest (5.90, 29.47 and 43.64 g/m², respectively). Total weed dry matter was significantly reduced due to application of pyroxasulfone 85% WG @ 127.5 g a.i./ha + metsulfuron methyl 20% WP @ 4 g a.i./ha (16.95, 41.67 and 62.56 g/m², respectively) which was at par to pinoxaden 5.1% EC @ 45 g a.i./ha + metsulfuron methyl 20% WP @ 4 g a.i./ha at 45, 90 DAS and at harvest (19.86, 42.89 and 65.05 g/m² respectively). Since, sole herbicides like isoproturon and 2,4-D controlled only single type of weed i.e. grassy or broad-leaved weeds, herbicide mixtures proved to be better in weed control by reducing the weed dry matter of all type of weed flora. The superior performance of herbicide mixtures may be attributed to the complementary modes of action of the two herbicides. It can be seen from the data that increasing fertility levels significantly affect the weed dry matter. The recommended dose of fertilizer (100% RDF) resulted in lower weed dry matter than compared to 125% and 150% RDF. This may be due to the fact that higher fertility levels contributed more in weed biomass than control. These results are similar to the findings of Katara *et al.* (2015) ^[4] and Meena *et al.* (2019) ^[6].

Effect on weed control efficiency

Table 2 indicates that all the weed control measures significantly affected weed control efficiency such that maximum weed control efficiency of total weeds was observed under two hand weeding at 30 and 45 DAS at 45, 90 DAS and at harvest (96.46, 87.94 and 85.29%, respectively). Tank mix application of pyroxasulfone 85% WG @ 127.5 g a.i./ha + metsulfuron methyl 20% WP @ 4 g a.i./ha resulted in significantly higher weed control efficiency at all stages (89.84, 83.04 and 78.91%, respectively) and was at par to pinoxaden 5.1% EC @ 45 g a.i./ha + metsulfuron methyl 20% WP @ 4 g a.i./ha (88.06, 82.52 and 78.12%, respectively). These mixture herbicides were superior in controlling weeds as they control broad spectrum of weeds than other herbicides and weedy check. The result substantiated the findings of Sasode *et al.* (2017) ^[10] Mishra *et al.* (2023) ^[7] and Lamani *et al.* (2024) ^[5].

Effect on yield and economics

It can be inferred from data presented in Table 1 that on a pooled basis, the highest grain and straw yields (59.47 and 79.91 q/ha, respectively) were achieved through two hand weedings at 30 and 45 days after sowing (DAS), followed closely by herbicide mixtures of pyroxasulfone + metsulfuron methyl and pinoxaden + metsulfuron methyl, which performed with statistical equivalence. These results, supported by the findings of Kaur *et al.* (2014), indicate that herbicide combinations provide superior yield over sole applications. Regarding soil fertility, the 150% NPK treatment produced the maximum grain (53.07 q/ha) and straw yield (69.70 q/ha), though it remained statistically comparable to the 125% NPK level (50.49 and 65.66 q/ha). Both elevated fertility levels significantly outperformed the control, aligning with observations reported by Saquib *et al.* (2012),

Sarita *et al.* (2022)^[9], and Puniya *et al.* (2023).

While two hand weeding at 30 and 45 DAS produced the highest yield, maximum B:C ratio was achieved through tank-mix of pyroxasulfone 85% WG + metsulfuron methyl 20% WP (3.03), closely followed by the pinoxaden 5.1% EC + metsulfuron methyl 20% WP (2.95). These chemical treatments

were statistically comparable to one another and significantly outperformed both the weedy check and other treatments in terms of profitability. This is primarily attributed to the higher labor costs associated with manual weeding. Similar results were quoted by Choudhari *et al.* (2017) and Sarita *et al.* (2022)^[9].

Table 1: Effect of weed control and fertility levels on weed density, weed dry matter of total weeds, yield and economics of wheat on pooled basis

Treatments	Weed density (No./m ²)			Weed dry matter (g/m ²)			Grain yield (q/ha)	Straw yield (q/ha)	B:C ratio
	45 DAS	90 DAS	Harvest	45 DAS	90 DAS	Harvest			
Weed control									
W1	13.88* (192.35)	14.77 (217.70)	14.58 (212.09)	164.57	297.87	245.91	31.67	44.37	1.69
W2	3.03 (8.78)	6.04 (36.13)	6.41 (40.57)	5.90	43.64	29.47	59.47	79.91	2.64
W3	9.89 (97.35)	10.69 (113.87)	10.79 (115.99)	58.13	143.64	95.28	46.18	57.63	2.38
W4	10.67 (113.48)	11.30 (127.22)	10.77 (115.66)	76.05	176.01	132.51	45.99	57.41	2.19
W5	8.23 (67.34)	9.34 (86.91)	9.39 (87.75)	31.64	102.91	65.06	50.93	65.21	2.59
W6	8.10 (65.28)	9.24 (85.07)	9.27 (85.51)	30.60	100.80	63.12	51.23	65.54	2.52
W7	6.65 (43.89)	8.37 (69.57)	8.44 (70.83)	19.86	65.05	42.89	55.57	72.63	2.95
W8	6.09 (36.76)	8.22 (67.22)	8.25 (67.69)	16.95	62.56	41.67	56.19	76.86	3.03
S.Em±	0.07	0.04	0.05	0.49	1.53	0.93	0.62	1.26	0.04
CD (P=0.05)	0.21	0.12	0.15	1.43	4.42	2.68	1.79	3.65	0.11
Fertility levels									
F1	8.23 (77.16)	99.66 (9.70)	9.69 (98.84)	41.82	111.43	79.56	45.39	59.48	2.26
F2	8.31 (78.18)	100.40 (9.75)	9.74 (99.53)	52.17	128.85	93.29	50.49	65.66	2.64
F3	8.40 (79.11)	101.33 (9.80)	9.79 (100.16)	57.40	131.90	95.62	53.07	69.70	2.59
S.Em±	0.05	0.03	0.03	0.82	1.77	1.51	0.85	2.02	0.05
CD (P=0.05)	NS	NS	NS	2.31	4.99	4.25	2.40	5.71	0.15

*Values are $\sqrt{x + 0.5}$ transformed and actual values are in parentheses

Table 2: Effect of weed control and fertility levels on weed control efficiency of total weeds on pooled basis

Treatments	Weed control efficiency (%)		
	45 DAS	90 DAS	Harvest
W1	0.00	0.00	0.00
W2	96.46	87.94	85.29
W3	64.53	61.13	51.67
W4	53.69	45.88	40.73
W5	80.87	73.45	65.36
W6	81.37	74.20	66.04
W7	88.06	82.52	78.12
W8	89.84	83.04	78.91
SEm±	0.25	0.30	0.31
CD (P=0.05)	0.73	0.87	0.91

Conclusion

From two year study it can be concluded that wheat was infested with wide variety of weed flora and on pooled basis two hand weeding at 30 and 45 DAS resulted in minimum weed density and weed dry matter at 45, 90 DAS and at harvest, followed by pyroxasulfone 85% WG @ 127.5 g a.i./ha + metsulfuron methyl 20% WP @ 4 g a.i./ha and pinoxaden 5.1% EC @ 45 g a.i./ha + metsulfuron methyl 20% WP @ 4 g a.i./ha. Similarly, among herbicidal treatments, significantly higher weed control efficiency was observed with pyroxasulfone 85% WG @ 127.5 g a.i./ha + metsulfuron methyl 20% WP @ 4 g a.i./ha, which was at par with pinoxaden 5.1% EC @ 45 g a.i./ha + metsulfuron methyl 20% WP @ 4 g a.i./ha. Mixture herbicides provide broad spectrum weed control. On pooled basis, two hand weeding at 30 and 45 DAS, pyroxasulfone 85% WG @ 127.5 g a.i./ha + metsulfuron methyl 20% WP @ 4 g a.i./ha and pinoxaden 5.1% EC @ 45 g a.i./ha + metsulfuron methyl 20% WP @ 4 g a.i./ha as post-emergence at 35 DAS resulted significantly higher grain yield (59.47, 56.19 and 55.57 q/ha, respectively) and straw yield (79.91, 76.86 and 72.63 q/ha,

respectively). Fertility level of 125% and 150% NPK were at par and significantly resulted higher growth parameters and yields as compared to 100% NPK.

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