Original Research Article

Effect of Herbicides and Nitrogen levels on *Phalaris minor* and its Impact on Nutrient Uptake in Wheat (*Triticum aestivum* L.)

Abstract

A field experiment was conducted during the winter (*Rabi*) season of 2018-19 at the Agricultural research farm, Banaras Hindu University, Varanasi to study the effect of herbicides and nitrogen levels on associated weeds and the yield of wheat. Nine weed species were commonly infested in the wheat field such as *Phalaris minor*, *Cynodon dactylon*, *Anagallis arvensis*, *Melilotus indicus*, *Chenopodium album Vicia sativa*, *Medicago denticulata*, *Solanum nigrum,* and *Cyperus rotundus*. Among these, *Phalaris minor* was the major weed. Application of Sulfosulfuron (25 g ha^{-1}) + 2, 4-DEE (750 ml ha^{-1}) significantly recorded the lowest weed density and biomass and higher weed control efficiency. Among nitrogen and herbicidal treatments, HW twice (30&60 DAS) in combination with 180 kg N ha^{-1} followed by application of Sulfosulfuron (25 g ha^{-1}) + 2, 4-DEE (750 ml ha^{-1}) in combination with 180 kg N ha^{-1} performed significantly with respect to reduction in density, the biomass of *Phalaris minor* as well as increased weed control efficiency. Nutrient uptake was significantly highest under HW twice plot (30&60 DAS) followed by application of sulfosulfuron (25 g ha^{-1}) + 2, 4-DEE (750 ml ha^{-1}). The total uptake of N, P and K in wheat grain and straw increased with an increased nitrogen levels (180 kg ha^{-1}), whereas uptake of these nutrients was low under lower level of nitrogen, which was attributed to less plant biomass (grain and straw) and low percentage of these nutrients in the plant.

Keywords: Nitrogen levels, sulfosulfuron, 2, 4-DEE, weeds, wheat.

1. Introduction

Weeds are frequently the most expensive inhibitory factor, which is regarded as the major biotic barrier in obtaining the potential yield of wheat, leading to rising poverty and food insecurity. In order to effectively manage weed infestations of both grassy and broad-leaved varieties, an integrated strategy combining chemical and non-chemical weed control techniques is required [2]. Multiple herbicides must be used together to effectively manage complex weed flora. Combinations of herbicides not only improve weed control's ability to deal with difficult-to-control weed flora, but also postpone the development of herbicide resistance [21]. Wheat grain output can be reduced by up to 52.2 percent by grassy weeds and up to 55.7 percent by wide leaf weeds revealed by [13]. [18] reported that weeds in the weedy check reduced the grain yield of wheat by 47.5% in comparison with other treatments. A combination of many herbicides is required to manage complex weed flora successfully; this combination not only improves weed control effectiveness against composite weed flora but also delays the development of herbicide resistance [16]. [4] revealed that increasing the level of nitrogen from 0 to 45, 45 to 90 and 90 to 135 kg ha^{-1} increased the nitrogen uptake by 28.2, 14.9, 7.7%, phosphorus by 26.2, 13.6, 8.5 % over the preceding levels. The presence and density of weeds in the field, however, were shown to be significantly influenced by the quantities of inputs and the timing of their application.. Increasing the nitrogen fertilization from 120 to 150 kg N ha^{-1} increased the dry matter accumulation, the number of tillers, and nutrient uptake in turn increasing the grain yield and straw yield [15].

2. Materials and Methods

The field study was carried out in the winter (rabi) of 2018–19 at the Banaras Hindu University's Agricultural Research Farm in Varanasi, Uttar Pradesh, in the subtropical Indo-gangetic Plains at $25^0$18' North Latitude and 83^0 03' East Longitude, which is located in the left bank of the River Ganga at an altitude of 75.70 metre above mean sea level. The soil was a sandy clay loam with a pH of 7, low organic carbon (0.21 percent), accessible N (152 kg ha^{-1}), medium P (23.5 kg ha^{-1}), and available K (188 kg ha^{-1}) (7.28). With three replications, the experiment was set up using a split plot design.

The treatments comprised of 3 nitrogen levels and 5 weed control methods, viz., nitrogen levels: 120 kg ha^{-1}, 150 kg ha^{-1}, 180 kg ha^{-1}, weed control treatments: Weedy check, Hand weeding at 30 DAS and 60 DAS, Pinoxaden 5.1% EC (40 ml a.i ha^{-1}) + 2,4-DEE 38% EC (750 ml a.i ha^{-1}) [Tank mixture at 29 DAS], Pendimethalin 30% EC at 1000 ml a.i ha^{-1} (pre-emergence) and 2,4-DEE 38% EC (750 ml a.i ha^{-1} at 30-35 DAS), Sulfosulfuron 75% WG (25 g a.i ha^{-1})+ 2,4-DEE 38% EC at 750 ml a.i ha^{-1} [Tank mixture at 29 DAS]. Wheat variety 'HD-2967' with

100 kg ha^{-1} seed rate was sown on 9th December, 2018 and the irrigation was provided at critical crop growth stages. A recommended dose of phosphorous, potassium were applied through single super phosphate (SSP), muriate of potash (MOP), respectively at the rate of 60, 60 kg ha^{-1}. Nitrogen is applied through urea as per the treatment. Half of the nitrogen with whole dose of phosphorous as well as potash were applied as basal application at the time of sowing and remaining half dose of nitrogen was applied as top-dressing in two equal splits after first and second irrigation. The effectiveness of different treatments considered with respect to weed population, weed dry matter accumulation, nutrient content, depletion (N, P and K) and weed control efficiency. Weeds were collected at randomly placing 25 x 25 cm quadrant in each plot and sundried. After sun drying, samples were placed in the electric oven at 60-65^{0}C for 48 hours for complete drying and the dry weight obtained was expressed in g m^{-2}. The weed population (pre-treatment), weed dry weight, and weed control efficiency were recorded at 15, 30, 60, and 90 days after treatment application (DAA), whereas nutrient content and its depletion by weed at 90 DAA. Various crop growth parameters *viz,* plant height (cm), number of tillers per running meter, plant dry matter accumulation (g) at 30, 60, 90 DAA and at harvest. Leaf chlorophyll content was estimated to measure leaf greenness, non-destructively by using a portable SPAD (Soil Plant Analysis Development)-502 chlorophyll meter (Minolta Camera Co. Ltd., Japan) and this meter operates by clamping the sensor head onto a leaf blade. Data related to weed components were analyzed using various statistical methods and square root transformation (√x+0.5) was undergone for uniformity. To study on uptake of different nutrients (nitrogen, phosphorus and potassium) by the crop in grain and straw of wheat were estimated at maturity. The plant samples (grain and straw) from wheat were collected separately as per treatment at the time of harvest. These samples were grinded in the grinder after oven dried at 75˚C for 72 hours. Thus, the grind plant materials passed through 30-mesh sieve, and these materials taken for determination of nitrogen, phosphorus, potassium and content. The nutrient contents of these materials were analyzed chemically in laboratory by following the standard procedures. The nutrient uptake was computed by multiplying nutrient content of grain and straw with respective dry weight/yield (kg ha^{-1}).

Nitrogen content (%): The nitrogen content was estimated in grain, straw and weeds by modified Kjeldahl method as per procedure described by Jackson (1973).

Phosphorous content (%): Content of phosphorus in grain, straw and weeds were estimated by Vanadomolybdo phosphoric yellow colour method as per procedure described by Jackson (1973).

Potassium content (%): Potassium content was estimated with the help of flame photometer as per procedure described by [5].

Nutrient uptake by crop (kg ha^{-1}): Nutrient uptake in grain and straw of the crops were calculated in kg ha^{-1} in relation to yield per ha by using the following formula.

$$\text{Nutrient uptake (kg/ha)} \quad \frac{\text{Nutrient content (\%)} \times \text{Yield (grain/straw in kg ha}^{-1}\text{)}}{100}$$

Weed control efficiency: Weed control efficiency (W.C.E.) can be calculated on the basis of dates of observation by using the formula suggested by **[7]**.

Weed control efficiency = [(DWC – DWT)/DWC]*100

Where DWC = dry weight of weeds in control (unweeded) plot

DWT = dry weight of weeds in the treated plot

3. RESULTS AND DISCUSSION

3.1 Weed flora

During the field research, the following prevalent weed species were found to be infested in the experimental field. Grasses like *Phalaris minor, Cynodon dactylon*, and the broad-leaved weeds; *Anagallis arvensis, Melilotus indicus, Vicia sativa, Chenopodium album, Medicago denticulata, Solanum nigrum,* and the only sedge was *Cyperus rotundus*. Here, the effect of herbicides and nitrogen levels on the major weed like *Phalaris minor* and its subsequent impact on growth parameters was shown.

3.2 Effect of density and dry weight of weeds: Critical analysis of data revealed that the population of Phalaris minor was significantly influenced by different treatments as presented in Table 1&2. The drymatter of grassy weeds like *Phalaris minor* reduced significantly by the application of sulfosulfuron (25 g ha^{-1}) + 2,4-DEE (750 ml ha^{-1}) during 60, 90 DAA. Several researchers like [10] and [9] also observed close conformity with above findings. Among the herbicidal treatments, application of pinoxaden (40 ml ha^{-1}) + 2,4-DEE (750 ml ha^{-1}) was recorded lowest weed dry matter accumulation in grasses like *Phalaris minor* also observed minimum dry weight at 15 and 30 DAA and this might be because of minimum weed population of grassy weeds due to the herbicidal effect. Similar findings has been also reported by [19] and [9]. The data on weed density and drymatter of different weeds (Table 1&2) as affected by different nitrogen levels envisaged non-significant differences in weed density of *Phalaris minor* at all the dates of observation. As, overall examination on density of *Phalaris minor* showed that increase in nitrogen application from 120 to 180 kg ha^{-1} increased population as well as drymatter of weeds. These results were in close conformity with findings of [1], [12] and [4].

3.3 Effect of herbicides on weed control efficiency

Critical analysis of data revealed that weed control efficiency (WCE) of *Phalaris minor* was influenced by different treatments are presented in Table 3. At 15 and 30 DAA, higher weed control efficiency was recorded under application of pinoxaden (40 ml ha^{-1}) + 2, 4-DEE (750 ml ha^{-1}) followed by sulfosulfuron (25 g ha^{-1}) + 2, 4-DEE (750 ml ha^{-1}) and lower weed control efficiency was recorded under application of pendimethalin (1000 ml ha^{-1}) *fb* 2, 4-DEE (750 ml ha^{-1}) at 30 DAA. Whereas at 60 and 90 DAA, higher weed control efficiency was recorded under application of sulfosulfuron (25 g ha^{-1}) + 2, 4-DEE (750 ml ha^{-1}) and lower weed control efficiency was recorded under application of pendimethalin (1000 ml ha^{-1}) *fb* 2, 4-DEE (750 ml ha^{-1}). However, the HW twice (30&60 DAS) plot recorded 100% control in *Phalaris minor* at 60, 90DAA. Close examination of data revealed that application of 180 kg N ha^{-1} recorded higher weed control efficiency at 60 and 90 DAA. However, higher weed control efficiency was observed under application of 120 kg N ha^{-1} at 15 and 30 DAA. These results were in close conformity with the findings reported by [6], [14], and [9].

3.4 Effect of nutrient content and its uptake by crop and weeds

The data presented in table 4&5 explain about nutrient exhaustion by weeds recorded at harvest stage, dry matter accumulation in weeds is the function of N, P and K. Higher weeds dry weight directs to higher removal of nutrient by weeds. Under herbicidal treatments, HW twice plot followed by application of sulfosulfuron (25 g ha^{-1}) + 2,4-DEE (750 ml ha^{-1}) recorded lower nutrient depletion by weeds than other weed control treatments. The possible reason might be due to weed density and weed dry weight were significantly lower under above mentioned treatments and this resulted in reduced nutrient removal by weed. The nutrient depletion by weeds was more under untreated plot, this may be due to heavy weed infestation, higher dry matter accumulation by weeds and these findings were in close conformity with findings of [4].

The data presented in table 4&5 to explain the nutrient content and its uptake by plant of various treatments. Higher content of N, P, and K in grain and straw was significantly recorded due to weed control treatments. Nutrient uptake is a function of N, P, and K content in grain and straw of crop. It was significantly highest under HW twice plot (30&60 DAS) followed by application of sulfosulfuron (25 g ha^{-1}) + 2, 4-DEE (750 ml ha^{-1}). Increase in availability of N, P and K under this treatment is due to suppression of weed growth and might acts as driving force behind higher dry matter production and nutrient uptake by wheat crop. However, lowest nutrient uptake was observed in weedy check and similar findings observed by [18] and [9]. The percentage of nitrogen, both in grain and straw, increased with increase in level of nitrogen from 120 kg N to 180 kg N ha^{-1} and this might be attributed to increased absorption and transport of N to different plant parts, including grains than crop supplied with nitrogen. The total uptake of N, P and K in wheat grain and straw increased with an increased nitrogen levels (180 kg ha^{-1}), whereas uptake of these nutrients was low under lower level of nitrogen, which was attributed to less plant biomass (grain and straw) and low percentage of these nutrients in the plant. These findings were in close conformity with the findings of [20] and [15].

Table 01: **Effect of herbicides and nitrogen levels on density (No. m^{-2}) of *Phalaris minor* in wheat**

Treatments	**Weed density (No. m^{-2})**				
	Pre-treatment	**15 DAA**	**30 DAA**	**60 DAA**	**90 DAA**
Nitrogen levels (kg ha^{-1})	***Phalaris minor***				

120	0.71 (0.00)	0.88 (0.33)	0.88 (0.33)	1.43 (1.87)	1.20 (1.00)
150	0.71 (0.00)	0.82 (0.33)	1.19 (1.00)	1.25 (1.33)	1.25 (1.33)
180	0.71 (0.00)	1.10 (0.67)	1.10 (0.67)	1.25 (1.33)	1.31 (1.67)
SEm ±	0.00	0.089	0.13	0.060	0.038
CD (P=0.05)	NS	NS	NS	NS	NS
Herbicides					
Weedy check	0.71 (0.00)	1.22 (1.00)	1.22 (1.00)	1.82 (2.89)	1.94 (3.33)
HW twice (30&60 DAS)	0.71 (0.00)	1.10 (0.67)	1.10 (0.67)	0.71 (0.00)	0.71 (0.00)
Pinoxaden 5.1% EC (40 ml) + 2,4-DEE* 38% EC (750 ml ha^{-1})	0.71 (0.00)	0.71 (0.00)	1.10 (0.67)	1.29 (1.33)	1.19 (1.00)
Pendimethalin 30% EC (1000 ml) *fb* 2,4-DEE 38% EC (750 ml ha^{-1})	0.71 (0.00)	1.10 (0.67)	1.22 (1.00)	1.69 (2.67)	1.29 (1.33)
Sulfosulfuron 75% WG (25 g) + 2,4-DEE 38% EC (750 ml ha^{-1})	0.71 (0.00)	0.71 (0.00)	1.10 (0.67)	1.10 (0.67)	1.10 (0.67)
SEm ±	0.00	0.104	0.16	0.151	0.126
CD (P=0.05)	NS	0.304	NS	0.442	0.367

*Ethyl ester, DAA= Days after treatment application, NS= Non-significant

Data subjected to square root ($\sqrt{x}$ + 0.5) transformation and original data presented in parenthesis

Table 02: **Effect of herbicides and nitrogen levels on drymatter (g. m^{-2}) of *Phalaris minor* in wheat**

Treatments	**Weed density (No. m^{-2})**				
	Pre-treatment	**15 DAA**	**30 DAA**	**60 DAA**	**90 DAA**

Nitrogen levels (kg ha^{-1})	***Phalaris minor***				
120	0.71 (0.00)	0.88 (0.33)	0.88 (0.33)	1.43 (1.87)	1.20 (1.00)
150	0.71 (0.00)	0.82 (0.33)	1.19 (1.00)	1.25 (1.33)	1.25 (1.33)
180	0.71 (0.00)	1.10 (0.67)	1.10 (0.67)	1.25 (1.33)	1.31 (1.67)
SEm ±	0.00	0.089	0.13	0.060	0.038
CD (P=0.05)	NS	NS	NS	NS	NS
Herbicides					
Weedy check	0.71 (0.00)	1.22 (1.00)	1.22 (1.00)	1.82 (2.89)	1.94 (3.33)
HW twice (30&60 DAS)	0.71 (0.00)	1.10 (0.67)	1.10 (0.67)	0.71 (0.00)	0.71 (0.00)
Pinoxaden 5.1% EC (40 ml) + 2,4-DEE* 38% EC (750 ml ha^{-1})	0.71 (0.00)	0.71 (0.00)	1.10 (0.67)	1.29 (1.33)	1.19 (1.00)
Pendimethalin 30% EC (1000 ml) *fb* 2,4-DEE 38% EC (750 ml ha^{-1})	0.71 (0.00)	1.10 (0.67)	1.22 (1.00)	1.69 (2.67)	1.29 (1.33)
Sulfosulfuron 75% WG (25 g) + 2,4-DEE 38% EC (750 ml ha^{-1})	0.71 (0.00)	0.71 (0.00)	1.10 (0.67)	1.10 (0.67)	1.10 (0.67)
SEm ±	0.00	0.104	0.16	0.151	0.126
CD (P=0.05)	NS	0.304	NS	0.442	0.367

*Ethyl ester, DAA= Days after treatment application, NS= Non-significant

Data subjected to square root ($\sqrt{x}$ + 0.5) transformation and original data presented in parenthesis

Table 03: Effect of herbicides and nitrogen levels on weed control efficiency (%) of wheat

Treatments	Weed control efficiency (%)

	15 DAA	30 DAA	60 DAA	90 DAA
Nitrogen levels (kg ha^{-1})				
120	68.67	69.78	54.55	64.62
150	61.09	66.61	54.70	59.47
180	62.11	69.00	59.34	56.92
Herbicides				
Weedy check	0.00	0.00	0.00	0.00
HW twice (30&60 DAS)	73.33	77.93	100.00	100.00
Pinoxaden 5.1% EC (40 ml) + 2,4-DEE* 38% EC (750 ml ha^{-1})	91.65	92.71	56.54	68.10
Pendimethalin 30% EC (1000 ml) *fb* 2,4-DEE 38% EC (750 ml ha^{-1})	71.65	83.77	50.12	53.85
Sulfosulfuron 75% WG (25 g) + 2,4-DEE 38% EC (750 ml ha^{-1})	83.15	87.90	74.34	79.72

EE=Ethyl ester, DAA= Days after treatment application, NS= Non-significant

Data subjected to square root ($\sqrt{x} + 0.5$) transformation and original data presented in parenthesis

Table 04: Effect of herbicides and nitrogen levels on nutrient content in grain and straw

Treatments	Nitrogen (%)		Phosphorus (%)		Potassium (%)	
	Grain	Straw	Grain	Straw	Grain	Straw
Nitrogen levels						
120 kg ha^{-1}	1.73	0.54	0.37	0.075	0.41	1.37
150 kg ha^{-1}	1.78	0.57	0.38	0.074	0.43	1.42
180 kg ha^{-1}	1.81	0.58	0.35	0.078	0.45	1.45
SEm ±	0.007	0.011	0.014	0.0005	0.010	0.022
CD (P=0.05)	0.029	NS	NS	0.002	NS	NS
Herbicides						
Weedy check	1.74	0.55	0.37	0.069	0.43	1.34
HW twice (30 & 60 DAS)	1.80	0.58	0.38	0.075	0.44	1.44
Pinoxaden 5.1% EC (40 ml) + 2,4-DEE* 38% EC (750 ml ha-1)	1.77	0.54	0.36	0.075	0.40	1.41
Pendimethalin 30% EC (1000 ml) *fb* 2,4-DEE* 38% EC (750 ml ha^{-1})	1.76	0.57	0.37	0.079	0.43	1.44
Sulfosulfuron 75% WG (25 g) + 2,4-DEE* 38% EC (750 ml ha^{-1})	1.79	0.58	0.36	0.080	0.45	1.43
SEm ±	0.011	0.012	0.011	0.002	0.013	0.022
CD (P=0.05)	0.033	NS	NS	0.007	NS	0.064

EE=Ethyl ester, DAA= Days after treatment application, NS= Non-significant

Data subjected to square root ($\sqrt{x} + 0.5$) transformation and original data presented in parenthesis

Table 05: Effect of herbicides and nitrogen levels on nutrient uptake in grain and straw

Treatments	Nitrogen (kg ha^{-1})		Phosphorus (kg ha^{-1})		Potassium (kg ha^{-1})	
	Grain	Straw	Grain	Straw	Grain	Straw
Nitrogen levels						
120 kg ha^{-1}	76.36	36.35	16.55	5.08	18.25	92.23
150 kg ha^{-1}	83.56	41.28	18.18	5.34	20.06	102.28
180 kg ha^{-1}	87.70	43.30	17.35	5.83	21.91	109.02
SEm ±	0.469	1.133	0.570	0.036	0.601	2.116
CD (P=0.05)	1.842	4.447	NS	0.141	2.362	8.310
Herbicides						
Weedy check	70.75	37.72	15.11	4.74	17.53	92.20
HW twice (30 & 60 DAS)	87.92	42.70	18.77	5.57	21.55	106.63
Pinoxaden 5.1% EC (40 ml) + 2,4-DEE* 38% EC (750 ml ha^{-1})	81.93	37.64	17.20	5.25	18.79	98.60
Pendimethalin 30% EC (1000 ml) *fb* 2,4-DEE* 38% EC (750 ml ha^{-1})	84.02	41.26	17.60	5.64	20.62	103.74
Sulfosulfuron 75% WG (25 g) + 2,4-DEE* 38% EC (750 ml ha^{-1})	88.07	42.24	18.10	5.89	21.89	104.70
SEm ±	0.852	1.058	0.523	0.168	0.661	1.823
CD (P=0.05)	2.486	3.089	1.527	0.489	1.928	5.321

EE= Ethyl ester, DAA= Days after treatment application, NS= Non-significant

Data subjected to square root ($\sqrt{x}$ + 0.5) transformation and original data presented in parenthesis

4. CONCLUSION

On the grounds of the above-summarized results, the following conclusions have been drawn: Application of sulfosulfuron (25 g ha^{-1}) + 2,4-DEE (750 ml ha^{-1}) recorded reduced weed density and weed drymatter due to higher weed control efficiency. Application of 180 kg N ha^{-1} in combination with sulfosulfuron (25 g ha^{-1}) + 2,4-DEE (750 ml ha^{-1}) recorded higher nutrient content and nutrient uptake in grain and straw of wheat.

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