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Effect of Herbicides and Nutrient Management on Weed Flora, Nutrient Uptake and Yield of Wheat (*Triticum aestivum*) under Irrigated Conditions

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ABSTRACT

Isoproturon, clodinafop and sulfosulfuron alone at 750, 60 and 30 g/ha, respectively, and tank mixture of isoproturon at 500 g/ha + 2, 4-D at 500 g/ha, isoproturon at 500 g/ha + clodinafop at 30 g/ha and isoproturon at 500 g/ha + sulfosulfuron at 15 g/ha were evaluated against mixed weed flora in wheat. All the herbicide treatments significantly reduced the dry weight of complex weeds, although they differed in their effect on weed species. While sulfosulfuron and clodinafop alone and as a tank mixture with isoproturon effectively controlled grassy weeds than all other herbicide treatments, the tank mix application of isoproturon at 500 g/ha + 2, 4-D at 500 g/ha and isoproturon at 500 g/ha + sulfosulfuron at 15 g/ha were equally effective against broadleaf weeds. The broadleaf weeds being dominant in the experimental field, the overall weed density and dry matter production at different stages of crop growth were minimized by isoproturon at 500 g/ha+sulfosulfuron at 15 g/ha and isoproturon at 500 g/ha+2, 4-D at 500 g/ha. Uninterrupted weed growth depleted 20.97 kg N, 3.13 kg P and 26.94 kg K/ha, while it was lowest with isoproturon at 500 g/ha + sulfosulfuron at 15 g/ha. Maximum uptake of N (150.20 kg/ha), P (41.00 kg/ha) and K (194.14 kg/ha) by wheat crop was in plots treated with tank mixture of isoproturon at 500 g/ha + sulfosulfuron at 15 g/ha, while in weedy check plots N, P and K uptake by crop was 87.87, 23.82 and 118.04 kg/ha, respectively. Uncontrolled weeds in weedy check plots reduced wheat yield by 31.4% as compared to herbicide treated plots. Highest grain yield obtained with isoproturon at 500 g/ha + sulfosulfuron at 15 g/ha (58 q/ha) followed by isoproturon at 500 g/ha + 2, 4-D at 500 g/ha (55.34 q/ha) was significantly higher than all other treatments. Among nutrient management treatments, application of 75% RDF+vermicompost at 1.5 t/ha and 50% RDF + vermicompost at 3.0 t/ha resulted in significant increase in weed dry matter, NPK uptake, chlorophyll and protein content and grain and straw yield over RDF alone.

Key words : Isoproturon, clodinafop, sulfosulfuron, herbicide mixture, weed control, vermicompost

INTRODUCTION

Wheat is a major cereal crop, which plays an important role in food and nutritional security. In recent years, its production in India has reached a plateau and there is urgent need to raise its productivity. Competition by weeds for soil moisture, mineral nutrients and solar radiation in wheat along with unhealthy nutrient management practices is major constraint in enhancing wheat productivity. Uncontrolled weeds in wheat remove 30-40 kg N, 10-20 kg P and 20-40 kg K/ha from soil (Mishra and Gautam, 1995). The continuous use of same herbicide for long reduces its efficacy and results in emergence of resistant weed species. This calls for evaluation of some herbicides either alone or tank mixed to broaden weed control spectrum. The herbicide mixtures have been reported to broaden the weed control spectrum and overcome resistance problem, are cost effective and result in biological activity higher than their individual application (Valverde, 2003). Besides weed control, nutrient management involving combined use of organic and inorganic nutrient sources is equally important to restore the soil productivity and improve health of arable lands. The use of fertilizers containing only one or two nutrients deteriorates the soil fertility through excess or deficiency of certain nutrients. Integrated use of organic manures and fertilizers besides improving physical condition of soil also provides both major and micro nutrients. Further the effect of vermicompost on weeds in terms of flora composition, weed density and biomass is not yet evaluated and reported. Therefore, the experiment was conducted to

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evaluate the effect of individual and tank mixed herbicides and vermicompost on weed population, nutrient uptake and wheat yield.

MATERIALS AND METHODS

The field experiment was conducted at Agronomy Farm, Rajasthan College of Agriculture, Udaipur during two consecutive **rabi** seasons of 2004-05 and 2005-06. The soil of the experimental site was clay loam in texture, medium in available N (26.9 kg/ha), low in P (19.1 kg/ha), high in K (322.2 kg/ha), medium in organic carbon content (0.72%) and slightly alkaline in reaction with pH 8.1. The experiment comprised seven weed control treatments [weedy check, post-emergent isoproturon (IPU) at 750 g/ha, clodinafop (CDF) at 60 g/ha, sulfosulfuron (SSN) at 30 g/ha, IPU at 500 g/ha+2, 4-D at 500 g/ha, IPU at 500 g/ha+CDF at 30 g/ha and IPU at 500 g/ha+SSN at 15 g/ha] and three nutrient management treatments [Recommended dose of fertilizer (RDF, 120 : 40 : 30 kg NPK/ha), 75% RDF+ vermicompost at 1.5 t/ha and 50% RDF+vermicompost at 3.0 t/ha] making thus 21 treatment combinations. These treatments were evaluated under randomized block design with three replications. Wheat variety GW 322 was sown in rows 23 cm apart using 100 kg seed/ha on 8th and 11th November in respective years. Herbicide treatments were applied 32 DAS with the help of knapsack sprayer fitted with flat fan nozzle using a spray volume of 650 l/ha. Weed density was recorded by placing a quadrat of 0.25 m^2 at two randomly selected spots in each plot and the samples were then kept in hot air oven at 70^0C till constant weight to determine dry matter accumulation. The data on weed density were subjected to square root transformation $\sqrt{X+0.5}$ to normalize their distribution. Weed control efficiency (WCE) was computed on the basis of dry matter of grassy and broadleaf weeds. The nutrient uptake by crop and weeds was computed by using the following formula :

$$\text{NPK uptake by crop/weeds (kg/ha)} = \frac{\text{NPK content in crop/weeds (\%)} \times \text{Total dry weight of crop/weeds (kg/ha)}}{100}$$

Protein content in grain was calculated from the per cent nitrogen content in the grain multiplied by the factor 6.25, while chlorophyll content was estimated by the method advocated by Arnon (1949). As per treatment, vermicompost was applied uniformly one week before sowing and incorporated into the soil, while among fertilizers, half N and full dose of P_2O_5 and K_2O were applied at sowing and remaining N was top dressed in two splits at first and second irrigations through urea, DAP and MOP. The crop was raised as per the recommended package of practices.

RESULTS AND DISCUSSION

The experimental plots were infested with broadleaf weeds (69.28%) chiefly *Chenopodium album*, *C. murale*, *Coronopus didymus*, *Convolvulus arvensis* and *Melilotus indica* and among grassy weeds (30.73%) *Phalaris minor* was the major weed during both the years.

Weed Density and Dry Matter

All the herbicidal treatments significantly reduced the weed density and dry matter compared to weedy check during both the years, although they differed in their effects on weed species (Table 1). While SSN and CDF, either alone (at 30 and 60 g/ha, respectively) or in combination (at 15 and 30 g/ha, respectively) with IPU at 500 g/ha proved superior in the control of *P. minor* than other herbicide treatments; the broadleaf weeds were better controlled by IPU at 500 g/ha+2, 4-D at 500 g/ha and IPU at 500 g/ha+SSN at 15 g/ha. The broadleaf weeds being dominant in the experiment, the overall weed density and dry matter recorded at different stages of crop growth were minimized by tank mixture of IPU at 500 g/ha+SSN at 15 g/ha and IPU at 500 g/ha+2,4-D at 500 g/ha. The reduction in weed dry matter at harvest with IPU at 500 g/ha+SSN at 15 g/ha and IPU at 500 g/ha+2, 4-D at 500 g/ha was 93.1, 88.1, 82.2, 56.6 and 47.8% as compared to weedy check, CDF at 60 g/ha, IPU at 500 g/ha+CDF at 30 g/ha, IPU at 750 g/ha and SSN at 30 g/ha, respectively. The superiority of these tank mixtures over other herbicides may be attributed to increase in herbicide activity due to synergist effect. The better performance of IPU and SSN as tank mixture than individual application was also reported by Kewat *et al*. (2003), while that of IPU and 2, 4-D by Pandey *et al*. (2005). Among individual herbicides, SSN at 30 g/ha reduced density and dry matter of complex weed flora significantly as against CDF at 60 g/ha but was at par with IPU at 750 g/ha. The reduced weed growth with SSN at 30 g/ha was due to its ability to control both grassy and broadleaf weeds and also due to its slow

Table 1. Effect of herbicides and nutrient management on weed density and biomass and weed control efficacy at harvest (Pooled data of two years)

Treatments	Weed density/m^2			Weed dry matter (kg/ha)			Weed control efficacy (%)		
	Grassy	Broadleaf	Total	Grassy	Broadleaf	Total	Grassy	Broadleaf	Total
Weed control									
Weedy check	7.29 (52.69)	10.90 (118.79)	13.10 (171.47)	388.80	888.87	1277.66	0	0	0
Isoproturon at 750 g/ha	2.14 (4.10)	3.73 (13.55)	4.25 (17.65)	54.29	148.22	202.51	86.0	83.3	84.27
Clodinafop at 60 g/ha	1.57 (1.99)	9.04 (81.60)	9.15 (83.59)	28.76	709.53	738.29	92.6	20.2	42.00
Sulfosulfuron at 30 g/ha	1.53 (1.88)	3.67 (13.15)	3.92 (15.04)	26.34	142.11	168.45	93.2	84.0	86.78
IPU at 500 g/ha+2,4-D at 500 g/ha	2.25 (4.66)	2.24 (4.71)	3.12 (9.37)	59.02	55.91	114.93	84.8	93.7	91.04
IPU at 500 g/ha+ CDF at 30 g/ha	1.61 (2.14)	6.37 (40.3)	6.53 (42.44)	31.76	463.23	494.99	91.8	47.9	61.05
IPU at 500 g/ha+SSN at 15 g/ha	1.49 (1.74)	2.56 (6.20)	2.89 (7.94)	24.36	63.59	87.95	93.7	92.8	93.58
S. Em±	0.054	0.133	0.125	3.21	12.00	12.62	-	-	-
LSD (P=0.05)	0.153	0.375	0.351	9.05	33.74	35.50			
Nutrient management									
RDF (120 : 40 : 30 kg NPK/ha)	2.5 (9.52)	5.39 (38.54)	6.01 (48.06)	80.02	327.08	407.09	-	-	-
75% RDF+Vermicompost at 1.5 t/ha	2.56 (9.92)	5.51 (39.78)	6.15 (49.7)	89.12	361.81	450.93	-	-	-
50% RDF+Vermicompost at 3.0 t/ha	2.61 (10.21)	5.61 (40.96)	6.25 (51.16)	93.72	370.30	464.02	-	-	-
S. Em ±	0.036	0.087	0.082	2.10	7.85	8.26	-	-	-
LSD (P=0.05)	NS	NS	NS	5.92	22.09	23.24	-	-	-

Figures in parentheses are original values while outside are transformed ($\sqrt{x}+0.5$). NS–Not Significant.

degradation in soil; it controls weeds throughout crop growth period.

Nutrient management treatments did not influence weed density but weed biomass increased significantly with the application of 75% RDF+ vermicompost at 1.5 t/ha and 50% RDF+vermicompost at 3.0 t/ha over RDF (Table 2). Maximum weed biomass of 230.44 kg/ha was recorded with 50% RDF+ vermicompost at 3.0 t/ha followed by 225.32 kg/ha with 75% RDF+vermicompost at 1.5 t/ha with a corresponding increase of 14.0 and 10.8% over RDF. The increase in weed biomass with the use of vermicompost might be due to increased and sustained availability of nutrients to the weeds (Singh *et al.,* 2004).

Weed Control Efficiency (WCE)

The efficacy of herbicides estimated on the basis of weed biomass (Table 1) indicated that tank mixture of IPU at 500 g/ha+SSN at 15 g/ha was most effective against grassy weeds with a WCE of 93.7% followed by SSN at 30 g/ha (93.2%), CDF at 60 g/ha (92.6%), IPU at 500 g/ha+CDF at 30 g/ha (91.8%), IPU at 750 g/ha (86.0%) and IPU at 500 g/ha+2, 4-D at 500 g/ha (84.8%), while against broadleaf weeds IPU at 500 g/ha+2, 4-D at 500 g/ha was most effective (WCE 93.7%) followed by IPU at 500 g/ha+SSN at 15 g/ha (92.8%), SSN at 30 g/ha (84%), IPU at 750 g/ha (83.3%), IPU at 500 g/ha+CDF at 30 g/ha (47.9%) and CDF at 60 g/ha was least effective (20.2%).

Nutrient Uptake by Weeds

All the herbicide treatments were statistically superior over weedy check in reducing NPK depletion by weeds (Table 2). Minimum depletion of N (1.41 kg / ha), P (0.21 kg /ha) and K (1.82 kg /ha) was recorded with tank mixture of IPU at 500 g/ha+SSN at 15 g/ha, followed by IPU at 500 g/ha+2, 4-D at 500 g/ha, SSN at 30 g/ha, IPU at 750 g/ha, IPU at 500 g/ha+CDF at 30 g/

Table 2. Effect of herbicides and nutrient management on NPK uptake by crop and weeds, protein and chlorophyll content and wheat yield (Pooled data of two years)

Treatments	Nutrient uptake (kg/ha) at harvest						Protein content (%)	Chlorophyll content (mg/g fresh weight)	Yield (q/ha)	
	N		P		K				Grain	Straw
	Crop	Weeds	Crop	Weeds	Crop	Weeds				
Weed control										
Weedy check	87.87	20.79	23.82	3.125	118.04	26.94	10.82	2.313	34.10	48.93
Isoproturon at 750 g /ha	128.24	3.32	34.81	0.499	169.53	4.26	11.12	2.344	49.15	68.48
Clodinafop at 60 g /ha	102.46	14.07	27.79	2.016	136.12	17.12	10.87	2.321	39.91	55.86
Sulfosulfuron at 30 g /ha	131.89	2.96	35.94	0.436	173.05	3.65	11.14	2.389	50.72	69.37
IPU at 500 g/ha+2, 4 D at 500 g/ha	144.49	1.58	39.51	0.245	190.22	2.19	11.16	2.401	55.34	76.03
IPU at 500 g/ha+CDF at 30 g/ha	115.52	9.33	31.41	1.347	152.82	11.28	10.94	2.326	44.96	62.05
IPU at 500 g/ha+SSN at 15 g/ha	150.20	1.41	41.00	0.210	194.14	1.82	11.18	2.379	58.00	77.03
S. Em±	2.26	0.242	0.60	0.035	3.21	0.303	0.11	0.027	0.96	1.42
LSD (P=0.05)	6.37	0.68	1.69	0.099	9.04	0.852	NS	NS	2.71	4.00
Nutrient management										
RDF (120 : 40 : 30 kg NPK/ha)	109.53	7.00	29.82	1.028	145.69	8.79	10.67	2.29	43.28	60.99
75% RDF+Vermicompost at 1.5 t/ha	127.60	7.81	34.72	1.154	167.85	9.84	11.16	2.374	48.91	66.87
50% RDF+Vermicompost at 3.0 t/ha	131.72	8.11	35.86	1.195	172.43	10.19	11.27	2.396	50.17	68.32
S. Em±	1.48	0.158	0.39	0.023	2.10	0.198	0.07	0.017	0.63	0.93
LSD (P=0.05)	4.17	0.445	1.11	0.065	5.92	0.558	0.20	0.049	1.78	2.61

NS–Not Significant.

ha and CDF at 60 g/ha, while maximum drain of N (20.79 kg/ha), P (3.12 kg/ha) and K (26.94 kg /ha) occurred in weedy plots. Considerable loss of nutrients by weeds in weedy plots was also reported by Sharma and Pahuja (2001). Significant increase in nutrient uptake by weeds occurred in plots where vermicompost at 1.5 and 3.0 t/ha used alongwith 75% and 50% RDF, respectively, over RDF. Lowest NPK removal by weeds was recorded with RDF which increased by 15.9, 15.5 and 15.9%, respectively, with 50% RDF+vermicompost at 3.0 t/ha and by 11.6, 11.6 and 11.9% with 75% RDF+vermicompost at 1.5 t/ha over RDF. Increase in uptake of nutrient by weeds in plots treated with organic manures was also reported by Mundra *et al*. (2002).

Nutrient Uptake by Crop

All the herbicidal treatments increased NPK uptake by wheat crop over weedy check (Table 2). Nutrient uptake was found to be maximum with tank mixture of IPU at 500 g/ha+SSN at 15 g/ha and this treatment was significantly superior to other herbicidal treatments except IPU at 500 g/ha+2, 4-D at 500 g/ha. The nutrient uptake by crop in weedy check plots was 87.87 kg N /ha, 23.82 kg P/ha and 118.04 kg/ha, while in IPU at 500 g/ha+SSN at 15 g/ha treated plots it was 150.20 kg N, 41.00 kg P and 194.14 kg K/ha. Thus, IPU at 500 g/ha+SSN at 15 g/ha saved 62.33 kg N, 17.18 kg P and 76.10 kg K/ha during crop season which otherwise would have been removed by weeds. Similar findings were also reported by Johri *et al*. (1992). Application of vermicompost along with chemical fertilizers significantly improved NPK uptake by wheat crop over RDF alone. Nutrient uptake was found maximum with 50% RDF+vermicompost at 3.0 t /ha followed by 75% RDF+vermicompost at 1.5 t /ha and these treatments increased NPK uptake by 21.9, 20.5 and 20.1% and 17.5, 16.5 and 15.9%, respectively, over RDF. Similar increase in nutrient uptake by crop with the application of vermicompost was also reported by Nehra *et al*. (2005).

Protein and Chlorophyll Content

Herbicide treatments had non-significant effect on grain protein and leaf chlorophyll content but nutrient management practices caused significant variation in them (Table 2). Maximum values for grain protein (11.27%) and leaf chlorophyll content (2.396 mg/g fresh weight) were recorded with the application of 50%

RDF+vermicompost at 3.0 t /ha and it was significantly higher than RDF by 5.62 and 4.62%, respectively but at par with 75% RDF+vermicompost at 1.5 t /ha. The increase in these components might be due to the availability of desired and required nutrients in the crop root zone resulting from solubilizaiton of fixed forms of nutrients and their availability to crop during vegetative, reproductive and grain filling stages.

Crop Yield

The grain and the straw yield of wheat increased significantly by all the herbicide treatments as compared to weedy check (Table 2). The tank mix application of IPU at 500 g/ha+SSN at 15 g/ha and IPU at 500 g/ha+2, 4-D at 500 g/ha being at par recorded significantly higher grain yield (58.0 and 55.34 q/ha, respectively) over other herbicidal treatments with an increase of 70.09 and 62.29%, respectively, over weedy check (34.10 q/ha). The increase in yield with tank mixtures was due to reduced crop-weed competition as they effectively suppressed both grassy (*P. minor*) and broadleaf weeds throughout crop growth period. SSN at 30 g/ha and IPU at 750 g/ha remained at par but yielded significantly higher over weedy check, CDF at 60 g/ha and IPU at 500 g/ha+CDF at 30 g/ha. These results are similar to those reported by Saini and Angiras (2005).

Amongst nutrient management, significant increase in grain yield of wheat by 13.0 and 15.92% was recorded with 75% RDF+vermicompost at 1.5 t / ha and 50 % RDF+vermicompost at 3.0 t/ha over RDF, respectively. The improvement in yield might have occurred due to the fact that vermicompost supplies nutrients to the plants in available form and also has solubilizing effect on fixed form of nutrients in soil. Thus, increase in level of nutrients in growth medium and their adequate translocation during reproductive and grain filling stages improved the yield attributes and yield. These findings are in accordance with those of Singh *et al.* (2005).

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