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Bioefficacy of sole and tankmix herbicides for control of complex weed flora in wheat (*Triticum aestivum*)

AJIT SINGH, DINDAYAL GUPTA* LAKHPAT SINGH AND S.B.SINGH

Department of Agronomy, Raja Balwant Singh College, Bichpuri, Agra (U.P.)-283105

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ABSTRACT

A field experiment was conducted during rabi seasons of 2011-12 and 2012-13 at Agricultural Research Farm, R.B.S. College, Bichpuri, Agra to evaluate the effect of different grass and broad-leaved herbicides as sole and their tankmix application on weed control in wheat (Triticum aestivum). The fourteen weed control treatments were tested in randomized block design with three replications. The lowest weed density and weed dry matter of grassy, broad leaved and total weeds were noted with weed free treatment followed by Sulfosulfuron+metsulfuron @ 32 g ha^{-1}. Application of Sulfosulfuron+metsulfuron @ 32 g ha^{-1} resulted in the highest WCE as well as HEI and lowest Weed Index of 95.74%, 2.94 and 3.29, respectively. Significantly higher values of growth parameters were obtained with weed free treatment followed by Sulfosulfuron+metsulfuron @ 32 g ha^{-1}. Maximum values of all the yield attributes were noticed with weed free treatment followed by Sulfosulfuron+metsulfuron @ 32 g ha^{-1}, but these treatments were failed to prove its superiority against all the tankmix application of different herbicides. Significantly higher bio-mass (116.5 and 111.1 q ha^{-1}), grain (52.6 and 50.9 q ha^{-1}) and straw (63.9and 60.3 q ha^{-1}) yields were produced with weed free and Sulfosulfuron+metsulfuron @ 32 g ha^{-1}, respectively on pooled basis. The highest net return (Rs. 61000 ha^{-1}) as well as B:C ratio (1:2.88) were gained with weed free treatment followed by Sulfosulfuron+metsulfuron @ 32 g ha^{-1} among tested herbicide treatments.

Key Words: Wheat, herbicides, growth, yield, economics

INTRODUCTION

Wheat (*Triticum aestivum* (L) *emend Fiori & Pool*) is staple food of approximately 23 per cent population of the world. 20 per cent energy is achieved through wheat at global level. Among food grains, wheat is the richest source of protein and its stands at second place after pulses. Besides staple food for human beings, wheat straw is a god source of feed for a large population of cattle in our country (*Jaiswal*, 2009).Weeds are important factors in the management of all types of land, which is the reduction in crop yield, has a direct correlation with weed competition. Generally weed competes with crop plant for nutrient, moisture and sunlight. Weeds remove plant nutrients more efficiently than crop plants. If weeds left uncontrolled, they can grow taller than crop plant and inhibit the growth depending upon degree of competition. Weed reduced the crop yield by 10-15 per cent (Kumar and Das, 2008). Anjuman and Bajwa (2010) reported that selected wheat varieties incurred 60-75% biomass loss due to weed infestation. Over the years, efficacy of these herbicides has started declining and there is possibility of development of cross resistance, an increase in GR_{50} values of clodinofop and fenoxaprop under continuous use of these herbicides (Dharwan *et al.*, 2009). To manage the dynamic and complex weed flora in wheat there is need to evaluate different herbicides to have a broad-spectrum for weed control **(**Chopra *et al.*, 2015). Weed control under such condition is necessary to take full advantage of other technological advancements in crop production. Herbicidal control, on the other hand, will prevent the costly input being eaten up by weeds and thus, save the management time and cost and will increase the yield and result the higher profit. Hence, the present study was limited using wheat S as test crop.

MATERIALS AND METHODS

The field experiment was conducted during winter (Rabi) seasons of 2011-12 and 2012-13 at Agricultural Research Farm, R.B.S. College, Bichpuri, Agra (U.P.), situated at 27^0 2' North latitude, 77^0 9' East longitude and altitude of 163.4 m above mean sea level. The experimental soil was sandy loam in texture containing organic carbon 3.6 g ha^{-1}, available N 189, P_2O_5 29 and K_2O 313 kg ha^{-1} with pH 8.5.

Corresponding author Email: dgupta072@gmail.com

There were fourteen weed-control treatments namely. T_1-Metribuzin @ 210 g ha^{-1}, T_2-Clodinafop @ 60 g ha^{-1}, T_3-Pinoxaden @ 40 g ha^{-1}, T_4-Sulfosulfuron @ 25 g ha^{-1}, T_5-Clodinafop+ metribuzin @ 60+210 g ha^{-1}, T_6-Pinoxaden+metribuzin @ 40+210 g ha^{-1}, T_7-Sulfosulfuron+metribuzin @ 25+210 g ha^{-1}, T_8-Accord Plus (Fenoxaprop+metribuzin) @ 120+210 g ha^{-1}, T_9-Total (Sulfosulfuron+metsulfuron) @ 32 g ha^{-1}, T_{10}-Atlantis (Mesosulfuron+Iodosulfuron) @ 14.4 g ha^{-1}, T_{11}-Vesta (Clodinafop+metsulfuron) @ 60+4 g ha^{-1}, T_{12}-Isoproturon+2, 4-D @ 1000+500 g ha^{-1}, T_{13}-Weedy check and T_{14}-Weed free, which were tested in randomized block design and replicated thrice. Nitrogen120 kg, 60 kg P_2O_5 and 40 kg K_2O ha^{-1} were applied for entire experimental plot. Full dose of phosphorus was applied through DAP (18% N and 46% P_2O_5). The nitrogen computed through DAP was deducted from the 120 Kg N and rest N was applied through urea. Potassium was applied through muriate of potash. One third nitrogen and full phosphorus and potash were applied at the time of sowing as basal application. One third dose of nitrogen was top dressed in the form of urea after first irrigation and remaining one third N was applied after second irrigation. Wheat (PBW-550) was sown in last week of November in both the years with the seed rate of 100 kg ha^{-1} and row spacing of 20 cm apart. Herbicides were sprayed as per treatment at 32 DAS by Knapsack sprayer fitted with flat fan nozzle using 500 litres of water ha^{-1}. Observations on weed density were recorded from 0.5 m^2 quadrate at two places in the net plot and converted in to density m^{-2}. The data were subjected to transformation to normalize their distribution. Later these samples were dried at 70^0C till a constant weight was obtained. The dry matter was then computed in terms of g m^{-2}. Weedy check plots remained infected with native population of weeds till harvest. The data on weed density and weed dry weight were subjected to transformation $\sqrt{X+1}$ before statistical analysis. Herbicide efficiency index (HEI) was calculated as per method of Krishnamurthy *et al.*, (1975)..The growth characters and yield attributes were recorded at harvest. The straw yield was computed by deducting the grain yield from the total biological yield. The economics was work out based on pooled yield data and considering price of input and output of the prevailing market rate.

RESULT AND DISCUSSION

Effect on weeds

Data (Tablen 1) revealed that all the herbicidal as well as weed free treatments proved significantly better than weedy check in respect of reducing the weed population and their dry matter of grassy, broad leaved and total weeds. In general, the lowest weed population and dry weight of grassy, broad leaved and total weeds was obtained with weed free treatment and this was found significantly superior as compared to other treatments. Among the applied herbicides, Sulfosulfuron+metsulfuron @ 32 g ha^{-1} recorded significantly lowest population of grassy, broad leaved and total weeds but this was statistically at par with Clodinafop+metribuzin @ 60+210 g ha^{-1}. This may be the reason for excellent control of total weeds population due to sequential weed free and differential selectivity toward grassy and broad leaved weeds with the application of Sulfosulfuron+metsulfuron @ 32 g ha^{-1} and Clodinafop+metribuzin @ 60+ 210 g ha^{-1}. The results are in the agreement with those of Chopra *et al.* (2013) and Kaur *et al.* (2015). Tankmix application of Sulfosulfuron +metsulfuron @ 32 g ha^{-1} significantly reduced the dry matter of grassy and broad leaved as well as total weeds over sole and tankmix application of different herbicides. There was an increase of 89.7 and 60.8% of dry weight of the total weeds in weedy check as compared to Sulfosulfuron+ metsulfuron @ 32 g ha^{-1} and Pinoxaden @ 40 g ha^{-1} at 120 DAS, respectively. With chemical and weed free treatments, the weed population was very much suppressed and hence the production of fresh and dry weight was considerably lower. Similar weed control results have also been reported by Jain *et al.* (2014) and Singh *et al.* (2015). The maximum weed control efficiency was obtained with weed free treatment followed by Sulfosulfuron+metsulfuron @ 32 g ha^{-1}. This might be owing to lower weed density and dry-matter production of weed which resulted successful checking of weed growth under these treatments. Tankmix application of Sulfosulfuron+metsulfuron @ 32 g ha^{-1} recorded

Table 1: Weed density, weed dry matter, WCE, WI and HEI in wheat as affected by different herbicides (pooled data of two years)

Treatments	Weed density (no m^{-2} at 120 DAS)			Weed dry matter (g m^{-2} at 120 DAS)			Weed Control Efficiency (%)	Weed Index	Herbicide Efficiency Index
	Grassy weeds	Broad leaved weeds	Total weeds	Grassy weeds	Broad leaved weeds	Total weeds			
T_1	19	25	6.71 (44)	33.5	48.8	9.11 (82.31)	73.28	16.86	0.33
T_2	20	26	6.85 (46)	34.3	52.1	9.33 (86.42)	72.13	17.75	0.28
T_3	22	27	7.07 (49)	35.6	53.4	9.53 (89.60)	70.34	18.12	0.26
T_4	17	21	6.24 (38)	32.8	48.3	9.05 (81.11)	76.26	16.07	0.37
T_5	06	05	3.46 (11)	13.1	20.3	5.85 (33.43)	93.30	11.25	1.33
T_6	13	11	5.00 (24)	27.6	40.7	8.31(68.31)	85.47	14.09	0.52
T_7	11	09	4.58 (20)	24.9	36.7	7.92 (61.62)	87.84	13.13	0.63
T_8	13	10	4.90 (23)	26.1	39.5	8.14 (65.60)	86.08	13.50	0.57
T_9	04	03	2.83 (07)	09.4	14.1	4.96 (23.51)	95.74	03.29	2.94
T_{10}	08	07	3.87 (15)	17.6	26.7	6.72 (44.32)	90.91	11.94	0.96
T_{11}	08	09	4.12 (17)	19.1	29.1	7.02 (48.24)	89.72	12.86	0.82
T_{12}	16	14	5.48 (30)	29.2	44.4	8.63 (73.62)	81.77	14.76	0.46
T_{13}	90	75	12.84 (165)	96.2	132.5	15.16 (228.73)	0.00	25.71	0.00
T_{14}	00	00	1.00 (00)	0.00	0.00	1.00 (0.00)	100.00	0.00	0.00
SEm±	1.07	1.06	0.33 (2.06)	1.03	0.96	0.28 (1.60)	1.20	-	-
CD (P=0.05)	3.11	3.08	0.98 (5.99)	3.00	2.80	0.81 (4.65)	3.50	-	-

Original figures in parentheses were subjected to square-root transformation $\sqrt{x+1}$ before statistical analysis

Table 2: Growth and yield contributing characters of wheat as affected by different herbicides (pooled data of two years)

Treatments	Growth characters			Yield contributing characters				
	No. of shoots m^{-1} row length	Plant height (cm)	Dry matter accumu-lation (g)	Effective shoots m^{-1} row length	Spike length (cm)	Grains $spike^{-1}$	Grains weight $spike^{-1}$	1000-grains weight
T_1	72.6	80.4	92.38	67.5	6.0	31.6	2.7	35.60
T_2	71.7	80.0	91.80	66.8	6.0	31.2	2.7	35.35
T_3	70.0	79.6	91.52	65.3	5.9	30.9	2.7	35.10
T_4	74.5	80.7	92.66	67.8	6.1	31.8	2.8	35.70
T_5	79.2	83.8	95.63	72.7	7.1	33.7	3.2	37.85
T_6	75.9	81.8	93.30	68.9	6.2	32.5	2.9	36.12
T_7	76.5	82.7	94.07	70.7	6.6	33.0	3.0	36.90
T_8	76.1	82.4	93.75	70.1	6.5	32.8	2.9	36.38
T_9	80.0	84.4	95.98	73.4	7.2	34.1	3.2	37.97
T_{10}	78.5	83.5	94.88	71.9	6.9	33.5	3.1	37.45
T_{11}	76.9	83.2	94.52	71.4	6.8	33.2	3.0	37.05
T_{12}	75.3	81.4	93.01	68.5	6.2	32.2	2.8	35.95
T_{13}	63.7	75.5	86.65	63.1	5.8	29.8	2.6	34.65
T_{14}	84.8	88.3	97.17	75.3	7.8	35.2	3.4	38.50
SEm±	1.29	0.62	0.65	1.42	0.47	0.95	0.16	0.76
CD (P=0.05)	3.75	1.81	1.89	4.11	1.37	2.76	0.46	2.21

Table 3: Yields and economics of wheat as affected by different herbicides (pooled data of two years)

Treatments	Yields							Economics			
	Biological yield (q ha^{-1})		Grain yield (q ha^{-1})			Straw yield (q ha^{-1})		Cost of cultivation ($x10^3$ ₹ ha^{-1})	Gross return ($x10^3$ ₹ ha^{-1})	Net return ($x10^3$ ₹ ha^{-1})	B:C Ratio
	2011-12	2012-13	2011-12	2012-13	Pooled	2011-12	2012-13				
T_1	93.05	94.61	43.33	44.11	43.72	49.72	50.50	30.10	76.62	46.52	2.55
T_2	91.97	93.67	42.80	43.70	43.25	49.17	49.97	30.32	75.73	45.41	2.50
T_3	91.55	92.61	42.75	43.36	43.06	48.8	49.25	30.81	75.29	44.48	2.44
T_4	94.37	95.77	43.83	44.44	44.14	50.54	51.33	30.39	77.42	47.03	2.55
T_5	100.87	102.33	46.27	47.06	46.67	54.60	55.27	30.68	82.23	51.55	2.68
T_6	97.05	98.25	44.93	45.43	45.18	52.12	52.82	31.17	79.36	48.19	2.55
T_7	98.60	99.58	45.44	45.92	45.68	53.16	53.66	30.75	80.36	49.61	2.61
T_8	97.91	98.73	45.30	45.68	45.49	52.61	53.05	31.50	79.91	48.41	2.54
T_9	110.60	111.62	50.72	51.00	50.86	59.88	60.62	30.73	89.75	59.02	2.92
T_{10}	100.35	101.27	46.02	46.60	46.31	54.33	54.67	31.37	81.59	50.22	2.60
T_{11}	99.00	99.82	45.72	45.93	45.83	53.28	53.89	31.57	80.62	49.05	2.55
T_{12}	96.30	97.46	44.74	44.90	44.82	51.56	52.56	30.97	78.73	47.76	2.54
T_{13}	83.90	84.40	38.88	39.25	39.07	45.02	45.15	29.37	69.12	39.75	2.35
T_{14}	115.90	117.10	52.18	53.00	52.59	63.72	64.10	32.37	93.37	61.00	2.88
SEm±	1.15	1.24	0.89	0.95	1.08	1.18	1.35	-	-	-	-
CD (P=0.05)	3.42	3.61	2.68	2.82	3.15	3.33	3.92	-	-	-	-

lowest weed index and second best treatment was Clodinafop+metribuzin @ 60+210 g ha^{-1} in this regard. The higher herbicide efficiency index was recorded with Sulfosulfuron+metsulfuron @ 32 g ha^{-1} followed by Clodinafop+metribuzin @ 60+210 g ha^{-1} which may be owing to the better control of weeds resulting in higher weed-control efficiency under these treatments. Among the sole application of herbicides, the lowest WCE and HEI and highest weed index obtained with Pinoxaden @ 40 g ha^{-1}. Similar results have also been reported by Chopra *et al.* (2015).

Growth parameters

The data (Table 2) indicated that the variations in all growth parameters due to different herbicides were significant. The number of shoots m^{-1} row length improved significantly with weed free treatment as compared to other treatments. Out of treated herbicidal treatments, application of Sulfosulfuron+metsulfuron @ 32 g ha^{-1} gave the maximum number of shoots m^{-1} row length but this was statistically at par with Clodinafop+ metribuzin @ 60+210 g ha^{-1}, Sulfosulfuron+metribuzin @ 25+210 g ha^{-1}, Fenoxaprop+metribuzin @ 120+210 g ha^{-1} and Mesosulfuron+Iodosulfuron @ 14.4 g ha^{-1}. Weed free treatment attained the significantly highest plant height over other treatments. Among all treated treatments, Sulfosulfuron+metsulfuron @ 32 g ha^{-1} was stood second best treatment in respect of plant height and also proved its superiority over sole application of different herbicides. This increase in plant height may be due to minimum competition between crop and weed plants under the said treatments. This finding is in agreement with those of Meena and Singh (2013) and Jat *et al.* (2014). Weed free treatment exhibited the best performance with respect of dry matter accumulation and next best treatment was tankmix application of Sulfosulfuron+ metsulfuron @ 32 g ha^{-1}. On other hand, lowest number of shoots m^{-1} row length (70.0), plant height (79.6 cm) and dry matter accumulation (91.5 g) was obtained with sole application of Pinoxaden @ 40 g ha^{-1}.

Yield attributes

The data (Table 2) evinced that all the herbicidal as well as weed free treatment were found significantly better than control in respect of yield attributes. The weed free treatment produced significantly more effective shoots row $length^{-m}$ over all sole and tankmix application of herbicidal treatments except Clodinafop+metribuzin @ 60+210 g ha^{-1}, Sulfosulfuron+ metsulfuron @ 32 g ha^{-1} and Clodinafop+metsulfuron @ 60+4 g ha^{-1}. The maximum spike length was obtained with weed free treatment followed by Sulfosulfuron+metsulfuron @ 32 g ha^{-1}. The highest grains $spike^{-1}$ were produced with weed free treatment followed by Sulfosulfuron + metsulfuron @ 32 g as post emergence. Weed free treatment attained the maximum grains weight $spike^{-1}$ and 1000-grains weight followed by application of Sulfosulfuron+ metsulfuron @ 32 g ha^{-1} and these treatments were significantly superior to Metribuzin @ 210 g ha^{-1}, Clodinafop @ 60 g ha^{-1}, Pinoxaden @ 40 g ha^{-1}. Out of all sole herbicidal treatments, Pinoxaden @ 40 g ha^{-1} showed poorest performance in respect of yield attributes. The crop remained in advantage with both the treatments and it completed its vegetative growth and development satisfactorily due to favourable temperature condition which ultimately accumulated more dry matter and promoted the yield attributes favourably. Similar results were also obtained by Mehmood *et al.* (2014).

Yields

Data (Table 3) showed that yields increased significantly in all the treated as well as weed free treatment over control. The maximum bio-mass was obtained with weed free treatment and this was significantly superior to other treated herbicidal treatments. Among the sole and tank mix herbicidal treatments, Sulfosulfuron+metsulfuron @ 32 g ha^{-1} produced the maximum bio-mass yield and proved superior to weed control treatments. The different weed control treatments may be arranged in descending order as T_{14}> T_9> T_5>T_{10}> T_{11}>T_7> T_8>T_6>T_{12}> T_4>T_1>T_2>T_3 in respect of bio-mass yield during both the seasons. The maximum grain yield of 52.59 q ha^{-1} was obtained with weed free treatment. The second highest yield was recorded with the application of Sulfosulfuron+metsulfuron @ 32 g ha^{-1} which was significantly superior to treated treatments. The per cent increases in grain yield due to T_1, T_2, T_3, T_4 T_5, T_6, T_7, T_8, T_9, T_{10}, T_{11}, T_{12}

and T_{14} treatments over T_{13} (weedy check) were 11.9, 10.7, 10.2, 13.0, 19.5, 15.6, 16.9, 16.4, 30.2, 18.5, 17.3, 14.7 and 34.6, respectively on pooled basis. Both the treatments showed their superiority in most of the yield contributing characters (effective shoots metre^{-1} row length, spike length, grains spike^{-1}, 1000-grains weight, weight of grains spike^{-1}) due to difference in weed dry weight which resulted in reduced crop weed competition for space, solar radiation interceptions, moisture and nutrient uptake. Hence, better grain yield with T_{14} and T_9 over rest of the herbicidal treatments is well justified. These results are in conformity with the findings of Jat *et al.* (2014) and Bajya *et al.* (2015).Weed free treatment produced highest straw yield followed by Sulfosulfuron+metsulfuron @ 32 g ha^{-1} and both the treatments proved significantly superior to rest of herbicidal treatments. The differences among T_5, T_6, T_7, T_8, T_{10}, T_{11} and T_{12} could not reach the level of significance. Out of different sole and tankmix application of herbicides, Pinoxaden @ 40 g ha^{-1} produced the lowest bio-mass (92.08 q ha^{-1}), grain (43.06 q ha^{-1}) and straw yield (49.02 q ha^{-1}) on pooled basis. It is obvious that dry matter is a net saving of photosynthesis and essential for the building up of plant organs, which ultimately reflect on biomass and straw production. Similar results were reported by Meena and Singh (2013), Tomar and Tomar (2014) and Singh *et al.* (2015).

Economics

The weed free and all the herbicides sole or in tankmix application recorded higher monetary returns than weedy check (Table 3). Among the weed control treatments, the maximum cost of cultivation (Rs. 32370 ha^{-1}) and gross income (Rs. 93370 ha^{-1}) were recorded with weed free treatment. Clodinafop+metsulfuron @ 60+4g ha^{-1} and Sulfosulfuron+metsulfuron @ 32 g ha^{-1} were next best treatments in respect of cost of cultivation (Rs. 31570 ha^{-1}) and gross income (Rs. 89750 ha^{-1}), respectively. The highest net return (Rs. 61000 ha^{-1}) as well as B:C ratio (1:2.88) were gained with weed free treatment as compared to all other treatments followed by Sulfosulfuron+metsulfuron @ 32 g ha^{-1}. All the herbicide mixtures resulted in higher monetary returns than their sole application. The profitability was lower under weedy check due to disproportionate decrease in yield on account of higher crop weed competition. These results are in line with those of Jain *et al.* (2014) and Chopra *et al.* (2015).

From the results, it may be concluded that metribuzin and sulfosulfuron were found compatible with clodinafop and metsulfuron and there was no adverse effect on efficacy of both the herbicides against the complex weed flora in wheat. Sulfosulfuron+metsulfuron and Clodinafop+ metribuzin were the most remunerative and effective herbicides mixture for controlling the weed flora in wheat for achieving maximum weed control efficiency and herbicide efficiency index and grain yield.

REFERENCES

Anjuman, T. and Bajwa, R. (2010) Competition loses caused by *Rumex dentatus* L. and *Chinopodium album* L. in wheat (*Triticum aestivum* L.). *The Philippine Agricultural Scientist*. 93 (3): 110-115.

Bajya, D.R.; Parveen, T.; Lakharam, M.C. and Raja, S.K. (2015) Efficacy of new formulations of trisulfuron on weeds in wheat and their residual effects onsucceeding maize. *Indian Journal of Agronomy*. 60 (1): 57-60.

Chopra, N.K.; Chopra, N. and Choudhary, D. (2015) Bioefficacy of sole and tankmix of pinoxaden and clodinofop with carfentazone and metsulfuron for control of complex weed flora in wheat. *Indian Journal of Agronomy*. 60 (1): 104-108.

Dharwan, R. ; Punia S.S.; Singh, S.; Yadav, D. and Malik, R.K. (2009) Productivity of wheat as affected by continuous use of new low dose hebicides for management of little canary grass (*Phalaris minor*). *Indian Journal of Agronomy*. 54 (1): 58-62.

Jain, V.*; Jain, N. and Kewat, M.L. (2014) Effect of application ofpost-emergence herbicides at different levels of available soil moisture content in irrigated wheat. Indian Journal of Agronomy*. 59 (1):91-95.

Jat, S.L.; Nepalia, V.; Choudhary. J. and Singh, D. (2014) Effect of nitrogen and weed management on productivity and quality of durum wheat. *Indian Journal of Agronomy*. 59 (2): 281-85.

Krishnamurthy, K.; Raju, B.G.; Raghunath, G.; Jagnnath, M.K. and Prasad, T.V.R. (1975) Herbicide efficiency index in Sorghum. *Indian Journal of Weed Science*. 7 (2): 75-79.

Kaur, T. Bhullar, M.S. and Walia, U.S. (2015) Bio-efficacy of ready mix formulation of clodinafop-propargyl + metsulfuron for control of mixed weed flora in wheat. *Indian Journal of Weed Science*. 47 (2): 121-124.

Kumar, A. and Das, T.K. (2008) Integrated weed management for system productivity and economics in soybean-wheat system. *Indian Journal of Agronomy*. 53 (3): 189-194.

Meena, B.L. and Singh, R.K. (2013) . Response of wheat to rice and weed management practices. *Indian Journal of Agronomy*. 58 (4): 521-524.

Mehmood, Zia; Ashiq, Muhammad; Noorka, Ijaz Rasool; Ali, Amjed; Tabasum, Saba and Iqbal, Muhammad Shahid (2014) Chemical Control of Monocot Weeds in Wheat (*Triticum aestivum* L.). *American Journal of Plant Sciences*. 5 (9): 5 pages DOI:10.4236/ajps.59140.

Tomar, S.K. and Tomar, T.S. (2014). Effect of herbicides and their tank mixture on weed dynamics and yield of zero-tilled wheat (*Triticum aestivum* L.) under rice (*Oriza sativa*) – wheat cropping system of eastern Uttar Pradesh. *Indian Journal of Agronomy*. 59 (4):624-628.

Singh, A.P.; Pandagare, T.; Abrahum, S.; Chandrakar, D. and Chowdhury, T. (2015) Evaluation of metribuzin in combination with clodinafop, sulfosulfuron and Pinoxaden for weed control in wheat. *International Journal of Life Science*. 10 (1): 271-274.