Mycopath (2013) 11(1): 39-44 **Research Article**

Evaluation of various herbicides for controlling grassy weeds in wheat

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Abstract

A field study was carried out to evaluate the efficacy of various herbicides for controlling grassy weeds in wheat crop during winter 2011-12 at Adaptive Research Farm, Sheikhupura, Pakistan. Four herbicides viz. pinoxaden/cloquintocet-mexyl (Axial 100 EC) @ 825 mL ha^{-1}, clodinafop (Topik 15 WG) @ 300 g ha^{-1}, fenoxaprop-p-ethyl (Puma Super 75 EW) @ 1250 mL ha^{-1}, Iodo + mesosulfuron (Atlantis 3.6% WG) @ 400 g ha^{-1} were used. A weedy check was also maintained for comparison. All the herbicides decreased total weed population and their biomass as compared to weedy check. Axial 100 EC @ 825 mL ha^{-1} was found to be the most effective in reducing weeds population as well as weed biomass with maximum mortality. Axial herbicide reduced total weed density and total weed dry weight over control by 88% and 87%, respectively. This herbicide increased grain yield of wheat by 42% and also increased tillers per unit area, spike length, number of grains per spike, 1000-grain weight over weedy check control. The economic analysis showed that Axial herbicide gave the highest net benefits of Rs. 78200 ha^{-1}. The application of Topik herbicide gave maximum marginal rate of return (1056%) followed by spray of Axial herbicide which resulted in 877% MRR.

Key words: Herbicides, wheat, grassy weeds.

Introduction

Wheat (*Triticum aestivum* L.) is important food grain crop being a staple diet. It is leading among cereals and is a main source of carbohydrates and protein for both human beings and animals; contains starch (60-90%), protein (11-16.5%), fat (1.5-2%), inorganic ions (1.2-2%), and vitamins B-complex and vitamin E (Guarda *et al.,* 2004; Rueda-Ayala *et al.,* 2011). It contributes 12.5% of the value added in agriculture and 2.6% to GDP. Wheat is cultivated on an area of 8.66 million hectares with an annual production of 23.52 million tons and an average yield of 2714 kg ha^{-1} (Government of Pakistan, 2012).

The potential of wheat yield is much high but unfortunately average grain yield in Pakistan is low as compared to other countries (Chivasa *et al.,* 1998). Several constraints are accountable for low wheat yield i.e. use of poor quality seeds, improper sowing, low seeding rate, imbalance use of fertilizers and irrigation, water logging and salinity. However, weeds disruption is the key factor in reducing wheat yield (Riaz *et al*., 2009; Grundy *et al.,* 2011; Lopez-Granados, 2011; Sanguankeo and Leon, 2011; Shehzad *et al.,* 2012). Weeds compete with crop plants for nutrients, solar radiation, water, carbon dioxide, space, and many other growth factors. In Pakistan, weeds are accountable for up to 30 percent loss in wheat grain yield resulting in monitory losses of Rs.1151 million annually (Marwat *et al.,* 2008; Cavero *et al.,* 2011). Annual wheat yield losses by weeds infestation are much higher than caused by other pests (Naseer-ud-Din *et al*., 2011). The control of weeds is a basic requirement and major component of management of crop production system (Young and Ogg, 1994). Chemical weed control method is preferred over other weed control methods because it is rapid, more effective and relatively cheaper (Chaudhry *et al.,* 2008). Efficacy of different herbicides in wheat was reported by many researchers (Naseer-ud-Din *et al*., 2011; Ahmadi and Alam, 2013). Tiwari *et al*. (2011) reported that all the herbicides decreased weed population and significantly increased the yield and yield components of wheat as compared to control. Ali *et al.* (2004) after testing six herbicides against narrow leaved weeds in wheat concluded that Isoproturon was the most effective herbicide in controlling *Phalaris minor*, while *Avena fatua* was controlled with Fenoxaprop and Chlodenafop giving maximum grain yield over control. Chlodenafop proved to be higher in benefit cost ratio of 4.08:1 as against the minimum (1.00) with Isoproturon + Carfentrazone.

Among competitive weeds with wheat *Phalaris minor* Retz. and *Avena fatua* L. are predominant and wide spread. In another field study, Mueen-ud-Din *et al*. (2011) investigated that Fenoxaprop and Chlodenafop gave maximum weeds mortality of 88.33 and 86.21% against *A. fatua* and 75.91 and 79.12% against *P. minor,* respectively. Yasin *et al*. (2010) reported that fenoxaprop-p-ethyl (Puma Super-75 EW) at 45 g a.i. ha^{-1} produced relatively less weed biomass, more plant height, number of spike bearing tillers, number of grains per spike, 1000-grain weight and grain yield (4.20 t ha^{-1}). Chaudhary *et al*. (2011) reported after conducting a field experiment that Axial + Starane - M, Puma Super + Starane - M, Atlantis and Leader performed better against *A. fatua* L. with 98.87, 97.10, 96.89 and 91.51% and against *P. minor* Retiz with 98.31, 97.99, 97.67 and 96.95% control, respectively. Ashiq *et al*. (2006) in a field study found that Puma Super 75 EW, Graminicide 69 EW and Topik 15WP gave effective control of *A. fatua* in wheat crop.

Under Sheikhupura conditions, the grassy weeds i.e. *A. fatua* L., *P. minor* Retz. etc. are very common in wheat crop and cause major loss to grain yield. Hence their control from wheat field is very important to have a good crop harvest. Therefore, the present study was undertaken to evaluate the efficacy of various herbicides against grassy weeds in wheat crop to find out the most effective and economical herbicide for higher wheat grain yield under rice-wheat cropping system.

Materials and Methods

A field study was conducted at Adaptive Research Farm, Sheikhupura, Pakistan during winter 2011-12 to investigate the effect of various herbicides on grassy weeds and wheat grain yield. The experiment was laid out in randomized complete block design with three replications. A net plot size of 10 m × 6 m was maintained for each treatment. Wheat cultivar Saher-2006 was sown in 25 cm apart rows with a single row hand drill on 8^{th} November, 2011. Seed rate was used @ 125 kg ha^{-1}. The NPK Fertilizer dose of 128-114-62 kg ha^{-1} was applied in the form of urea, diammonium phosphate (DAP) and sulphate of potash. Whole of P, K and half of N was applied as a basal dose while remaining half of N was top dressed at first irrigation by broadcast method. Threshing for each plot was done separately and manually when the green colour from the glumes and kernels disappeared completely (Shehzad *et al*., 2012) in first week of April, 2012.

Natural weed flora at experimentation site was as; canarygrass (*Phalaris minor* R.), wild oat (*Avena fatua* L.), blue pimpernel (*Anagallis arvensis* L.), nettle leaved goosefoot (*Chenopodium murale* L.), lamb's quarters (*Chenopodium album* L.), swine cress (*Coronopus didymus* L.) and purple nutsedge (*Cyperus rotandus* L.). In the check and other plots, all broad leaves weeds were removed manually and only narrow leaves weeds were remained.

Experiment was comprised five treatments such as Axial 100 EC @ 825 mL ha^{-1}, Topik 15 WG @ 300 g ha^{-1}, Puma Super 75 EW @ 1250 mL ha^{-1}, Atlantis 3.6% WG @ 400 g ha^{-1} and weedy check (control). Herbicides were sprayed after 1^{st} irrigation in moist condition with a knapsack hand sprayer fitted with T-jet nozzle. Volume of spray was determined by calibration method and water was used at 250 L ha^{-1}. Data on weed count, weed biomass was collected from an area of 1 m^2 selected at random from each experimental plot. All weeds were cut near the ground surface, counted and then oven-dried at 70 °C for 72 h. Percent reduction in weeds dry weight was measured by using two 0.25 m^2 quadrates from each plot. The reduction was calculated by subtracting weed biomass from weedy check, dividing the product by weed biomass in the weedy check and multiplied with 100. For recording plant height (cm), number of spike bearing tillers (m^{-2}), grains per spike, 1000-grain weight (g), and grain yield (kg ha^{-1}), a unit area of 1 m^2 was nominated randomly from two different locations of each plot.

Statistical analysis

All the data collected were subjected to Fisher's analysis of variance technique (Steel *et al.,* 1997) using the "MSTATC" statistical package (Anonymous, 1986). The least significant difference (LSD) test at 0.05 probability was employed to compare the differences among treatment means. Economic and marginal analyses, as well as variable cost based on prevailing market prices of herbicides and wheat, were carried out to evaluate the comparative benefits of each herbicide dose (CIMMYT, 1988).

Results and Discussion

Total weed density and total weed dry weight

All herbicides reduced number of weeds as compared with weedy control significantly ($P \leq 0.05$). The highest suppression (88%) of weeds was observed in plots treated with Axial herbicide as compared with weedy check followed by Topik herbicide which gave 83% suppression of weed population which was also statistically at par with Puma Super giving 80% reduction of weed density. The highest number of weeds was found in control plots (Table 1). These results are in conformity with those as described by Ali *et al.* (2004) who found that Fenoxaprop and Chlodenafop gave maximum control against *A. fatua.* Studies of Tickes (2003) have shown that Puma Super provided good (92%) control of *P. minor* and *A. fatua* and increased yield and yield components of wheat. These results are also in conformity with those as described by Mueen-ud-Din *et al*. (2011) who reported that Fenoxaprop and Chlodenafop herbicides gave maximum weeds mortality of 88.33% and 86.21% against *A. fatua* and 75.91% and 79.12% against *P. minor*, respectively in wheat crop. Ahmed *et al.* (1995) investigated almost similar results regarding Topik 240 EC and Puma Super 69 FW which gave 96.37% and 97.95% control of *P. minor*, respectively as compared with weedy check.

The data revealed almost same trend in reducing total weed dry weight as in case of total weed density (Table 1).

Number of tillers

All treatments significantly (*P≤0.05*) affected the number of productive tillers per unit area of wheat crop. The highest number (240.7) of tillers of wheat crop was observed in plots treated with Axial herbicide followed by Topik herbicide (228.3). Topik, Puma Super and Atlantis herbicides were also found statistically at par for producing number of tillers per unit area. The lowest number of productive tillers per unit area (210.7) was recorded in weedy check (Table 2). Similar results were found in previous literature (Alvi *et al*., 2004; Hussain *et al.*, 2003) who reported that the increase in number of tillers, 1000-grain weight, number of grains spike^{-1} may be attributed to better weed control and elimination of weed crop competition for nutrients, moisture and light and better utilization of available resources by the crop.

Plant height

The data depicted that there was highest plant height (107 cm) in plot treated with Axial herbicide which was statistically (*P≤0.05*) at par with Topik (104.7) and puma Super (104.3 cm) treated plots (Table 2). These results are in accordance with those as reported by Sherawat *et al*. (2005). Among herbicidal treatments, the Atlantis herbicide gave lowest plant height (99 cm) but was statistically better as compared with control (90.67 cm).

Spike length

There were significant differences (*P≤ 0.05*) among treatments used in the study with respect to spike length. The highest spike length (10.40 cm) of wheat plants was observed in plots treated with Axial herbicide followed by Topik (9.67 cm) and Puma Super (9.33 cm) which were also statistically at par with each other. The spike length observed in plots treated with Atlantis was 8.67 cm. The lowest spike length (7.6) was found in weedy check (Table 2).

Number of grains Spike^{-1}

The data show that the highest numbers of grains per spike (52.33) of wheat were found in Axial treated plots followed by Topik (48), Puma Super (44) and Atlantis (41.33). Topik was statistically (*P≤0.05*) at par with Axial, while Puma Super was statistically equal to Topik and Atlantis herbicides in producing number of grains per spike of wheat plant. The lowest number of grains was calculated in weedy check plots. This is attributed to lower number of weeds in herbicidal treatments which resulted in more absorption of nutrients from soil due to less competition (Table 2). Almost similar results were described by Kumar *et al*. (1986), who reported increase in number of grains per spike due to herbicides application. Similarly, Hussain *et al.* (2003) and Alvi *et al*. (2004) also reported that the increase in number of grains spike^{-1} may be attributed to better weed control and elimination of weed crop competition for nutrients, moisture and light and better utilization of available resources by the crop.

1000-grain weight

It is evident from the data that the highest 1000-grain weight of wheat (40.73 g) was found in Topik herbicide which was statistically (*P≤ 0.05*) at par with Axial treated plots (39.63 g) followed by Puma Super with 37.50 g 1000-grain weight. Among herbicides, Atlantis remained least effective in giving 1000-grain weight but it was statistically better than control (Table 2). In a field study, Alvi *et al*. (2004) and Hussain *et al. (*2003) reported that the increase in 1000-grain weight may be attributed to better weed control and elimination of weed crop competition for nutrients, moisture and light and better utilization of available resources by the crop.

Grain yield

All treatments significantly ($P \leq 0.05$) affected grain yield of wheat crop. The highest grain yield (3400 kg ha^{-1}) was recorded from plots treated with Axial herbicide which was 42% more as compared with control (2400 kg ha^{-1}) followed by Topik treated plots with grain yield of 3183 kg ha^{-1} (33% more over control). The grain yield recorded in Puma Super treated plots was 3067 kg ha^{-1} which was also 28% higher as compared with control. Topik and Puma super herbicides were statistically equal to each other. Among herbicidal treatments, the least effective herbicide with respect to grain yield was Atlantis which produced grain yield of 2683 kg ha^{-1} (12% more over control) (Table 2). These results are also in agreement with previous findings (Fenni *et al.*, 2001; Yasin *et al.*, 2010; Mueen-ud-Din *et al.*, 2011). They reported an increase in grain yield of wheat due to maximum values obtained for yield components by the application of herbicides in treated plots. Enhanced grain yield in herbicide treated plots might be due to availability of more nutrients, light, moisture and space resulting in better crop growth (Ahmad *et al.*, 1995; Malik *et al.*, 1998).

Economic and marginal analyses

The economic analysis (Table 3) showed that application of Axial herbicide gave highest net benefits (Rs. 78200 ha^{-1}. The marginal analysis (Table 4) showed that application of Topik herbicide gave maximum marginal rate of return (1056%) while spray of Axial herbicide resulted in 877% MRR. Other treatments were dominated due to higher costs involved.

The findings of our study lead to the conclusion that the spray of Axial 100 EC herbicide @ 825 mL ha^{-1} provided efficient control of grassy weeds in wheat crop and increased its grain yield significantly. Hence this herbicide can be used in wheat crop to control grassy weeds more efficiently and economically in rice-wheat cropping system.

Table 1: Effect of different herbicides on total weed density and total weed dry weight of grassy weeds in wheat.

Treatments	Total weed density (m^{-2})	Total weed dry weight (g m^{-2})
Axial 100 EC @ 825 mL ha^{-1}	5 c (-88)	2.17 c (-87)
Topik 15 WG @ 300 g ha^{-1}	7 bc (-83)	4.07 bc (-76)
Puma Super 75 EW @ 1250 mL ha^{-1}	8 bc (-80)	4.40 b (-74)
Atlantis 3.6% WG @ 400 g ha^{-1}	10 b (-76)	6.00 b (-65)
Weedy check (control)	41 a (-)	17.21 a (-)
LSD ($P \leq 0.05$)	4.060	2.224

Means sharing same letters in a column do not differ significantly at $P \leq 0.05$. Figures given in parenthesis indicate percent decrease over control.

Table 2: Effect of different herbicides on growth, yield and yield components of wheat.

Treatments	No. of Tillers (m^{-2})	Plant height (cm)	Spike length (cm)	No. of Grains $spike^{-1}$	1000- grain weight (g)	Grain yield (kg ha^{-1})
Axial 100 EC @ 825 mL ha^{-1}	240.7 a	107.0 a	10.40 a	52.33 a	39.63 a	3400 a (42)
Topik 15 WG @ 300 g ha^{-1}	228.3 b	104.7 a	9.667 b	48.00 ab	40.73 a	3183 b (33)
Puma Super 75 EW @ 1250 mL ha^{-1}	226.7 b	104.3 a	9.333 b	44.00 bc	37.50 b	3067 b (28)
Atlantis 3.6% WG @ 400 g ha^{-1}	222.7 b	99.00 b	8.667 c	41.33 c	33.00 c	2683 c (12)
Weedy check (control)	210.7 c	90.67 c	7.600 d	32.67 d	30.00 d	2400 d
LSD ($P \leq 0.05$)	10.12	4.053	0.5742	4.94	1.655	211.2

Means sharing same letters in common do not differ significantly at $P \leq 0.05$. Figures given in parenthesis indicate percent increase over control.

Table 3: Economic analysis of different herbicides for the control of grassy weeds in wheat crop

Treatments	Grain yield (kg ha^{-1})	Adjusted grain yield (kg ha^{-1})	Gross income (Rs. ha^{-1})	Variable weed control costs (Rs. ha^{-1})			Total cost that varied (Rs. ha^{-1})	Net benefits (Rs. ha^{-1})
				a. Cost of herbicides	b. Sprayer cost	c. Labour charges for herbicides application		
T_1	3400	3060.00	80325	1825	100	200	2125	78200
T_2	3183	2864.70	75198	1300	100	200	1600	73598
T_3	3067	2760.30	72458	1525	100	200	1825	70633
T_4	2683	2414.70	63386	2675	100	200	2975	60411
T_5	2400	2160.00	56700	-	-	-	-	56700

T_1: Axial 100 EC @ 825 mL ha^{-1}; T_2: Topik 15 WG @ 300 g ha^{-1}; T_3: Puma Super 75 EW @ 1250 mL ha^{-1}; T_4: Atlantis 3.6% WG @ 400 g ha^{-1}; T_5: Weedy check (control); Price of wheat grain @ Rs. 1050 40 kg^{-1}. As the crop was harvested by combine harvester, so there was no income of wheat straw.

Prevailing market prices of herbicides**:**

Axial 100 EC @ Rs. 1825; Topik 15 WG @ Rs. 1300; Puma Super 75 EW @ Rs. 1525; Atlantis 3.6% WG @ Rs. 2675.

Table 4: Marginal analysis of different herbicides for the control of grassy weeds in wheat crop

Treatments	Cost that varied (Rs. ha^{-1})	Net benefits (Rs. ha^{-1})	Marginal variable costs (Rs. ha^{-1})	Marginal net benefits (Rs. ha^{-1})	**MRR (%)
T_5	-	56700	-	-	-
T_2	1600	73598	1600	16898	1056
T_3	1825	70633	-	-	D***
T_1	2125	78200	525	4602	877
T_4	2975	60411	-	-	D

T_1: Axial 100 EC @ 825 mL ha^{-1}; T_2: Topik 15 WG @ 300 g ha^{-1}; T_3: Puma Super 75 EW @ 1250 mL ha^{-1}; T_4: Atlantis 3.6% WG @ 400 g ha^{-1}; T_5: Weedy check (control); Cost that vary is the cost that is incurred on variable inputs in the production of a particular commodity; **Marginal rate of return (MRR%)= Marginal net benefit/ Marginal variable cost × 100; ***D = dominated.

References

Ahmad S, Sarwar M, Tanveer A, Khaliq A, 1995. Efficacy of some weedicides in controlling *Phalaris minor* Retz. Proc. 4th All Pak. Weed Sci. Conf., Faisalabad. March, 26-27. pp. 89-94.

Ahmadi A, Alam JN, 2013. Efficiency of new herbicide of sulfosulfuron + metosulfuron in weed control of wheat. 2013. *Int. J. Agron. Plant Prod.,* **4**: 714-718.

Ali M, Sabir S, Din QM, Ali MA, 2004. Efficacy and economics of different herbicides against narrow leaved weeds in wheat. *Int. J. Agric. Biol*., **6**: 647-661.

Alvi SM, Chaudhry SU, Ali MA, 2004. Evaluation of some herbicides for the control of weeds in wheat crop. *Pak. J. Life Soc. Sci*., **2**: 24-27.

Anonymous, 1986. MSTATC. Microcomputer Statistical Programme. Michigan State University, Michigan, Lansing, USA.

Ashiq M, Muhammad N, Ahmed N, 2006. Comparative efficacy of different herbicides to control grassy weeds in wheat. *Pak. J. Weed Sci. Res*., **12**: 157-161.

Cavero J, Zaragoza C, Cirujeda A, Anzalone A, Faci JM, Blanco O, 2011. Selectivity and weed control efficacy of some herbicides applied to sprinkler irrigated rice (*Oryza sativa* L.). *Span. J. Agric. Res*., **9**: 597-605.

Chaudhry S, Hussain M, Ali MA, Iqbal J, 2008. Efficacy and economics of mixing of narrow and broad leaved herbicides for weed control in wheat. *J. Agric. Res.* **46**: 355-360.

Chaudhary S, Hussain M, Iqbal J, 2011. Chemical weed control in wheat under irrigated conditions. *J. Agric. Res*., **49**: 353-361.

Chivasa W, Chidza HC, Nyamudeza P, Mashingaidze AB, 1998. Agronomic practices, major crops and farmers perceptions of the importance of good stand establishment in Musikavanhu Cnmunal Area, Zimbabwe. *J. Appl. Sci. S. Afr*., **4**: 9-25.

CIMMYT, 1988. From agronomic data to farmer recommendations: An economics training manual. Completely revised edition. Mexico. pp. 31-33.

Fenni M, Shakir AN, Maillet J, 2001. Comparative efficacy of five herbicides on winter cereal weeds in semi-arid region of Algeria, in 2001 Proc. 53rd Int. Symposium on Crop Protection, Gent, Belgium. pp. 791-795.

Government of Pakistan. 2011-12. Economic Survey of Pakistan. Finance and Economic Affairs Division, Islamabad. pp. 21-22.

Grundy AC, Mead A, Bond W, Clark G, Burston S, 2011. The impact of herbicide management on long-term changes in the diversity and species composition of weed populations. *Weed Res*., **51**: 187-200.

Guarda G, Padovan S, Delogu G, 2004. Grain yield, nitrogen use efficiency and baking quality of old and modern Italian bread wheat cultivars grown at different nitrogen levels. *Eur. J. Agron*., **21**: 181-192.

Hussain N, Khan MB, Khan B, Tariq M, Hanif S, 2003. Spectrum of activity of different herbicides on wheat. *Int. J. Agric. Biol*., **5**: 166-168.

.Kumar A, Singh SJ, Mishra SS, 1986. Studies on chemical weed control in late sown wheat. *Indian J. Agron.,* **1**: 84-86.

Lopez-Granados F, 2011. Weed detection for site-specific weed management: mapping and real-time approaches. *Weed Res*., **51**: 1-11.

Malik RK, Yadav A, Singh S, Malik YP, 1998. Development of resistance to herbicides in *Phalaris minor* and maping of variations in weed flora. Proc. Int. Conf., Karnal, India. August 12-14. pp. 291-296.

Marwat KB, Saeed M, Hussain Z, Gul B, Rashid H, 2008. Study of various herbicides for weed control in wheat under irrigated conditions. *Pak. J. Weed. Sci. Res*., **14**: 1-8.

Mueen-ud-Din, Ali L, Ahmad SB, Ali M, 2011. Effect of post emergence herbicides on narrow leaved weeds in wheat crop. *J. Agric. Res*., **49**: 187-194.

Naseer-ud-Din GM, Shehzad1 MA, Nasrullah HM, 2011. Efficacy of various pre and post-emergence herbicides to control weeds in wheat. *Pak. J. Agric. Sci.,* **48**: 185-190.

Riaz T, Khan SN, Javaid A, 2009. Weed flora of Gladiolus fields in district Kasur, Pakistan. *J. Anim. Plant. Sci*., **19**: 144-148.

Rueda-Ayala VP, Rasmussen J, Gerhards R, Fournaise NE, 2011. The influence of post-emergence weed harrowing on selectivity, crop recovery and crop yield in different growth stages of winter wheat. *Weed Res*., **51**: 478-488.

Sanguankeo PP, Leon RG, 2011. Weed management practices determine plant and arthropod diversity and seed predation in vineyards. *Weed Res*., **51**: 404-412.

Shehzad MA, Maqsood M, Anwar-ul-Haq M, Niaz A, 2012. Efficacy of various herbicides against weeds in wheat (*Triticum aestivum* L.). *Afr. J. Biotechnol*., **11**: 791-799.

Sherawat SM, Inayat M, Ahmad M, 2005. Bio-efficacy of different graminicides and their effect on the growth and yield of wheat crop. *Int. J. Agric. Biol*., **7**: 438-440.

Steel RGD, Torrie JH, Dickey D, 1997. Principles and procedures of statistics: A biometrical approach 3rd ed. McGraw Hill Book Co. Inc. New York, USA. pp. 172-177.

Tickes B, 2003. Canarygrass (*Phalaris* minor) control in wheat. Project report, Univ. of Arizona Coop. Ext. 1-2.

Tiwari RK, Khan IM, Singh N, Jha A, 2011. Chemical weed control in wheat through on farm demonstrations in Rewa district of Madhya Pradesh. *Indian J. Weed Sci.,* **43**: 215-216.

Yasin M, Tanveer A, Iqbal Z, Ali A, 2010. Effect of herbicides on narrow leaved weeds and yield of wheat (*Triticum aestivum* L.). *World Acad. Sci., Eng. Technol*., **68**: 1280-1282.

Young FL, Ogg AG, 1994. Tillage and weed management effect on winter wheat yield in an integrated pest management system. *Agron. J*., **86**: 147-54.