*Indian Journal of Agronomy* **58** (4): 525–528 (December 2013)

**Research Paper**

# Weed management in irrigated wheat (*Triticum aestivum*) through tank mix herbicides in Malwa Plateau of Central India

TEEKAM SINGH[1]

*Krishi Vigyan Kendra, Banswara, Maharana Pratap University of Agriculture & Technology, Udaipur, Rajasthan 313 001*

Received : December 2012; Revised accepted : November 2013

## ABSTRACT

An on-farm trial was conducted during the winter (*rabi*) seasons of 2010–11 and 2011–12 at five farmers' field, to validate, refine and popularize the technology developed at Maharana Pratap University of Agriculture and Technology, Udaipur, for managing weeds in wheat [*Triticum aestivum* (L.) emend. Fiori & Paol.] crop. Effectiveness of isoproturon @ 1.0 kg ai/ha and tank-mix application of metsulfuron-methyl with clodinafop @ 60 g ai/ha and sulfosulfuron @ 25 g ai/ha over farmer's practice (2,4 D @ 0.75 kg ai/ha) was studied on weed growth and profitability of wheat. Tank-mix application of metsulfuron-methyl @ 4 g ai/ha with clodinafop and sulfosulfuron at 35 days after sowing significantly reduced the weed density and resulted in respectively 26.2% and 18.9% higher grain yield, net returns (₹12,997 and ₹9,436), benefit: cost ratio (0.54 and 0.39) and energy output (27,077 MJ and 20,775 MJ) higher over farmer's practice.

***Key words :*** Crop protection, Herbicides, Weed management, Wheat

Irrigated wheat is the second most important cereal crop after rice and widely cultivated in the World. In Rajasthan, it is cultivated over an area of 2.39 million ha with a total production of 7.5 million tonnes with an average yield of 3.1 t/ha, which is higher than that of national average productivity (2.9 tonnes/ha), DAC (2012), but still below from its potential, i.e. 11.2 tonnes/ha Singh *et al.* (2010). Productivity of wheat is very low due to stiff competition from weeds, high seed rate, low seed replacement rate, multiple nutrient deficiencies, insect-pests and incidence of diseases. Infestation by different species of weeds in wheat is one of the major problems faced by the farmers. The severe weed competition has resulted from the change in morphological characteristics of wheat varieties and shift in sowing paradigm over a period of four decades. Moreover, initial high soil moisture and free space leads to severe infestation of grassy and broad leaf weeds. Globally yield reduction in wheat due to weeds is 13.1% (Oerke *et al.,* 1994) or even more. (Anjuman and Bajwa, 2010) reported that selected wheat varieties incurred 60–65% biomass loss due to weed infestation. The effect was evident on tillering capacity, which was decreased by 41.6%. Among different weed species, the infestation by little seed canary grass (*Phalaris minor*) in wheat is rampant and caused depletion of 42.2 kg N, 6.5 kg P and 71.6 kg K/ha from wheat crop field (Walia and Gill, 1985).

Manual weeding is a common practice in the region but it is less efficient, labour intensive, costly and often not done on right time. Manual weeding is generally done when weed infestation is quite visible in the field and at this stage weeds have already done the damage to the crop. Use of suitable and conventional herbicide like 2, 4 D provides more efficient and cost effective weed control in wheat except grassy weeds. To manage the dynamics of weed flora, there is a need to evaluate a range of herbicides alone and as tank mixture to have broad spectrum weed control (Dixit and Singh, 2008). Hence, present investigation was conducted at selected farmer's fields to validate, assess and refine the sustainability and energy use efficiency of improved technology of weed management over traditional farmer's practice.

## MATERIALS AND METHODS

Initially Participatory Rural Appraisal (PRA) was done to identify causes of low yield of wheat and high cost of production. It was found that heavy infestation by weeds particularly *Chenopodium album, Melilotus indica, Avena fatua* and *Phalaris minor,* which pose a serious constraint

**Corresponding authors Email:** tiku_agron@yahoo.co.in
[1]Senior Scientist (Agronomy), Regional Rainfed Lowland Rice Research Station, CRRI, Gerua, Hajo, Kamrup, Asom 781 102

in Malwa region of Central India. Therefore, based on PRA two villages, namely Narelapara and Nichala Ghantala, of Banswara district of southern Rajasthan were selected for On farm trials at farmer's fields during the winter (*rabi*) season of 2010–11 and 2011–12. These locations are situated at 220 m above mean sea-level and characterized on the basis of long term by semi-arid and subtropical type of climate. The average annual rainfall is 850 mm but crop received only 12.3 and 15 mm during entire growth period, as most of which occurs during June–September. All the farmers selected for on farm trials were small farmers. A composite soil sample of all selected sites was analyzed. The soil of the sites was light black to red loam in texture, with pH 7.82 and low in available N (223.5 kg/ha), medium in P (15.6 kg/ha) and K (248 kg/ha). The experiment comprised 4 treatments viz. farmer's practice (2, 4-D ethyl ester @ 0.75 kg ai/ha), isoproturon @ 1.0 kg/ha, tank mix application of clodinafop @ 60 g ai/ha + metsulfuron-methyl @ 4 g ai/ha and tank mix of sulfosulfuron @ 25 g ai/ha + metsulfuron-methyl @ 4 g ai/ha, were laid out in randomized block design at each farmer's field and each treatment provided 0.1 ha area. Wheat 'Raj 4037' was sown by using seed rate of 150 kg/ha during the second fortnight of November in all the years. The crop was fertilized with recommended doses of fertilizers viz. 100, 50, 50 kg N,$P_2O_5$ and $K_2O$/ha. Whole quantity of P and K and one-third of N were applied basal and the remaining N was applied in 2 equal splits–at first and second irrigation. Herbicides were applied with manually operated knapsack sprayer delivering a spray volume of 500 l/ha through flat-fan nozzle 35 days after sowing of wheat. Data on weed density were recorded 90 days after sowing in each plot in quadrate of $1 \times 1$ m$^2$. Crop was manually harvested in the last week of March in all the years. The grain yield data were recorded and adjusted to 14% of the moisture content. For estimation of energy inputs and outputs, energy equivalents were worked out as suggested by Devasenapathy *et al*. (2009) and Salami and Ahmadi (2010). The sustainable yield index was computed as suggested by Reddy and Babu (2003).

All data were analyzed statistically. Economics were computed using the prevailing market price of inputs such as 2,4 D ester @ ₹340/l, Isoproturon @₹550/kg, Clodinafop @ ₹ 650/60 g, Metsulfuron-methyl @ ₹ 350/2 g, sulfosufuron @ ₹ 450/12.5g, labour wages @ 150/man day and out puts viz. wheat grain @ ₹11.80/kg and straw 1/kg.

## RESULTS AND DISCUSSION

### *Effect on weed flora*

The major weed flora observed in the experiment sites comprised broad-leaf weeds, viz. *Chenopodium album, Melilotus indica, Anagallis arvensis, Convolvulus arvensis*, and grassy weeds, viz. *Phalaris minor, Poa annua, Avena fatua*. Tank mix application of both the herbicide combinations and isoproturon alone significantly reduced population of weeds compared to the farmer's practice (Table 1). It was mainly because of effective weed control of both broad-leaves and grassy weeds during early stages of crop growth, whereas in farmer's practice 2, 4-D alone was used when all weeds were quite healthier and visible at 50–60 days after sowing. The lowest weed density was observed with tank mix application of clodinafop and metsulfuron-methyl followed by sulfosulfuron + metsulfuron-methyl and isoproturon respectively. Metsulfuron-methyl and its tank mix with isoproturon showed excellent control of weeds of wheat Pandey and Verma (2004). Similarly, Singh (2012) and Bharat and Kachroo (2007) also observed the same trend with tank mix herbicide applications.

### *Wheat growth and yield*

Lesser crop-weed competition due to effective weed control with tank mix herbicide treatments resulted in significant improvement in growth, yield components and grain yield of wheat as compared to farmer's practice (Table 1). Maximum plant height was achieved from application of isoproturon alone but remained at par with tank mix application of metsulfuron-methyl with clodinafop and sulfosulfuron, while the minimum plant height was achieved with farmer's practice. The tank mix application of metsulfuron-methyl with clodinafop and sulfosulfuron being at par with the application of isoproturon alone produced significantly higher spike length, number of spikes/m row length and seeds/spike of wheat over farmer's practice. The maximum values of yield attributes, viz. spikes/m, spike length, seeds/spike and 1,000-seed weight (42.6 g) were observed with tank mix application of clodinafop+metsulfuron-methyl and found significant over farmer's practice. Reduction in both grassy and broad-leaf weeds was accredited to the reason with tank mix application of clodinafop+ Metsulfuron-methyl as clodinafop is a strong inhibitor of acetyl CoA carboxylase (ACCase) and the activity of metsulfuron-methyl selectively to certain broad-leaf weeds to which clodinafop is generally ineffective. Clodinafop actually blocks an enzyme called ACCase which helps formation of lipids in the roots of grass plants. Without lipids, susceptible grassy weeds die (Bharat and kachroo, 2007). Thus, clodinafop and metsulfuron-methyl having an enhanced compatibility between the 2 active ingredients and which shows superior and effective weed control for maximizing yield of wheat. Bharat and Kachroo (2007) and Ashrafi *et al.* (2009) also observed similar results with tank mix herbicides like fenoxaprop + metribuzin, sulfosulfuron + 2,4-D, clodinafop + metsulfuron - methyl, isoproturon + 2, 4-D, and clodinafop + 2, 4-D in wheat. The tank mix application of metsulfuron - methyl with clodinafop and sulfosulfuron produced the higher values of yield attributes, which resulted significantly higher grain yield of wheat, i.e. 26.2% and 18.9% higher over farmer's practice and 17.9% and 11.0% higher over isoprpturon alone respectively. Bharat and Kachroo (2009) also recorded significantly higher grain yield of wheat with tank mix herbicides over their alone application. Grain yield of wheat had a significant negative correlation (-0.46*) with weed density while a positive linear correlation with number of spike/m row length and dry-matter accumulation of wheat (0.73** and 0.81**) (Table 3). Further, association between weeds, yield attributes and grain yield was also confirmed through correlation and regression studies by Singh (2012) and Ravisankar *et al.* (2008).

### *Economics*

Owing to higher crop yield and timely management of weeds with tank mix herbicides resulted higher net returns and benefit: cost ratio over farmer's practice as well as application of isoproturon alone (Table 2). The maximum net return (₹45,098) and benefit: cost ratio was recorded with tank mix application of clodinafop and metsulfuron-methyl, i.e. ₹12,997 and 0.54, being higher over farmer's practice. This was mainly owing to significantly lower crop yield and poor weed control in farmer's practice. Singh (2012) and Prakash *et al.* (2008) also reported similar findings with the tank-mix application of herbicides.

### *Energetic and sustainability*

Energy output has direct relation with total biomass production. The maximum energy output and sustainability yield index (SYI) was recorded with tank-mix application of metsulfuron-methyl and clodinafop (Table 2) followed by sulfosulfuron+metsulfuron-mthyl,

**Table 1.** Effect of different weed control treatments on weed density, growth, yield attributes and yield of wheat (mean data of 2 years)

| Treatment | Weed density (No./m$^2$) | Plant height (cm) | Spikes/m row length | Spike length (cm) | Seeds/ spike | 1,000-seed weight (g) | Biological yield (t/ha) | Straw yield (t/ha) | Grain yield (t/ha) | Harvest index |
|---|---|---|---|---|---|---|---|---|---|---|
| Isoproturon (1.0 kg/ha) | 14.2 | 85.37 | 122.80 | 8.43 | 41.55 | 42.80 | 12.03 | 7.35 | 4.37 | 0.37 |
| Clodinafop + Metsulfuron (60+4 g/ha) | 11.70 | 83.83 | 129.30 | 8.70 | 42.80 | 42.60 | 12.69 | 7.61 | 5.15 | 0.40 |
| Sulfosulfuron + Metsulfuron (25+4 g/ha) | 12.20 | 84.00 | 126.80 | 8.48 | 42.40 | 42.00 | 12.36 | 7.49 | 4.85 | 0.39 |
| Farmer's Practice (2, 4-D @ 0.75 kg/ha) | 17.90 | 82.06 | 117.10 | 8.08 | 38.10 | 41.70 | 11.37 | 6.89 | 4.08 | 0.36 |
| SEm± | 1.36 | 1.52 | 3.76 | 0.20 | 2.08 | 1.51 | 0.40 | 0.28 | 0.20 | 0.01 |
| CD (P=0.05) | 2.42 | 2.71 | 6.71 | 0.36 | 4.21 | 2.14 | 0.71 | 0.50 | 0.47 | 0.02 |

**Table 2.** Effect of different weed control treatments on economics, sustainability and energetics of wheat (mean data of 2 years)

| Treatment | SYI | Cost of cultivation (×10$^3$ ₹/ha) | Net returns (×10$^3$ ₹/ha) | Benefit: cost ratio | Energy input (×10$^3$ MJ/ha) | Energy output (×10$^3$ MJ/ha) | Energy-use efficiency | Net energy return (×10$^3$ MJ/ha) | Energy productivity (kg/MJ) |
|---|---|---|---|---|---|---|---|---|---|
| Isoproturon (1.0 kg/ha) | 0.79 | 23.1 | 35.8 | 2.55 | 15.6 | 180.1 | 11.52 | 164.5 | 0.28 |
| Clodinafop + Metsulfuron (60+4 g/ha) | 0.80 | 23.3 | 45.1 | 2.94 | 15.8 | 195.6 | 12.40 | 179.9 | 0.33 |
| Sulfosulfuron + Metsulfuron (25 +4 g/ha) | 0.79 | 23.2 | 41.5 | 2.79 | 15.8 | 189.3 | 12.00 | 173.6 | 0.31 |
| Farmer's Practice (2,4 D @ 0.75 kg/ha) | 0.73 | 22.9 | 32.1 | 2.40 | 15.6 | 168.6 | 10.80 | 153.0 | 0.26 |

**Table 3.** Correlation between grain yield, weed density and yield attributes of wheat (mean data of 2 years)

| Y | X | Correlation coefficient ($R^2$) (n=20) |
|---|---|---|
| Grain yield (kg/ha) | Weed population/m$^2$ | –0.46* |
| Grain yield (kg/ha) | Spikes/m row length | 0.73** |
| Grain yield (kg/ha) | Spike length (cm) | 0.381 |
| Grain yield (kg/ha) | Grains/spike | 0.531* |
| Grain yield (kg/ha) | Dry matter accumulation (g/m$^2$) | 0.81** |

while farmer's practice had lowest energy output and SYI (Table 2). Similarly, energy-use efficiency and energy productivity were also higher with tank-mix application of metsulfuron-methyl with clodinafop and sulfosulfuron compared to farmer's practice. Singh (2012) and Kumar *et al*. (2010) also reported higher energy indices and SYI under improved weed-management practices.

Based on 2 year data it may be concluded that weeds associated with irrigated wheat of southern Rajasthan and adjoining Guajrat and Madhya Pradesh can be effectively managed through tank-mix application of metsulfuron-methyl (4 g/ha) with clodinafop (60 g/ha) and sulfosulfuron (25 g/ha) 35 days after sowing. The effect of tank-mix of metsulfuron-methyl and clodinafop was consistent and resulted in higher grain yield and economic return than that of farmers' practice. With this technology resources can be utilized efficiently by the farmers.

## REFERENCES

Anjuman, T. and Bajwa, R. 2010. Competition losses caused by *Rumex dentatus* L. and *Chenopodium album* L. in wheat (*Triticum aestivum* L.). *The Philippine Agricultural Scientist* **93**(3): September.

Ashrafi, Z.Y., Mashnadi, H.R., Sadaghi, S. and Blackshaw, R.E. 2009. Study effects of planting methods and tank mixed herbicides on weed controlling and wheat yield. *Journal of Agricultural Sciences* **1**(1): 101–11.

Bharat, R. and Kachroo, D. 2007. Effect of different herbicides on mixed weed flora, yield and economics of wheat *(Triticum aestivum)* under irrigated conditions of Jammu. *Indian Journal of Agricultural Sciences* **77**(6): 383-86.

DAC. 2012. Directorate of Economics and Statistics, Department of Agriculture and Cooperation. Government of India, New Delhi.

Devasenapathy, P., Senthilkumar, G. and Shanmugam, P.M. 2009. Energy management in crop production. *Indian Journal of Agronomy* **54**(1): 80–90.

Dixit, A. and Singh, V.P. 2008. Efficacy of a ready mix application of carfentrazone plus isoproturon (affinity) to control weed in wheat (*Triticum aestivum*). *Indian Journal of Agricultural Sciences* 7**8**(6): 495–97.

Kumar, N., Mina, B.L., Singh, K.P., Chandra, S., Kumar, M. and Srivastava, A.K. 2010. Weed control for yield and profit maximization in wheat (*Triticum aestivum*) in Indian Himalayas. *Indian Journal of Agronomy* **55**(2): 119–22.

Oerke, E.C., Dehne, H.W., Schonbeck, F. and Weber, A. 1994. *Crop Production and Crop Protection: Estimated Losses in Major Food and Cash Crops*. Elsevier, Amsterdam.

Pandey, J. and Verma, A.K. 2004. Effect of isoproturon tank mix with metsulfuron and 2, 4-D on weeds and yield of wheat (*Triticum aestivum). Indian Journal of Agronomy* **49**(2): 114–16.

Prakash, V., Gopinath, K.A. and Srivastava, A.K. 2008. Butter cup managed by herbicides in irrigated wheat of Uttarakhand Valley. *Indian Farming* **58**(7): 15–6.

Ravisankar, N., Chandrasekaran, B., Raja, R., Din, M. and Ghosal C.S. 2008. Influence of integrated weed management practices on productivity and profitability of wet seeded rice (*Oryza sativa*). *Indian Journal of Agronomy* **53**(1): 57–61.

Reddy B.N. and Babu S.N.S. 2003. Sustainability of sunflower based crop sequences in rainfed Alfisols. *HELIA* **26**(39): 117–24.

Salami, P. and Ahmadi, H. 2010. Energy inputs and outputs in a chickpea production system in Kurdistan, Iran. *African Crop Science Journal* **18**(2): 51–57.

Singh, R.J. 2012. Weed management in irrigated wheat *(Triticum aestivum)* with special reference to buttercup weed (*Ranunculus* spp.) in north-west Himalayas. *Indian Journal of Agricultural Sciences* **82**(8): 706–10.

Singh, G., Singh, O.P., Singh, S. and Prasad, K. 2010. Weed management in late sown wheat (*Triticum aestivum*) after rice (*Oryza sativa*) in rice–wheat system in rainfed lowland. *Indian Journal of Agronomy* **55**(2): 83–88.

Walia, U.S. and Gill, H.S. 1985. Influence of nitrogen and substituted urea, herbicide on the uptake of N, P and K by *Phalaris minor* Retz. and wheat. *Indian Journal of Weed Science* **17**: 12–17.