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Research Communication

Chemical weed management in wheat (*Triticum aestivum*) under semi-arid conditions of Kandahar, Afghanistan

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ABSTRACT

A field experiment was conducted during winter season of 2014–15 at the Research Farm, Tarnak, Afghanistan National Agricultural Science and Technology University (ANASTU), Kandahar, Afghanistan to evaluate the chemical weed control effects on weeds and wheat [*Triticum aestivum* (L.) emend Fiori & Paol.]. The treatments comprised of isoproturon @ 0.75 and 1.00 kg/ha at 35 DAS, sulfosulfuron @ 20 and 25 g/ha at 35 DAS, isoproturon + 2,4-D @ (0.75 + 0.5) kg/ha at 35 DAS (tank-mix treatment), weed-free check and weedy check, laid out in a randomized complete block design with three replications. Sulfosulfuron 25 g/ha at 35 DAS resulted in significant reduction in weed growth (population and dry weight) and caused a considerable increase in weed control efficiency (WCE) and weed control index (WCI) in wheat. This treatment led to a significant improvement in yield attributes and yield of wheat. It also caused a considerable reduction in wheat yield losses due to weeds, and was superior to all other herbicide treatments. Sulfosulfuron 20 g/ha at 35 DAS was the next best treatment. Sulfosulfuron 25 g/ha applied at 35 DAS gave significantly higher gross and net returns, but comparable with sulfosulfuron 20 g/ha. Therefore, sulfosulfuron 25 g/ha applied at 35 DAS may be recommended for effective broad-spectrum weed control in wheat in Kandahar, Afghanistan. However, this report highlights the results of a location-specific study, conducted for one year, which needs to be replicated over times for more refinement/ validation and sound recommendation.

***Key words* :** Isoproturon, Sulfosulfuron, Weeds, Wheat, 2, 4-D,

Wheat is a staple food crop in Afghanistan, accounting for about 83% of total cereal consumption. Among various biotic stresses, weeds are considered as one of the most serious problems. The yield losses due to weeds vary between 30-50% based on weed infestation (Pandey and Singh, 1997). In order to achieve higher wheat yields, it is important to control weeds (Khan *et al*., 2003). Among various weed management options, chemical weed management is economic and easy to adopt compared to other methods. Ahmad *et al*. (1993) have observed that herbicides application and hand weeding significantly decreased dry weight of weeds compared to non-treated plots. But, the response of newer low-dose high potency herbicides like sulfosulfuron and tank-mix application for broad-spectrum weed control have not been studied/standardized for wheat crop in Afghanistan. Therefore, this study was planned and undertaken to find out appropriate herbicide and its dose and time of application for effective weed management in wheat in Afghanistan.

The field experiment was conducted during winter season of 2014–15 at the Research Farm, Tarnak, Afghanistan National Agricultural Science and Technology University (ANASTU), Kandahar. The soil was sandy clay loam with *p*H 8.3, electrical conductivity 0.21 dS/m, organic carbon 0.8%, available N 0.06% w/w, available P 12.3 mg/kg, and available K 108.9 mg/kg. There were seven treatments [i.e. isoproturon @ 0.75 and 1.00 kg/ha at 35 days after sowing (DAS), sulfosulfuron @ 20 and 25 g/ha at 35 DAS, isoproturon + 2,4-D @ 0.75 + 0.5 kg/ha at 35 DAS (tank-mix treatment), weed-free check (through manual weeding) and weedy check, laid out in a randomized complete block design with three replications. Wheat cultivar 'PBW 154' was sown on 28 December, 2014 using 100 kg

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seed/ha. All the herbicides were applied by a knapsack sprayer fitted with a flat fan nozzle at 35 DAS of wheat with different concentration as per the treatments. The volume rate used was 400 litres of water/ha. The recommended dose of N: P_2O_5: K_2O: 120: 60: 30 kg/ha was applied to wheat crop. The full dose of P and K and one-third dose of N were applied to all the plots across replications as basal at final land preparation/harrowing before seed drilling. Rest of N was applied in equal splits at crown root initiation (CRI) and panicle initiation stages of wheat as top dressing. Species-wise weeds across treatments were collected at 45 DAS and harvest in all the plots using a quadrat of 0.5 m × 0.5 m. Changes in weed flora due to treatments were noted and weed populations were recorded from this area and expressed in no./m^2. Then, weeds were categorized into narrow-leaved, broad-leaved and total (narrow-leaved + broad-leaved) weeds. They were sun-dried for 2 days and kept in an oven at 70±5^{0}C for 48 hrs for dry weight estimation. Dry weight was expressed as g/m^2. Weed control efficiency (WCE) based on weed populations, weed control index (WCI) based on weed dry weights, and weed index (WI; per cent yield loss) were determined as per Das (2008). The economic analysis in terms of gross and net returns, and benefit: cost ratio (returns per Afghani invested) was worked out on the basis of existing rates of inputs and outputs.

The major broad-leaved weeds of the experimental wheat field comprised of *Launaea asplenifolia* (Willd.) Hook. f. (Launaea), *Chenopodium album* L. (Common lambsquarters), *Convolvulus arvensis* L. (Field bind weed), *Fumaria indica* Pugsley (Fumitory), *Alhagi maurorum* L. (Camel thorn), *Polygonum aviculare* L. (Prostrate knotweed), *Carthamus oxyacantha* Bieb. (Wild safflower) and *Melilotus indica* (L.) All. (Yellow sweetclover). Major narrow-leaved weeds were *Avena fatua* L. (Wild oat), *Bromus tectorum* L. (Downybrome), *Cynodon dactylon* (L.) Pers. (Bermuda grass), *Lolium temulentum* L. (Darnel), *Phalaris minor* Retz. (Littleseed canarygrass), *Polypogon monspeliensis* (L.) Desf. (Foxtailgrass), *Setaria viridis* (L.) Beauv. (Green foxtail).

It was observed that grass weeds were pre-dominant than broad-leaved weeds in population and dry weight. The application of sulfosulfuron 25 g/ha resulted in significant reduction in the population of total weeds at 45 DAS and at harvest (Table 1) compared to weedy check. It increased weed controlled efficiency (WCE) by 95.8% and weed control index (WCI) by 93.7% at harvest (Table 1) over weedy check. It also resulted in significant reduction in dry weight of total weeds by 95.1% at 45 DAS and 93.7% at harvest (Table 1) compared to weedy check. Reasons could be that sulfosulfuron is an effective low-dose new herbicide, having broad-spectrum activity against weeds. Besides, the field was dominated by grassy weeds, and sulfosulfuron was more effective against grassy weeds, namely *Avena fatua, Phalaris minor* and so on (Das, 2008). Singh *et al*. (2013) reported similar results. Sulfosulfuron 20 g/ha and isoproturon + 2,4-D (0.75 + 0.5) kg/ha closely followed the sulfosulfuron 25 g/ha in this regard. Nath *et al*. (2015) reported that the application of pendimethalin 1.0 kg/ha as pre-emergence, followed by sulfosulfuron 25 g/ha as post-emergence led to higher weed control efficiency and weed control index in wheat. Shyam *et al*. (2014) observed that sulfosulfuron 33.3 g/ha resulted in significantly lower weed density and biomass and higher weed control efficiency, which was found on par with hand weeding at 30 DAS, but superior to isoproturon and 2,4-D sodium salt.

The application of sulfosulfuron 25 g/ha, being comparable with sulfosulfuron 20 g/ha recorded higher values of all yield attributes, viz. tillers and spikes/m^2, spikelets/spike and grains/spike (Table 1). The collective effects of yield attributes led to higher grain yield of wheat by 24.3% over weedy check (Table 1). Straw and biological yields were increased by 23.1% and 17.8% in this treatment over weedy check. The results are in conformity with Ahmadi and Alam (2013). Das and Kulshrestha (2002) obtained higher wheat grain yields due to sulfosulfuron 25 g/ha without any phototoxic effects on wheat for two years. Grain yield obtained due to sulfosulfuron 25 and 20 g/ha was even higher than that in weed-free check. The application of sulfosulfuron 25 and 20 g/ha increased wheat yield by 8.8% and 3.7% respectively over weed-free check. The negative weed index (WI) reflected their superiority over weed-free check. Indeed, sulfosulfuron 25 g/ha provided almost weed-free situations. Fewer numbers of weeds, which were present in this treatment, could hardly compete with vigorously-growing wheat plants. Due to greater suppression of weeds by sulfosulfuron 25 g/ha, the negative effects of weeds on growth parameters, yield attributes and yields were greatly reduced in wheat. Sulfosulfuron (~sulfonylureas) inhibits acetolactate synthase/acetohydroxyacid synthase (ALS/AHAS) enzyme and is effective against broad-spectrum of weeds, but with more activity against grassy weeds. Probably, higher effects of this herbicide against dominant grassy weeds in this study played a role. Besides, another chemical surfactant had been inherently added with sulfosulfuron, which prevented phytotoxicity and growth inhibition in wheat, which, otherwise, used to be observed upon sulfosulfuron applications. This sulfosulfuron was rather promotive to wheat growth. In weed-free check, hand weeding done at later stages might inflict slight damage to wheat crop. Beside, the post-emergence herbicide like sulfosulfuron may pose slight repellent actions against pests and dis-

Table 1. Yield attributes, weed population, dry weight, weed control efficiency (WCE), weed control index (WCI) and wheat grain, straw and biological yields, harvest index, yield losses and economics across the weed control treatments

Treatment	Tillers/ m^2	Spikes/ m^2	Spikelets/ spike	Grains/ spike	Total weed population (No./m^2)		Total dry weight of weeds (g/m^2)		WCE (%)	WCI (%)	Grain yield (t/ha)	Straw yield (t/ha)	Harvest index (%)	Wheat yield losses (WI) (%)	Net returns ($\times10^3$ AFN*/ha)	Net benefit: cost
					45 DAS	At harvest	45 DAS	At harvest								
Isoproturon 0.75 kg/ha	307	255.0	17.0	32.7	12.5† ‡ (163.0)	9.5† ‡ (113.3)	5.8† ‡ (33.7)	7.4† ‡ (55.7)	52.2	45.0	3.7	5.5	40.0	10.8	110.7	2.0
Isoproturon 1.00 kg/ha	312	271.7	17.8	38.9	8.3 (70.0)	8.6 (82.7)	5.2 (26.7)	7.3 (53.0)	65.2	47.7	3.9	5.8	40.9	7.0	119.1	2.1
Sulfosulfuron 20 g/ha	354	293.3	18.3	38.9	3.8 (14.3)	3.6 (13.0)	2.0 (3.9)	3.6 (13.7)	94.5	86.5	4.3	6.1	41.9	-3.7	134.5	2.4
Sulfosulfuron 25 g/ha	360	296.7	18.7	39.1	3.2 (11.3)	3.0 (10.0)	1.7 (3.0)	2.6 (6.3)	95.8	93.7	4.6	6.4	43.0	-8.8	144.3	2.6
Isoproturon + 2,4-D (0.75 +0.5) kg/ha	333	278.3	17.7	35.8	7.8 (61.0)	7.8 (64.3)	3.6 (13.1)	6.5 (42.0)	72.9	58.5	4.0	5.4	40.3	3.6	118.1	2.1
Weed-free check	352	291.0	18.9	38.2	0.7 (0.0)	0.7 (0.0)	0.7 (0.0)	0.7 (0.0)	100.0	100.0	4.2	6.1	40.5	0.0	124.3	1.9
Weedy check	300	255.0	17.0	35.1	13.8 (193.7)	14.5 (237.3)	7.8 (61.1)	9.7 (101.3)	0.0	0.0	3.7	5.2	41.4	12.4	107.6	1.9
SEm±	5.2	13.0	0.5	2.4	0.82 (21.1)	2.2 (58.0)	0.6 (5.8)	1.0 (16.8)	7.8	7.2	0.2	0.2	2.1	4.5	5.59	0.10
CD (P=0.05)	16.1	40.0	1.5	NS	2.5 (65.0)	6.8 (178.6)	1.8 (17.7)	2.9 (51.6)	24.9	23.1	0.6	0.7	NS	13.8	17.2	0.3

†Square-root [$\sqrt{x+0.5}$] transformed data, and ‡original data of weed populations and dry weights; *1AFN (Afghani)=0.0147929 USD (i.e. 1 USD = 67.6 AFN)

eases (not studied) at later stages of wheat. Das *et al.* (2010) reported the plant-parasitic nematodes control ability of atrazine in maize crop. Tadesse *et al.* (2010) observed lower infestations of shoot fly (*Atherigona soccata* Rondani) and spotted stem borer (*Chilo partellus* Swinhoe) in atrazine-treated plots than in weed-free plots. In contrast, Shyam *et al.* (2014) reported that weed-free treatment recorded maximum nutrient removal by wheat crop and gave 129.6% higher wheat yield over weedy check, followed by sulfosulfuron 33.3 g/ha).

Weed control/herbicides treatments increased the cost of cultivation slightly over that incurred due to weedy check treatment. Yet, they resulted in higher net returns and net benefit: cost ratio than in weedy check (Table 1). Maximum net returns (144300 AF/ha) and net benefit: cost ratio (2.6) were recorded due to sulfosulfuron 25 g/ha; the minimum net returns (107600 AF/ha) and benefit: cost ratio (1.9) was recorded in weedy check. The reasons for superiority of the sulfosulfuron 25 g/ha application could be better weed control, higher growth and yield attributes of wheat, leading to higher grain and biomass yield. Saquib *et al*. (2012) found that sulfosulfuron 25 g/ha gave significantly higher grain yield (3.71 t/ha) and straw yield (4.79 t/ha). Higher value of benefit: cost ratio (1.91) was also obtained with the application of sulfosulfuron 25 g/ha. Similarly, Shyam *et al.* (2014) observed that the maximum net returns (₹31,475/ha) and benefit: cost ratio (1.8) in wheat cultivation was obtained through sulfosulfuron 33.3 g/ha, which was on par with weed-free check, and the treatment that received weeding at 30 DAS. In contrast, Bharat *et al*. (2012) observed the highest benefit: cost ratio (1.97) with isoproturon + 2,4-D than in sulfosufuron 25 g/ha + 2,4-D 500 g/ha.

Maintaining weed-free situation for whole cropping season using manual labourers is costlier than herbicides and not profitable/economic and time consuming. Therefore, sulfosulfuron 25 g/ha applied at 35 DAS may be recommended for effective broad-spectrum weed control in wheat in Kandahar, Afghanistan. However, integration of herbicides with cultural/ecological options such as furrow-irrigated raised bed planting, zero-tillage with crop/plant residue and adjusting time, method and rate of sowing and spacing may be studied in future for longer, better and efficient weed management in wheat in Kandahar, Afghanistan.

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