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Effect of herbicides in weed management of wheat-chickpea intercropping system

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Abstract
The review paper is based on the effect of various herbicides in weed management of wheat (*Triticum aestivum L.*)- Chickpea (*Cicer arietinum L.*) intercropping system. Weeds are considered most harmful to the crops. They interfere with crops during the different growth stages and reduce the growth and yield of the crop drastically. Therefore, different weed management practices have been taken to decrease the crop-weed competition, especially by using herbicidal treatments. So in reference to the weeds found in the wheat-chickpea intercropping and their control, various herbicidal treatments are used to check the weed competition with crops. The chemical weed control method is the most effective and time saving. The herbicides should be selected properly on the basis of selectivity, so they do not harm the main crop. Pre-emergence like Pendimethalin are translocated herbicide, they are applied in the soil and inhibit the cell division in the weed seeds. Post-emergence herbicides like Isoproturon, clodinafop-propargyl, pinoxaden etc are contact herbicide, they enter through aerial parts like leaves and affect the photosynthesis (photosystem-I, II). All these herbicides were proven to be efficient in reducing weed density, dry matter accumulation of weeds and increased the yield and net returns of main crop grown in the field.

Keywords: Herbicide, weed management, efficiency, competition, yield losses

1. Introduction
Wheat (*Triticum aestivum* L.) is one of the most important cereal crop grown in the world. Popularly it is also called as the 'king of the cereals'. Chickpea (*Cicer arietinum* L.) is the third most important pulse crop, which plays an immense role in economy of agriculture globally (FAO, 2003) [9]. The protein content present in wheat is 11-12% while in chickpea, it is about 21%. Among the cereals, Wheat ranks first in the world both in terms of area and production and in India it ranks second after rice. The state having maximum area and production under wheat cultivation is U.P. while the productivity is highest in Punjab (45q/ha). Productivity of wheat in highest in Punjab is due to the fact that most of the land is irrigated and more demand for higher doses of fertilizer requirement and consumption. While in case of chickpea, India is the largest producer of gram in the world. In India, Madhya Pradesh is the state having maximum area and production under chickpea cultivation (Nem Raj Sundha).
In modern world, intercropping has become a topic of tremendous attention because of its potential advantages as it offers. When a legume crop is intercropped with any other crop (preferably a cereal crop), then the nitrogen fixation of the linked crop will also be improved by direct nitrogen transfer from legume to cereal crop (Giller and Wilson, 1991) [10]. Heavy incidence of weeds cause hindrance in increasing the productivity of wheat and chick pea globally. Weeds are the unwanted material grown in the wrong place and compete with the main crop for moisture, sunlight, space and nutrition and retarded the proper growth and development of main crop in the field. Uncontrolled weeds are reported to cause up to 66% yield reduction in wheat (Angiras *et al.* 2008, Kumar *et al.* 2009 and Kumar *et al.* 2011) [2, 16, 17]. Whereas, in chickpea, weed cause yield reduction up to 75% (Chaudhary *et al*. 2005) [6] Chemical weed control is a preferred practice over hand weeding due to requirement of scare and expensive labour as well as lesser likelihood of mechanical or manual weeding. So, the use of herbicides will be the only adequate method of weed control in the future (Young *et al.*, 1996 and Norris, 1982) [32, 25].

2. Weeds associated with wheat and chickpea intercropping

Weeds found in Wheat

S. No.	Weeds Classification	
1.	Grasses	▪ *Avena fatua* ▪ *Cynodon dactylon* ▪ *Digiteria abbisinica* ▪ *Phlaris paradoxa*
2.	Broad-leaf weeds	▪ *Amaranthus spinosus* ▪ *Conolvulus arvensis* ▪ *Chenopodium album* ▪ *Chenopodium nobile* ▪ *Corrigola capensis* ▪ *Oxalis latifolia* ▪ *Raphanus raphanistrum* ▪ *Spergula arvensis* ▪ *Tagetes minuta*

(Amare *et al.* 2014) [1]

Weeds found in Chickpea

S. No.	Weeds Classification	
1.	Grasses	▪ *Echinochloa spp.* ▪ *Panicum spp.* ▪ *Sporobolus spp.* ▪ *Cynodon dactylon*
2.	Sedges	▪ *Cyperus rotundus*
3.	Broad-leaf weeds	▪ *Chrozophora rottleri* ▪ *Phyllanthus niruri* ▪ *Aristolochia bracteata* ▪ *Trianthema portulacastrum* ▪ *Portulaca oleracea* ▪ *Digera arvensis*

(Ratnam *et al.* 2011) [26]

3. Effect of various herbicides in weed management of wheat- chick pea intercropping

Effect of Isoproturon

Application of the isoproturon @ 1 kg/ha after 2 weeks of sowing helps in reducing the weed competition and increases the yield and yielding attributes traits in wheat (Sharma *et al.* 1985). Pre-emergence application of herbicide, isoproturon @2kg/ha+ 1 hand hoeing after 50 days after sowing results in highest grain yield (6.3t/ha), harvest index (44.96%) and net income of wheat (Rs. 45625/ha) **(**Khaliq *et al*. 2003) [14]. Isoproturon @ 1kg/ha had shown the best weed killing efficiency (42.26%) alongside with highest yield and yield contributing traits like spike length, no. of tillers, no. of grains per spike, test weight, grain yield, biological yield and harvest index in wheat (Marwat *et al.* 2005) [23]. Highest weed control efficiency (84%), maximum number of tillers/m^2 (250) and yield/ha in wheat was found best by the post-emergence application of isoproturon 50WP@ 1.0kg *ai*/ha (Fahad *et al.* 2009). Puma super (isoproturon) 75EW@1.2 lit/ha were found to give highest seed yield and also controls the weeds in chick pea under rainfed and semi arid conditions (Ansar *et al*. 2010). In wheat, application of isoproturon+2, 4-D results in maximum decline in weed population (89.6%) and dry matter content (78.8%) (Kumar *et al.* 2010). In chick pea, weed population and weed density (98/m^2) were recorded to be less by the application of isoproturon 500EW. Highest 100 seed weight (20.25g) was observed in plots treated with isoproturon 500EW@125g/ha **(**Khan *et al.* 2011). Isoproturon gave the best control of weeds in. It also reduces the weed density by 86%, dry weight by 89% and moreover increases the yield by 40% over weedy check (Mahmood *et al*. 2013) [22]. Post emergence herbicide like isoproturon @1.50kg/ha+ 15 cm row spacing were proved to be efficient in control of broad leaved and total weeds and also improve the weed suppressive efficiency of wheat crop (Amare 2014) [1].

Effect of Pinoxaden

Pinoxaden, the post- emergence herbicide applied @ 30-60g *ai*/ha was found efficient against many grassy weed species *viz*., *Alopecurus myosuroides, Aperaspica-venti, Avena spp., Lolium spp., Phalaris spp., and Setaria sp.* (Hofer *et al.* 2006) [11]. Herbicide pinoxaden 5EC @50g/ha reduced the dry weight of *Phalaris minor* to the level of 92-99% and 89 -98% correspondingly and also increased the grain yield of wheat to the amount of 6.1-6.2 t/ha and 5.7-6.1 t/ha. It also results in the highest net returns and maximum benefit ratio in the cost of cultivation of wheat crop (Yadav *et al.* 2009) [31]. In chick pea, *Phlaris minor* weed were effectively controlled by the post emergence application of Pinoxaden@ 50g/ha and cladinofop@ 60g/ha. The highest grain yield was recorded by the pre-emergence application of Pinoxaden@ 50g/ha applied after 45 days of sowing (Kumar *et al.* 2014). In wheat cultivation, application of pinoxaden @50g/ha significantly controlled the population of the grassy weeds and broad leaf weeds with more than 90% weed control efficiency and also reduced the dry weight of weeds (Kamboj *et al.* 2017) [13].

Effect of pendimethalin

Pre-emergence treatment of pendimethalin @ 0.90kg/ha reduces the number of weeds, increases weed control efficiency and in turn also increased the grain yield of wheat per hectare (Jhala *et al.* 2008) [12]. Application of pre-emergence herbicide, pendimethalin@0.5 kg/ha combined with one hand hoeing after 40 days of sowing considerably reduced the dry weight of the weeds in chickpea from 16.5% and 15.3% respectively (Singh and Mukiierjee 2009) [30]. It was recorded that between all individual herbicide treatments, pre-emergence application of pendimethalin @ 1.5 kg/ha substantially reduced the weed density, dry weight of weeds and tremendously increased the grain yield in chickpea (Ratnam *et al.* 2011) [26]. Pendimethalin @1 kg/ha along with one hoeing after 40 days of sowing results in reducing weed population, dry matter content and increased the highest yield/ha in chickpea (Bhutada *et al.* 2013) [4]. One hand weeding at 20,40 and 60 days after sowing results in lowest dry weight of weeds and maximum yield followed by pendimethalin@ 0.75kg/ha (Chandrakar e*t al.* 2015). In chick pea, reduction in the total weed density and dry matter of weed was significantly reduced by the application of pendimethalin@1.25kg/ha. It also resulted in higher net return and B: C ratio (Kumar *et al*. 2015) [19]. In chick pea, highest yield and yield attributing traits were recorded by the pre-emergence treatment of herbicide pendimethalin@1kg *a.i.*/ha along with one hand weeding at 48 days of sowing (Singh *et al.* 2019) [28].

Effect of cladinofop-propargyl

Spray of clodinafop-propargyl @75g/ha at an interval of 35 days after sowing significantly controlled the broad leaf and grassy weed in wheat and also results in reducing the dry matter accumulation of weeds. Moreover, it considerably increased the grain yield and net return (Angiras *et al.* 2008) [2]. The experimental plots treated with Topik 15WP (cladinofop- propargyl) results in minimum weed density, weed fresh biomass, maximum grain yield, number of tillers and maximum plant height at maturity in wheat (Bibi *et al.* 2008) [5]. Maximum weed control efficiency, crop resistance index, efficiency index and also highest net return due to efficient weed control were recorded in the plots treated with cladinofop 60g/ha +metribuzin 122.5g/ha (Kumar *et al*. 2013)

[21]. In wheat, use of metribuzin combined with cladinofop-propargyl @500-600g/ha resulted in reduced density of weeds after 30 and 60 days of sowing. This combination of two herbicides also increases the grain yield (Singh *et al.* 2015) [29]. Maximum grain yield, weed control efficiency, effective and efficient cost of cultivation were recorded in chickpea by the pre-emergence application of herbicide, pendamethalin 1000g/ha combined with post-emergence application of clodinafop propargyl @60g/ha (Dubey *et al.* 2018) [7].

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