Integrated weed management in wheat (*Triticum aestivum* L.) - A Review

Avinash Dnyandeo Kadam, Mayur Gopinath Thalkar, Laxman Somanath Vyvahare, Pratap Jambuvant Khose and Gaurav Hemantrav Joshi

Abstract

Wheat (*Triticum aestivum* L.) is an important cereal crop in India. It is belong to Poaceae family. It is widely cultivated, produced and used throughout the world and India. Wheat is staple food in all grain crops. Yield reduction in wheat crop due to weeds are 30 to 80% (Amre et al., 2016; Kaur et al., 2017; Chandra et al., 2018) [15, 26]. The combination of grassy and non-grassy leaf herbicides was found maximum output as compare to single herbicide spray in wheat crops. The combination of herbicide with cultural and mechanical method are the better way to reduced weed population in wheat field. The long-time use one herbicide gives resistance in weeds. Integrated weed management approach have use to control long time weed population in wheat field and ultimately increase yield under wheat field.

Keywords: herbicides, weed index, weed flora, weed control efficiency, weed population and weed dry weight.

1. Introduction

Wheat (*Triticum aestivum* L.) is one of the most important staple food crop cultivated in almost all countries in the world. One of major *rabi* crops cultivated in India is wheat specially Punjab and Haryana, it’s like a backbone of food security of nation as evident from its contribution to nearly one third of total food grain productions. Wheat positions second next to rice in area and production, but first in productivity among all the cereals. In India is grown in an area of 29.58 Million ha with a production of 99.70 Million Tonnes. The productivity of wheat in India is about 3371 kg ha⁻¹ (Anon., 2018) [1, 2]. In Punjab wheat grown in an area of 3480 thousand ha with a production of 16360 thousand tonnes. The productivity of wheat in Punjab is about 4700 kg ha⁻¹ (Dept. of agriculture and Govt. of Punjab 2018).

The weed flora associated with wheat in Punjab during 2008-2018 ten new weed species namely *Galium spurium*, *Geranium nepalense*, *Lamium amplexicaule*, *Evolvulus nummularius*, *Euphorbia thymifolia*, *Oenothera laciniata*, *Soliva anthemifolia*, *Verbesina encelioides*, *Nicotiana plumbaginifolia* and *Portulaca oleracea* (Kaur et al., 2018) [14, 26].

Again, weeds have a habit to shift with the alteration in tillage, agronomic management, and cropping system although there are other factors that govern the alterations in the weed flora. Although being a serious problem in crop field, this problem always remains under-estimated although they cause higher reduction in economic yield of crops than other pests and diseases. The critical period of crop weed competition is 11-21 days after crop emerged (Galon et al., 2019) [8] and reduction of grain yield in late sown wheat was reported up to 34.3% due to mixed weed flora (Meena et al. 2017a) [19]. Integrated weed management (IWM) involves deployment of different methods of weed prevention and control in right proportion and at appropriate time against the target weeds (Gupta et al., 2008) [9]. Popular of the research in India on integrated weed management was herbicide-based. However, majority of the farmers have not been benefitted by herbicides in India. Herbicides must be made economically and ecologically affordable to farmers by creatively integrating with other components of integrated weed management. Usage of some herbicides has led to development of resistant weeds and has worsened weed problems. For example, in rice-wheat cropping system of Punjab and Haryana, *Phalaris minor* (Wild oat) has developing resistance against isoproturon.

2. Review of literature

2.1 Weed flora

Tuti and Das (2011) at New Delhi (IARI) observed that major weed flora at the wheat
experimental field comprised of Chenopodium album, Melilotus indica, Avena sterilis ssp ludoviciana (Dur) among grasses, and Cyperus rotundus among sedges. Pisal and Sagarka (2013) [24] at Gujarat observed among the monocot weeds such as, Brachiaria serrata, Echinochloa colomn and dicot weeds Amaranthus viridis, Digeria arvensis, Chenopodium album, Euphorbia hirta and sedges Cyperus rotundus. (Pisal et al., 2013) [24] from Kharagpur West Bengal the predominant weeds flora recorded on the experimental site were Brachiaria serrata, Echinochloa colomn, and Cyperus roudus.

The occurrence of weeds at Tucuman, Argentina were Avena spp. Bromos sp, Parietaria debilis, Bowlesia incana, Hybanthus parviflora (Olea et al., 2011) [21].


Kumar et al., (2018) from Bihar was found that grassy weeds Avena fatua was most dominant and among the non-grassy weeds, Chenopodium album and Fumaria parviflora, Melilotus indica, Coronopus didymus and Chenopodium album in wheat field. Kumar and Singh (2018) at Uttarakhand among monocot weeds were Phalaris minor, Avena fatua, Cydonon dactylon in grassy, Melilotus alba, Chenopodium album, Anagallis arvensis, Convolvulus arvensis and Fumaria indica among dicot weeds whereas Cyperus rotundus in sedges group in wheat field.

Kumar et al., (2019) [16, 17] the flora was dominated by grassy weeds Avena ludoviciana (34.30%), Phalaris minor (25.26%), Lolium temulentum (15.14%), Vicia sativa (10.79%), Anagallis arvensis (9.80%), Coronopus didymus (4.71%). Banerjee et al., (2019) [8] at West Bengal Weed flora in the wheat experimental field was dominated by Phalaris minor and Avena ludoviciana.


2.2 Crop weed competition
(Singh et al., 2013) [28] The crop weed competition was markedly lowest by weed control treatments as is evident from the significant decrease in weed population, dry matter accumulation, weed killing efficiency, weed control efficiency and weed control index by wheat (6.1%, 41 g m⁻², 38.1%, 67.4%, -23.5%).

Nanher et al., (2015) [20] This indicated that unchecked weeds beyond 15 DAS and weed free 10 condition at early stage (up to 15 DAS) failed to check crop weed competition, which was detrimental to cumin growth.

Galon et al., (2019) [8] the weed control methods of the crop weed competition in the period between 11 to 21 days of crop emergence which is wheat grain yield loss competing with ryegrass reached 59% when grown with ryegrass. Hussein et al., (2020) [10] a weed control percentage of 88.35% and gave the lowest dry weight for the weed reached 35.6 g m⁻² compared with the comparison treatment, which reflected positively on increasing the average plant height (102.3 cm), number of tillers (146.8 tillers m⁻²), and the spike length (10.1 cm), which caused an increase in the grain yield by 26%.

2.3. Effect of Integrated weed management on weed growth
(Pisal and Sagarka, 2013) [24] Pendimethalin 0.9 kg ha⁻¹ as pre-emergence + HW at 40 DAS proved greater to rest of the treatment by recording reduced dry weight of weeds. Pisal et al., (2013) [24] from Gujarat reported that among herbicides treatments, application of pendimethalin @ 0.9 kg ha⁻¹ as pre-emergence resulted in maximum control of monocot and dicot weeds.

Pisal and Sagarka (2013) [24] found that combination of one hand weeding with pendimethalin 0.9 kg ha⁻¹ as pre-emergence, pendimethalin at 0.9 kg ha⁻¹ as pre emergence + clodinafop as post emergence proved more effective in reducing the weed population at harvest in comparison to herbicides applied singly. Meena and Singh (2011) [18] from a field experiment conducted at Uttar Pradesh, India found that application of 2, 4-D @ 625 g ha⁻¹ was found effective in controlling majority of dicot weeds thereby decreasing weed density and weed dry weight.

Post-emergence application of 2, 4-D amine salt @0.9 kg ha⁻¹ at 25-30 days effected on grassy and broad leaf weeds (Pisal et al., 2013) [24].

Metsulfuron methyl at 2 g ha⁻¹ had recorded higher plant dry matter than 2, 4-D @ 625 g ha⁻¹ (Meena and Singh, 2011) [18]. Pisal et al., (2013) [23] reported that post-emergence application of Metsulfuron methyl controls broad leaf weeds efficiently and recorded maximum weed control efficiency.

Kaur and Walia (2015) [12] the results to be found that ready-mix of clodinafop+ Metsulfuron at 75 g ha⁻¹ + 0.2% surfactant recorded effective control of grass and broadleaf weeds. Nanher et al., (2015) [20] post-emergence application of Sulfosulfuron + Metribuzin 25 + 105 g a.i ha⁻¹ recorded reduced the weed population (4.1 m⁻²), dry weight of weed (9.20 g m⁻²), highest weed control efficiency (89.89%) and minimum loss of nutrient in wheat field.

Devi et al., (2018) The tank mix application of pinoxaden (50 g ha⁻¹)+RM of carfentrazone and Metsulfuron (25 g ha⁻¹) recorded lowest total weed density (3.47 m⁻²), weed index (2.72%) and weed persistence index (0.17), and highest value of weed control efficiency (95.03) in wheat crop.

Sharma et al., (2018) Pre-emergence application of pendimethalin (30 EC) 2.5 L ha⁻² along with the post-emergence application of Atlantis 400 g resulted in the reduced weed density and weed dry matter. Banerjee et al., (2019) [5] post-emergence application of Pinoxaden at 352.94 g/ha in wheat crop at 45 day after application was recorded minimum weed population in Phalaris minor (1.56 m⁻²) and Avena ludoviciana (1.34 m⁻²), dry weight in Phalaris minor (6.1 g m⁻²) and Avena ludoviciana (6.3 g m⁻²), higher weed control efficiency in Phalaris minor (81.70%) and Avena ludoviciana (80.80%).

Ahmed et al., (2020) [4] post-emergence application of 2,4-D + ethoxy at 1288+ 18 g a.i ha⁻¹ at 10 DAS was recorded reduced mean weed density (229 m⁻²), weed biomass (12 g m⁻²) and higher weed control efficiency in wheat crop (84%).

Patel et al., (2021) [25] post-emergence application of clodinafop + metsulfuron 60 + 4 g ha⁻¹ was recorded reduced mean weed density (1 m⁻²), weed dry weight (1 g m⁻²), weed index (0.00%) and higher weed control efficiency in wheat.
crop (100%).

2.4. Effect of Integrated weed management on crop growth

Application of pendimethalin @ 0.7 kg ha\(^{-1}\) decreased the density of *Chenopodium album*, *Melilotus indica*, grasses and total weed density at 60 DAS, (Tuti and Das, 2011). Pisol and Sagarka, (2013)\(^{24}\) at Junagadh, Gujarat noticed that significantly higher number of effective tillers, spikelets per spike and grain weight per plant were recorded under weed free condition over weedy check which was closely followed by treatment of pendimethalin 0.9 kg ha\(^{-1}\) as pre-emergence.

2, 4-D Na. Salt @625g ha\(^{-1}\) was found effective on plant height ear head length compared to an weeded check, (Meena and Singh, 2011)\(^{18}\).

Application of 2, 4-D in wheat was recorded 24.5% higher productive tillers m\(^{-2}\), 3.4% higher spike length and 7.2% higher filled grains/panicle with enhanced grain yield (31.4%) and straw yield (31.4%) compared to weedy check, (Surin et al., 2013)\(^{29}\).

Metribuzin had the positive influence on plant height, effective tiller m\(^{-2}\), spikelet number ear\(^{-1}\), and ear length as compared to farmer practice (Singh et al., 2010)\(^{27}\). Singh et al., (2013)\(^{24}\) pointed out increased crop growth under herbicide spray (metsulfuron + 2, 4-D) which was significantly superior to farmer’s practices.

Application of metsulfuron @6 g ha\(^{-1}\) as post-emergence, at 25 - 30 DAS increased number of tillers m\(^{-2}\), plant height than the weedy check, (Pisol et al., 2013)\(^{34}\).

Kaur and Walia (2015)\(^{12}\) the results indicated that ready-mix of clodinafop+ metsulfuron at 75 g ha\(^{-1}\) plus 0.2% surfactant recorded higher panicle length and effective tillers plant\(^{-1}\) (11.2 cm and 351.65 tillers plant\(^{-1}\) in wheat field.

Nanher et al., (2015)\(^{30}\) post-emergence application of sulfosulfuron + metribuzin 25 + 105 g a.i ha\(^{-1}\) recorded plants height (110 cm), maximum number of tillers m\(^{-2}\) row length (110.18 tillers m\(^{-1}\)row length), dry matter accumulation (148.17 g m\(^{-2}\)row length) in wheat.

Devi et al., (2018) The tank mix application of pinoxaden (50 g/ha) +RM of carfentrazone and metsulfuron (25 g ha\(^{-1}\)) recorded higher Crop Resistance Index (22.83%), NAR (6.23 g m\(^{-2}\)day\(^{-1}\)) and LAD (113.03 Days) in wheat.

Sharma et al., (2018) among the herbicidal treatments the highest number of grains per spike (43) were observed with combination of pre-emergence application of pendimethalin (30 EC) 2.5 L ha\(^{-1}\) along with post-emergence application of atlantis 400 g ha\(^{-1}\).

Kumar et al., (2019)\(^{16, 17}\) post-emergence application of marck clodina at 60 g ha\(^{-1}\) recorded total weed population (5.17 m\(^{-2}\)), total weed dry weight (6.09 g ha\(^{-1}\)) and weed control efficiency (86.3%) in wheat crop.

Ahmed et al. (2020)\(^{5}\) post-emergence application of ethoxy at 10 DAS was recorded higher mean plant density (370.5 m\(^{-2}\)) and plant biomass in wheat field (147 g m\(^{-2}\)).

2.5. Effect of Integrated weed management on yield and yield attributes

Tuti and Das (2011) positive influence on grains ear\(^{-1}\), and 1,000 grain weights and grain yield in wheat crop were observed in the Pre-emergence application of pendimethalin @ 0.75 kg ha\(^{-1}\) had Pre-emergence application of pendimethalin was found equally effective and significantly better over mechanical weeding and unweeded control in higher the earheads m\(^{-2}\), earhead length, grains per head and 1000 grain weight (Singh et al., 2011).

Pisol et al., (2013)\(^{24}\) from Junagadh Agricultural University Gujarat, observed that pendimethalin as pre emergence + one hand weeding at 40 DAS produced the maximum grain yield. Application of the pendimethalin enhanced seed yield which was closely followed by pendimethalin @0.9 kg ha\(^{-1}\) as pre-emergence + 1 HW at 40 DAS (Pisol and Sagarka, 2013)\(^{24}\).

Pendimethalin @0.9 kg ha\(^{-1}\) as pre-emergence enhanced the wheat seed yield (3723 kg ha\(^{-1}\)) (Pisol et al., 2013)\(^{24}\).

The higher seed (3.8 t ha\(^{-1}\)) and straw yield (4.4 t ha\(^{-1}\)) was recorded with pendimethalin @ 0.9 kg ha\(^{-1}\) pre-emergence plus one hand weeding at 40 DAS (Tuti and Das, 2013).

2, 4-D Na. salt @625 g ha\(^{-1}\) was found to be maximum on plant height, ear head length, number of grains ear\(^{-1}\) head compared with unchecked weed (Meena and Singh, 2011).

2, 4-D had positive effect on effective tillers m\(^{-2}\), spikelet number ear\(^{-1}\), and ear length as compared to unchecked weed, at BAU, Ranchi, Jharkhand, (Surin et al., 2013)\(^{29}\).

Pisol et al., (2018) the tank mix application of clodinafop+ metsulfuron at 75 g ha\(^{-1}\) recorded higher no. of effective tillers m\(^{-2}\), ear length, number of grains ear\(^{-1}\) and 1,000-grain weight (Dev et al., 2013)\(^{7}\).

Application of metribuzin at 250 g ha\(^{-1}\) had improved the number of effective tillers m\(^{-2}\) ear length, number of grains ear\(^{-1}\) and 1,000-grain weight (Dev et al., 2013)\(^{7}\).

Meena and Singh (2011)\(^{18}\) noticed that metsulfuron methyl at 2 g ha\(^{-1}\) recorded better performance of yield attributes in comparison to 2, 4-D @625 g ha\(^{-1}\) alone with respect to number of ear head m\(^{-2}\), ear head length, number of grains ear\(^{-1}\) head and test weight, increased grain yield 2.9 t ha\(^{-1}\) than 2, 4-D Na. salt.

Kaur and Walia (2015)\(^{12}\) the results indicated that ready-mix of clodinafop+ metsulfuron at 75 g ha\(^{-1}\) recorded maximum grain yield (5.6 t ha\(^{-1}\)).

Nanher et al., (2015)\(^{30}\) post-emergence application of sulfosulfuron + metribuzin 25 + 105 g a.i ha\(^{-1}\) recorded higher grain and straw yield in wheat crop (5.5 t and 7.8 t ha\(^{-1}\)).

Devi et al., (2018) the tank mix application of pinoxaden (50 g/ha) +RM of carfentrazone and metsulfuron (25 g ha\(^{-1}\)) recorded maximum seed yield (5.3 t ha\(^{-1}\)).

Kumar et al., (2018) post-emergence application of 2, 4-D @0.5 kg a.i ha\(^{-1}\)at 30 DAS recorded higher ear length (9.7 cm), no. of spikelet per ear (15.2), no. of grains per ear (37.7), grain weight per ear (1.50 g), 1000- grain yield (42.8), seed and straw yield (3.7 t and 5.2 t ha\(^{-1}\)) in wheat crop.

Sharma et al., (2018) highest grain yield (5773 kg ha\(^{-1}\)) was recorded with pre-emergence application of pendimethalin 2.5 L ha\(^{-1}\)fb post-emergence application of atlantis 400 g ha\(^{-1}\).

Kumar et al., (2019a)

Kumar et al., (2019b) Hand weeding twice at 30 and 60 DAS was recorded higher seed and straw yield in wheat crop (4.9 t and 6.64 t ha\(^{-1}\)).

Banerjee et al., (2019)\(^{5}\) post-emergence application of Pinoxaden at 352.94 g ha\(^{-1}\) was recorded higher mean no. of effective tillers (355.4 m\(^{-2}\)), ear length (12.5 cm), no. of grain ear\(^{-1}\) (42.2), test weight (74 g) and grain yield (3.24 t ha\(^{-1}\)) in wheat crop.

Patel et al., (2021)\(^{25}\) post-emergence application of clodinafop + metsulfuron 60 + 4 g ha\(^{-1}\) was recorded higher mean seed and straw yield in wheat crop (5.80 t and 8.55 t ha\(^{-1}\)).
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