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# Review on: Effect of Integrated Weed Management Practice on Bread Wheat (*Triticum aestivum* L.)

**Birhanu Gebeyehu**

Plant Science Department, Mekdela Amba University, South Wollo, Ethiopia.

Corresponding author email id: birhanugebeyehu1@gmail.com

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**Abstract** – Weed infestation is one of the major biotic constraints in wheat production. Wheat is infested with diverse type of weed flora, as it is grown under diverse agro climatic conditions, different cropping sequence, and tillage and irrigation regimes. For controlling weeds in wheat, growers mostly rely on herbicides due to cost and time effectiveness. For control of diverse weed flora in wheat combination of herbicides or as sequential, if not compatible are required. However, sole dependence on herbicides is also not desirable as it contributes to shift towards difficult-to-control weeds and the rapid evolution of herbicide resistance, which is a threat for sustainable wheat production. For efficient weed management, the non-chemical weed management tactics should be adopted in conjunction with chemicals (like herbicide mixture and rotation, optimum spray time, dose and methods). Some of the non-chemical agronomic strategies like tillage, sowing time, sowing methods, competitive crop cultivars, higher crop density, closer spacing, irrigation, fertilization and crop rotation can be adjusted and adopted in such a manner that they provide the competitive edge to the crop over weeds. Integration of knowledge of weed biology and non-chemical methods of weed control with chemical methods will help in increasing the life of existing herbicides and make the weed management cost-effective and efficient.

**Keywords** – Bread Wheat, Weed, Integrated, Management.

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## I. INTRODUCTION

Wheat belongs to the family Gramineae and to the tribe Hordea. The term wheat is normally used to refer to the cultivated species of the genus *Triticum*. Among many wheat plants, only three species are commercially important. These are bread wheat (*Triticum aestivum* L.), durum wheat (*Triticum turgidum* L.) and emmer wheat (*Triticum compactum*). But, now day cultivation is restricted almost entirely to the tetraploid durum wheat (*Triticum turgidum* L.) and hexaploid bread wheat (*Triticum aestivum* L.). From the two of them, hexaploid bread wheat is the most grown throughout the world. This includes the vast majority of varieties, which show great diversity in agro-ecological adaptation and utilization (Gooding and Davies, 1997).

Wheat is an essential grain food component and is a very important commodity among cereal crops (Baghestani *et al.*, 2007). Globally, it is the most important food grain and ranks second in total production as a cereal crop behind maize; the third being rice. It is reported that per 100 g of wheat grain contains 326-335 calories, 11.57-14.0 g water, 9.4-14.0 g protein, 1.2-2.5 g fat, 69.1-75.4 g total carbohydrate, 1.8-2.3 fiber, 1.7 g ash, 36-46 mg calcium, 354-400 mg phosphorus, 3.0-4.3 mg iron, 370-435 mg potassium, 0.43-0.66 mg thiamine, 0.11-0.12 mg riboflavin and 4.3-5.3 mg niacin (Harker *et al.*, 2005).

Wheat is one of the most important cereal crops and is extensively grown, produced and consumed in the world (Leser, 2013). A 17% world's cropped area is under wheat cultivation which together adds 35% of the staple food and 20% of the calories (Chhokar *et al.*, 2006). A quantum jump in wheat production has been recorded from 2001-2007 with the total area of production 210-220 million hectares was 598.33 million tones. The average wheat productivity in SSA is 1.7 tons/ha (FAOSTAT, 2014), nearly 50% below the world average

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and the national average wheat productivity in SSA varies across countries where It ranges from 0.7 tons/ha in Burundi to 3.4 tons/ha in Mali.

Wheat is one of the major crops grows in the Ethiopian highlands (Hailu, 2003). In Ethiopia, however the introduction of wheat productivity has increased and more than 65% of cultivated wheat farms are with improved cultivars the average national productivity is not more than 2.2 t/ha against the best performers and model farmers who managed to produce more than 6 t/ha (EIAR, 2012). Again this average national productivity is much less than 3 t/ha; which is the average world productivity. Besides varied causes of this low grain yield per unit area, presence of weeds has also been become a key factor is reduction of yields. Weeds competition with wheat crop is a key point in yield reduction (Waheed *et al.*, 2009).

Zand *et al.* (2007) reported 30% wheat yield loss and sometimes complete and the most important are *Avena spp.*, *Bromus spp.*, *Promus spp.*, *Parietaria debilies*, *Bowlesia incana*, *Hybanthus parviflorus spp* of weeds in wheat resulted considerabl losses on its yield. Weeds are seriously managed in crop production as they are not only reduced crop yield but they may causes the quality of farm is also affected. Friesen *et al.* (2000) mentioned that herbicides would continue to be a key component in most weed management systems in wheat. Application of pre- and Post- emergence herbicide /or hand weeding and hoeing at tiller stage could further reduce the deleterious effect of weeds on wheat. But depend on herbicide causes environmental hazards and may not be accessed to poor farmers and also hand weeding may not be more important due to many reasons. So integrated weed management may be more important and economical than the other.

IWM is a science-based decision-making process that coordinates the use of environmental information, weed biology and ecology, and all available technologies to control weeds by the most economical means, while posing the least possible risk to people and the environment (Singh, 2006). By using different appropriate management practices against weeds, farmers have more options for controlling them, thereby reducing the possibility of escapes and weed adaptations to any single weed management tactic. IWM task into account all relevant control tactics and methods available locally, evaluating their potential cost effectiveness. So the objective this review is *to review the effect of integrated weed management practice on wheat (Triticum aestivum L.)*.

## II. LITERATURE REVIEW

### 2.1. Genetics and Origin of Wheat

Wheat is classed in the grass tribe (*Triticeae*) and the genus *Triticum* (Poehlman and Sleper, 1995). All wheat species, whether wild or cultivated, belong to the genus *Triticum* and the family Poaceae (the “grass family”). The genus *Triticum* contains about 30 wheat types that have enough genetic differences to be considered separate species or sub-species (Breth, 1975). According to their chromosome number they are grouped into diploid, tetraploid and hexaploid wheat. Domestication of the diploid and tetraploid wheat is thought to have occurred at least nine thousand years ago with hybridization event producing hexaploid wheat occurring more than six thousand years ago (Simmons, 1987; Feuillet *et al.*, 2007).

Feldman and Sears (1981) listed 13 diploid, 12 tetraploid and 5 hexaploid species of *Triticum*, of which only two species are of commercial importance (Poehlman and Sleper, 1995). These are the hexaploid species, *T. aestivum*, the bread wheat and the principal wheat in commerce; and the tetraploid species, *T. turgidum*, the



durum wheat. The allohexaploid common or bread wheat has the genome constitution of AABBDD ( $2n = 6x = 42$ ), formed through hybridization of *T. urartu* (AA) with an unknown diploid B genome (possibly *Aegilops speltoides*), and subsequent hybridization with a diploid D genome, *Ae. tauschii* (Vasil, 1997).

Evidence indicates that diploid and tetraploid wheat first appeared before 8000 BC in the “Fertile Crescent”, an area found within the drainage basins of the Euphrates and Tigris Rivers in present day Syria and Iraq, and most wheat grown today is hexaploid (Martin *et al.*, 2006). The modern hexaploid bread wheat (*T. aestivum* L.) evolved later and became abundant about 8000 years ago (Curtis, 2002).

## 2.2. Importance and Adaptation of Wheat

Wheat (*Triticum spp.*) is one of the most important cereal crops worldwide in total production and use (Evans, 1998). The domestication of wheat, more than any other plant, has allowed food to be produced in sufficient quantities to support community settlement, religious or cultural development, and continuing population growth (Gooding *et al.*, 2003). Its importance derives from the properties of wheat gluten, a cohesive network of tough endosperm proteins that stretch with the expansion fermenting dough, yet coagulate and hold together when heated to produce a risen loaf of bread (Poehlman and Sleper, 1995).

The diversity of uses, nutritive content, and storage qualities has made wheat a staple food for more than one-third of the world’s population. It is utilized for making bread, flour confectionery products (cakes, cookies, and pretzels), unleavened bread, semolina, bulgar, and breakfast (Poehlman and Sleper, 1995). In this country, wheat is used to prepare various traditional food items alone or in mixture with other cereals and/ or legumes. Globally, it is the most important food grain and ranks second in total production as a cereal crop behind maize; the third being rice. It is reported that per 100 g of wheat grain contains 326-335 calories, 11.57-14.0 g water, 9.4-14.0 g protein, 1.2-2.5 g fat, 69.1-75.4 g total carbohydrate, 1.8-2.3 fiber, 1.7 g ash, 36-46 mg calcium, 354-400 mg phosphorus, 3.0-4.3 mg iron, 370-435 mg potassium, 0.43-0.66 mg thiamine, 0.11-0.12 mg riboflavin and 4.3-5.3 mg niacin (Muir *et al.*, 2004).

Wheat is poorly adapted to warm or moist climates unless there is a comparatively cool dry season that favors plant growth and retards plant pathogens and the development of respective disease (Martin *et al.*, 2006). According to these authors the wheat crop is grown in temperate regions where the annual rainfall averages between 254 to 1780 mm, with the exception of drier irrigated areas; and it is mostly grown in regions with annual precipitation of 380 to 1140 mm. The ideal daily temperature for different stages of wheat growth and development varies from 20 to 25 oC for germination, 16 to 20 oC for good tillering, and 20 to 23 oC for proper plant development (Bekele *et al.*, 2000). High rainfall, especially when accompanied by high temperatures, is unfavorable for wheat because these conditions promote development of wheat diseases (Martin *et al.*, 2006).

## 2.3. Wheat Production in Ethiopia

Wheat is one of the most important cereal crops and is extensively grown, produced and consumed (Rafi *et al.*, 2019). Wheat is one of the major crops grows in the Ethiopian highlands (Hailu, 2003). Despite its importance in Ethiopia, the mean yield is 1.3 ton /ha which is 24% below the mean yield of Africa and 48% below the global mean yield wheat. In Ethiopia it ranks 5th after teff, barley, maize and sorghum in area of production but in terms of productivity it ranks 2nd next to maize (Hailu. 2003). Wheat used to be predominant in Ethiopian wheat production systems, but bread wheat has now gained in popularity and approximately 80%



of the wheat area in Ethiopia is now planted to bread wheat. CIMMYT-derived spring wheat material predominates throughout the region, with an estimated 85% of the spring wheat area (Heisey & Lantican, 2000).

Wheat is generally planted in the summer, before the meher (main) season rains in June-September, and then harvested in October-November (Sadok *et al.*, 2019). The majority (59-75%) of wheat is grown in the region of Oromia, particularly the Arsi-Bale wheat belt that begins just north of Addis Ababa and extends to the southeast. Amhara region is also a major producer, and these two regions accounted for 88% of domestic production in the 2006/07 season (Rashid, 2010).

#### 2.4. Weeds Associated with Wheat

Montazeri *et al.* (2005) reported that *Phalaris minor*, *Alhagi persarum* (camelthorn), *Avena fatua* (Wild oat), *Cirsium arvense* L, *Glycyrrhiza glabra* L. (licorice), *Sinapis arvensis* L. (wild mustard), *Convolvulus arvensis* L. (field bindweed), *Lamium amplexicaule* (Henbit), *Descurania Sophia* L. (Flixweed) and *Galium sp.* (bedstraw) are the most harmful and upsetting weeds in wheat crop. Pandey and Dwivedi (2007) found that predominant weeds in wheat included *Chenopodium album*, *Fumaria parviflora*, *Convolvulus arvensis* (Bindweed, field) *Nicotiana plumabginifolia*, *Spergula arvensis*, *Phalaris minor*, *Avena fatua*(Wild oat), *Cynodon dactylon* ((Bermudagrass) and *Cyperus rotundus* (Purple nutsedge).

#### 2.5. Effects of Weeds on Wheat Production

Weeds are notorious yield reducers that are, in many situations, economically more important than insects, fungi or other pest organisms (Savary *et al.*, 2000). The key factors in crop yield reduction were identified with weed-crop emergence, competition duration, weed lifecycle and growth habit, density of weeds and crop plants, crop species and cultivars. Weeds are good competitors with crop plants because of their growth habits. Weeds grow quicker and taller than crop plants, produce a foliar canopy that shades the crop plants and have greater root elongation and branching which result in a root system that absorbs more nutrients and water from the soil at the expense of the crop plant. Wheat is one the most important crop which is seriously affected with weeds and so that yield will be reduced at a great extent.

Chopra *et al.* (2008) studied that the mixed population of grass and broad-leaf weeds showed 25.7 % reduction in wheat seed yield in weedy check conditions. Bharat and Kachroo (2010) also reported that weeds caused 40.25 % reduction in grain yield of wheat compared with weed free plots. Singh *et al.* (2014) concluded that yield losses of wheat especially from *Phalaris minor* alone are estimated from 25 to 50 % and under very severe infestations the losses may go up to 80 %. According to Kumar *et al.* (2010) who reported from Palampur, Himachal Pradesh weeds caused 55.7 % reduction in wheat grain yield.

Some weed species supplement competitiveness by production of phytotoxic substances that adversely affect growth and development of crop plants. These chemicals are released in to the soil as root exudates or as leachates of the living or dead plants (Qasem, 2017). Chachar *et al.* (2009) reported that *Avena spp.*, *Bromus spp.*, *Promus spp.*, *Parietaria debilies*, *Bowlesia incana*, *Hybanthus parviflorus spp* of weeds in wheat resulted considerable losses on its yield.

Apart from yield losses, weeds harbor insects and pests and hence harmful to the crop, human beings and livestock. Other losses due to weeds include increases in expenditure on labor and equipment in their eradication.



-n, rendering harvesting difficult and reducing the quality and marketability of agricultural produce.

Weed problems are more severe in tropical regions because weeds grow more vigorously and regenerate more quickly in the presence of warm climate and higher light intensity. Therefore, it is not easy to evaluate the relative importance of different weed species in causing yield loss for producers. However, an evaluation would be valuable both when making management decisions and when setting research priorities.

## 2.6. Weed Control Methods

Despite Weeds are difficult to manage than any other pests because they are stationary and competition usually does not result from just one species, weed control is an important management practice for wheat production that should be carried out to ensure optimum grain yield. The objective of weed control is to create unfavorable conditions to weeds while maintaining conditions conducive for plant growth. On the other hand, weed control in is to reduce weed populations to levels that do not affect the yield, quality or harvesting of the current or sequential crops.

### 2.6.1. Cultural Methods

Crop rotation, crop selection, variety selection, adjusting planting date, plant population and spacing, plus fertilizer rate and method of application and are all cultural practices that affect weed management.

Crop rotation is one of the most important factors in an integrated weed management program. Different crop also allow rotation of herbicides having a different mode of action. There are several crops that can be rotated with wheat in the winter season such as potato, onion, winter maize, mustard and sunflower. Other rotations include rice-potato-sunflower, rice-mustard-sugarcane and rice-potato-onion has been found best alternate (Singh, 2007).

Placement of fertilizers significantly reduce weed dry biomass from 8.5 to 7.9 g/m<sup>2</sup> than broadcast method of fertilizer application due to lesser availability of applied nutrient in inter row spaces and also due to weed smothering to crop plants (Pandey *et al.*, 2006). Ijaz *et al.*, (2013) who observed that better weed control increased the nutrients availability to the crop which ultimately increased the spike bearing tillers. Higher dose of nitrogen (160 kg N/ha) significantly reduced the dry matter accumulation by weeds as compared to 120 kg N/ha (Ashrafi *et al.*, 2010). Due to less competition between weeds and wheat crop plants, resulted in improved flow of nutrients towards grains, which enhanced the wheat yield (Khalil *et al.*, 2008).

Variety with quick initial growth and more leaf area must be preferred in order to reduce crop weed competitions. Travlos (2012) observed that some wheat cultivars with enhanced weed competitiveness can improve the efficacy of herbicides.

The sowing of crop can be manipulated in such a way that ecological conditions for germination of weed seeds are not met due to escape mechanism. Singh *et al.* (2013) observed less weed density and lower total weed biomass in early planting (October, 22) wheat crop as compared to November, 11 and November, 21 sown crop. Kumar *et al.* (2013) noted that weed free treatment resulted in significantly lower total weed count and total weed dry weight at 90 days after sowing in wheat.

Sharma *et al.* (2011) reported that increased seed rates from 75 to 150 kg/ha significantly decreased dry weight of weeds in wheat. Khan & Marwat (2006) also reported that higher seeding rate of wheat suppressed the



weed in the first year while in the second year, higher seeding rate could not suppress weeds due to change in the climatic conditions. Increased seed rate helps in smothering weeds particularly *Phalaris minor* by providing early competition advantage due to more number of crop plants per unit area. As wheat density increased weed shoot biomass decreased significantly (Toorabi *et al.*, 2018).

### 2.6.2. Mechanical and Manual Weeding

Removal of weeds by various means of tools and implements, hand weeding and pulling comes under mechanical and physical practices of weed control, respectively. Mechanical weeding done twice at 15 and 30 days stage was found most effective in reducing weed dry matter accumulation in wheat (Sharma *et al.*, 2011). Pandey *et al.* (2007) revealed that hand weeding significantly reduced the intensity of perennial grasses and sedges in wheat. Radhey Shyam *et al.* (2009) noted that hand weeding twice at 35 and 55 days after sowing was most effective to minimize the weed density and their dry weight under all the wheat establishment methods.

### 2.6.3. Chemical Control

Weed management in wheat is not accomplished by using agronomical and cultural practices exclusively. Herbicides continue to be the most powerful and reliable way to control weeds in wheat. Herbicide mixtures may also be one of the options for management or delay of cross resistance development (Dhawan *et al.*, 2009). Alternate herbicides with different mode of action also help in delaying the cross resistance. Brar and Walia (2009) reported that mesosulfuron+ iodosulfuron, sulfosulfuron and clodinafop fb 2, 4-D were quite effective against *Phalaris minor* and broad leaf weeds. Malik *et al.* (2010) reported that chlorsulfuron 30 g/ha, triasulfuron 40 g/ha and metsulfuron 4g/ha reduced the density and dry weight of total weed to the extent of 85-89 % and produced grain yield of wheat statistically similar to weed free check.

Bharat and Kachroo (2010) opined that in wheat broad leaved weeds were significantly controlled with application of metsulfuron methyl (4 g ha<sup>-1</sup>), 2, 4-D (750 g ha<sup>-1</sup>) and metribuzin (175 g ha<sup>-1</sup>). Maximum weed control efficiency was observed with sulfosulfuron + 2, 4-D (25+ 500 g ha<sup>-1</sup>) followed by metribuzin (200 g ha<sup>-1</sup>). This may be due to their broad spectrum action. Chopra and Chopra (2010) carried out a field experiment on wheat at Karnal, Haryana and studied that sole application of fenoxaprop (100g ha<sup>-1</sup>) and clodinafop (60 g ha<sup>-1</sup>) were ineffective against broad leaved weeds like *Rumex maritimus* and *Medicago denticulata*. Application of both these herbicides when followed by metsulfuron (4 g ha<sup>-1</sup>) resulted in lowest weed density and weed dry weight and highest weed control efficiency.

### 2.6.4. Integrated Weed Management

Integrated weed management for crops is a concept that combines weed control principles, practices, materials, and strategies to maintain plant health by minimizing damage from weeds. It is very clear that herbicide alone will not be the solution for weed problem in wheat. Therefore, perfect sowing techniques that allow integration of mechanical methods with herbicides or cultural methods require urgent attention. Weed intensity and dry matter of weeds at harvest were significantly lower in weed free followed by pendimethalin pre emergence @ 1.0 kg/ha + hand weeding and was maximum in weedy check (Patil and Dhonde, 2009).

Integration of isoproturon @ 0.75 kg/ha + 2,4-D @0.5 kg/ha with one inter culture at 30 DAS was the best treatment in terms of reducing weed population and dry weight at different stage of crop growth (Rathi *et al.*,



2008). Singh *et al.* (2013) noticed that post emergence application of metsulfuron (6 g ha<sup>-1</sup>) and 2, 4-D (500g ha<sup>-1</sup>) at 30-35 days after sowing in wheat recorded higher weed killing efficiency (38.1 %), weed control efficiency (78.3 %), lower weed index (23.5 %) and reduced their dry matter accumulation by 67.4 % as compared to farmer's practice.

Abbas *et al.* (2014), and Chachar *et al.* (2009), who also found that close planting (22.5 to 15 cm row to row distance) combined with chemical weed control, gave minimum dry weed weight and maximum weed control. Chachar *et al.* (2009) also reported higher 1000-grain weight in widely spaced rows with chemical weed control in contrast to lower 1000-grain weight in close-row spacing with no weed control. Chemical weed control in combination with 22.5 cm single-row sowing, cross-row sowing, or closer spaced rows of 15 cm reduced weed competition and resulted in increased grain yields of wheat. Ashrafi (2009) also found a significantly higher grain yield in 20 cm row spacing subjected to broad-spectrum herbicide spray. Pradhan and Chakraborti (2010) found that minimum weed density and dry weight of weeds in wheat were recorded with two manual weeding's followed by metribuzin (175 g ha<sup>-1</sup>) at 28 days after sowing in alone or in combination with hoeing with dutch hoe at 21 days after sowing.

### III. SUMMERY

Weed infestation is one the main biotic constraints in wheat production and productivity. Wheat is infested by different weed flora comprising grasses and broad leaved weeds. For weed control most the wheat producer farmers depends on herbicides due to cost and time effectiveness compared to manual weeding. However continuous use of the same herbicide or herbicide of the same mode and mechanism of action resulting in the buildup of resistance and tolerant weed variety.

Integration of herbicides with hand weeding attributed to efficient and prolonged weed control. Herbicide supplemented with hand weeding for the control of late emerging weeds. An integrated approach, where herbicide plays a pivotal role is the only way ahead for effective weed management. Use of weed free seed, use of well rotten farm yard manure, method of sowing, seed rate, sowing time, varietal selection, amount of fertilizer application, proper herbicide selection, proper dose, time and method of herbicide application, herbicide rotation and mixture, use of adjuvant, mechanical weeding and crop rotation are the major constituents of integrated weed management.

### APPENDIX

FAO : Food and Agriculture Organization of the United Nations.

SSA : Sub –Saharan Africa.

USDA : United States Department of Agriculture.

FAOSTAT : Food and Agriculture Organization of the United Nations  
Statistics

IWM : Integrated Weed Management.

2, 4-D : 2, 4-dichlorophenoxy acetic acid.

@ : At the Rate of.



USDA FAS : United States Department of Agriculture Foreign Agricultural Service

CIMMYT : Centro Internacional de Mejoramiento de maize and wheat ye trigo.

EIAR : Ethiopian Institute of Agricultural Research.

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## AUTHOR'S PROFILE



**Birhanu Gebeyehu**, I was born in August 1988 at Chagni, Awi Zone Amhara Region, Ethiopia. I attended my elementary education at Zigem Elementary Schools from 1994 to 2000 and Junior and my high school education at Chagni Secondary School from 2001 to 2006. Finally I was joined to Bahir Dar University College of Agricultural and Environmental Sciences in 2006 and I received my Bachelor degree in the field of plant science on July 01 2009. Still now I am jobless.