Asian Journal of Advances in Research

4(1): 1214-1225, 2021

REVIEW OF MAJOR CEREAL CROPS PRODUCTION LOSSES, QUALITY DETERIORATION OF GRAINS BY WEEDS AND ITS PREVENTION IN ETHIOPIA

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AUTHORS' CONTRIBUTIONS

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

Received: 01 September 2021
Accepted: 11 November 2021
Published: 13 November 2021

Review Article

ABSTRACT

Grain production plays a vital role in feeding an ever-increasing world population. Among grain crops that are serving as a food source, rice, wheat, maize, sorghum, and barley rank the most important ones. However, the production status of important cereals is highly reduced by intrinsic and extrinsic factors. Amongst these, weeds are key production constraints that reduce yield and deteriorate the quality of crops product. This paper was aimed to review studies that were conducted on the effect of weeds in crops production both on quantitative as well as qualitative losses. Weeds affect crops by competing for light, moisture, nutrients, and space, and produce seeds by suppressing crop plants faster. Crop yield losses are estimated at 10 to 90% depending on the crop type and area. On a crops basis, total losses are estimated about as high as 26–29%, 31%, 90%, 60%, 64% for wheat, maize, rice, sorghum, and barley, respectively if good weed control is not carried out. The negative impact of weeds on the quality of grains ultimately reduces the market value, nutritional status, and viability of the crop's seeds. Therefore, it is crucial to managing weeds infestation through the application of integrated weed management strategies that can be cultural practices, use of herbicides, manual and mechanical weeding including a quarantine control system.

Keywords: *Competition; integrated weed management; qualitative loss; quantitative loss; weed infestation.*

1. INTRODUCTION

The most important cereal grains in the world are wheat, maize and rice, millet, and sorghum [1]. The amount of production and estimated grain yield growth is closely linked to food security. Grain consumption is projected to surpass production, although in the mid-term production is expected to rise at a rate higher than demand [2]. A rise in the grain supply deficit compared to consumption is high, mainly in developing countries. According to the International Grains Council's forecast, yield increases are projected to rise from 0.8% to 1.5% per annum from 2013/2018 to 2020/2024 [2].

Weeds infestation is one of the major threats which limit crops yield and food quality unless it is managed properly [3]. Weeds competition has become more serious when the new varieties are shorter than them [4]. Pre-harvest losses by biotic and abiotic constraints are about 1051.5 metric tons which are 35% of the total possible biological

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product of 3.153 mt and grain losses at harvest are estimated at 3% or 60 mt annually, with wide regional variations between small and large farms [2].

Weeds are generally defined as plants growing where are unwanted and they differ in the damage that they cause to crops and this is governed by their growth habit, vigor, seed production, regenerative capacities, and time of germination [5]. Weed infestation has been reported as the main yield reducer to crop production in Ethiopia in both peasants as well as state farm sectors [4]. The concern provided to weeds is low in tropical producers though its negative impact is influencing human livelihood over other agricultural pests which contributes to crops yield reduction. The distribution and density of weeds in this area are highly influenced by cultural and other management strategies taken earlier, soil characteristics, and the climate of the area [6].

Weeds cause a total loss of about 45% of agricultural produce annually (Mohamed *et al*., 2014). The presence of weeds in crops increases harvesting costs and reduces the quality of grain for marketing and consumption [6]. Moreover, weeds harbor insects and pathogens and lead to high production costs to manage them apart from the yield reduction of 57.6 to 73.2% [7]. This paper, therefore, is aimed to review studies that have been conducted regarding the impact of weeds on important cereal crops production including on quality deterioration of grains.

2. METHODOLOGY

This paper is written as a review article the data included in it is collected from secondary data sources that were conducted previously in Ethiopia and globally. Hence, various journal articles, proceedings, books, and reports were used to review and organize it. Tables and figures were used as reviewing techniques to make the review briefer.

3. RESULTS AND DISCUSSION

3.1 Production Losses of Major Grain Crops Caused by Weeds

Crop losses caused by weeds can be both quantitative and qualitative. Quantitative loss is the reduction of crop productivity whereas qualitative losses by pests may be accounted from a decline of valuable ingredients content, and quality of market due to contamination of the product with weed seeds, fungus, or insects damage and faces. These can be expressed in kg/ha, financial loss/ha, or percentage loss (relative terms) [8].

The total global potential loss due to weeds varied from crop to crop. Weeds, insect pests, and pathogens caused the highest potential loss (34%, 18%, and 16%), respectively, whereas the actual loss is severed by insects, pathogens, and weeds, respectively. This is since the efficacy and knowledge to manage these pests were higher by producers [8].

3.1.1 Production loss of wheat by weeds

Wheat (*Triticum aestivum* L.) is one of the most important cereal crops developed globally and marketed that covers 15% of the world's total cereal crops acres [9]. It is a valuable industrial and food grain that ranks second among the most productive cereal crops after rice and is globally traded [10]. The country's southern, southeastern, and northwestern highlands are Ethiopia's major wheat-growing regions and the regional wheat production in the country comes from Oromia (57.4%), Amhara (27%), Southern Nations Nationalities and Peoples (8.7%), and Tigray (6.2%) [11].

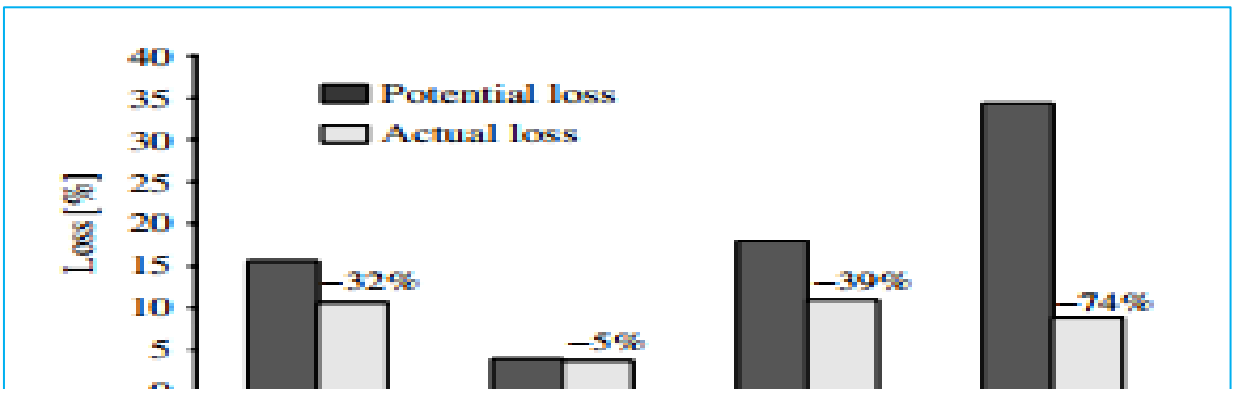

Fig. 1. Major crops global losses by pests in 2001-2003 (Source: Oerkece, [8])

Table 1. Global estimated potential and actual losses in major crops by weeds in 2001-2003

Crop	Attainable production (mt)	Weeds	
		Potential	Actual
Wheat	785.0	23.0 (18-29)	7.7 (3–13)
Rice	933.1	37.1 (34–47)	10.2 (6–16)
Maize	890.8	40.3 (37-44)	10.5 (5-19)
Potatoes	517.7	30.2 (29-33)	8.3 (4-14)
Soybeans	244.8	37.0 (35-40)	7.5 (5-16)
Cotton	78.52	35.9 (35-39)	8.6 (3-13)

Source: Oerkece, [8]

Table 2. Regional area coverage, production, and productivity from 2016/2017 to 2017/2018

Region	2016/2017 production season			2017/2018 production season		
	Area (ha)	Production (qt)	Yield (qt/ha)	Area (ha)	Production (qt)	Yield (qt/ha)
Oromia	898.46	26,640.24	29.65	898.68	26,699.18	29.71
Amhara	554.28	13,190.62	23.80	554.66	14, 047.07	25.33
SNNP	127.21	3,287.59	25.84	127.25	3391.96	26.66
Tigray	107.72	2,128.67	19.76	107.63	2,140.03	19.83
Benishangulgumz	2.08	-	-	2.46	59.08	24.06

Source: CSA (2017 and 2018)

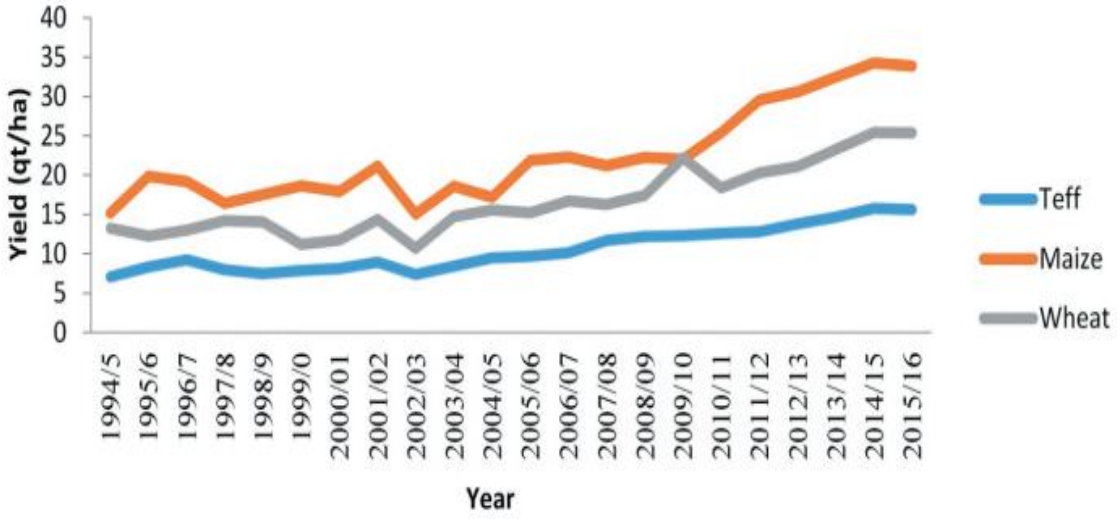

Fig. 2. The average yield of wheat, maize, and *teff* from 1994 to 2016 (Source: PARI, 2015)

Table 3. The effect of weed infestation on the wheat and its estimated yield loss [15]

% yield loss	Ambo		Dand		Toke Kutaye		Cheliya		Mean
	F	(%)	F	(%)	F	(%)	F	(%)	(%)
<20	4	27	6	40	7	47	7	47	39
20-30	2	13	0	0	4	27	4	27	17
31-40	5	33	3	20	4	27	4	27	27
41-50	4	27	3	20	0	0	0	0	12
>50	0	0	3	20	0	0	0	0	5

F=Frequency

The major yield-limiting factor for wheat productivity is weed infestation (Fig. 2). Weed interference is one of the most significant but less understood factors that contribute to a reduction in wheat yields [12]. Weed as the key restriction and its rise in infestation in the last five years has had a strong effect on the production of wheat [4]. Weed infestation is a significant barrier to higher wheat production and represents a loss of more than 48% of potential wheat yield [13]. However, the extent of weed-related losses depends on the form and density of a given weed species, their time of emergence, and the period of intervention. Yield losses are most serious when resources are scarce and at the same time weeds and crops emerge [14].

Uncontrolled growth of weeds during crop development has resulted in a yield reduction of 57.6 to 73.2% while rising production costs and intensifying the disease and insect pest problem by serving as alternative hosts (Amare *et al*.,2014). Moreover, weeds show economic losses for wheat crops ranging from 24-39, 95% must be controlled during the crop's full growing season to achieve satisfactory crop yields [16].

Weeds infestation is a very serious constraint in wheat production in Ethiopia, especially during the rainy season [4]. In Ethiopia, farmers are aware of the weed problem in their fields even though they cannot cope-up with heavy weed infestation during the peak period of agricultural activities due to labor shortage as hand weeding is the most dominant practice, and their fields are weeded late or left un-weeded [17]. The main factor for the low yield of wheat is ineffective weed management and it results in yield loss ranging from 45% to 86% when there is uninterrupted weed growth [4] (Eshetu et al., 2006).

According to Belete et al. [4], the grain yield of wheat was significantly differed due to the weed management method, and the highest grain yield of 4788 kg ha^{-1} was recorded from the weed-free treatment whereas the lowest of 1299 kg ha^{-1} was recorded from the treatment of weedy plots. So that, weeds have a great production loss effect on the wheat crop (Table 4) [4]. Moreover, as to the response of 38%, 27%, 17%, 12%, and 5% of farmers, an estimated yield loss of wheat due to weeds were less than 20%, 31-40%, 20-30%, 41-50%, and >51%, respectively [15].

3.1.2 Global and Ethiopian production loss of rice caused by weeds

There are about 350 weed species with more than 150 genera and 60 plant families in the world so far identified as rice weeds [19]. Gramineae are the most frequent species with more than 80 reported as rice weeds [20]. Cyperaceae, Alismataceae, Compositae, Leguminosae, Lythraceae, and Scrophulariaceae are other plant families with various species that are common rice weeds [19]. The 10 most common weed species of rice worldwide are *Echinochloacrusgalis*, *E. colonum*, *Cyprus difformis*, *C. rotundus*, *C. iria*, *Eleusine indica*, *Fimbristylismiliacea*, *Ischaemumrugosum*, *Monochoria vaginalis*, and *Sphenocleazeylanica* [19,21]. Some of these weeds are problems in all rice cultures, and others are problems in only one culture [19].

The yield loss of rice due to weeds is estimated at 56 million metric tons, priced at $12 billion globally. These losses are influenced by the competition of weeds and rice species or groups of weeds, weed density, duration of the competition, planting method, cultivar, fertility level, water management, crop row spacing, allelopathy, and interactions of these [19]. The direct competition for sunlight, nutrients, and water by weeds increases production costs and reduces yields and quality [22]. Yield loss is highly variable among the different locations, crop, and soil types and in direct-seeded rice, it can be 15-66% (Gharde *et al*., 2020). Johnson et al. [23] was also described as it can be up to 46% and 90%. Weeds can also cause about 37.02% of yield loss [24].

Table 4. Effect of weed control methods and wheat production loss

Treatments	Grain yield (kg ha^{-1})		HI (%)		RYL (%)	
	2014	2015	2014	2015	2014	2015
Hand weeding	3500.0^{b}	2851.1^{a}	25.12^{b}	26.3^{b}	16.4^{c}	28.2^{b}
2,4-D at 2.0 kg ha^{-1} + Hand weeding	4322.2^{a}	3988.9^{a}	31.56^{ab}	29.7^{a}	0.0^{d}	0.00^{c}
2,4-D at 2.0 kg ha^{-1}	2444.4^{c}	2526.7^{b}	22.21^{b}	20.6^{c}	41.5^{b}	6.3^{b}
Weedy check	1166.7^{d}	1082.2^{c}	11.4^{c}	9.8^{d}	72.0^{a}	72.7^{a}
LSD (0.05)	802.31	746.3	5.41	1.9	14.89	16.44
CV (%)	14.17	13.61	11.39	9.7	22.93	22.8

HI: Harvest Index, RYL: Relative Yield Loss (Source: Amare et al., [18])

In Southwestern Ethiopia, weeds are major rice production constraints especially in labor-limited upland rice-based systems [25]. In addition, weeds in any of the rice ecosystems are cited among the main production constraints [21]. Poor soil preparation, contamination of rice seeds with weed seeds, use of poor quality rice seeds, transplanting of seedlings in lowlands, use of old rice seedlings for transplantation, poor water, and fertilizer management, monocropping, labor shortages, and delayed herbicide application are the most common agronomic factors that contribute for weeds problem in rice production crop intensification and inadequate fallow management are also contributing factors in the upland systems [26].

However, the type and extent of weed issues differ as per the rice ecosystem. Similarly, the agroecosystem determines the weed management activities to be used, biophysical and socioeconomic factors [21,25]. In 80% of the total rice production area of upland rice-growing countries' survey data, weeds were the most widely recorded biological yield-limiting factors. But upland rice, in particular, competes poorly with weeds and uncontrolled weed growth often results in negligible or zero yields [25].

About 23% of potential and actual yield losses in rice are accounted for by weeds problem worldwide [27]. Losses due to uncontrolled weed growth in Indian upland rice were up to 90%, and in both lowland and upland systems in Africa ranged from 28 to 100% (and losses in both lowland and upland systems in Africa ranged from 28 to 100% [28]. Yields could be increased by 23% in areas of rain-fed lowland rice through improved weed control, while yields could be increased by 16 percent in the most common upland rice systems without bunds [26].

The problem of weeds in Sub-Saharan Africa account for tice yield losses of at least 2.2 million tons per annum at a value of $1.45billion, apart from weed control costs [25]. On the other hand, uncontrolled weed growth significantly reduced rice grain yield by 68% compared to the grain yield obtained from the weed-free check plots [29]. However, the beginning and the end of the critical period of weed crop competition were based on 5 to 10% acceptable yield loss levels [29].

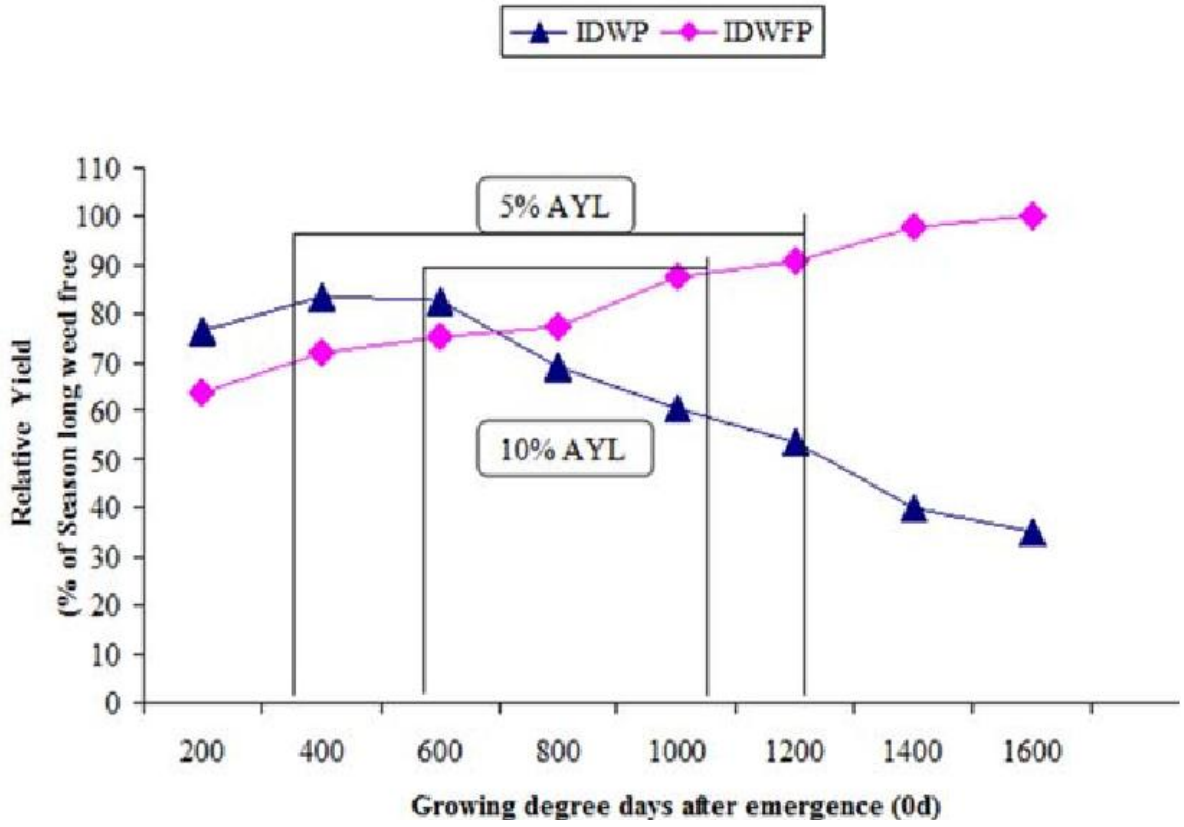

Fig. 3. The relation of weed crop competition and relative rice yield at Gojeb during 2016 main cropping season (*AYL: Acceptable yield loss level, IDWP: Increasing duration of weed-interference periods, IDWFP: Increasing duration of weed-free periods)* (Source: Mekonnen et al., [29])

3.1.3 Effect of weeds on the production of sorghum

Weeds cause a considerable crop loss and allow farmers to spend their time on management and this sadly is a common feature observed in Ethiopia's sorghum and maize growing areas (Asmare *et al*., 2015). As studies showed that sorghum and maize crops are highly sensitive to weed competition, especially during their early growth stage (Cerrud *et al*., 2012). Uncontrolled weed growth is reported to result in at least 30% yield loss in sorghum [30]. Weed flora shifts by the management taken and the environmental degradation attest to develop sustainable weed management systems [31].

The productivity of sorghum is reduced due to several biotic and abiotic stresses [71]. The major constraints in Africa and Ethiopia, in particular, are the problems of various invasive and devastating weeds including Striga [32]. *Striga spp*. are compulsory hemiparasitic plants that attack their host roots to obtain water, nutrients, and carbohydrates [33]. Striga is a major biotic constraint in Ethiopia and a serious threat to food subsistence production.*S.hermonthica* mainly attacks sorghum, finger millet, and maize in tropical and subtropical regions that spread to Ethiopia across west Africa [34]. *Striga hermonthica*, the dominant species in the highly degraded northern, northwestern and eastern parts of the country, such as Tigray, Wollo, Gonder, Gojam, northern Shewa, and Harerghe [35].

Striga (witchweeds) are notorious root hemiparasites on cereal and legume crops especially in the tropical and sub-tropical semi-arid regions of Africa, India, the Arabian Peninsula, and parts of eastern United States. It causes yield losses which are between 5 and 90%; total crop loss data were reported [36,37,34]. Striga infests and significantly decreases cereal crop yields including rice, pearl millet, corn, and sorghum [38]. It is commonly distributed in the lowland regions in Ethiopia where sorghum is dominantly cultivated and its yield loss due to Striga damage varies from place to place [34]. It is estimated an average yield loss of 65% in moderate to heavy infestations [39].

Tomado et al. [41] also reported a 69 percent decrease in the yield of sorghum grain on 3 plants of parthenium m^{-2} and to alleviate such a serious threat of parthenium to crops, no substantial work has yet been done with precise regard to forage crops and their level of economic threshold. Parthenium causes significant losses of yield in sunflower, sorghum, maize, pigeon pea, black grams, and fodder [42].

3.1.4 Effect of weeds on the production of Maize

Maize yield can be reduced by the supreme importance biotic factor, weed infestation, and its production is hampered up to 40% by competition from weeds [43]. Maize grain yield, organic yield, 100-grain weight, grain weight per cob and its harvest index decreased when five or more plants of parthenium weed per m-2 infested the crop plants and yield losses varied between 21 and 50% with *Parthenium hysterophorus*5 to 20 plants density [44]. This adverse impact is due to *Parthenium hysterophorus* maximum uptake of N, P, and K which was 78.0, 9.0, and 64.0 kg ha^{-1}, respectively, and thus, it should be controlled at density levels of 1.2 and 1.0 plants m^{-2} as determined by the predictive model [45].

Table 5. The proportion of Striga severity on sorghum production in north-eastern Ethiopia

Constraint	Low altitude			Mid altitude		
	HS	MS	LS	HS	MS	LS
Moisture stress	84.8	10.1	5.1	87.0	8.7	4.3
Insects	57.0	34.2	8.9	54.3	32.6	13.0
Striga	50.6	31.6	17.7	59.8	21.7	18.5
Diseases	12.7	38.0	49.4	43.5	32.6	23.9
Birds	36.7	44.3	19.0	16.3	18.5	65.2
Flooding	12.7	50.6	36.7	15.2	19.6	65.2
Poor soil fertility	34.2	55.7	10.1	54.4	25.0	19.6
Limited land availability	31.6	45.6	22.8	53.3	39.1	7.6
Production inputs	12.7	24.1	63.3	15.2	23.9	60.9
Low-yielding local cultivars	24.1	50.6	25.3	10.9	28.3	60.9
Lack of improved cultivars	19.0	48.1	32.9	18.5	32.6	54.4
Undesired improved cultivars	31.7	43.0	25.3	27.2	29.3	43.5

HS = Highly severe, MS = Moderately severe, LS = Less severe; (Source: Assefa et al., [40])

In Ethiopia, both biotic (weeds, plant pathogens, insect pests, rodents, and wild animals) and abiotic factors (drought, hailstorm, flood, nutrient deficiency, soil type, topographic features) are the major maize production problems [46]. Amongst, the competition of weeds for light, nutrients, water, carbon dioxide reduced maize yield as well as interfering with harvesting and increasing the cost of crop production [47]. Amare *et al*. (2014) reported that weeds impose the highest loss potential (37%) over animal pests and pathogens (36%). The common loss (40%) due to weeds infestation in maize is higher than wheat, sorghum, *teff*, and barley losses (35%, 30%, 30%, and 18%), respectively in most farmers of Ethiopia [48].

Although it is necessary to keep the maize weed-free for the cropping season to achieve the highest possible yield, weeding costs increased and the grain yield declined as the weed removal period was delayed [49]. Yield loss due to weeds in the first 6, 9, and 12 weeks after emergence (DAE) and 36, 61, 80, and 85% for the entire growing season, respectively [50]. Up to 69% yield loss has been reported on the unweeded control plots. For the first six weeks, competition at Asossa was serious [51]. At Awassa, weed rivalry had a critical time of between 31 and 49 DAE [52]. The authors proposed two weeding at the beginning and the end of the period to substantially reduce the competitive impact of weeds (Taddesse, 2008).

3.1.5 Production loss of barley by weeds infestation

Weed competition reduces the yield of barley at the third to sixth leaf highly sensitive stage which is about two to four weeks after the emergence. Weeds that emerge after this time have less competitive effects, but may interfere with harvesting, and act as a subsequent source of field infestation [53]. An average of about 18% barley yield loss has resulted when the crop has not received weed control [30]. Nowadays, grass and sedge weeds are more troublesome in the development of barley than broadleaf species due to the limited existence of available herbicides and difficulties in distinguishing between species at the time of weeding by hand [53].

In addition to intraspecific competition, interspecific competition occurs in weed-infested fields between different weed species and between weeds and crops [54]. Weeds can significantly reduce yields due to an increased number of plants within a given area as crop density is chosen to maximize yield under prevailing environmental conditions [55]. Different crop species have different competitive abilities with weeds competition, and the ability to compete (AC), as well as the ability to withstand competition (AWC), should be investigated comparing the competitiveness of species [56].

Weeds are common in Ethiopia's crop fields, and approximately 81 weed species have been reported in barley-grown fields in Ethiopia, of which 26 have been classified as major [57]. *Avenasp* (wild oat), *Medicago polymorpha*, *Scorpiurusmuricatus*, *Erucastrumarabicum*, *Cynodondactylon*, *Lolium temulentum*, *Digitaria sp*. are among the most dominant weed species affecting barley production [58]. Weed infestation can cause yield loss of 37% under natural weed infestation barley and in a field experiment, losses can be 60% of yield and 40% of dry aboveground biomass in fields artificially infested with 50% wild oat weed seeds at planting (Abrha *et al*., 2016).

Broadleaf herbicides are mostly applied in many barley fields and under such partial weed management, barley fields infested with grass weeds are commonly observed, causing yield losses of up to 60% in some growing areas [59]. Weeds can play a major role in harboring insects, which serve as an alternative host for certain diseases and add to the production costs (Capinera, 2005). Moreover, weeds threaten future crops where seeds can be produced and shed to regenerate apart from their effect on yield and profitability reduction [53]. The percent grain yield loss of *Snowdenia polystachya* (66,73) competition was highest with barley, whereas the percent grain yield loss per weed plant per unit of area (I) was highest for Erucastrumarabicum (0.64%) (Table 6) [53].

Table 6. The effect of major weeds on barley yield

Weed species	Parameter		
	ywf (kg/ha)	A (%)	I (% m^2/plant)
Avena fatua	3256	57.24	0.47
Erucastrum arabicum	3615	12.26	0.64
Guizotia sabra	2952	41.59	0.50
Snowdenia polystachya	2896	66.73	0.30

Ywf = weed free yield, A = maximum percent yield reduction, I = Percent yield loss per unit of density (Source: Bayeh Mulatu and Grando, [53])

3.2 Quality Deterioration of Grains Caused by Weeds and its Prevention

Weed seeds should be rejected when the crop contains it and is grown for seed. For example, the wild oat weed seeds are similar in shape in size and shape of the crops like barley, wheat, and its admixture may lead to rejection for seed purposes [60]. The seed of grains is unacceptable if it is contaminated by poisonous weed seeds and increases the costs of crop cleaning [61]. About 35% of the total possible biological product is lost yearly due to diseases, animal pests, weeds, and abiotic stresses and harvest destroy with 1051.5 mt being lost before harvest [2].

Weed always has a negative connotation not only by its presence as a plant but as a primary source of new populations on the site of their production or elsewhere, and its actual problems start with weed seeds [62]. The weed seed contaminants in the crop produce cause quality deterioration and weed seeds in grain crops perpetuate when the seed is replanted [61]. The colonization of new areas by most of the weeds by the movement of weed seeds, once seeds have been produced, they disperse in space by several methods [63].

Many weed species possess well-adapted appendages which enable it to attach and to assist in the long-distance movement of their seeds, by which the opportunity of biological invasion begins [64]. In nature, their distribution is facilitated by winds, water, or animal movement [63]. However, globalization and World Trade Organization (WTO) regime result in the free flow of food grains and other commodities across borders that enhance the possibility of movement of weed seeds along with food grains from one country to other [65].

Controlling weeds in a seed production plot is crucial because weeds result in a loss of crop yield and quality [66]. It also serves as alternative hosts for other pests, reduces nutrient use efficiency, lowers the efficiency of irrigation systems, and impairs quality and quantity of harvest [17]. Other important ways of interference are by allelopathy, increasing cost of seed production due to additional cost involved in weed removal/control [67]. The quality is affected due to weed interference by reduction of size, shape, color, the weight of individual seed, etc. by competition as well as by admixture of weed seeds with crop seeds [68].

Weed management is essential in seed production for producing seeds of high quality and optimizing yields, but large quantities of valuable crop seed can be lost during seed cleaning and conditioning when harvesting weed seeds [69]. For effective control of weeds, all management practices such as field selection, crop rotation, tillage, seed source, cultivation, irrigation, herbicides, and harvest methods must be used together [68]. Better conditions for harvesting and storage could avoid losses of 420 mt [2].

Belete *et al*. [4] has reported as 2,4-D might be applied as salts, esters, amines or free acid formulations at rates ranging from 250 g to 2 kg/ha depending on the type of cereal crop, the weed spectrum, cultural practices, and climatic factors. Good weed management is one of the essential ingredients to increasing food production and knowledge of weed seed characteristics, morphology, ontogeny, nature of competition, and degree of association with crops are pre-requisite for suggesting some efficient weed control measures [70].

4. CONCLUSION AND RECOMMENDA-TIONS

Crops yield can be reduced by various factors, such as climatic conditions, edaphic factors, weeds, insect pests, and diseases. Weeds are one of the major bottlenecks of crop production and productivity. The crop loss caused by weed infestation is varied depending on the crop type, agroecology (soil type, moisture status), and location. Uncontrolled weed growth caused a total of a yield reduction that ranges from 45 to 73.2%throughout the crop production season. The losses can be estimated as high as26–29%, 31%,90%, 60%, 64% for wheat, maize, rice, sorghum, and barley, respectively. These losses have resulted from the suppressive effect and competition of weeds for light, nutrients, and moisture. Weeds can also be used as alternative hosts of insects and pathogens, indirectly affecting the crop yield.

Moreover, weeds affect the quality of grain since their seed contaminants in crop production and perpetuate when the seed is replanted. Weed seeds serve as a primary source of new populations on the site of their production or elsewhere which increases the field weed seed bank. Poor quality of grain ultimately reduces the market value, nutritional status, and viability for a long storage period. Generally, weeds affect the quality and quantity of agricultural produce. Therefore, it is recommended to manage weeds infestation in different strategies that can be cultural practices, use of herbicides, manual and mechanical weeding including quarantine control system (application of integrated weed management).

ACKNOWLEDGEMENT

I sincerely thank MerkuzAbera (Ph.D.) from Bahir Dar University who encouraged me to write the review on the title and show weed's negative impact on the most important cereal crops.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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