

Effect of Weed Control Methods on Weeds and Wheat (*Triticum Aestivum* L.) Yield

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Abstract A field experiment was conducted from June to December during 2010/11 crop season at HARC to study the effect of herbicides rates on weed dynamics and yield of wheat (*Triticumaestivum* L.) variety “HAR 604” in randomized complete block design with three replications. the herbicides rates: clodinafop-propargyl(0.065,0.080, 0.105kg ha^{-1}) and isoproturon (1.00, 1.25, 1.50kg ha^{-1}), hand weeding at tillering and weedy checkwere used. The crop was infested with *Avenafatua*L. and *Phalarisparadoxa*L. among grass weeds and *Cayluseaabbyssinica*Meisn, *C. trigyna*L., *Chenopodium album* L., *Corrigoialacapensis* Wild, *Guizotiascabra*(Vis) Chiov, *Oxalis latifolia*HBK, *Polygonumnepalense*L., *Raphanusraphanistrum*L., *Spergulaarvensis*L. and *Tagetesminuta* L. among broadleaved weeds. Hand weeding followed isoproturon at 1.50 kg ha^{-1} significantly reduced density and dry weight of weeds. Among herbicides, isoproturon provided better control of broadleaved and total weeds, whereas; clodinafop-propargyl proved better than isoproturon in controlling grass weeds. Hand weeding and hoeing at tillering resulted in lowest weed dry weight. Highest grain yield (2289.4 kg ha^{-1}) in was recorded in hand weeding followed by isoproturon at 1.5kg ha^{-1} (2177.3 kg ha^{-1}). The highest straw yield was recorded in hand weeding followed by isoproturon 1.50 kg ha^{-1} , and harvest index was also maximum with hand weeding. Maximum N-uptake was also recorded in these treatments. Post emergence herbicides and /or hand weeding and hoeing at tillering can further enhance the weed suppressive effect of the crop.

Keywords: weeds, weed control, wheat (*Triticumaestivum* L.)

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1. Introduction

Wheat occupies about 17% of the world’s cropped land and contributes 35% of the staple foods so its increased production is essential for food security [17]. Wheat is one of the major cereal crops grown in the Ethiopian highlands [10]. Despite its importance in Ethiopia, the mean national yield is 1.3 tons ha^{-1} which is 24% below the mean yield of Africa and 48% below the global mean yield of wheat [10]. Weeds are one of the major constraints in wheat production as they reduce productivity due to competition, allelopathy, by providing habitats for pathogens as well as serving as alternate host for various insects and fungi and increase harvest cost [1,6]. Studies indicated that crop losses due to weed competition throughout the world as a whole, are greater than those resulting from combined effect of insect pests and diseases. It causes yield reduction in wheat from 10- 65% [8]. Physical methods are laborious, tiresome and expensive due to increasing cost of labor, draft animals and implements and Weeds cannot effectively be managed merely due to crop mimicry, therefore, the use chemical weed control has

become necessary [15]. However, the choice of most appropriate herbicide, proper time of application and proper dose is an important consideration for lucrative returns [1,13,15,19]. Application of herbicides decreased dry weight of weeds significantly compared to dry weight in non-treated plots and increased yield components and grain yield [5,7]. Therefore seeking and evaluation of herbicides is excellent option for efficient weed control. In view of these facts the present study was designed with the following objectives are to evaluate the efficacy of herbicides rates on weeds and yield and yield components of wheat.

2. Materials and Methods

The experiment was conducted at Holleta Agricultural Research Center which is located 34 km to the west of Addis Ababa. The soil of the experiment was clay loam in texture with pH 6.65, organic carbon 2.26%, available P 14.17 mg kg^{-1} soil, total nitrogen 0.12% and cation exchange capacity, 17 Cmol kg^{-1} soils. The experiment comprised eight treatments of two herbicides each at three rates of application, one hand weeding and hoeing at

tillering and weedy check. The experiment was laid out in a randomized complete block design with three replications.

Table 1. Common, trade and chemical names of the herbicides

Common name	Trade name	Chemical name
Clodinafop-propargyl	Topik 15%EC	[Propanoic acid, 2-[4-[(5-chloro-3-fluoro-2-pyridinyl)oxy]phenoxy]-2-propynyl ester, (2R)]
Isoproturon	Isoguard 75% WP	[3-(4-isopropylphenyl)-1, 1-dimethylurea; 3-p-cumenyl-1, 1-dimethylurea]

Herbicides were applied as post emergent at crop tillering stage i.e. about 30-35 days. Wheat variety HAR 604 was planted at recommended seed rate (150 kg ha⁻¹) in plots. Fertilizer was used at the rate of 64 kg N ha⁻¹ and 46 kg P₂O₅ ha⁻¹ through diammonium phosphate (DAP) and urea. Half of nitrogen and full amount of phosphorus was drilled in rows at the time of sowing and the remaining N through urea was applied at shoot elongation stage of crop.

Weed population was counted with the help of quadrat (0.25cm X 0.25cm) thrown randomly at three places in each plot at jointing, ear head emergence and converted in to m² area. The aboveground weed dry matter was also recorded from the above thrown quadrates after cutting weeds from the ground level and then oven dried at 70 °C and converted to m². Tillers m⁻², plant height, number of grains per spike thousand kernel weights grain yield and straw yield were recorded. Harvest index (%) was calculated by the following formula;

$$HI = \frac{\text{Grain yield}}{\text{Total above ground dry biomass yield}} \times 100$$

The total nitrogen uptake by the wheat crop and associated weed was determined by Kjeldhal digestion method (Jackson, 1958). The uptake of nitrogen (kg ha⁻¹) was calculated as

$$\text{Uptake of N} = \frac{N(\%) \times \text{dry weight} \left(\frac{\text{kg}}{\text{ha}} \right)}{100}$$

Weed control efficiency (WCE) was determined by the following formula;

$$WCE = \frac{WDC - WDT}{WDC} \times 100,$$

Where, WDC = weed dry mass from the control plot (untreated), WDT = weed dry matter from treated plot. Weed count were subjected to square root transformation, $\left(\sqrt{(X + 0.5)} \right)$. Analysis of variance and mean separation tests were applied according to the method described by [9] using the SAS computer software package.

3. Results and Discussion

3.1. Weed Flora

The weed community comprised both broadleaved and grass weeds. Out of total weeds present in the experimental field 83.3 % were broadleaved while 16.6% were grasses (Table 2).

Table 2. Scientific names, families, life form and categories of weeds in experimental field

Scientific name	Family	Life form (Category)
<i>Avena fatua</i> L.	Poaceae	Annual (Grass)
<i>Cayusea abyssinica</i> Meisn	Resedaceae	Annual (Broadleaved)
<i>C. trigyna</i> L.	Resedaceae	Annual (Broadleaved)
<i>Chenopodium album</i> L.	Chenopodiaceae	Annual (Broadleaved)
<i>Corrigiolalacapsensis</i> Wild	Caryophyllaceae	Annual (Broadleaved)
<i>Guizotia scabra</i> (Vis) Chiov	Asteraceae	Annual (Broadleaved)
<i>Oxalis latifolia</i> HBK	Oxalidaceae	Usually perennial (Broadleaved)
<i>Phalaris paradoxa</i> L.	Poaceae	Annual (Grass)
<i>Polygonum nepalense</i> L.	Polygonaceae	Annual (Broadleaved)
<i>Raphanus raphanistrum</i> L.	Brassicaceae	Annual (Broadleaved)
<i>Spergularia arvensis</i> L.	Caryophyllaceae	Annual (Broadleaved)
<i>Tagetes minuta</i> L.	Asteraceae	Annual (Broadleaved)

3.2. Weed Density

The effects weed management practices on weeds density were also significant. Among the weed management practices the minimum weeds density (2.61 m⁻²) was recorded in hand weeding followed by isoproturon at 1.50 kg ha⁻¹ (3.05 m⁻²) and 1.25 kg ha⁻¹ (4.03 m⁻²) while the maximum total weed density (6.53 m⁻²) was in weedy check (Table 3). These findings are in accordance with result of [3] who stated that weed population is lower in herbicides treated plot than control plot.

Table 3. Effect of weed management practices on weed density (m⁻²) at different crop growth stage

Weed management practices	Weed density (m ⁻²)		
	Jointing stage	earhead emergence stage	dough stage
Clodinafop-propargyl 0.065 kgha ⁻¹	5.72(35.44)	7.17(52.89)	8.78(77.78)
Clodinafop-propargyl 0.080 kgha ⁻¹	5.73(33.78)	7.16(52.33)	8.80(77.78)
Clodinafop-propargyl 0.105 kgha ⁻¹	5.69(33.11)	7.13(51.89)	8.39(70.78)
Isoproturon 1.00 kgha ⁻¹	4.98(25.89)	6.49(43.67)	8.40(71.67)
Isoproturon 1.25 kgha ⁻¹	4.03(17.00)	5.24(28.67)	7.264(53.67)
Isoproturon 1.50 kgha ⁻¹	3.05(9.44)	4.12(17.89)	5.92(35.89)
Hand weeding at tillering	2.61(5.22)	3.36(10.78)	4.51(20.22)
Weedy check	6.53(43.44)	8.20(68.33)	10.02(100.7)
LSD(0.05)	0.35	0.25	0.34
CV (%)	4.60	4.00	3.85

Figures in parenthesis are the original values, LSD =least significant difference, CV =coefficient of variation

3.3. Weed Dry Weight

The effect of weed management practices on weed dry weight was significant. The lowest weed dry weight (1.64 g m⁻²) was recorded in hand weeded plots but it did not differ significantly with isoproturon at 1.50 kg ha⁻¹ (2.54 g

m⁻²) whereas the highest weed dry weight (7.36 g m⁻²) was recorded in weedy check (Table 4). These findings are also in conformity with those of [18] who reported that broad spectrum herbicides like isoproturon significantly reduced weed biomass in the plots having both grass as well as broadleaved weeds. In general, significant

reduction in weed dry weight with the application of isoproturon might be due to more effectiveness of isoproturon than clodinafop-propargyl on broadleaved weed. These findings are also in conformity with those of

[18]. These results were also in agreement with the work of [12] who verified that broad spectrum herbicide that reduced the weed dry weight as compared to narrow spectrum herbicide and weedy check.

Table 4. Effect of weed management practices on total weed dry weight (g m⁻²) at early jointing earhead emergence and dough stage

Weed management practices	Weed dry weight		
	Early jointing	Earhead emergence	Dough
Clodinafop-propargyl 0.065kg ha ⁻¹	6.33	14.89	22.88
Clodinafop-propargyl 0.080 kg ha ⁻¹	5.92	14.25	22.51
Clodinafop-propargyl 0.105 kg ha ⁻¹	5.45	14.04	21.84
Isoproturon 1.00 kg ha ⁻¹	5.02	12.98	20.59
Isoproturon 1.25kg ha ⁻¹	3.94	11.17	17.62
Isoproturon 1.50 kg ha ⁻¹	2.54	8.48	15.47
Hand weeding at tillering	1.64	7.94	14.21
Weedy check	7.36	17.02	24.78
LSD (0.05)	1.16	1.89	0.93
CV(%)	6.48	5.48	6.85

LSD =least significant difference, CV =coefficient of variation

3.4. Weed Control Efficiency

Effect of weed management practices on weed control efficiency was significant at all crop growth stage. The data (Table 5) showed that among the weed management a practice early jointing stage, the highest weed control efficacy (78.40%) was recorded in hand weeding followed by isoproturon at 1.50 kg ha⁻¹ (67.99 %). Increasing isoproturon rates significantly increased weed control efficiency. Similarly the ear head emergence stage, effect of weed management practices on weed control efficiency was significant. The highest was recorded in hand weeding (54.23%) followed by isoproturon 1.50 kg ha⁻¹ (52.00 %) however, nonsignificant difference was

observed between them. Further at dough stage also effect of weed management practices on weed control efficiency was significant. The highest was recorded in hand weeding (44.02%) followed by isoproturon 1.50 kg ha⁻¹ (39.01%) however nonsignificant difference was observed between them. Interestingly as stage of crop development increase there was decrement in weed control efficiency and isoproturon at all rate of application was better than clodinafop-propargyl at all rate of application this might be due to broadness of isoproturon against both broad and grassy weeds. These finding are in accordance with [3] who reported that herbicides with broad spectrum provided better weed control efficiency than control treatment.

Table 5. Effect of weed management practices on weed control efficiency (%) at different growth stage

Weed management practices	Weed control efficiency (%)		
	Early jointing stage	Earhead emergence stage	Dough stage
Clodinafop-propargyl 0.065 kgha ⁻¹	14.59	12.58	8.47
Clodinafop-propargyl 0.080 kgha ⁻¹	20.62	16.02	10.12
Clodinafop-propargyl 0.105 kgha ⁻¹	28.72	17.87	13.03
Isoproturon 1.00 kgha ⁻¹	33.721	24.96	19.57
Isoproturon 1.25 kgha ⁻¹	48.970	35.66	30.25
Isoproturon 1.50 kgha ⁻¹	67.99	52.00	39.01
Hand weeding at tillering	78.40	54.23	44.02
Weedy check	-	-	-
LSD (0.05)	8.48	5.61	5.59
CV	13.43	15.77	11.22

LSD =least significant difference, CV =coefficient of variation

3.5. Plant Height

Effect of weed management practices on plant height was not significant. However, numerically the highest plant height was recorded from hand weeded (hoeing and

weeding) plots (114.1cm) followed by isoproturon at 1.50 kg ha⁻¹ (111.3 cm) whereas; the lowest was recorded in weedy check (103.1 cm) and clodinafop-propargyl at the lowest dose (102.0 cm). This indicated plants growing with effective weed control could attain higher height.

Table 6. Effect of weed management practices on plant height (cm), tiller (m⁻²), grain per spike(g) and 1000 kernel weight (g)

Weed management practices	Plant height (cm)	Tiller (m ⁻²)	Grain per spike (g)	1000 kernel weight(g)
Clodinafop-propargyl 0.065 kg ha ⁻¹	102.0	179.8	8.24	23.54
Clodinafop-propargyl 0.080 kg ha ⁻¹	104.7	190.5	10.21	25.57
Clodinafop-propargyl 0.105 kgha ⁻¹	105.9	197.3	12.44	27.64
Isoproturon 1.00 kgha ⁻¹	107.8	203.1	14.78	25.23
Isoproturon 1.25 kgha ⁻¹	109.3	211.3	18.23	28.11
Isoproturon 1.50 kgha ⁻¹	111.3	220.2	20.09	31.16
Hand weeding at tillering	114.1	226.7	21.28	33.47
Weedy check	103.1	166.4	7.11	19.88
LSD (0.05)	NS	2.76	0.97	1.55
CV(%)	6.29	4.15	5.94	7.46

LSD =least significant difference, CV =coefficient of variation, NS= nonsignificant difference

3.6. Number of Tillers

Effects of weed management practices on number of tillers were significant. The result showed highest number of tillers in hand weeding followed by isoproturon at 1.50 kg ha⁻¹ whereas it was the lowest in weedy check. As the application rate of the herbicides increased there was an increment in number of tillers. The higher number of tillers recorded in hand weeding and isoproturon at 1.50 kg ha⁻¹ might be due to more effectiveness of these treatments on weeds that resulted in lower weed dry weight thus reduced weed crop competition that contributed to more number of tillers. These results are in agreement with the work of [3,712,16] and [4].

3.7. Grain Per Spike

Effect of weed management practices on grains per spike was significant. The highest number of grains per spike was recorded in hand weeding followed by isoproturon at 1.50 kg ha⁻¹ whereas the lowest was recorded in weedy check. The data revealed that, as the rate of application of both herbicides increased grains per spike also increased however, isoproturon was better than clodinafop-propargyl in affecting grains per spike. This result is in accordance with the work of [12] who found

that broad spectrum herbicides gave higher grains per spike.

3.8. Thousand Kernel Weight

Effect of weed management practices on 1000 kernel weight was significant. The maximum 1000 grain weight (33.47 g) was recorded in hand weeding followed by isoproturon at 1.50 kg ha⁻¹ (31.56 g) and isoproturon at 1.25 kg ha⁻¹ (28.11g) that might have resulted due to effective weed control. These results are in agreement with the work [11].

3.9. Grain Yield

Effect of weed management practices on grain yield was significant. The overall grain yield in the experiment was low (Table 7) that was due to severe infestation of yellow rust in the crop. Among weed management practices, the highest grain yield (2102.4 kg ha⁻¹) was recorded in hand weeding followed by isoproturon at 1.50 kg ha⁻¹ (2027.1 kg ha⁻¹) whereas; the lowest was recorded in weedy check (819.2 kg ha⁻¹). These findings are in agreement with the work of [11,16] who reported that post emergence application of isoproturon was found to be the best treatment in reducing dry matter of weeds and producing the higher grain yield compared to control treatment in wheat crop.

Table 7. Effect of weed management practices on grain yield (kg ha⁻¹), Straw yield (kg ha⁻¹), Harvest index (%) of wheat

Weed management practices	Grain yield (kg ha ⁻¹)	Straw yield (kg ha ⁻¹)	Harvest index (%)
Clodinafop-propargyl 0.065 kg ha ⁻¹	1001.6	3285.3	23.3
Clodinafop-propargyl 0.080 kg ha ⁻¹	1169.4	3510.4	24.9
Clodinafop-propargyl 0.105 kg ha ⁻¹	1298.5	3719.9	25.8
Isoproturon 1.00 kg ha ⁻¹	1442.1	4137.7	25.9
Isoproturon 1.25 kg ha ⁻¹	1719.9	4745.2	26.3
Isoproturon 1.50 kg ha ⁻¹	2027.1	5295.5	27.6
Hand weeding at tillering	2102.4	5431.7	27.9
Weedy check	819.2	2926.3	21.7
LSD (0.05)	52.27	240.35	1.38
CV(%)	2.2	2.8	5.75

LSD= least significant difference, CV=coefficient of variation

3.10. Straw Yield

Similar to the effect on grain yield, the straw yield was also significantly affected weed management practices. Among the weed management practices (Table 7), the highest straw yield (5431.7 kg ha⁻¹) was recorded in hand weeding followed by isoproturon at 1.50 kg ha⁻¹ (5295.5 kg ha⁻¹), however, no significant difference was observed between them whereas, and the lowest was recorded in control (2926.3 kg ha⁻¹). Furthermore, with the increase in herbicide application rates, this was an increase in the straw weight but no significant difference existed between clodinafop-propargyl at 0.065 kg ha⁻¹ and at 0.080 kg ha⁻¹ and clodinafop-propargyl at 0.080 kg ha⁻¹ and at 0.105 kg ha⁻¹. Contrary to the effect of clodinafop-propargyl rates, with the subsequent increase in isoproturon rates the straw yield increased significantly.

3.11. Harvest Index

Effect of weed management practices on harvest index was significant. Among the weed management practices, the highest harvest index (27.9%) was recorded

isoproturon at 1.50 kg ha⁻¹ followed by hand weeding (27.6%) however, no significant difference was observed among them whereas; the lowest harvest index was recorded in control treatment (21.7%).

3.12. Nitrogen Uptake by Wheat

Weed management practices were significantly influenced N-uptake by the crop. The highest amount of nitrogen (101.7 kg ha⁻¹) was recorded in hand weeding followed by isoproturon at 1.50 kg ha⁻¹ (93.7 kg ha⁻¹), whereas; the lowest uptake by wheat (41.8 kg N ha⁻¹) was recorded in weedy check (Table 8). The significant variation in N uptake by wheat crop might be due to better control of weeds that enhanced growth and development of the crop. Thus the reduced weed competition for nutrients favored the crop against weeds resulting in increased N-uptake. These findings are in agreement with the work of [17] who reported herbicide use reduced the N-uptake by weeds in wheat and post-emergence application of isoproturon increased the nitrogen uptake in wheat over control and [14] also reported higher N uptake in herbicides treated plots.

Table 8. Effect of weed management practices on N uptake (kg ha⁻¹) by wheat crop (straw +grain)and weeds

Weed management practices	Nitrogen uptake (kg ha ⁻¹)	
	wheat crop	Weeds
Clodinafop-propargyl 0.065 kgha ⁻¹	51.2	7.96
Clodinafop-propargyl 0.080 kgha ⁻¹	57.0	7.57
Clodinafop-propargyl 0.105 kgha ⁻¹	64.3	7.17
Isoproturon 1.00 kgha ⁻¹	73.2	6.61
Isoproturon 1.25 kgha ⁻¹	83.9	5.27
Isoproturon 1.50 kgha ⁻¹	93.7	4.71
Hand weedingat tillermg	101.7	3.67
Weedy check	41.8	10.90
LSD (0.05)	5.75	0.94
CV(%)	4.93	8.49

LSD= Least Significant Difference, CV=Coefficient of Variation

3.13. Nitrogen Uptake by Weeds

Nitrogen uptake by weeds increased with the increase. These finding are in agreement with the work of [2,14] who observed that weeds compete very effectively with the crop for available nitrogen to the point that the reduction in yields from weed competition were generally accompanied by reduction in protein content as well.

4. Conclusions

From the one year experiment result, among the weed management practices it could conclude that hand weeding reduce broadleaved weed density, total weed density and dry weight of weeds at all stage of crop growth followed by isoproturon at 1.50 kg ha⁻¹. However density of grassy weeds in all crop growth stage were lower in plot treated with clodinafop-propargyl at 0.105 kg ha⁻¹. These treatments also increase yield and yield component and uptake of nitrogen of wheat significantly. However, because of the variation infecundity estimates in the study, further research is necessary in order to provide more accurate recommendation this research must be repeated.

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