



Evaluation and Demonstration of Different Post-Emergence Herbicides for Controlling Wild Oat (*Avena fatua* L.) and Other Grass Weeds in Wheat (*Triticum Spp*) at Bore



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Abstract

In the high lands of Ethiopia, weed causes considerable yield losses on wheat production due to absence of better management options for the producers. This also true, in the highlands of Guji Zone, Southern Oromia. Field experiment was conducted to study the effect of different Post-Emergence herbicides to Control wild oat and other grass weeds in wheat (*Triticum aestivum* L.) at Bore Agricultural Research Center on station and Ana Sora district on farm during 2015/16 cropping season to identify the most effective herbicide for the control of the targeted weeds thereby improving wheat production to the area. The Experiment was laid out in randomized complete block design using three replications. Pallas 450D, Current 8EC, Ralon super 144, hand weeding at tillering and weedy (check) were used as treatments. Based on the combined analyzed data result, significant variation was observed among treatments used for all of the parameters tested. Among the utilized herbicides, Pallas 450D showed better control of wild oat and other grass weeds. In other cases, hand weeding and hoeing at tillering resulted in lowest weed density. Highest grain yield (4210.7kg ha^{-1}) was recorded in Pallas 450D followed by Current 8 EC (4000.3kg ha^{-1}). Partial budget analysis of the study revealed that, applying Pallas 450D had the highest net field benefit (30591.9 ET birr) followed by Current 8EC (29512.3 ET birr ha^{-1} compared to Ralon Super 144 (26265.1 ET birr ha^{-1}), Three times hand weeding (22911.6 ET birr ha^{-1}) & weedy check (22919.4 ET birr ha^{-1}). However, Current 8EC had showed maximum economic profitability than Pallas 450D and other types with marginal rate of return (MRR) of 6494.4%.

Therefore, Current 8EC at rate of 1litre ha^{-1} is the best herbicide for the effective control of wild oat and other grass weeds in wheat under proper cultural practices and there by improve yield production of wheat up to 25.1% at high lands of Guji Zone, Southern Oromia.

Keywords: Wheat; Herbicide; Weed

Introduction

Wheat (*Triticum aestivum* L.) is the most important cereal crop cultivated worldwide and there by sustaining the livelihood of the world hungrier. Because, it serve as staple food for more than 40% of the world population [1]. Of the total cereal crop, wheat ranked fourth next to sorghum both interms of area (1.66 million hectare) and production (42.19 million qt) [2]. The national average yield of the crop is about 2.5t/ha. This is by far below the global average which is about 3.5t/ha. Multifaceted biotic & a biotic factor are responsible for this low yield. Cultivation of unimproved low yield varieties, insufficient and erratic rainfall, poor agronomic practices, disease and insect pests are among the most important constraints to wheat production in Ethiopia. Weeds are one of the major factors reducing crop

yield, deteriorate quality of crops and reduce farmers' income. Weed infestation is a very serious and less attended issue in the country. It has been estimated that delaying in weed causes up 35% yield loses in wheat annually [3]. They compete with crop plants for light, nutrient, moisture and space which they could be either of broad leaf or grasses. The major weeds compete with wheat are: Wild oat (*avena fatua*), *Phalaris minor*, *Cirsium arvense*, *Convolvulus arvensis*, *Ammi visnaga*, *Chenopodium album*, *Carthamus oxycantha* and *Euphorbia helioscopiais* are grassy weeds which have now became a threat to the nutritional requirement of mankind. Wild oat (*Avena fatua*) has increased tremendously in rain fed areas in the country. It is an c and difficult to eradicate because the seeds shatter before crop

maturation and many of the seeds are plowed into the soil where they lie dormant for one to many years and germinated when they are turned up near the surface.

Weed control is a major component in the production system of wheat whether it may manually, mechanically or physically. The use of herbicide is considered to be the most viable option for controlling weeds in wheat production. However, the existence of many grass weeds, specially, wild oat (*avena fatua*) create obstacle to increase production and productivity of wheat. Despite of development of high yielder, insect pest resistance varieties and other agronomic packages production of wheat in Southern Southern Oromia is challenged with several grass weed infestation. They are more problematic in wheat production than broadleaf species because of the selective nature of available herbicides and the difficulties of distinguishing between species while hand weeding. Hence many weed management practices such as, two times hand weeding, Mecoprop, 2,4-D, Brittox and the ready tank mixture of Mecoprop and 2,4-D, all at respective manufacturer recommendation rates can be a best management option in wheat production, control only broad leaves species while grass weeds, especially, wild oat (*Avena fatua*) compete with crop and causes significant yield losses in southern Oromia farming community.

Therefore, the present study was conducted to address the following objectives:

- a. To evaluate the efficacy of different herbicides on wild oat and other grass weeds
- b. To identify and recommend economically visible herbicides for wheat production to the study area

Materials and Methods

Description of the study area

The experiment was conducted at Bore Agricultural Research center on station and Ana Sora district on farm during 2015 and 2016 the main cropping season. Bore is located at about 387Km from A.A to South and that of Ana Sora is about 25Km from Bore which is 402Km from A.A to similar direction. Both locations represented high land agro-ecologies of Guji Zone having an altitude range of 2200-2780M.a.s.l. Both locations receive an annual rain fall of 1200-1750mm per annum. Maize, Barley and wheat are majorly produced cereal crops in the area.

Description of materials employed

For this experiment, two types of weed management practices (cultural and chemical) involving five treatments were used. Pallas 450D, Current 8EC, Ralon super144, hand weeding at tillering and weedy check were the utilized treatments. Improved bread wheat variety (Senate) was used as seed source. Knapsack sprayer was used for applying the herbicide. Quadrant having a size of 2.5M² was used to score weed population.

Experimental design and methods of treatment application

The trial was arranged in randomized complete Block Design (RCBD) with three replications on 5mx5m plot size. 1m and 1.5m were used between the plots and the blocks respectively. All inputs and agronomic practices were applied as per of its recommendation for wheat production. All herbicides were emulsified in water at recommended rate and applied once time at 35 days or (between 2-4 crop leaves stage) after sowing using manual knapsack sprayer and weed infestation was assessed and scored by number and species by throwing quadrat with 50cmx50cm area three times per plot.

Data collection and analysis

Data was collected on various parameters including Tillers per plan (fertile tillers were recorded), plant height (cm), number of grains per spike, thousand kernel weights ,grain yield (kg) and straw yield (kg). Four harvestable rows were used for data collection. The collected data was subjected to analysis of variance (ANOVA) as suggested by Gomez & Gomez [4] using SAS soft ware (version 2009). Least significant difference at 5% probability level was used to test the mean separation.

Harvest index (%) was calculated by the following formula;

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

Harvest index (%) was calculated by the following formula; Economic data were collected to compare the economic advantage of each herbicide in different treatments. These included variable input costs and costs for the herbicides and labour during the execution of the experiment. Costs of herbicides were obtained from pesticide companies and local distributing agencies. Based on the data obtained from both locations, economic analysis was computed using partial budget analyses, Marginal Rate of Return (MRR) [5]. The following formulas were used to compute partial budget and marginal rate of return (MRR) analysis, respectively.

Net field benefits (NBs) = Gross field benefits (GB)-Total Variable costs (TVC) and

$$MRR = DNI/DIC$$

Where: MRR = the marginal rate of return;

DNI = difference in net income compared with control; and

DIC = difference in input cost compared with control.

Results and Discussion

Analysis of variance

Combined analyzed data of two locations revealed that, all the utilized treatments showed significant variations (P<0.05)

for all the parameters tested except spike length that showed highly significant variation ($P < 0.01$). Similarly, highly significant effect of the herbicides on wheat parameters was observed across the locations (Table 1).

Table 1: Mean squares of different parameters of bread wheat as affected by treatments and location during 2016/17 cropping season at Bore and Ana Sora.

Source of variation	Df	NT	NFT	PH(cm)	PL(cm)	SL(cm)	BIM	TKW(g)	GY/P
Trt	4	2.82*	2.8*	72.27*	0.68*	259.22**	45.97*	386.67*	1322.33*
Rep	2	0.14ns	0.28 ns	36.44 ns	0.006 ns	2.53ns	5.02 ns	120 ns	266.57 ns
Loc	1	121.97**	158.33**	2815.14**	12.58**	288.3**	630.73**	653.33*	8672.56**
Error	10	0.88	0.77	11.69	0.36	28.42	16.07	120	336.39

*, **, Significant at $p < 0.05$, $P < 0.01$, LSD= Least significance difference ($P < 0.05$), NT= Number of tillers, NFT= Number of fertile tiller, PH= Plant height (cm), PL=Peduncle length (cm), SL= Spike length (cm), GPS= Grain /spike, TKW=Thousand kernel weight, GY/ha=Grain yield per hectare (Kg)

Mean performances of different herbicides on different wheat parameters

Growth parameters

Plant height

Highly significant variation was observed across location among herbicides treatments for plant height. Similar result was also reported by Zahara Mohammed & Shugute Addisu [6] who also found highly significant variation among different herbicides for plant height over the locations tested. However, non-significant variation among the tested herbicides was reported by Sareta et al. [7]. Analysis of the data indicated that maximum plant height of 97.22cm followed by 92.99cm and 92.78cm was

obtained from plots treated by Pallas 450D, Current 8EC and Ralon Super 144. Where as, minimum plant height was depicted by hand weedy (89.51cm) followed by Weedy check (88.36cm).

Peduncle length

Analysis of variance showed highly significant differences among weed management treatments for peduncle length. Means for peduncle length of the treatments was ranged from 6.70 to 7.59cm with the mean value of 7.12cm (Table 2). Among the treatments, the maximum peduncle length (7.59cm) was recorded by Pallas 450D followed by Current 8EC (7.31cm) and Ralon Super 144(7.02cm); while the minimum peduncle length (6.70cm) was recorded by weedy check (6.15cm) followed by hand weeding (6.99cm).

Table 2: Mean effect of different weed management practices on different parameters of Bread wheat at Bore and Ana Sora during 2015/16 cropping season.

Treatments	NT	NFT	PH	PL	SL	GPS	TKW	GYLD	HI
Pallas 450D	5.75 a	5.42a	97.22a	7.59a	52.00a	31.57a	53.33a	4210.7a	35.98a
Current 8EC	5.54a	5.33a	92.99b	7.31ab	51.83a	29.21ab	46.67ab	4000.3a	35.01a
Ralon Super 144	5.0ab	4.67ab	92.78b	7.02ab	41.17b	26.74b	40.0bc	3569.3ab	33.83a
Hand weeding	4.9ab	4.61ab	89.51bc	6.99ab	39.83b	26.19b	36.67bc	3544.0ab	33.62a
weedy check	3.99b	3.72b	88.36c	6.70b	39.0b	24.50b	33.33c	2996.0b	28.39b
Over all mean	5.04	4.75	92.17	7.12	44.77	27.64	42	3664.07	33.37
CV (%)	18.63	18.51	3.71	8.42	11.92	14.5	26.08	15.83	10.53
LSD(0.05)	1.125	1.05	4.09	0.72	6.38	4.8	13.11	694.46	4.21

LSD= least significant difference, CV=coefficient of variation, NT= Number of tillers, NFT= Number of fertile tiller, PH= Plant height (cm), PL=Peduncle length (cm), SL= Spike length (cm), GPS= Grain /spike, TKW=Thousand kernel weight, GY/ha=Grain yield per hectare (Kg)

Spike length

Height of spike is an important part of plant growth parameter for cereal crops that could determines the grain holding capacity of a particular variety. Thus, in current study significant effect of different weed management treatments were

observed on spike length of bread wheat variety at both testing site. According to analysis of the data, maximum spike length was obtained from plots treated by Pallas 450D (52cm) followed by Current 8EC (51.83cm). But, short spike length was scored from untreated plots or weedy check (39cm) followed by hand weeding (39.83cm).

Yield and yield components

Number of tillers

According to the result of the analysed data, all the treatments had showed significant (<0.05) effect on number of tillers at both locations. Number of tillers per plant was scored in a range of 3.99 to 5.75 with the mean value of 5.04. Maximum number of tillers per plant was scored from plots treated by Pallas 450D (5.75) followed by current 8EC (5.54) and Ralon super 144(5). However, minimum number of tillers per plant was scored from plots treated by weedy check (3.99). Non-significant effect of different herbicides on number of tillers was reported by Sareta et al. [7].

Number of fertile tillers

Significant effect was observed among the applied weed management treatments for number of fertile tillers per plant, which ranged from 3.72 to 5.42 with the mean value of 4.75 (Table 3). Maximum number of fertile tillers was scored from plots treated by Pallas 450D (5.42) followed by current 8EC (5.33). While minimum number of fertile tillers was scored from untreated plots or weedy check (3.72).

Table 3: Efficacy of different herbicides at different growth stage of wheat at Bore and Ana Sora during 2016/17 cropping season.

Treatments	Weed Control Efficiency (%)		
	Early Jointing Stage	Head Emergence Stage	Dough Stage
Pallas 45 OD	74	66.8	47.5
Current 8 EC	48.1	42	25.9
Ralon super EW 144	48	36	27.5
Hand weeding	83	67.9	46.3
Weedy check	-	-	-

Grain per spike

Significant difference was observed among herbicides treatments (P<0.05) for grain per spike. The highest grain per spike was recorded from Pallas 450D (31.57) treated plot. The lowest grain per spike was recorded from untreated plot (24.5) followed by plot treated by hand weeding (26.19) and Ralon super (26.74) (Table 1). As it is revealed by the study result, applying recommended rate of Pallas 450D at effective stage of weed emergence would significantly affect weed population and improve number of wheat grain development through proper utilization of available nutrients without any competition.

Thousand kernel weight

The combined analysis over locations was significant for thousand kernel weight. However, non-significant effect of different herbicides on this parameter was reported by Sareta et al. [7]. The mean value of TKW due to herbicide application was ranged from 33.33 to 53.33 (Table 4). The maximum TKW was obtained from the plot treated by Pallas 450D (53.33) followed by Current 8EC (46.67). The lowest number of TKW was obtained from untreated plot (33.33).

Table 4: Effect of different herbicides on weed density (m⁻²) at different crop growth stages of bread wheat at Bore and Ana Sora during 2016/17 cropping season.

Treatments	Weed Density (m ⁻²)		
	Jointing Stage	Ear Head Emergence Stage	Dough Stage
Pallas 450D	0.63 (15.833)	0.60(14.965)	0.77(19.208)
Current 8ec	1.2(30)	1.30(32.542)	1.76(43.957)
Ralon super EW 14	1.19(29.665)	1.20(30.223)	2.03(50.833)
Hand weeding	0.21(5.235)	0.44(10.890)	0.74(18.417)
Weedy check	1.83(45.740)	2.66(66.555)	3.62(90.483)

Biological yield

Biological yield showed significant difference (P<0.05) due to Pallas 450D, Current 8EC, Ralon Super 144, hand weeding and weedy check. Means for biological yield of the treatments was ranged from 24.5 to 31.57 gm with the mean value of 27.64gm (Table 5). The highest biological yield was recorded from plot treated by Pallas 450D (31.57gm) where as the lowest was recorded from weedy check (24.5gm). Similar result was reported by Zahara M and Shugute A 2016 and Sareta et al. [7] who found maximum amount of crop biomass from plots treated by different herbicides across the testing sites whereas lowest amount was reported from weedy check.

Table 5: Major weed species identified from the experimental sites (Bore and Ana Sora).

Scientific Name	Family	Life cycle	Life form (Category)
<i>Avena fatua L.</i>	Poaceae	Annual	Grass
<i>Bromus pectinatus, pilg</i>	Poaceae	Annual	Grass
<i>Snowdenia Polystachya(Fresen.)</i>	Poaceae	Annual	Grass
<i>Phalaris paradoxa L.</i>	Poaceae	Annual	Grass
<i>Galinsonga parviflora Cav.</i>	Asteraceae	Annual	Broad leaved
<i>Bidens pilosa L</i>	Asteraceae	Annual	Broad leaved
<i>Chenopodium album L.</i>	Chenopodiaceae	Annual	Broad leaved
<i>Guizotiascabra(Vis) Chiov</i>	Asteraceae	Annual	Broad leaved
<i>PolygonumnepalenseL.</i>	Polygonaceae	Annual	Broad leaved
<i>Galium</i>	Rubiaceae	Annual	Broad leaved
<i>Tagetes minuta L.</i>	Asteraceae	Annual	Broad leaved

Harvest index

Combined analysis of the study revealed that, non stastical difference was observed on harvest index of bread wheat due to the application of different herbicides and hand weeding except weedy check. 25.38 to 33.35 mean range of harvest index with mean value of 30 was obtained from the study. High harvest

index was obtained from plot treated by Pallas 450D followed by the rest of herbicides and hand weeding. Lowest value of harvest index was obtained from untreated plot.

Grain yield/hectare

According to the combined analysis of this study, significant variation was observed among the herbicides on grain yield/hectare having a range of 2996kg/ha to 4210kg/ha with mean value of 3664.07kg/ha. The highest grain yield was recorded in Pallas 450D (4210kg/ha) followed by current 8EC (4000kg/ha). The lowest grain yield was recorded from weedy check treatment (2996kg/ha). This result is concord with the result of Sareta et al. [7] who found high grain yield per hectare from herbicide treatment and low yield from weedy check treatment.

Weed control efficiency: Effect of different herbicides on weed control was observed (Table 3). The highest weed control efficacy (82.955%) was recorded in hand weeding followed by Pallas 45 OD (74.01%). Similarly the head emergence stage, effect of weed management practices on weed control efficiency was significant. The highest was recorded in hand weeding (67.898%) followed by Pallas 45 OD (66.823%) however, no significant 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 Pallas 45 OD (47.545%) followed by hand weeding (46.262%). However no significant difference was observed between them. Interestingly as stage of crop development increase there was decrement in weed control efficiency and Pallas 45 OD application was better than all applied herbicides at both sites against both grassy and broadleaved weeds. These finding are in accordance with Ashiq, Noor Muhammad and Noor Ahmad, 2007. who reported that herbicides with broad spectrum provided better weed control efficiency than control treatment.

Weed Density: The effects weed management practices on weeds density were also significant. Among the weed

management practices the minimum weeds density (2.61m²) was recorded in hand weeding followed by Pallas 45 OD (3.05m²), Current 8 EC (4.03m²) and Ralon® Super EW 144 while the maximum total weed density (6.53m²) was in weedy check (Table 3). These findings are in accordance with result of Ashiq, Noor Muhammad and Noor Ahmad, 2007. who stated that weed population is lower in herbicides treated plot than control plot.

Weed species: As part of the study, identification of weed species which were observed in quadrant was also conducted. Because, it's imperative to know the nature of the existed weed species to the area towards seeking effective management practice. Accordingly, about 11 weed species which have different families, life cycle and life category were identified from both trial sites. Out of these species 63.63% were categorized under grass weeds and 36.36 were broad leaved species. However, all of the identified weed species from both sites have annual life cycle (Table 2).

Partial budget analysis: For this study, yield and economic data were collected to compare the economic advantage of each herbicide with control treatment. Accordingly, cost of each herbicides were estimated based on the current price which was 1100 ET birr for 0.5 litre Pallas 450D, 570 birr for 1 litre Current 8EC, and 520 birr for 0.5litre Ralon super 144. Labour cost for three times hand weeding was calculated as 35birr/person/day*40*3 which was =4200. The average grain price of wheat was 850 birr per 100kg in 2016/17 season. Average daily labourer cost and rent for knapsack sprayer for herbicide application was 520 birr ha⁻¹. To minimise unnecessary exaggerations of grain yield, productivity of the location mean grain yield obtained was adjusted by 10%. Labour costs for three times hand weeding were determined by man-days and it was 4200 ha⁻¹ indicated that application of Pallas 450D had the highest net field benefits (Table 5). But, the marginal rate of return (MRR) analysis revealed that Current 8EC was more profitable for farmers, and resulted in a MRR of 6494.4% (Table 6) [8].

Table 6: Partial budget analysis of different herbicides for control of weeds at Bore and Ana Sora, Southern Oromia.

Treatments	Rate of herbicide L/ha	Net benefit in birr	Total variable cost in birr	MRR
Weedy check	0	22919.4	0	
Ralon Super 144	0.5	26265.1	1040	321.7
Current 8EC	1	29512.3	1090	6494.4
Pallas 450D	0.5	30591.9	1620	203.7
Three times hand weeding	0	22911.6	4200	D

Conclusion

In the present study different herbicides had showed significant effect on different characters of Bread wheat variety. Highest grain yield was obtained from plot treated by Pallas 45 OD (4201kg/ha) followed by current 8EC (4000kg/ha). The lowest grain yield was recorded from weedy check treatment

(2996kg/ha). However, economic analysis of the study indicated that applying Pallas 450D had the highest net field benefit (30591.9 ET birr) followed by Current 8EC(29512.3ET birr ha⁻¹) compared to Ralon Super 144 (26265.1ET birr ha⁻¹), Three times hand weeding (22911.6 ET birr ha⁻¹) & weedy check (22919.4ET birr ha⁻¹). However, Current 8EC had showed maximum economic

profitability than Pallas 450D and other types with marginal rate of return (MRR) of 6494.4%.

Therefore, Current 8EC at rate of 1litre ha⁻¹ is the best herbicide for the effective control of wild oat and other grass weeds in wheat and there by improve yield production of wheat up to 25.1% under proper land management during production season at high lands of Guji Zone, Southern Oromia.

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