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Validation of Different Post-Emergence Herbicides for Controlling Wild Oat (Avena fatua L.) and Other Grass Weeds in Wheat (Triticum spp) at Western Oromia

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Abstract
A field experiment on weed control in wheat was conducted at Bako Agriculture Research center during the main season of 2017. Different herbicides were evaluated against the hand weeding and weedy check, for weed competition and grain yield of wheat. The experiment was laid out in randomized complete block design with three replications using the wheat variety "Danda'a" with a seed rate of 150 kg ha^{-1}. The treatments consisted of four post-emergence herbicide; Pallas™ 45 OD, Puma super EW 75, Current 8 EC and Axial, and including Hand weeding and unwedded check for comparison. Significantly lowest weed population (10.7m^2) and maximum grain yield of 3306.4 kg ha-1 (with 48.4% increase in grain yield over weedy check) were recorded in the plot pallas was treated in contrary the highest weed population and low grain yield was recorded in weedy check were 54.1 weeds m^{-2} and 1692.1 kg ha^{-1} , respectively. Therefore, pallas 45 OD provided significant control of weeds causing significant reduction in density of target weed flora and also significantly improved the grain yield in comparison with other herbicides and weedy check. Hand weeded treatments fetched highest gross income and added income followed by hand weeding and current treatments. However, maximum CBR was calculated for Pallas followed current. The CBR calculated in the hand weeded treatments was though the lowest. pallas therefore recommended for effective weed control as post emergence herbicide respectively for wheat economic yield in western Ethiopia .
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Introduction

Wheat (*Triticum aestivum* L.) is the most important cereal cultivated in Ethiopia (Hailu, 1991). It ranks fourth in total annual grain production next to maize (8.4 mill tons), teff (5.2mill tons) and sorghum(5.1mill tons) (CSA, 2017/18). In area coverage, it is the fourth important cereal crop after Tef, maize and sorghum.

The national average yield of wheat in Ethiopia is about 2.7 t/ha (CSA, 2017/18). This is by far below the world average yield. There is a wide range of factors that affecting wheat productivity in Ethiopia. Actual productivity and yield stability are influenced by biotic factors including weeds such as broad leave and grass family, and a number of pathogens (Rezenne et al., 1993; Hailu et al., 1991; Hailu and Woldeab, 2015).

Weed is one of the most important factors causing reduction of grain yield, deteriorate quality of crops and reduce farmers' income. It has been estimated that weed causes 17-50% yield losses in wheat annually (Shad, 1987; Anonymous, 1996).They compete with crop plants for light, nutrient, moisture and space which they could be either of broad leaf or grasses(Arnon, 1972). The major weeds found in ethiopia: 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)is* one of the major weed that contributes for the low yield in the wheat production system in Ethiopia. Balyan et al., (1991) quantified 17 to 62% losses in winter wheat yield due to wild oats competition depending on cultivars. It is an annual grass 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 (Arnon 1972). Walia *et al,* (1998) reported that, as the density of wild oats increased, wheat yield decreased exponentially. Wheat yield loss was below 1% up to 3 plants of wild oats m^{-2}, reached 2.2% at 5 plants and was 50-60% at 100 plants of wild oats m^{-2} (Ijaz Ahmad Khan et al.,2008) Wheat yield loss could also be related mathematically to the dry weight of wild oats.

Grass spp weed management is a major component in the production system of wheat in Ethiopia whether it may manually, mechanically and physically. Weed management practices such as hand weeding and using herbicides at respective manufacturer recommendation rates can be a best management option in wheat production to control grass weeds, especially, wild oat(*Avena fatua)* compete with crop and causes significant yield losses in western ethiopia farming community. Therefore, the aim of this study is to evaluate and promote economically and agronomical feasibility of post-emergence herbicides against wild oat (*Avena fatua L.)* and other

grass weeds in wheat.

Materials and method

Treatments and design

The experiment was carried out during *cropping* season of 2016/17 at sub-station of Bako Agriculture Research center, using variety Danda'a with seed rate of 125kg /ha. The trial was laid out in Randomized Complete Block (RCB) design, with three replications involving 6 treatments. Treatments consisted of post-emergence application of Pallas™ 45 OD, Puma super EW 75, Current 8 EC and Axial, Hand weeding and unwedded check. The herbicides were applied 30 ≤days after sowing or (between 2-4 crop leaves stage) using Knapsack sprayer fitted with flat fan nozzle by mixing 500 liters of water per ha. Puma super EW 75, Current 8 EC and Axial were applied at the rates of 1 L ha^{-1} and Pallas™ 45 OD rates of 0.5 L ha^{-1} . Weed infestation was assessed and scored by number and species by throwing quadrate with 50cm x 50cm area three times per plot. The collected data were subjected to analysis of variance (ANOVA) using SAS the statistical software (SAS, 2008) (version 9.3). The mean separation, in cases where there were significant differences among treatments, was done using LSD (0.05) to facilitate the comparison of all pairs of treatment means .

Treatment Descriptions:

Weedy check
Hand weeding
Pallas™ 45 OD 0.5liter per hector
Puma super EW 75 1.25liter per hector
Ralon® super EW 75 1.0liter per hector
current 8 EC 1liter per hector

Results and Discussion

Statistical analysis of the data illustrated that total weed density and number of weed species was significantly affected by post-emergency herbicide at p≤ 0.05 (Table 1). The result of data showed that significantly lowest weed density (10.7m^2) and species (5.1/m^2) was recorded in the plot treated Pallas 45 OD followed by hand weeding, which had 19.1/m^2 total weed population and 5.4/m^2 weed species while while, weedy check had showed highest number of weed population and species (54.1pop/m^2 and 6.1spp/m^2, respectively(Table1)).

The highest number of weed population and species (broad and grass leaves) with the main species Ambrosia artemisiifolia L., Chenopodium al- bum L. and Polygonum lapathifolium L were found in untreated plot. However, the lowest number of weed population and species (broad and grass leaves) were observed in the plot treated with Pallas 45 OD.

Therefore, Pallas 45 OD constantly reduce the number of dominant weed species in the area such as: *Guzoitia scabra, Commiline species, Eleusine Indica, Cyperus species, Polygonum, Datura Digitaria* and others in maize without any negative effect to the crop.

Table1. The effect of Post-emergence herbicides on major weed species.

Treatment	Gu/sca	Acant/hip	Polg/nep	Sprgul/ha	Gal/spor	Raphns/r	Aven/fat	Totn/wed	Totn/wspp
Weedy check	8.1a±3.2	6.2a±2.5	7.3a±3.1	11.4a±2.4	2.8a±1.71	5.61a+2.78	14.9a+3.85	54.1a+7.06	6.1a+2.43
Current 8 EC	6.6a±2.9	2.2cb±1.3	4.5bc±2.3	7.6a±2.3	2.4ba±1.68	2.91ba+2.08	4.8c+2.18	31.1b+5.53	6.0ba+2.40
Axil	5.9ba+2.6	3.7b±1.9	6.0ba+2.6	8.7a±2.4	0.5b±0.78	5.2a+2.66	1.8de+1.43	34.4b+5.58	5.6ba+2.33
super EW 75	3.3bc±2.3	1.9cb±1.2	4.6bac±2.5	6.7ba±2.2	2.2ba±1.66	1.3b+1.43	4.1dc+1.93	24.4cb+4.70	5.3ba+2.26
Hand weeding	1.6c±1.8	1.7c±1.1	1.4d±1.4	2.3bc±2.1	1.6ba+1.46	0.9b+1.08	9.6b+3.32	19.1cd+4.32	5.4ba+2.28
Pallas™ 45 OD	1.5c±1.6	1.6c±0.9	2.2dc±1.9	1.5c±2	0.8ba+1.0	1.5b+1.48	1.3e+1.40	10.7d+3.18	5.1b+2.23
cv	14	15	19	11	14	19	16	13	13
trt	0.0003**	0.0005**	0.0019	0.0026	0.2056	0.0075	<.0001	<.0001	0.4805
rep	0.3059	0.6388	0.0618	0.4805	0.2431	0.1409	0.2381	0.3738	<.0001
loc	<.0001**	0.7029	<.0001	<.0001	0.0009	0.9657	<.0001	<.0001	0.0168
trt*loc	0.0208*	0.3904	0.0453	0.0168	0.6832	0.1348	<.0001	0.001	0.001

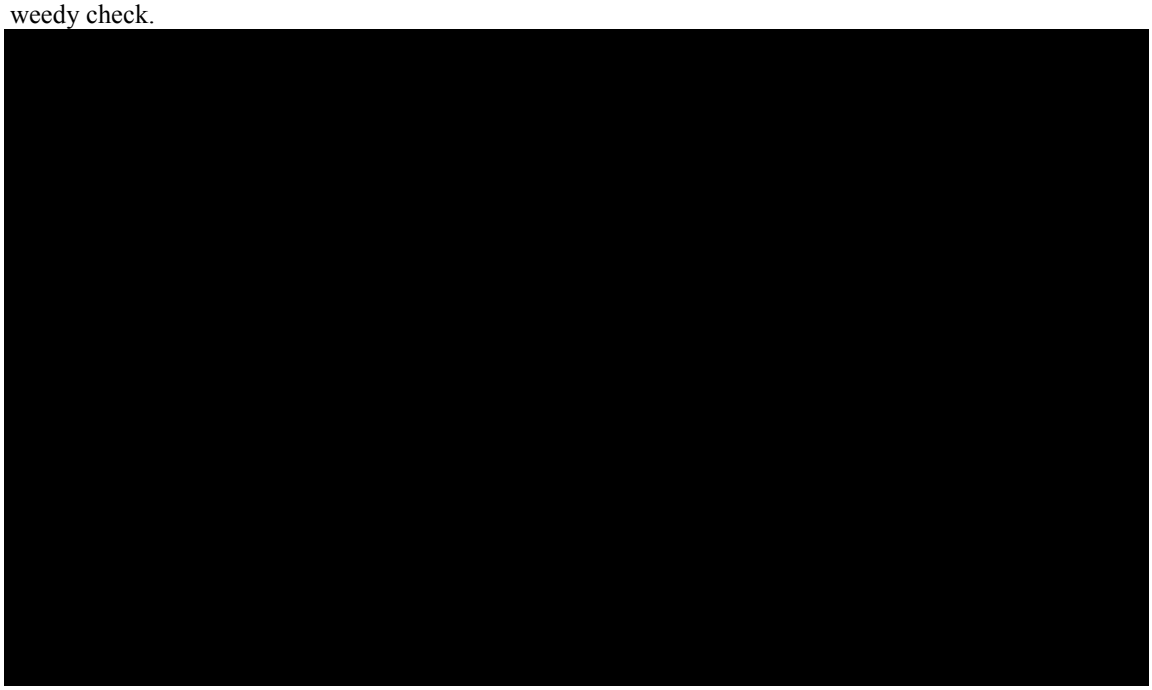
Gu/sca = Guizota scarba, Acant/hip = Acanthospermum hispidum, Polg/nep = Sprgul/ha = Spergula arvenses, Gal/spor =Galium sporium

Raphns/r = Raphanus raphanistrum, Aven/fat = Avena fatua, totn/wed = Total nomber of weed , Totn/wspp = Total number of weed species

Thousand-grain weight is a major contributor to the final grain yield. The data regarding thousand grain weights are presented in Table-4. The result of analysis variance revealed that post emergency herbicides had significantly affected thousand-grain weight. Higher 1000-grain weight (44.64 g) was recorded in plot treated with pallas 45 OD followed by hand weeding plot, while the minimum 1000-grain weight (37.30 g) grain

weight was recorded in weedy check plot.This might be due to the great influence type of post herbicide that was treated at critical stages of that have substantially increased thousand-grain weight.

Grain yield is the principal and primary parameter for assessment of any weed control treatment. Analysis of variance indicated that there was statistically significant variation of yield was observed among herbicide treatments (Table 2). Significantly highest grain yield (3306.4 kg ha-1) was obtained from Pallas plot followed by hand weeding (3003.8 kg ha^{-1}) while low grain yield (1692.1 kg ha^{-1}) was obtained from untreated plot .Therefore, Pallas was found to be recorded superior grain yield, which had 48.4% yield advantage over weedy check.



Economic analysis of weed management using different post-emergency herbicides in maize is shown in Table-3 . Higher gross income was recorded in pallas 45 OD (21491.6 Etbr) followed Super EW 75 (19524.7EtBR).Variable cost was higher for Hand weeding (3278.7 EtBR). In the same manner, Pallas 45 OD WAS fetched higher net income (19491.6 EtBR) followed by Super EW (18536.05 EtBR).unlikely, maximum cost benefit ratios (CBR) was recorded for Current 8EC (1:37) followed by Supper Ew (1:15). Therefore, pallas 45 OD was effective and economically feasible herbicide for management of weeds in wheat.

Table 3. Cost benefit analysis of different post-emergency herbicides for management of weeds on wheat at Bako

Treatments	Average grain yield(kg/ha)	Gross field benefit (ETB/ha)	Cost that vary (ETB/ha)	Net benefit (br)	cost benefit ratio
Current 8 EC	2693.7	17509.05	465	17044.05	1:37
super EW 75	2931.7	19056.05	520	18536.05	1:15
Pallas™ 45 OD	3306.4	21491.6	1000	20491.6	1:10.5
Hand weeding	3003.8	19524.7	3278.7	16246D	1:2.5
Axil	2231.8	14506.7	-	-	-
Weedy check	1692.1	10998.65	-	-	-

Conclusion and Recommendation

Avena spp and other weed species are the major constraint in wheat production in western part of our country and its control is too important to increase wheat production and productivity. Only a 2, 4-D herbicide is available for management of weeds in wheat which is not effective on controlling grass species. From the tested herbicides, Pallas 45 OD was found to be recorded superior grain yield and better in controlling grass and broad leaf weeds, which was 1614.3 kg ha-1 i.e. 48.4% increased over weedy check followed by hand weeding plots (3003.8 kg ha^{-1}).

In this study, hand weeding was recorded superior grain yield however, impractical to control weeds in large scale farms due to it is labor intensive, tedious and time consuming. Using chemical (Pallas 45 OD) weed control method is the best option to minimize the yield losses due to weed competition, and also need less labor and time. In western Oromia, only 2,4-D- is available for management of weeds in wheat but could not be

effective e for management of some broad leaf and all grass weed species .Thus, Pallas 45 OD post-emergence is the promising herbicide for management of broad leaf weed species and grass species of wheat in western Ethiopia.

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