Efficacy of certain herbicides in dry bean crop

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ABSTRACT:

Field experiments were carried out at Ashmoun district, Menofia Governorate to study the efficacy of certain pre-emergence (PRE) and post-emergence (POST) herbicides in controlling weeds in dry bean crop compared to hang hoeing and the untreated check during 2019 and 2020 seasons. Herbicides used were pendimethalin, halosulfuron-methyl, *s*-metolachlor, bentazon, oxyfluorfen and fluazifop-p- butyl, hand hoeing (16 and 27) days after sowing (DAS) and the untreated check. Results illustrated that the predominant weed species in dry bean field were, *Amaranthus cruentus, Chenopodium album, Portulaca oleracea* and *Sonchus oleraceus* as broad-leaved weeds, while *Cyperus longus, Setaria verticillata and Echinochloa colonum* were the predominant grassy weeds. Results indicated that oxyfluorfen (PRE) and halosulfuron-methyl (POST) treated plots caused visible injury to dry bean plants. Generally, all weed control treatments significantly reduced weed biomass (fresh weight of weeds g m^{-2}) of the predominant weeds in comparison with the untreated. Maximum reduction in fresh weight of weeds, highest weed control efficiency (WCE), highest bean seeds and highest net benefits were recorded in POST halosulfuron-methyl + bentazon tank mix at 15 + 240 g fed.$^{-1}$ followed by hand hoeing treatment and pendimethalin fb bentazon (PRE fb POST at 455+ 240 g a.i. fed^{-1}) during the two studied seasons.

Keywords: Weeds; herbicides; dry bean; net benefit.

INTRODUCTION:

Bean (*Phaseolus vulgaris* L.) is considered the most important crop worldwide. Bean production is challenging because this crop isn't as robust as the soybean crop and isn't considered a competitive crop with weeds (Van Acker *et al*. 2000). It is consumed as dry seeds or green pods (Ragab, Mona *et al*., 2015). Moreover, the bean crop is a vital food legume for direct human consumption and accounts for 50% of the legumes consumed worldwide (Broughton *et al*., 2003 and Graham *et al*., 2003). Also, bean crop is a cheap source of protein, carbohydrates, unsaturated fatty acids, vitamins and minerals (Nassar *et al*., 2011; Beebe *et al*., 2013; Yunsheng *et al*., 2015 and Ganesan and Xu, 2017). Bean crop provides fodder for feeding livestock and improves soil fertility through atmospheric nitrogen fixation (Asfaw, 2011; Ambachew *et al*., 2015 and Abebe and Mekonnen, 2019). In Egypt, dry and green beans are among the most important leguminous crops grown for local consumption and exportation. The area planted with dry and green beans in Egypt in 2018 amounted to 120728 fed., producing about 122871 tons (Anonymous, 2018).

Weed management remains one of the major production problems for white bean growers and is necessary to improve the productivity of this non-competitive crop (Bauer *et al*., 1995b and Urwin *et al*., 1996). Uncontrolled weeds can reduce dry bean yield by 48% to 81% (Chikoye *et al*. 1995; Soltani *et al*. 2014a and 2014b and Li *et al*. 2016a and 2016b). Weeds cause an economic loss of 20-30 % of bean seed yield and it can reach 70-80 % in some weak growth stages (Elsayed *et al*., 2019). Moreover, weeds can affect harvest efficiency and lower bean quality due to their mixing with weed seeds (Chikoye *et al*. 1995). Chemical weed management may be a better supplement to standard methods and is a significant part of the trend towards integrated crop production. Chemical control of weeds is important to scale back weed infestation, and cause rapid and desirable control of weeds and today it's considered one of the most popular methods for controlling weeds (Aboali and Saeedipour, 2015). Use of herbicides to manage weeds is another choice to hand weeding. (Mashingaidze *et al*., 2003). The herbicide is highly effective in weed control and provides a significant increase in crop yield by eliminating weeds (Kahramanoglu and Uygur, 2010) as well as causing improvement in the quality of common bean crop (Arevalo *et al.* 1992).

The present study aims at evaluatingeffectiveness of different application rates and times of herbicides on the predominant weed species and their effects on bean yield in dry bean fields.

MATERIALS AND METHODS:

Field experiments were carried out during the two successive seasons of 2019 and 2020 at Ashmoun district, Menofia Governorate, Egypt. Dry bean seeds (c.v. Giza 6) were sown in the first of September of each season. Experiments were designed in a randomized complete block design (RCBD) with three replications (each of 21m², 2.1 m in width and 10 m in length, which represents 1/200 from fed). Each replicate includes 3 rows with a length of 10 meters for each row and the distance between both rows was 70 cm. The herbicides and rates and time of application for each are shown in Table (1). Each experimental plot received one liter of the herbicide spray solution using -5liter knapsack sprayer (Gloria hoppy No.29.9 .TS). Hand hoeing treatment was done twice at 16 and 27 DAS.

For each plot, the growing weeds in one square meter were collected after 48 days after application then sorted, classified and weighed and mean fresh weight of weeds in each treatment was calculated. Weed control efficiency (WCE) was also determined using the following formula.

$$\mathbf{WCE} = \frac{C - T}{C} \times 100$$

Where:

C = weed fresh weight (g m^{-2}) in the untreated plot.

T = weed fresh weight (g m^{-2}) in the treated plot.

Crop injury was evaluated visually 1, 2, 3, 4 and 5 weeks after emergence (WAE) using a scale of 0 to 100%, where a rating of 0 was defined as no visible plant injury and a rating of 100 was defined as plant death (including chlorosis and necrosis of leaves, leaf crinkling and growth reduction). Dry bean plants were considered mature when 90% of the pods in the weed-free check had turned from green to a golden color. The seeds yield was estimated at 95-100 DAS (crop maturity) by harvesting from the middle row for each plot (one-third of the plot, 7 m²) and then weighed and converted to kg/fed. (Soltani *et al*., 2013).

The ANOVA test was used to analize the data statistically, and the mean values were tested after Duncan's Multiple Range Test (1955) at $P = 0.05$).

RESULTS AND DISCUSSION:

Phytotoxicity of herbicides to the main crop:

The phytotoxic effects on dry bean plants caused by used herbicides are shown in Table (2). Results revealed that maximum visible injury was observed at 1 and 2 WAE with oxyfluorfen when applied as PRE and at 3 and 4 WAE with halosulfuron-methyl application POST during both growing seasons 2019 and 2020. Results also indicated that 3 and 4 WAE the application of 15 g a.i fed^{-1} halosulfuron-methyl alone as POST caused 17.67 and 5.00 % injury, respectively, in the first season and caused 16.00 and 4.00 % injury, respectively, in the second season, but when 240 g a.i fed^{-1} of bentazon was added to the same herbicide, the incidence of the injury was reduced to 4.00 and 0.00 %, respectively, in the first season and to 2.67 and 0.00 %, respectively, in the second season after the same weeks. These results are in agreement with Soltani *et al*. (2013) who found that there's an adequate margin of crop safety for application of PRE pendimethalin at 1080 gm a.i. ha^{-1} in cranberry, white and kidney bean. Additionally, Soltani *et al*. (2012) mentioned that tank mixture of bentazon has been shown to have the potential to decrease the injury to bean plants from POST halosulfuron-methyl. While Wall (1995) observed about 50% injury to bean plants with POST application of halosulfuron., Silvey *et al*. (2006) found that application of halosulfuron POST caused 5% injury to bean plants. Also, Stewart *et al*. (2010) reported that application of halosulfuron as POST at 35 and 70 gm a.i.·ha^{-1} caused 67% and 86% injury to bean plants.

Predominant weed species and biomass:

Results in Table (3) indicated that *Amaranthus cruentus, Portulaca oleracea, Chenopodium album* and *Sonchus oleraceus* were the dominant broad-leaved weeds in seasons 2019 and 2020. From the total weeds, our results showed that *Amaranthus cruentus* recorded the highest weed biomass (87.62 and 85.99 %) during seasons 2019 and 2020, respectively, in the untreated plots of the dry bean field, while *Sonchus oleraceus* recorded the lowest weed biomass (1.42 and 1.34 %, respectively) during the both seasons. In addition, results also indicated that *Cyperus longus, Setaria verticillate* and *Echinochloa colonum* were the predominant grassy weeds in the both seasons. Obtained results showed that *Cyperus longus* represented the highest grassy weed biomass percentages, while *Setaria verticillata* recorded the lowest biomass percentages during the two studied seasons. Our results agreed with Rana *et al*. (2004), who found that the dominant weed flora in french bean (*Phaseolus vulgaris* L.) fields were *Digitaria sanguinalis*, *Chenopodium* sp., *C. bonus*, *C. album*, *Poa annua* and *Amaranthus* sp. under Palampur (Indian) conditions. Pacanoski and Glatkova (2014) found that weed flora observed in green bean fields in Macedonia were *Portulaca oleracea, Echinochloa-crus galli, Amaranthus retroflexus* and *Chenopodium album*. Moreover, Li *et al*. (2016a) reported that major weed flora infested white bean crop in Canada were *Chenopodium album*, *Amaranthus retroflexus*, *Ambrosia artemissifolia*, *Sinapis arvensis* and *Setaria faberii Herrm.*

Efficiency of the tested herbicides:

Against broad-leaved weeds.

Results in Tables (4 and 5) show the effect of weed control treatments on broad leaved weeds in 2019 and 2020 season. Our results indicated that maximum reduction in fresh weight of the broad leaved weeds was achieved with halosulfuron-methyl + bentazon (POST application at 15+240 gm a.i. fed.$^{-1}$), hand hoeing, pendimethalin fb bentazon (PRE fb POST application at 455+240 gm a.i. fed^{-1}), bentazon (POST application at 240 and 480 gm a.i. fed^{-1}), halosulfuron-methyl + s-metolachlor (PRE application at 15+ 288 gm a. i. fed^{-1}), halosulfuron-methyl + pendimethalin (PRE application at 15+ 455 gm a. i. fed^{-1}) and halosulfuron-methyl (POST application at 15 gm a.i. fed^{-1}) , they gave 99.62, 99.55, 98.37, 98.81, 97.26, 96.88, 96.66 and 96.95 %, respectively, reduction in the total broad leaved weeds in the first season compared to control, while in the second season, POST application of halosulfuron-methyl + bentazon at 15+ 240 gm a.i. fed^{-1}, hand hoeing, bentazon (POST application at 480 gm a.i. fed^{-1}), pendimethalin fb bentazon (PRE fb POST application at 455+240 gm a.i. fed^{-1}), bentazon (POST application at 240 gm a.i. fed^{-1}), halosulfuron-methyl (POST application at 15 gm a.i. fed^{-1}) halosulfuron-methyl + s-metolachlor (PRE application at 15+ 288 gm a. i. fed^{-1}) and halosulfuron-methyl + pendimethalin (PRE application at 15+ 455 gm a. i. fed^{-1}) they gave 99.62, 99.55, 98.84, 98.49, 97.38, 97.05, 96.97 and 96.90 %, respectively, reduction in the total broad leaved weeds in the second season compared to control. On the other hand, fluazifop-p- butyl gave poor reduction in the total broad leaved weeds (39.93 and 39.55 %) WCE, respectively, in two studied seasons.

Against grassy weeds.

Results in Tables (4 and 5) illustrate the effect of herbicidal treatments on grassy weeds during the 2019 and 2020 seasons, respectively, in the dry bean crop. Generally, all tested herbicides and hand hoeing treatments significantly reduced the average fresh weight of grassy weeds and gave higher weed control efficiency compared to the unweeded control during the two studied seasons. Halosulfuron-methyl + *s*-metolachlor (PRE application at 15+ 288 gm a. i. fed^{-1}), halosulfuron-methyl (POST application at 15 gm a.i. fed^{-1}), halosulfuron-methyl + pendimethalin (PRE application at 15+ 455 gm a. i. fed^{-1}) and pendimethalin fb bentazon (PRE fb POST application at 455+240 gm a.i. fed^{-1}) gave 89.12, 88.34, 88.34 and 87.82 %, respectively, reduction in the total grassy weeds in the first season compared to the control treatment, while in the second season, pendimethalin fb bentazon (PRE fb POST application at 455+240 gm a.i. fed^{-1}), halosulfuron-methyl + pendimethalin (PRE application at 15+ 455 gm a. i. fed^{-1}), halosulfuron-methyl + bentazon (POST application at 15+240 gm a.i. fed^{-1}), halosulfuron-methyl + *s*-metolachlor (PRE application at 15+ 288 gm a. i. fed^{-1}) and halosulfuron-methyl (POST application at 15 gm a.i. fed^{-1}) gave 90.67, 90.43, 87.56, 87.32 and 84.69 %, respectively reduction in the total grassy weeds compared to the untreated control. On the other hand, oxyfluorfen, *s*-metolachlor and pendimethalin gave a poor reduction in the total grassy weeds in both seasons.

Against total weeds.

Results in Tables (4 and 5) showed the effect of herbicidal treatments on the total weeds during the 2019 and 2020 seasons. Obtained results indicated that all weed control treatments significantly (p=0.05) reduced weed biomass (fresh weight of weeds g m^{-2}) of the total weeds in comparison with the untreated plots. Total weeds were effectively controlled by the mixture of POST halosulfuron-methyl + bentazon at 15 + 240 gm a.i. fed^{-1} (98.97 and 98.93% reduction) followed by hand hoeing (98.36 and 98.44% reduction), pendimethalin + bentazon PRE fb POST application at 455+240 gm a.i.fed^{-1} (97.83 and 98.04% reduction), POST application of bentazon at 480 gm a.i.fed^{-1} (97.83 and 98.00% reduction), POST application of halosulfuron-methyl at 15 gm a.i.fed^{-1} (96.50 and 96.34% reduction), halosulfuron methyl + s-metalachlor applied as PRE at 15 + 240 gm a.i.fed^{-1} (96.47 and 96.42% reduction) and halosulfuron methyl + pendimethalin PRE at 15 + 455 g a.i.fed^{-1}(96.23 and 96.53% reduction), respectively, in seasons, 2019 and 2020, respectively, compared to the unweeded check. On the other hand, the least percent reduction in fresh weight in the total weeds was observed with fluazifop-p- butyl treated plots (40.45 and 40.47 %) respectively, in the 2019 and 2020 seasons. Our results are in accordance with those obtained by Cox (1981), who reported that pendimethalin fb alachlor provided the best reduction in grassy weeds in bean crop when applied at 1.5 kg ha^{-1} to the soil after sowing under moist soil conditions. Likewise, in a study at Kanpur by Anonymous (1986), it was reported that efficient weed control was achieved by PRE of either oxyfluorfen at 0.5 kg ha^{-1} or pendimethalin at 0.75 kg ha^{-1}. Prajapati *et al.* (2004) stated that application of pendimethalin as PRE at 0.75 kg a.i. ha^{-1} + hand weeding at 45 DAS resulted in a minimum population of weeds. Most studies markedly indicated that the tank mix of herbicides for weed management in common bean is associated with dimethenamid-P, *s*-metolachlor, and trifluralin with imazethapyr, because they increase the spectrum of weed control (Soltani *et al*. 2007 and 2010). Halosulfuron does not control grasses (Buker *et al*. 1998), however, it can be combined with a grass herbicide for broadspectrum weed control (Li *et al*. 2016a, 2016b). Halosulfuron gave poor control of the grass weeds when applied alone as POST (Li *et al*., 2017). Bentazon achieved control of common lambsquarters, mustard species, velvetleaf, and *Cyperus spp*., (HCPMRA 2008). The effectiveness of weed control with bentazon herbicide is related to the size of the weeds at the time of application, as the weed control decreases with the increase in the size of the weeds at the time of application, as large weeds often-escape control (Bauer *et al*. 1995a and Wall 1995). Blackshaw *et al*. (2000) reported that combination between grassy and broad-leaved herbicides improved the level of weed control in dry bean. Pendimethalin controlled annual grassy weeds, including large crabgrass, smooth crabgrass, giant foxtail and yellow foxtail as well as certain annual broadleaved weeds such as redroot pigweed and common lamb'squarters including acetolactate synthase and triazine-resistant biotypes (OMAFRA, 2011).

Effect of herbicides on seeds bean yield

Results listed in Table (6) showed the effect of treatments on bean seeds yield (kg fed^{-1}) compared with untreated control during the 2019 and 2020 seasons. It seemed that seed yield was 320 and 316.67 kg fed^{-1} in the untreated control in the two tested seasons, respectively. This indicated that the weeds greatly reduced Seed yields. All treatments significantly (p=0.05) increased yield of bean more than the untreated control. The best yield was obtained through the use of hand hoeing and halosulfuron-methyl + bentazon POST at 15 + 240 gm a.i. fed^{-1} which highly controlled the total weeds, as they caused an increase in yield, it gave 862.00 and 858.00 kg fed.$^{-1}$, respectively, in the first season and 868.00 and 860.67 kg fed.$^{-1}$, respectively, in the second season, followed by halosulfuron-methyl (POST at 15 gm a.i. fed^{-1}), pendimethalin (PRE at 455 gm a.i. fed^{-1}), bentazon (POST at 480 gm a.i.fed^{-1}), pendimethalin fb bentazon (PRE fb POST at 455 fb 240 gm .a.i.fed^{-1}), bentazon (POST at 240 gm a.i. fed^{-1}), halosulfuron methy+ *s*-metalachlor (PRE at 15+288 g a.i.fed^{-1}), and halosulfuron methyl (PRE at 15 g .a.i.fed^{-1}), followed by *s*-metalachlor (PRE at 576 and 288 gm a.i. fed^{-1}), followed by halosulfuron-methyl + pendimethalin (PRE at 15+455 gm a.i. fed^{-1}) and oxyfluorfen (PRE at 60 gm a.i. fed^{-1}). On the other hand, Fluazifop-p- butyl (POST at 187.5 gm a.i. fed^{-1}) which had the lower herbicidal activity, also gave the lowest yield 405.33 and 406.67 kg fed.$^{-1}$, respectively, in the both seasons. These results are harmonized with those obtained by Mishra *et al.* (1998), who found that the application of pendimethalin increased common bean yield components because it decreased weed index. In addition, Powell *et al*. (2004) reported no yield reduction with dinitroaniline herbicides application. Aleksandra (2010) mentioned that application of herbicides in common bean under field conditions leads to excellent weed control and the highest bean yield. Similarly, Jafari *et al.* (2013) reported that maximum bean seeds yield was noted in plots treated with bentazon alone. Moreover, Soltani *et al*. (2013) recorded that the application of pendimethalin as PPI at 2160 gm a.i. ha^{-1} and as PRE at either1080 or 2160 gm a.i. ha^{-1} increased seed yield by up to 7 and10%, respectively over the untreated control. Mahgoub and Mukhtar (2014) found that weed competition in bean is primarily responsible for theloss of yield. Unrestricted weed growth reduced crop yield to about 47.01 – 54.44%. The available testimonies suggest that the use of the herbicide pendimethalin is likely to have been a conclusive factor in reducing the effect of weeds in bean fields. While, Soltani *et al.* (2020) reported that weed interference reduced seed yield of white bean by 70%. Moreover, white bean seed yield increased by 53-66% higher than the weed-free control using trifluralin, pendimethalin, ethalfluralin and *s*-metolachlor and by 81and 58% higher than the weed-free control using EPTC and halosulfuron as PPI, respectively. Also, ethalfluralin + halosulfuron, trifluralin + halosulfuron, pendimethalin + halosulfuron, *s*-metolachlor + halosulfuron, dimethenamid-P + halosulfuron, and EPTC + halosulfuron, applied as PPI at the evaluated rates, increased the white bean seed yield by 87-95% higher than the weed-free control.

Economic analysis:

The total cost, gross income and net benefit of herbicidal treatments in dry bean yield through seasons 2019 and 2020 are shown in Tables (7 and 8). The highest net profit was for the treatment with halosulfuron-methyl + bentazon (POST at 15 + 240 g a.i. fed.$^{-1}$), which gave a net profit of 14206.00 and 14251.30 Egyptian pounds for both seasons, 2019 and 2020, respectively, and was followed by the treatments of halosulfuron-methyl (POST at 15 gm a.i. fed.$^{-1}$) and bentazon (POST at 240 and 480 gm a.i. fed.$^{-1}$) compared to the untreated control, which gave a net profit of 5440.00 and 5383.39 Egyptian pounds for both seasons, respectively. Panotra and Kumar (2016) reported that maximum net returns in both years Rs 27095 and Rs 26432 per hectare were recorded with the application of fluchloralin at the rate of 1.00 kg a.i. ha^{-1} and which at par with pendimethalin at the same rate. The highest B. C. ratios of 2.18 and 2.11 were achieved with the treatments of fluchloralin and pendimethalin respectively, at 1.00 kg a.i. ha^{-1} for each. Chavan *et al*. (2020) found that weed free treatment recorded significantly higher gross monetary (Rs.950000 ha^{-1}) which was at par with pendimethalin 30% EC (1.0 kg ha^{-1}) applied as PRE + one hoeing at 30 DAS and quizalofo-p-ethyl 5% EC (100 gm ha^{-1}) at 20 DAS + one hoeing at 30 DAS and found significantly superior over the rest of the treatments. The application of pendimethalin 30% EC (1.0 kg ha^{-1}) as PRE + one hoeing at 30 DAS and quizalofo-p-ethyl 5% EC (100 gm ha^{-1}) at 20 DAS + one hoeing at 30 DAS were equally effective in producing higher gross monetary return of French bean as that of weed free treatment.

CONCLUSION:

In Egypt, fluazifop-p-butyl is the only registered herbicide for weed control in common bean crop. Generally, it can be concluded that application of chosen herbicides or hand hoeing played a vitally important role in controlling grassy and broad-leaved weeds in bean fields and resulted in an increase in yield and net benefits compared to the unweeded control.

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Table 1: Common names, trade names, applied rates and time of application of used herbicides**:**

Common name	Trade name	Rate a.i. fed $^{-1}$	Time of application
pendimethalin	Stomp Extra 45.5% CS	455	PRE
halosulfuron-methyl	Inpul 75% WG	15	PRE
halosulfuron-methyl	Inpul 75% WG	15	POST
S-metolachlor	Gardo 96 % EC	288	PRE
S-metolachlor	Gardo 96 % EC	576	PRE
Bentazon	Basagran 48% AS	240	POST
Bentazon	Basagran 48% AS	480	POST
oxyfluorfen	Nasr Gool Super 24 % EC	60	PRE
fluazifop-p- butyl	Fusichem 12.5 % EC	187.5	POST
halosulfuron-methyl + pendimethalin	Inpul 75% WG + Stomp Extra 45.5% CS	15 + 455	PRE
halosulfuron-methyl + *s*-metolachlor	Inpul 75% WG + Gardo 96 % EC	15 + 288	PRE
halosulfuron-methyl + bentazon	Inpul 75% WG + Basagran 48% AS	15 + 240	POST
pendimethalin + bentazon	Stomp Extra 45.5% CS followed by Basagran 48% AS	455 + 240	PRE followed by POST
Hand hoeing		Twice at 16 and 27 DAS	-------
Untreated control			-------

Table 2: Visual injury caused by herbicidal treatments to dry bean plants in seasons 2019 and 2020.

Treatments	Application time	Rate g ai. fed^{-1}	Injury % 2019					Injury % 2019				
			1 WAE	2 WAE	3 WAE	4 WAE	5 WAE	1 WAE	2 WAE	3 WAE	4 WAE	5 WAE
Pendimethalin	PRE	455	1.00	0.00	0.00	0.00	0.00	1.33	0.00	0.00	0.00	0.00
Halosulfuron-methyl	PRE	15	1.67	0.00	0.00	0.00	0.00	1.67	0.00	0.00	0.00	0.00
Halosulfuron-methyl	POST	15	---	---	17.67	5.00	0.00	------	-------	16.00	4.00	0.00
S-metolachlor	PRE	288	0.67	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00
S-metolachlor	PRE	576	1.67	0.00	0.00	0.00	0.00	1.33	0.00	0.00	0.00	0.00
Bentazon	POST	240	------	------	1.00	0.00	0.00	------	-------	0.00	0.00	0.00
Bentazon	POST	480	------	------	1.33	0.00	0.00	----	------	1.00	0.00	0.00
Oxyfluorfen	PRE	60	23.33	5.67	0.67	0.00	0.00	21.67	6.67	1.33	0.00	0.00
Fluazifop-p-butyl	POST	187.5	---	---	0.00	0.00	0.00	------	------	0.00	0.00	0.00
Halosulfuron-methyl + pendimethalin	PRE	15 + 455	2.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00
Halosulfuron-methyl + *s*-metolachlor	PRE	15 + 288	1.33	0.00	0.00	0.00	0.00	1.33	0.00	0.00	0.00	0.00
Halosulfuron-methyl + bentazon	POST	15 + 240	---	---	4.00	0.00	0.00	------	-----	2.67	0.00	0.00
Pendimethalin + bentazon	PRE fb POST	455 fb 240	1.33	0.00	0.00	0.00	0.00	1.67	0.00	0.00	0.00	0.00
Hand hoeing	Twice at 16 and 27 days after sowing		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Untreated control			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L.S.D. at 5% of treatments with control			1.70	0.90	0.86	0.43	0.00	1.20	0.70	0.90	0.40	0.00
L.S.D. at 5% of treatments without control			1.77	0.93	0.89	0.45	0.00	1.30	0.70	1.00	0.40	0.00

fb = followed by; PRE = pre-emergence; POST = post –emergence; WAE= weeks after emergence

Table 3: The predominant weeds in the untreated plots in dry bean field during the two seasons of 2019 and 2020.

Weeds		2019 season			2020 season		
		Fresh weight (g m^{-2})	% from Weed type	% from total Weeds	Fresh weight (g m^{-2})	% from Weed type	% from total weeds
Broad-leaved weeds	*Amaranthus cruentus*	2178.33	92.41	87.62	1995.00	91.39	85.99
	Chenopodium album	69.33	2.94	2.79	80.00	3.66	3.45
	Portulaca oleracea	74.33	3.15	2.99	77.00	3.53	3.32
	Sonchus oleraceus	35.33	1.50	1.42	31.00	1.42	1.34
	Total	2357.33	100.00	94.82	2183.00	100.00	94.09
Grassy weeds	*Cyperus longus*	98.00	76.17	3.94	100.00	72.99	4.31
	Setaria verticillata	13.67	10.62	0.55	18.00	13.14	0.78
	Echinochloa colonum	17.00	13.21	0.68	19.00	13.87	0.82
	Total	128.67	100.00	5.18	137.00	100.00	5.91
Total weeds		2486.00	-------	100.00	2320.00	------	100.00

Table 4: Effect of herbicides and hand hoeing on weed biomass (fresh weight gm m^{-2}) of broad-leaved and grassy weeds in dry bean crop in 2019 season.

Treatments	Application timing	Rate g ai. fed^{-1}	Mean fresh weight (g m^{-2})					
			Broad leaved weeds		Grassy weeds		Total weeds	
			Fresh weight	WCE %	Fresh weight	WCE %	Fresh weight	WCE %
Pendimethalin	PRE	455	199.67	91.53	86.67	32.64	286.33	88.48
Halosulfuron-methyl	PRE	15	242.67	89.71	38.33	70.21	281.00	88.70
Halosulfuron-methyl	POST	15	72.00	96.95	15.00	88.34	87.00	96.50
S-metolachlor	PRE	288	372.33	84.21	84.00	34.72	456.33	81.64
S-metolachlor	PRE	576	266.67	88.69	55.33	56.99	322.00	87.05
Bentazon	POST	240	64.67	97.26	47.00	63.47	111.67	95.51
Bentazon	POST	480	28.00	98.81	26.33	79.53	54.33	97.81
Oxyfluorfen	PRE	60	411.33	82.55	105.00	18.39	516.33	79.23
Fluazifop-p- butyl	POST	187.5	1416.00	39.93	64.33	50.00	1480.33	40.45
Halosulfuron-methyl + Pendimethalin	PRE	15 + 455	78.67	96.66	15.00	88.34	93.67	96.23
Halosulfuron-methyl +*s*-metolachlor	PRE	15 + 288	73.67	96.88	14.00	89.12	87.67	96.47
Halosulfuron-methyl + bentazon	POST	15 + 240	9.00	99.62	16.67	87.05	25.67	98.97
Pendimethalin + bentazon	PRE fb POST	455 fb 240	38.33	98.37	15.67	87.82	54.00	97.83
Hand hoeing	Twice at 16 and 27 days after sowing		10.67	99.55	30.00	76.68	40.67	98.36
Untreated			2357.33	0.00	128.67	0.00	2486.00	0.00
L.S.D. at 5% of treatments with control			57.71		7.43		55.12	
L.S.D. at 5% of treatments without control			56.06		7.44		52.96	

fb = followed by; PRE = pre-emergence; POST = post –emergence

Table 5: Effect of herbicides and hand hoeing on weed biomass (fresh weight gm m^{-2}) of broad-leaved and grassy weeds in dry bean crop in 2020 season.

Treatments	Application timing	Rate g ai. fed^{-1}	Mean fresh weight (g m^{-2})					
			Broad leaved weeds		Grassy weeds		Total weeds	
			Fresh weight	WCE %	Fresh weight	WCE %	Fresh weight	WCE %
Pendimethalin	PRE	455	191.33	91.65	86.33	38.04	277.67	88.57
Halosulfuron-methyl	PRE	15	239.67	89.54	49.67	64.35	289.33	88.09
Halosulfuron-methyl	POST	15	67.67	97.05	21.33	84.69	89.00	96.34
S-metolachlor	PRE	288	351.67	84.65	97.33	30.14	449.00	81.53
S-metolachlor	PRE	576	257.00	88.78	80.33	42.34	337.33	86.12
Bentazon	POST	240	60.00	97.38	45.67	67.22	105.67	95.65
Bentazon	POST	480	26.67	98.84	22.00	84.21	48.67	98.00
Oxyfluorfen	PRE	60	397.00	82.67	100.67	27.75	497.67	79.52
Fluazifop-p- butyl	POST	187.5	1385.00	39.55	61.67	55.74	1446.67	40.47
Halosulfuron-methyl + Pendimethalin	PRE	15 + 455	71.00	96.90	13.33	90.43	84.33	96.53
Halosulfuron-methyl + *s*-metolachlor	PRE	15 + 288	69.33	96.97	17.67	87.32	87.00	96.42
Halosulfuron-methyl + bentazon	POST	15 + 240	8.67	99.62	17.33	87.56	26.00	98.93
Pendimethalin+bentazon	PRE fb POST	455 fb 240	34.67	98.49	13.00	90.67	47.67	98.04
Hand hoeing	Twice at 16 and 27 days after sowing		10.33	99.55	27.67	80.14	38.00	98.44
Untreated			2291.00	0.00	139.33	0.00	2430.33	0.00
L.S.D. at 5% of treatments with control			66.90	--------	13.90	--------	71.80	--------
L.S.D. at 5% of treatments without control			54.30	---------	14.00	--------	59.40	--------

fb = followed by; PRE = pre-emergence; POST = post –emergence

Table 6: Effect of herbicides and hand hoeing on seed yield (kg fed.-1) in dry bean field in seasons of 2019 and 2020.

Treatments	Application timing	Rate g ai. fed^{-1}	2019 yield (kg fed.$^{-1}$)	2020 yield (kg fed.$^{-1}$)
Pendimethalin	PRE	455	838.00	840.00
Halosulfuron-methyl	PRE	15	810.00	813.33
Halosulfuron-methyl	POST	15	840.00	845.33
S-metolachlor	PRE	288	750.00	755.33
S-metolachlor	PRE	576	760.00	766.67
Bentazon	POST	240	836.00	838.67
Bentazon	POST	480	837.33	841.33
Oxyfluorfen	PRE	60	680.00	694.00
Fluazifop-p- butyl	POST	187.5	405.33	406.67
Halosulfuron-methyl + Pendimethalin	PRE	15 + 455	694.00	696.67
Halosulfuron-methyl +*s*-metolachlor	PRE	15 + 288	822.00	824.67
Halosulfuron-methyl + bentazon	POST	15 + 240	858.00	860.67
Pendimethalin + bentazon	PRE fb POST	455 fb 240	836.00	838.67
Hand hoeing	Twice at 16 and 27 days after sowing		862.00	868.00
Untreated			320.00	316.67
L.S.D. at 5% of treatments with control			21.12	25.60
L.S.D. at 5% of treatments without control			21.24	25.80

fb = followed by; PRE = pre-emergence; POST = post –emergence

Table 7: Effect of herbicides and hand hoeing on economic analysis in dry bean crop (cv. Giza 6) in season 2019.

Treatments	Application timing	Rate g ai. fed^{-1}	Egyptian pound fed.$^{-1}$ Herbicide cost (L.E.)	Cost/worker/1 spray or cost/10 worker hoeing (L.E.)	Total cost of Treatment (L.E.)	Yield (kg fed.^{1})	Gross income (L.E.)	Net benefit (L.E.)
Pendimethalin	PRE	455	260	100	360	838.00	14246.00	13886.00
Halosulfuron-methyl	PRE	15	170	100	270	810.00	13770.00	13500.00
Halosulfuron-methyl	POST	15	170	100	270	840.00	14280.00	14010.00
S-metolachlor	PRE	288	72	100	172	750.00	12750.00	12578.00
S-metolachlor	PRE	576	144	100	244	760.00	12920.00	12676.00
Bentazon	POST	240	110	100	210	836.00	14212.00	14002.00
Bentazon	POST	480	220	100	320	837.33	14234.61	13914.61
Oxyfluorfen	PRE	60	60	100	160	680.00	11560.00	11400.00
Fluazifop-p- butyl	POST	187.5	420	100	520	405.33	6890.61	6370.61
Halosulfuron-methyl + Pendimethalin	PRE	15 + 455	430	100	530	694.00	11798.00	11268.00
Halosulfuron-methyl +*s*-metolachlor	PRE	15 + 288	242	100	342	822.00	13974.00	13632.00
Halosulfuron-methyl + bentazon	POST	15 + 240	280	100	380	858.00	14586.00	14206.00
Pendimethalin + bentazon	PRE fb POST	455 fb 240	370	200 (2 sprays)	570	836.00	14212.00	13642.00
Hand hoeing	Twice at 16 and 27 days after sowing		-----	1500	1500	862.00	14654.00	13154.00
Untreated			-------	---------	0.00	320.00	5440.00	5440.00

Hand hoeing cost: 10 laborers fed.$^{-1}$ for 2 hoeing at 150 Egyptian pound (L.E.) laborer-1 day^{-1}, herbicide application cost: 1 laborer fed.$^{-1}$ at 100 L.E.laborer^{-1} day^{-1}, price of dry bean: 17 L.E. kg^{-1}, Gross income = dry bean yield (kg fed.$^{-1}$)× price (L.E. kg^{-1}), Net benefit = gross income - totalweeding cost.
fb = followed by PRE = pre-emergence; POST = post –emergence

Table 8: Effect of herbicides and hand hoeing on economic analysis in dry bean crop (cv. Giza 6) in season 2019.

Treatments	Application timing	Rate g ai. fed^{-1}	Egyptian pound fed.$^{-1}$					
			Herbicide cost (L.E.)	Cost/worker/1 spray or cost/10 worker hoeing (L.E.)	Total cost of Treatment (L.E.)	Yield (kg fed.^{1})	Gross income (L.E.)	Net benefit (L.E.)
Pendimethalin	PRE	455	260	100	360	840.00	14280.00	13920.00
Halosulfuron-methyl	PRE	15	170	100	270	813.33	13826.61	13556.61
Halosulfuron-methyl	POST	15	170	100	270	845.33	14370.61	14100.61
S-metolachlor	PRE	288	72	100	172	755.33	12840.61	12668.61
S-metolachlor	PRE	576	144	100	244	766.67	13033.39	12789.39
Bentazon	POST	240	110	100	210	838.67	14257.39	14047.39
Bentazon	POST	480	220	100	320	841.33	14302.61	13982.61
Oxyfluorfen	PRE	60	60	100	160	694.00	11798.00	11638.00
Fluazifop-p- butyl	POST	187.5	420	100	520	406.67	6913.39	6393.39
Halosulfuron-methyl + Pendimethalin	PRE	15 + 455	430	100	530	696.67	11843.39	11313.39
Halosulfuron-methyl +s-metolachlor	PRE	15 + 288	242	100	342	824.67	14019.39	13677.39
Halosulfuron-methyl + bentazon	POST	15 + 240	280	100	380	860.67	14631.39	14251.39
Pendimethalin + bentazon	PRE fb POST	455 fb 240	370	200 (2 sprays)	570	838.67	14257.39	13687.39
Hand hoeing	Twice at 16 and 27 days after sowing		-----	1500	1500	868.00	14756.00	13256.00
Untreated			-------	---------	0.00	316.67	5383.39	5383.39

Hand hoeing cost: 10 laborers fed.$^{-1}$ for 2 hoeing at 150 Egyptian pound (L.E.) laborer-1 day^{-1}, herbicide application cost: 1 laborer fed.$^{-1}$ at 100 L.E.laborer^{-1} day-1, price of dry bean: 17 L.E. kg^{-1}, Gross income = dry bean yield (kg fed.$^{-1}$)× price (L.E. kg^{-1}), Net benefit = gross income - totalweeding cost.
fb = followed by PRE = pre-emergence; POST = post –emergence.

كفاءة بعض مبيدات الحشائش في محصول الفاصوليا الجافة

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الملخص العربي

أجريت التجارب الحقلية بمحافظة المنوفية مركز أشمون لتقييم فاعلية بعض مبيدات الحشائش قبل وبعد الانبثاق في مكافحة الحشائش في محصول الفاصوليا الجافة مقارنة بغير المعامل (الكنترول) والعزيق خلال موسمي 2019 و2020. وكانت مبيدات الحشائش المستخدمة هي بنديميثالين و هالوسولفورون-ميثيل و اس ميتلاكرول و بنتازون و أوكسي فلورفين و فلوازيفوب-بي -بيوتيل مقارنة بالكنترول والعزيق مرتين بعد 16 و27 يوم من الزراعة . أظهرت النتائج أن الحشائش المصاحبة لمحصول الفاصوليا هي حشيشة أبوطرطور والزربيج البيضاء والرجلة والجعضيض كحشائش عريضة الأوراق والسعد وصيفية وأبو ركبة كحشائش رفيعة الأوراق. أشارت النتائج بشكل عام إلى أن المعاملات بمبيد أوكسي فلورفين (قبل الانبثاق) والهالوسولفورون-ميثيل (بعد الانبثاق) تسببت في سمية نباتية لنباتات الفاصوليا الجافة بشكل مرئي. كما حققت جميع معاملات مكافحة الحشائش سيطرة معنوية على الحشائش أعلى من الكنترول خلال الموسمين الدراسة. كما لوحظ الحد الأقصى من الانخفاض في الوزن الطازج للحشائش وأعلى كفاءة لمكافحة الحشائش، وأعلى انتاج لبذور الفاصوليا وأعلى صافي دخل عند خلط مبيد الهالوسولفورون-ميثيل مع مبيد بنتازون (بعد الانبثاق) بمعدل 15 + 240 جرام للفدان يليه العزق و البنديميثالين بمعدل 455 جرام للفدان (قبل الانبثاق) متبوعاً ببنتازون (بعد الانبثاق) بمعدل 240 جم للفدان خلال موسمين الدراسة..

الكلمات الاسترشادية: الحشائش, مبيدات الحشائش, الفاصوليا الجافة, صافي العائد.