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Comparative Performance of Herbicides for Grassy Weed Management in Winter Wheat (*Triticum aestivium* L.) under Egyptian Conditions

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EGYPT, Is considered as one of the bigger country importing for grain wheat. As, weeds cause many problems in agriculture reducing grain yield, the grass weeds are the most weed issue. Hence we tested some herbicides in wheat *viz Clodinafop-Propargyl* (WP 15%) at 0.050 kg a.i ha^{-1}, *Pinoxaden* (OD 10%) 0.06kg a.i. ha^{-1} , *Pinoxaden* (EC 0.06 %) 0.078kg a.i. ha^{-1} and newly *Tralkoxydim* at 0.12kg a.i. ha^{-1}, during two successive seasons 2020 and 2021 applied at 2-3leaf stage before tillering stage. The dominant grasses were (Wild oat) *Avena fatua*, (Ryegrass) *lolium temulentum* and (Canary grass) *phalaris minor*. The results showed increased grain yield by all herbicides applications over weedy check, *Tralkoxydim* (EC 10% a.i.) 8.53 t ha^{-1} and *Pinoxaden* (EC 6 % a.i.) 8.31t ha^{-1} and *Pinoxaden* (OD 10% a.i.) 8.14t ha^{-1} were superior. The maximum grain index (1000-grain weight) was in *Clodinafop-propargyl* WP 15% at 0.050 during both seasons (42.4g and 40.8g), respectively. Herbicides were effective for weed control parameters, weed population/m^2, fresh weights and dry weights g/m^2.

Keywords: Grasses, Herbicides, Weed control, Wheat.

Introduction

Weed control is an important practice for improving crop production. Yield losses up to 80% are caused by weeds. Agronomic farming practices that produce a vigor and fast-growing crop increase their competitive abilities against weeds (Rajpoot et al., 2018, 2019, 2021). Weeds have a direct impact on the profitability of wheat production systems, including: costs of chemicals, equipment, labour and other inputs. Also, weeds compete for available growth resources, reducing grain yield and quality of wheat (Zimdahl, 2018). Weed causes 10- 65% yield losses in wheat depending up on weed species (Ayana, 2020). Cereals are the most sensitive to weed competition in early stages of growth during 3 and 6-leaf stage (Koscelny & Peeper, 1997). Herbicides applications are highly effective for weed control, reducing weed competition and increasing the crop yield. Repeated application of certain herbicides without rotating modes of action may induce tolerant or resistant to herbicides (Johnson et al., 2009; Choudhary et al., 2021). Herbicides effectively reduce the weed densities by 93–95% compared to weedy checks and produce higher wheat grain yield (Usman et al., 2012). Herbicides are important to weed control, but the range of effective herbicides on key weeds is shrinking due to the evolution of herbicide resistance (Van der Meulen & Chauhan, 2017). The repeated use of herbicides with the same mode of action ultimately leads to the rapid spread of the resistant genotypes in the weed population (Nakka et al., 2019; Rajpoot et al., 2021). Hand pulling is a costly method and herbicides application is the suitable alternative method in combinations with other mechanical and agronomic methods (Patro & Ray, 2016; Rajpoot et al., 2018, 2019).

Wheat is considered a strategic feeding crop due to its importance in the Egyptian diet. It provides more than one-third of the daily caloric intake of Egyptian consumers and

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45% of their total daily protein consumption (Ghaffar, 1994). Wheat also provides ~21% of humans' daily dietary protein intake. Wheat is mainly consumed in the form of bread and major staple crop produced in Egypt, occupying ~32.6 % of the total winter crop area (Kherallah, 2000). Full weed competition in wheat reduces yield drastically (Angiras, 2008). Conventional methods are time consuming; hence, herbicides are effective and easy compared to handing methods (Chhokar & Malik, 2002).

Grassy weeds are highly competitive and produce large numbers of seeds with dormancy, although their half-life in the soil seed bank is relatively short (Taylor et al., 1999). Annual weeds are more costly to control by herbicides as broad-leaved weeds (Walker et al., 1999). *Lolium and Avena* are most grassy weed infested wheat, has evolved resistance to many herbicides. Mixing or rotating herbicide applications are effective, with a significantly lower resistance frequency than single herbicides to delay weed resistance (Busi & Beckie, 2021; Diggle et al., 2003). Worldwide, 263 weed species have developed resistance to at least one herbicide (Heap, 2021). Farmers have responded to this rise in herbicide-resistant weeds by using more robust and costlier herbicides (Livingston et al., 2015). Repeating the same herbicide is not adequate for weed control (Vijayalaxmi et al., 2012). A single herbicide leads to development of resistance in weed biotypes, species shifts and increase in perennial weeds. (Tewari & Singh, 1991). Hence, our work aims to investigate some of recommended and newly released herbicides for grassy weed control in wheat under Egyptian conditions.

Materials and Methods

Two experiments were conducted at the Agricultural Research and Experiments Station, Faculty of Agriculture, Cairo University, Egypt during 2020-2021 winter seasons. The experimental design was Randomized Block Design (RCBD) with six treatments replicated 3-times with plot size 3m × 3.5m using wheat variety *'*Giza 171*'* from Agricultural Research Center ARC, Egypt with 150kg ha^{-1}) seeding rate by drilling seeds. Sowing date was the second and the third week of November during both seasons at plant spacing of 10 cm ×5 cm on flat beds. The treatments were as follows: T1 = Aldo, T2= Axial, T3=OD-Actel, T4= Antilop, T5= Herbini, T6= Action, T7=Lema K-drin, T8= Fexy, T9= Weedy check (full season) as given in Table 1. During two successive seasons 2020 and 2021, treatments were applied at 2-3 leaf growth stage before wheat tillering after the first irrigation. Recommended broadleaf weeds' herbicide was applied for removing them. Agronomic practices such as pest control, fertilizers, irrigation requirements etc were carried out according to the recommended practices for wheat crop at the site of experiments. The soil at the experimental field was heavy clay with pH 5.1 and 257.0 kg, 26.3 kg and 152.8 kg ha^{-1} available N, P_2O_5 and K_2O, respectively. The information on types of herbicides used in the study was presented in Table 1.

Weed characteristics

Weed parameters were recorded after 45 days sowing date (DAS). Weed density, fresh and dry weights of weeds were recorded per square meter in twice for all treatments, by throwing a quadrate (0.5m×0.5m) randomly at two places in each plot. Then, weed samples were exposed to fresh air-dried in the sun and then in an electric oven a constant temperature of 70°C for 72h. Afterword, dry weights were recorded. Parameters were calculated as weed control efficiency and weed index and weed density by following formula:

1- Weed density m^2= Total number of particular weed species/ Total number of treatments.

2- Weed Index (%)= Grain yield of weed free– grain yield of treated plot/ grain yield of weed free

Crop growth parameters

It was measured for 10 randomly selected plants per plot at harvest. Growth and yield recorded parameters were: Weight spike (g), grain yield spike (g), number of tillers, 1000 grain weight (g), plant grain yield (g), and Grain yield (t ha^{-1}) .

Data analysis

Data were subjected to the analysis of variance (ANOVA) appropriate to the experimental design using SAS version 9.2. Mean separation was done using Fisher's protected least significant difference (LSD) test at 5% level of significance.

TABLE 1. Treatments Common, trade and chemical names of the herbicides applied

Treat.	Trade name	*Common name*	Active ingredient	Rate h^{-1}
1	Aldo	*Clodinafop-propargyl*	15	392gm
2	Axial	*Pinoxaden*	5	1400cm^3
3	Od actel	*Pinoxaden*	10	700cm^3
4	Antilop	*Clodinafop-propargyl*	10	560cm^3
5	Herbino	*Clodinafop-propargyl*	24	280cm^3
6	Action	*Clodinafop-propargyl*	15	1540cm^3
7	Lemak drin	*Pinoxaden*	6	1400gm
8	Fexy	*Tralkoxydim*	10	392cm^3
9	Weedy check			

Results and Discussion

Weed density

Data in Table 2 presented a significant reduction in weed density, weed dry weights and reduction in dry weight in all plots where applied the herbicides. All weed control treatments significantly reduced weed densities over weedy check. Fexy and lemak drin were superior over all herbicides in reducing weed density during both seasons. On the other hand, both herbicides were superior in reducing weed dry weights (67.6, 66.8%), respectively. Other herbicides significantly reduced weed dry weights. Khan et al. (2011) has also reported reduction in weed dry weight with different weed control treatments.

Relative grassy weed density

The three dominant grass weeds at the experimental site (Table 3) included common wild oat (*Avena fatua* L.), Ryegrass (*Lolium temulentum* L.) and canary grass (*Phalaris minor* L.). The results indicated that Relative weed density of wild oat had the highest relative weed density (41.8% each), followed by Ryegrass (33.6% each), and canary grass (24.7% each).

The results presented in Table 4 revealed significant increases in weight spike by applied herbicides compared to weedy check which was primarily due to the better crop growth as a result of less competition with weeds (Table 2). Maximum weight spikes produced by OD- Actel and Herbino and as resulting of grain yield spike/g, during both seasons. These results are in line with the previous finding by Khan et al. (2011).

The results presented in Table 5 revealed significant increases in number of tillers, with all application herbicides recorded compared to weedy check. Maximum number of tillers in the first season (142.67) and (142.37) were recorded by Herbino and Antilop respectively. While, Antilop and Fexy (146.33 and 145.23) recorded highest number of tillers. Herbino was the most effective herbicide to increase 1000 grain weight followed by Fexy during both seasons. Weed control treatments significantly increased grain yield (Table 5). Among applied herbicides which produced the highest grain yield were: fexy, lemak-drin and herbino (7.63, 7.60, and 7.11t ha^{-1}) during first season, respectively. During the second season, fexy and lemakdrin (8.60, 8.38t h^{-1}) produced the highest grain yield values followed by action (7.17t ha^{-1}) respectively. While the lowest grain yields (4.63t ha^{-1}, 4.93t ha^{-1}) were recorded by weedy checked (control) during both seasons. These results matched by the work of Akhtar et al. (1998) and Malik et al. (2002) who reported that chemical control of weeds resulted in having more grain yield. These results are also in agreement with those of Chilot et al. (1993) who determined that the application of herbicide gave a yield advantage of 27% in wheat.

The significantly lowest values of all growth characters were registered in weedy check treatment due to their high intensity of weeds which suppressed growth of wheat (Choudhary et al., 2021). These results were in conformity with Kumar et al. (2011), Paighan et al. (2013) and Safina & Mahmoud (2017).

TABLE 2. Weed densities (plant /m^2) and dry weights (gm/m^2) as affected by weed treatments as combined over both seasons

Weed treatments	Weed density (plant/m^2)	Weed dry weight (gm/m^2)	Reduction in dry weight (WCE) %
Aldo	32.16	20.01	63.22
Axial	32.50	20.41	62.48
Od actel	26.66	19.14	64.82
Antilop	32.00	20.01	63.22
Herbino	30.50	19.13	64.83
Action	33.33	20.30	62.68
Lemak drin	29.66	18.04	66.84
Fexy	27.83	17.61	67.63
Weedy check	67.67	54.40	0
LSD $_{.05}$	4.91	4.77	

TABLE 3. Grass weed species, common names, fresh weight and relative weed density weedy check during both seasons

Scientific names	Common names	Fresh weight (g)/m^2		Mean	Relative density (%)
		S1	S2		
Avena fatua	Wild oat	342.2	312.8	327.5	41.8
Lolium temulentum	Ryegrass	258.4	242.2	250.3	33.6
Phalaris minor	Canary grass	212.5	240.6	226.55	24.7

TABLE 4. Effect of weed control treatments on weight spike/(g) and grain yield spike (g)

Treatments	Weight spike (g)		Grain yield spike (g)	
	2020	2021	2020	2021
Aldo	3.19	3.02	2.30	2.17
Axial	3.32	3.40	2.58	2.57
Od actel	3.38	3.37	2.69	2.57
Antilop	3.17	3.40	2.43	2.87
Herbino	3.80	3.70	2.96	3.00
Action	3.51	3.60	2.71	2.97
Lemak drin	3.12	3.37	2.75	2.77
Fexy	3.20	3.27	2.60	2.93
Weedy check	3.01	2.43	2.07	2.03
LSD at $_{0.05}$	0.67	0.34	0.61	0.39

TABLE 5. Number of tillers, thousand grain weight (g) and Grain yield (t ha^{-1}) of wheat as affected by herbicides during two growing seasons

Treatments	No tillers/m^2		1000 grain weight (g)		Grain yield (t /h)	
	2020	2021	2020	2021	2020	2021
Aldo	120.00	127.00	28.2	34.9	5.68	5.46
Axial	126.62	133.33	38.4	38.4	6.28	5.42
Od actel	141.00	143.55	40.0	38.7	7.44	8.20
Antilop	142.37	146.33	38.8	40.5	6.19	5.49
Herbino	142.67	138.00	42.4	41.1	7.11	6.18
Action	138.00	140.14	40.5	35.8	6.90	7.17
Lemak drin	140.67	143.30	39.5	38.1	7.60	8.38
Fexy	141.33	145.23	40.8	41.5	7.63	8.60
Weedy check	125.47	122.54	27.1	22.5	4.63	4.93
LSD at $_{0.05}$	9.60	6.41	3.3	7.8	0.61	1.32

Conclusion

Applied herbicides development grain yield in wheat, mixed herbicides and using different active ingredients or different concentrations of active ingredients may good for weed management in wheat and reduce herbicides resistant in weed biotypes, in this work newly herbicides increased grain yield and superior on old and traditional herbicides for grassy weed in wheat.

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اداء بعض مبيدات الحشائش لمكافحة الحشائش النجيلية فى القمح تحت الظروف المصرية

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تعتبر مصر من اكبر الدول المستوردة للقمح فى العالم، ويمثل القمح محصول الحبوب الرئيسي فى الغذاء بالنسبة لباقى المحاصيل. وتعتبر الحشائش وهى النباتات الغريبة التى تنمو مع المحصول بصورة طبيعية اكبر معوقات الانتاج الزراعى وتؤثر سلبيا فى خفض انتاجية المحاصيل ومنها القمح الذي يتأثر بشدة نتيجة منافسة الحشائش.

تم اختبار عدد من مبيدات الحشائش لدراسة مقارنة وتقييم لكفاءة هذه المبيدات فى مكافحة الحشائش النجيلية الحولية فى القمح خلال موسمين متتاليين 2020 و2021 وتم تنفيذ 9 معاملات هى كالاتى: 3 مبيدات تحتوي على المادجة الفعالة بينوكسدين *Pinoxaden* باستخدام ثلاث صور تحتوي على هذه المادة الفعالة بتركيزات 10% مبيد او دي-اكتل، 6% ليماكى درين ، 5% اكسيال بمعدل 700 سم^3، 1400سم^3، 1410 سم ^{3} للهكتار على التوالى.

واربعة مبيدات تحتوي على المادة الفعالة كوادينافوب –برباجيل *Clodinafop-Propargy* باستخدام اربعة صور تجارية فى شكل بودرقابل للبلل بتركيزات 15% مبيد الدو، 10% انتيلوب، 15% اكشن وهيربينو 24% بمعدل 392، 560، 1540 و280 سم ^{3} للهكتار على التوالى. وصورة واحدة لمبيد ترالكسوديم *Tralkoxydim* بتركيز 10% بمعدل 392 سم ^{3} للهكتار هذا بالاضافة الى معاملة الكنترول او المقارنة التى تترك الحشائش بدون مكافحة طول الموسم. تم تطبيق جميع المبيدات بعد الانبات وخلال مرحلة 3-2 اوراق لنباتات محصول القمح. وتم مكافحة الحشائش العريضة الاوراق لجميع المعاملات باستخدام احدى المبيدات الموصي بها فى القمح. وكانت الحشائش النجيلية السائدة خلال مواسم الزراعة هى الزمير، الفلارس والصامة.

واظهرت النتائج تفوق جميع المبيدات المستخدمة بالنسبة لمعاملة الكنترول وتفوقت مبيدات على غيرها كما يلى اعطى مبيد *Tralkoxydim* بتركيز 10% محصول حبوب بمعدل 8.53 طن/ هكتار ومبيد *Pinoxaden* بتركيز 6% محصول يعادل 8.31 طن / هكتار ومبيد *Pinoxaden* بتركيز 10% محصول يعادل 8.14 طن/ هكتار. بينما اعطى مبيد هربينو *Clodinafop-Propargy* بتركيز 15% اعلى وزن لدليل الحبوب وزن 1000 حبة خلال موسمي الزراعة على التوالى.