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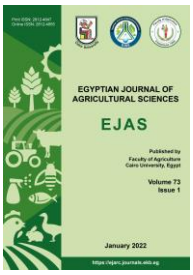

Effectiveness of Sowing Methods and Certain Herbicides against Dodder and Annual Weeds Associated with Flax

By

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ABSTRACT

Two field experiments were conducted during 2019/20 and 2020/21 seasons to evaluate the influence of two sowing methods (broadcasting and drilling) and nine herbicides on dodder *(Cuscuta epilinum)*, annual weeds and the productivity of flax (*Linum usitatissimum* L.). Economic evaluation of the interaction between sowing methods and weed control methods was also assessed. The application sequences of nine herbicides in six treatments included tribenuron-methyl 75% DF (Aonostar 75 DF) followed by fluazifop-p-butyl, 12.5% EC (Fusilade super 12.5% EC) (T1), tribenuron-methyl, 75% WG (Zinostar 75% WG) followed by (Fusilade super) (T2), bromoxynil octaoate, 24% EC (Brominal 24% EC) followed by clodinafop propargyl 2.5% + pinoxaden 2.5% (Traksos 5% EC) (T3), bromoxynil octanoate, 24% EC (Bromo plus 24% EC) followed by clodinafop propargyl 2.5% + pinoxaden 2.5% (Traksos) (T4), florasulam 7.5% + flumetsulam10% (Derby 17.5% SC) 17.5% SC followed by clethodim 12.5% EC (Select super 12.5% EC) (T5) and dicamba, 48% SL (Dimo up 48% SL) followed by (Select super) (T6). The herbicide treatments were compared to hand weeding (twice) (T7) and unweeded control (T8). The obtained results revealed that seed drilling method increased straw, seed, fiber and oil yield in both seasons, compared to broadcasting method. Herbicide treatments of T_5, T_6, T_1 and T_2, T_3 and T_4 decreased dry weight of dodder and annual weeds 90 days after application, in both seasons, as compared to unweeded control. The result suggested that seed drilling method combined with the herbicidal treatments of T_5, T_6, T_1 and T_2 were greatly effective against heavily infestation with dodder and total annual weeds. These practices reflected on greater fiber, oil seed yield and higher economic profit.

Keywords: *Flax, dodder, drilling, broadcasting, weeds, hand weeding, herbicides.*

1. INTRODUCTION

Flax (*Linum usitatissimum*, L.), is one of the oldest crops since beginning of civilization (Goyal *et al.*, 2014). Flax is grown as a dual purposes crop, for fiber and oil production. It is a source of industrial fibers as it currently processed, provides long and short fibers. Long line fiber is used in the manufacturing high value linen textiles, while short staple fiber has historically been the waste from long line fiber and used for lower value products (Jhala and Hall, 2010). Flax fibers have become an important part of new composite materials utilized in automobile and constructive industries. Bio-composites made up from the flax fibers is an ecofriendly and biodegradable alternative to conventional plastics (Bodros *et al.*, 2007). Flax seed oil has many human health benefits, including

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lowering inflammation, preventing heart disease, and reducing cancer risk (Goyal *et al.,* 2014). The flax cultivated area decreased due to some constraints included marketing aspects and weed competition. In 2019, the cultivated area of flax in Egypt reached 25018 feddans (feds), produced 105509 tons of straw and 17860 tons seeds (Anonymous (2019). Weeds are one of the major obstacles in crop production responsible for more than 45% crop yield reduction through their ability to compete for resources and their negative influence on the quality and quantity of crop yield (Korav *et al.*, 2018). Such influence depends on the density and type of weeds and approaches of control. The annual weeds (broad-leaved and grass) in flax fields, not only compete with seedling for growth factors, but also, act as hosts for insects and fungal diseases. The broad leaved and grassy weeds caused a significant decrease in growth characters, yield and its components, compared to unweeded plants (Kenaper *et al.,* 2018). In the recent years, dodder (*Cuscuta epilinum*) caused severe damage as a parasitic weed in many crops including flax and decreases flax growth, technical length, fiber length, straw yield and seed yield (Al-Shair (1986), El-Kady (2010) and Soliman and Hamza (2010)). Hand weeding was not efficient against dodder in both growing seasons (Soliman and Abd El-Hamid, 2009). Sowing methods can influence weed control and provide a good opportunity to overcome undesirable weeds (Albert *et al.,* 2008). Drilling as sowing method is better than any other cultivation methods because it allows for proper plant density and distribution. The drilling method significantly surpassed broadcasting method in straw and fiber yields and its components (El Azzouni *et al.,* 2006). The differences between planting methods were not significant for technical length, stem diameter, straw yield/plant, number of seeds/plant and seed yield/plant. While, such differences were significant for straw and seed yield/fed, seed index and seed oil percentage, whereas drilling was superior to broadcasting (El-Borhamy, 2011). In other studies, the planting method was significantly influenced several characters *i.e.*, plant height, fiber yield components, and seed yield components (Sorour *et al.,* 2015 and Shaheen, 2017).

Herbicides are the most successful weed control technology ever developed (Nagar *et al.,* 2020). Herbicides significantly increased flax growth characters, straw and seed yields/fed (Soliman and El-Kady 2010). Tribenuron-methyl significantly reduced the dry weight (g/m^2) of broad-leaved at 45 and 75 days after application, which consequently increased yield and its components (El-Hariri *et al.,* 2002). Also, fluazifop-p-butyl (Fusilade super) achieved the highest reduction of annual grassy weeds compared to weedy check (Ghalwash and Soliman, 2008). Both of tribenuron-methyl and fluazifop-p-butyl gave the best control against annual grassy weeds with an increase in oil contend of flax seeds and fiber characters compared to untreated control (Kenaper *et al*., 2018).

Tribenuron-methyl (Aonostar) gave the best control of dodder and the quality of the crop, after treatments but insignificantly decreased oil content of flax seeds (Soliman and Abd El- Hamid, 2009). Interaction between drilling method and bromoxynil-octaoate (Brominal) with 0.5 l/fed, Granstar at rate 6 g/fed, against broad weeds and fluazifop-p-butyl (Fusilade super) with 0.5 l/fed, and clethodim **(**Select) at rate 0.25 l/fed, against grassy weeds in flax seed yields successfully decreased weed competition and consequently improved straw, fiber and seed yields (El-Hag, 2019).

The present investigation evaluated the effects of two sowing methods and six various weed control treatments on dodder and annual weeds. In addition, the study also determined the impacts of these weed control treatments on flax growth, fiber characters and seed oil quantity. Economic profit resulted from combined effect was also determined.

2. MATERIAL AND METHODS

Two field experiments were carried out at Sakha Agricultural Research Station, Kafr Elsheikh, Egypt, during two successive winter seasons of 2019/2020 and 2020/2021 to study the effectiveness of sowing methods (broadcasting and drilling) and herbicide treatments on controlling dodder (*Cuscuta epilinum*), annual weeds and flax yield components. Sakha 3 flax cultivar was obtained from Fiber Research Section, Sakha Agricultural Research Station, Kafr Elsheikh, Egypt. The seeding rate in both seasons was 60 kg/fed, mixed with soil and distributed homogeneity on the plot. The sowing dates were 12^{th} and 15 November, during first and second seasons, respectively. The preceding summer crop was maize (*Zea mays* L.) in both seasons. The experimental design was spilt plot arrangement in a randomized complete blocks design (RCBD) with three replications. Sub-plot area was 3.5 x 3m with area 10.5 m^2. Plots were artificially infested with dodder seeds using 50 gm dodder seeds/kg flax seeds, which ensure homogeneity in the plot.

2.1. The herbicides under evaluation in both seasons

The herbicides under evaluation in both seasons were sprayed by using Knapsack Sprayer CP3 in water volume of 200 l/fed. Nomenclatures of herbicides are listed in Table (1).

T_6: Dicamba, 48% SL (Dimo up)® with 0.25 l/fed, applied 25 days after sowing followed by clethodim 12.5% EC (Select super) with 0.25 l/fed, applied 30 days after sowing.

T_7: Hand weeding (twice), were carried out at day 35 and 50 after sowing.

T_8: Unweeded (control).

Table (1): Common, trade and group names of the tested herbicides.

No	Common name	Trade name	Group name
1	Tribenuron-methyl	Aonostar	Sulfonylurea
2	Tribenuron-methyl	Zinostar	Sulfonylurea
3	Bromoxynil-octaoate	Brominal	Hydroxybenzonitrile
4	Bromoxynil-octaoate	Bromo plus	Hydroxybenzonitrile
5	Florasulam 7.5% + flumetsulam10%	Derby	Triazolo pyrimidines
6	Dicamba	Dimo up	Benzoic acid
7	Fluazifop-p-butyl	Fusilade super	Aryloxyphenoxy propionate
8	Clethodim	Select super	Cyclohexanedione
9	Clodinafop-propargyl 2.25%+ pinoxaden 2.25%	Traksos	Aryloxphenoxy propinate + phenylpyrazoline

2.2. Weed control treatments

Each experiment included sixteen treatments, consisting of the combination of two sowing methods (broadcasting and drilling) added in the main plots and eight weed control treatments in sub plot as follows:

T_1: Tribenuron-methyl, 75% DF (Aonostar)® using 8.0 g/fed, applied 21 days after sowing followed by fluazifop-p-butyl, 12.5% EC (Fusilade super)® with 1.0 l/fed, applied 30 days after sowing.

T_2: Tribenuron-methyl, 75% WG (Zinostar)® with 8.0 g/fed, applied 21 days after sowing followed by fluazifop-p-butyl, 12.5% EC (Fusilade super) with 1.0 l/fed, applied 30 days after sowing.

T_3: Bromoxynil octanoate, 24% EC (Brominal)® with 0.5 l/fed, applied 25 days after sowing followed by clodinafop propargyl 2.5% + pinoxaden 2.5% (Traksos)® 5% EC with 0.5 l/fed, applied 30 days after sowing.

T_4: Bromoxynil octanoate, 24% EC (Bromo plus)® with 0.5 l/fed, applied 25 days after sowing followed by clodinafop propargyl 2.5% + pinoxaden 2.5% (Traksos) 5% EC with 0.5 l/fed, applied 30 days after sowing.

T_5: Florasulam 7.5% + flumetsulam 10% (Derby)® 17.5% SC with 0.003 l/fed, applied 25 days after sowing followed by clethodim 12.5% EC (Select super)® with 0.25 l/fed, applied 30 days after sowing.

Calcium Super Phosphate (15.5% P_2O_5), was added during seedbed preparation using 100 kg/fed. Nitrogen fertilizer was added with 45 Kg N/fed in the form Urea in two equal splits before the first and second irrigations. Other cultural practices for flax production were applied according to recommendation. Soil texture of the experimental plots in both seasons was clay loamy. The collected data were as follows:

2.3. Estimated parameters

2.3.1. Dry weight of annual weeds (g m^{-2})

Annual weeds in cultivated flax (Table 2) were hand pulled at 70 and 90 days after sowing and classified into broad-leaved and grassy and the dry weight of each and the total of both was determined (gm^{-2}). Weed control treatments were evaluated in the form of reduction percentage (R%) in dry weight of each individual weed species, as well as total weeds as follows:

$$Reduction\ \% = \frac{Unweeded\ control - Treatment}{Unweeded\ control} \times 100$$

2.3.2. Dry weight of dodder (gm^{-2})

Dodder was hand pulled randomly from one square meter of each plot after 50, 70 and 90 days from last treatment. After that, dodder was air-dried for 3 days then, oven dried at 70 °Ĉ for 72 hours, and then the dry weight of dodder weeds was recorded as gm^{-2}.

Table (2): English, scientific, and family names for weeds associated with flax crop during 2019/2020 and 2020/ 2021 seasons.

Categories	English name	Scientific name	Family name
Broad-leaved	Common lambsquarters	*Chenopodium album,* L	Chenopodiaceae
	Sea beet	*Beta vulgaris,* L	Chenopodiaceae
	Mary's thistle	*Silybum marianum,* L.	Asteraceae
	Sow thistle	*Sonchus oleraceus,* L.	Asteraceae
	Toothed medik	*Medicago intertexta,* L.	Leguminosae
	Cheese weed mallow	*Malva parviflora,* L.	Malvaceae
	Scarlet pimpernel	*Anagallis arvensis,* L.	Primulaceae
	Dentated dock	*Rumex dentatus,* L.	Polygonaceae
Grassy weeds	Lesser canary grass	*Phalaris minor,* L.	Poaceae
Parasitic weed	Dodder	*Cuscuta epilinum,*	Cuscutaceae

2.3.3. Flax growth characters and yield components

Samples of ten flax plants randomly taken from each plot at harvest to determine straw and seed yield components. Whole plants of the sub plot were taken to determine straw and seed yields per plot, which converted to be per feddan. The following characters were studied:

2.3.3.1 Straw yield and its components

The plant characters of height (cm), technical length (cm), stem diameter (mm), straw yield plant^{-1} (g) and straw yield (ton fed^{-1}) were studied.

2.3.3.2. Seed yield and its components

The seed characters of fruiting zone length (cm), number of capsule plant^{-1}, seed yield plant^{-1} (g) and seed yield (Kg fed^{-1}) were studied.

2.3.3.3. Fiber characters

The fiber characters of fiber length (cm), fiber percentage, fiber yield (kg/fed^{-1}), and fiber yield per feddan (Kg) calculated from whole plot. Ten fiber ribbons from each treatment were speeded out and each ribbon was measured then the average fiber length (cm) was recorded and total fiber percentage was calculated formulas follows:

Fiber percentage (%) = Fiber yield/Straw yield after retting x 100.

2.3.3.3.1. Oil content

The samples of seeds were taken randomly from each treatment to determine oil content according to the method described by the A.O.A.C. (1990), using petroleum ether at (40–50°C) in a Soxhlet apparatus.

2.4. Economic evaluation

Economic evaluation of interaction between sowing methods and weed control treatments was done according to the method described by CIMMYT (1988).

-Total income of straw yield = straw yield t fed^{-1} x price of ton.

-Total income of seed yield = seed yield kg/fed^{-1} x price of kg.

-Total income of the yield = Total income of straw yield + Total income of seed yield

-Net income (NI) = Gross income minus Total costs.

-Profitability (P) = (Net income/Total costs) x 100.

Benefit/Costs Ratio (B/C) = Gross income/Total costs

2.5. Statistical analysis

The obtained field data were subjected to analysis of variance (ANOVA) of split plot design in the RCBD as described by MSTAT software package (Snedecor and Cochran, 1980). The correlation coefficients were estimated to explore the relationship among the dry weight of each weed category (broad- leaved, grassy and total weeds) and flax yield and its components according to Steel and Torrie (1980).

3. RESULTS AND DISCUSSION

3.1. Effects of sowing methods, weed control treatments and their interaction

3.1.1. Dry weight of annual weeds (gm^{-2})

The results presented in Tables (3 and 4) indicated that dry weights of broad-leaved and their total annual weeds were significantly decreased under drilling sowing method in both seasons. At day 70 after sowing, drilling sowing decreased the dry weight of broad-leaved weeds by 66.7 and 52.5%, grassy weeds by 76.4 and 53.5%, and total annual weeds by 70.9 and 52.9% compared to corresponding broadcasting method, for the first and second seasons, respectively. However, at day 90 after sowing, the percentages of weed dry weight reduction of broad-leaved weeds reached

63.8 and 45.1%, grassy weeds by 61.5 and 39.3%, and total annual weeds 62.7 and 42.6% compared to broadcasting method, for first and second seasons, respectively.

The six herbicide treatments, hand weeding twice, and the unweeded control treatments in both seasons affected significantly the dry weight of broad-leaved, grassy and total annual weeds at 70 and 90 days after sowing. The highest reduction percentage (R%) in the dry weight of total annual weeds at day 70 after sowing (DAS) recorded in a descending order from Derby followed by Select super (T5), Dimo up followed by Select super (T6), Zinostar followed by Fusilade super (T2), Aonostar followed by Fusilade super (T1), Bromo plus followed by Traksos (T4), Brominal followed by Traksos, (T3) and hand weeding twice (T7). For the first season, the descending reduction rates in dry weight were 94.2, 93.5, 91.5, 89.8, 87.8, 86.4 and 67.9% for the abovementioned treatments, respectively. For the second season, the extent of reduction rates was 96.3, 96.1, 94.3, 93.3, 91.7, 90.6 and 72.9%, for the same order compared to unweeded control treatment.

At day 90 after sowing, the dry weight of total annual weeds was significantly affected by the investigated herbicide treatments and unweeded control, in both seasons. The reduction percentages (R%) in total annual weeds were recorded in a descending order for Derby followed by Select super (T5), Dimo up followed by Select super (D6), Zinostar followed by Fusilade super (T2), Aonostar followed by Fusilade super (T1), Brominal followed by Traksos (T3), Bromo plus followed by Traksos (T4) and hand weeding twice. The reduction rates were 91.3, 90.4, 87.0, 85.0, 81.2, 80.0 and 69.6%, in 2019/2020 season, and 95.1, 94.8, 92.2, 91.1, 88.8, 87.3 and 68.4%, in 2020/2021 season for the same abovementioned treatments, compared to unweeded control, respectively.

The interaction between sowing methods and weed control treatments is significant for reduction percentages of dry weight of annual weeds at days 70 and day 90. The application of Derby followed by Select super (T5), Dimo up followed by Select super (T6) under seed drilling method gave significantly the least annual weeds dry weight either at day 70 or day 90, (Figs. 1 and 2). Generally, the results showed that herbicide treatments combined with drilling sowing were more effective for controlling the annual weeds associated with flax plants than broadcasting sowing method. All applied herbicide treatments affected both broad-leaved and grassy weeds, which reflected in longer control period and resulted in least dry weight of weeds. This may be due to mode of action of herbicides, as photosystems II inhibitors for broad-leaved and grassy of weeds. These effects reduced the competition of weed with the growing flax plants. Similar results were reported by Shaheen (2017), El-Hag (2019) and Nagar *et al.* (2020).

3.1.2. Dry weights of dodder (g m^{-2})

Data presented in Table (5) showed that the effect of sowing methods, weed control treatments and their interaction on the reduction percentages of dry weight of dodder (g/m^{-2}) at days 50, 70 and 90 after sowing. Data clearly indicated that the difference was significant between sowing methods and dry weight of dodder. Drilling methods was better than broadcasting methods by 63.8 and 31.7%, for both seasons, respectively. The infestation of dodder was greatly affected by herbicidal treatments. The dry weight of dodder was decreased gradually by using Derby followed by Select super (T5), Dimo up followed by Select super (T6), Zinostar followed by Fusilade super (T2), Aonostar followed by Fusilade super (T1) and Brominal followed by Traksos (T3) and Bromo plus followed by Traksos (T4) treatments. Such treatments reduced dodder dry weight by 98.7, 98.5, 93.6, 92.7, 92.6 and 92.4%, in the first season 2019/20. In the second season 2020/21, the reduction rate was 96.7, 96.1, 92.3, 91.5, 89.9 and 88.9 % for the same abovementioned treatments, respectively. However, hand weeding twice was the least effective controlling method for dodder with percent of reduction 43.0 and 44.8 at 90 days after sowing in both seasons, respectively. It was observed that the reduction rate (%) of dodder was slightly affected by hand weeding treatment as compared with other tested herbicidal treatments. These results confirmed that hand weeding twice was not enough to control dodder. The interaction between sowing methods and weed control treatments caused significant reduction percentages of dodder in flax plants (Fig. 3). The application of all herbicides provided the best results under the drilling sowing method compared to unwedded control under broadcasting sowing. In general, the applied herbicides were the most effective treatments compared to unwedded control consequently, it could be attributed to the inhibition of ALS (acetolactate synthase) and inhibition of ACCase (acetyle CoA carboxlyase) (Fig. 3). These results are in agreements with those obtained by Soliman and Abd El-Hamid (2009) and Soliman and Hamza (2010).

Table (3): Effects of sowing methods and weed control treatments on dry weight of annual weeds (gm^{-2}) 70 days after sowing during 2019/2020 and 2020/2021 seasons.

Weed categories	Dry weight of annual weeds (gm^{-2}) At 70 days after sowing							
	Broad-leaved weeds		Grassy weeds		Total annual weeds			
Seasons	**2019/2020**	**2020/2021**	**2019/2020**	**2020/2021**	**2019/2020**	**R%***	**2020/2021**	**R%**
Sowing methods (S)								
Broadcasting (BC)	137.8	61.3	105.5	52.1	243.3	0	113.5	0
Drilling (D)	45.9	29.1	24.9	24.3	70.8	70.9	53.37	53.0
LSD 5% (S)	**36.7**	**21.3**	**15.5**	**15.9**	**32.1**	**-**	**36.9**	**-**
Weed control treatments (T)								
T1	42.95	14.92	25.11	12.42	68.1	89.8	27.3	93.3
T2	35.50	12.70	21.32	10.58	56.8	91.5	23.3	94.3
T3	55.27	20.68	35.48	17.23	90.8	86.3	37.9	90.6
T4	49.98	18.30	31.0	15.27	81.0	87.8	33.6	91.7
T5	23.93	8.13	14.78	6.78	38.7	94.2	14.9	96.3
T6	26.78	8.58	16.18	7.15	43.0	93.5	15.7	96.1
Hand weeding (twice)	95.77	57.47	117.6	52.01	213.4	67.9	109.5	72.9
Unweeded control	404.8	220.9	260.0	184.1	664.8	-	405.1	-
LSD 5% (T)	**38.49**	**19.13**	**32.18**	**14.21**	**45.52**		**33.08**	
LSD 5% (S x T)	**54.42**	**27.05**	**45.51**	**20.09**	**91.17**		**46.78**	

T1= Aonostar followed by Fusilade, super T2= Zinostar followed Fusilade super *= Reduction rate (%)
T3= Brominal followed by Traksos T4= Bromo plus followed by Traksos
T5= Derby followed by Select super T6= Dimo up followed by Select super

Table (4): Effect of sowing methods and weed control treatments on dry weight of annual weeds (gm^{-2}) 90 days after sowing during 2019/2020 and 2020/2021 seasons.

Weed categories	Dry weight of annual weeds (gm^{-2}) at 90 days after sowing							
	Broad-leaved weeds		Grassy weeds		Total annual weeds			
Seasons	**2019/2020**	**2020/2021**	**2019/2020**	**2020/2021**	**2019/2020**	**R%**	**2020/2021**	**R%**
Sowing methods (S)								
Broadcasting (BC)	281.2	140.2	220.4	105.4	501.6	0	245.5	0
Drilling (D)	101.9	76.9	84.9	64.0	186.9	62.7	140.9	42.7
LSD 5%	**55.02**	**33.04**	**52.26**	**36.36**	**26.32**		**56.95**	
Weed control treatments (T)								
T1	104.1	42.1	90.4	36.3	194.4	85.0	78.3	91.1
T2	92.3	37.6	76.1	31.1	168.3	87.0	68.7	92.2
T3	153.2	62.8	117.1	48.8	270.3	80.0	111.6	87.3
T4	136.9	55.7	106.6	44.1	243.6	81.2	99.7	88.7
T5	63.8	24.4	49.6	19.2	113.4	91.3	43.5	95.1
T6	69.2	25.3	54.7	20.2	123.9	90.4	45.4	94.8
Hand weeding (twice)	203.4	176.0	190.2	102.5	393.6	69.6	278.5	68.4
Unweeded control	809.7	544.5	486.7	335.5	1296.4	-	880.0	-
LSD 5% (T)	**78.8**	**59.8**	**55.44**	**35.52**	**130.2**		**79.7**	
LSD 5% (S xT)	**111.4**	**84.6**	**78.42**	**50.24**	**184.2**		**112.6**	

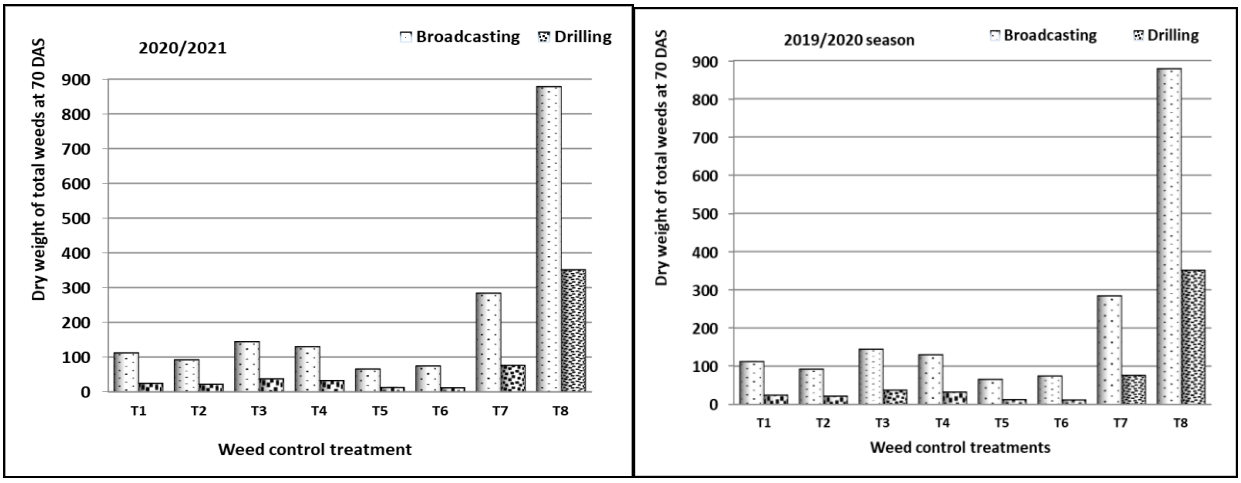

Fig. (1): Interaction between sowing methods and weed control treatments and its effect on dry weight of total annual weeds 70 days after sowing during 2019/2020 and 2020/2021 seasons.

T_1: Aonostar+Fusilade super **T_2: Zinostar +Fusilade super** **T_3: Brominal + Traksos** **T_4: Bromo plus + Traksos**
T_5: Derby + Select super **T_6: Dimo-up + Select super** **T_7: Hand weeding (twice)** **T_8: Unweeded control**

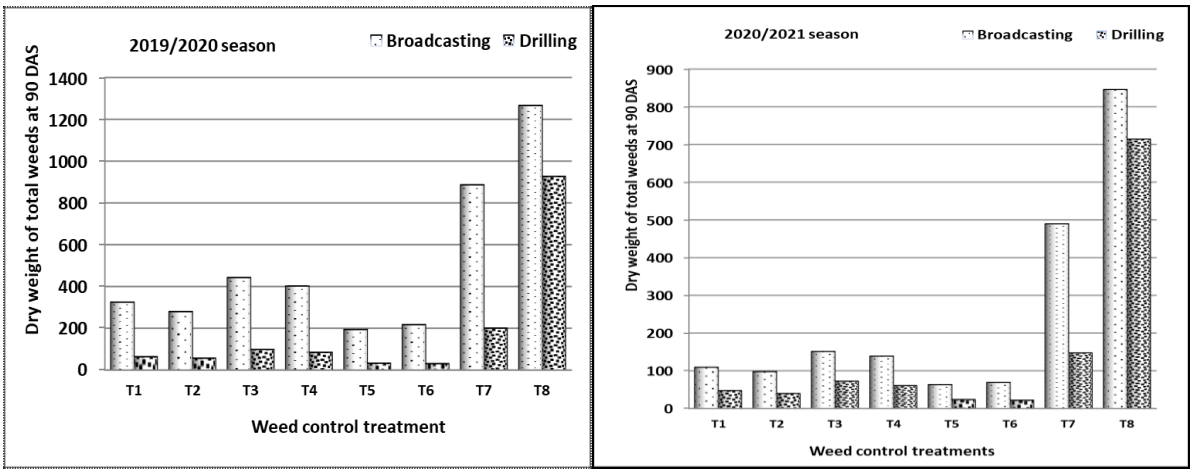

Fig. (2): Interaction between sowing methods and weed control treatments and its effect on dry weight of total annual weeds 90 days after sowing during 2019/2020 and 2020/2021 seasons.

Table (5): Effect of sowing methods and weed control treatments on dry weight of dodder 50, 70 and 90 days after sowing during 2019/2020 and 2020/2021 seasons.

Weed category	Dry weight of dodder (g m^{-2})							
	50 days after sowing		70 days after sowing		90 days after sowing			
Seasons	2019/2020	2020/2021	2019/2020	2020/2021	2019/2020	R%	2020/2021	R%
Sowing methods (S)								
Broadcasting (BC)	53.9	69.2	67.1	109.3	107.2	0	122.4	0
Drilling (D)	20.8	46.3	27.2	80.2	43.4	63.8	83.6	31.7
LSD 5% (S)	**7.2**	**10.7**	**17.7**	**10.7**	**28.0**		**37.7**	
Weed control treatments (T)								
T1	13.5	21.2	14.8	61.30	23.6	92.6	33.8	91.5
T2	11.6	18.3	12.8	52.98	20.4	93.6	30.4	92.3
T3	13.3	20.8	14.5	60.31	23.2	92.7	41.1	89.9
T4	13.9	21.9	15.3	63.57	24.5	92.4	44.6	88.9
T5	2.3	3.6	2.5	10.57	4.1	98.7	12.8	96.7
T6	2.8	4.4	3.1	12.65	4.9	98.5	15.4	96.1
Hand weeding (twice	93.4	142.1	114.0	207.5	182.2	43.0	218.8	44.8
Unweeded control	148.4	229.7	200.2	289.2	319.9	0	396.3	0
LSD 5% (T)	**15.5**	**21.3**	**22.3**	**17.6**	**35.6**		**27.0**	
LSD 5% (S xT)	**21.9**	**30.2**	**31.5**	**24.9**	**50.3**		**38.2**	

3.2. Effect of weed control treatments on straw yield and its components

3.2.1. Plant height (cm)

Data presented in Table (6) show the effect of sowing methods and weed control treatments on plant height (cm) at harvest. The data indicated that plant height was not significantly affected in both sowing methods at harvest.

Weed control treatments had a significant effect of plant height at harvest. All herbicide treatments increased plant height of flax plants compared to hand weeding treatment. These results are similar to that obtained by Soliman and Abd El-Hamid (2009), who reported that, parasitic weed not only deprive the host plants nutrients but also inhibit growth. Also, the obtained data revealed that the herbicide treatments of Derby followed by Select super (T5) and Dimo up followed by Select super (T6) provided the tallest plants and increased the plant height by about 27.0 and 23.5 cm compared to unweeded control. The adoption of Aonostar followed by Fusilade super (T1) and Zinostar followed by Fusilade super (T2) followed the aforementioned treatments. However, Bromo plus followed by Traksos (T4) and Brominal followed by Traksos (T3) provided the shortest flax plant related to other herbicidal treatments

Plant height of flax was not significantly affected by the interaction between sowing methods and weed control treatment.

3.2.2. Technical length and stem diameter (cm)

Data also, indicated a significant difference among the weed control treatments regarding technical length and stem diameter of flax plants. The herbicide treatments increased both traits compared to hand weeding treatment in both seasons. The tested herbicide treatments were necessary to eliminate dodder and annual weeds to avoid their negative impacts of flax plants. Similar results were reported by Soliman and El-Kady (2010) and Kenaper *et al*. (2018). The interaction between sowing methods and weed control treatments was not significant with regard to the technical length and stem diameter at harvest in only the yield of the first season.

3.2.3. Straw yield plant^{-1} and straw yield (tons/ fed^{-1})

The straw yield/plant^{-1} and straw yield/ feddan^{-1} were significantly influenced by sowing methods and weed control treatments during both seasons. Drilling method surpassed the straw yield/plant^{-1} and feddan compared with broadcasting method in both seasons (Table 6).

The herbicide treatments using Derby followed by Select super (T5) and Dimo up followed by Select super (T6) produced higher straw yield plant in both seasons. In contrast, the unweeded control treatment recorded the least flax straw yield. The reduction in straw yield values under hand weeding

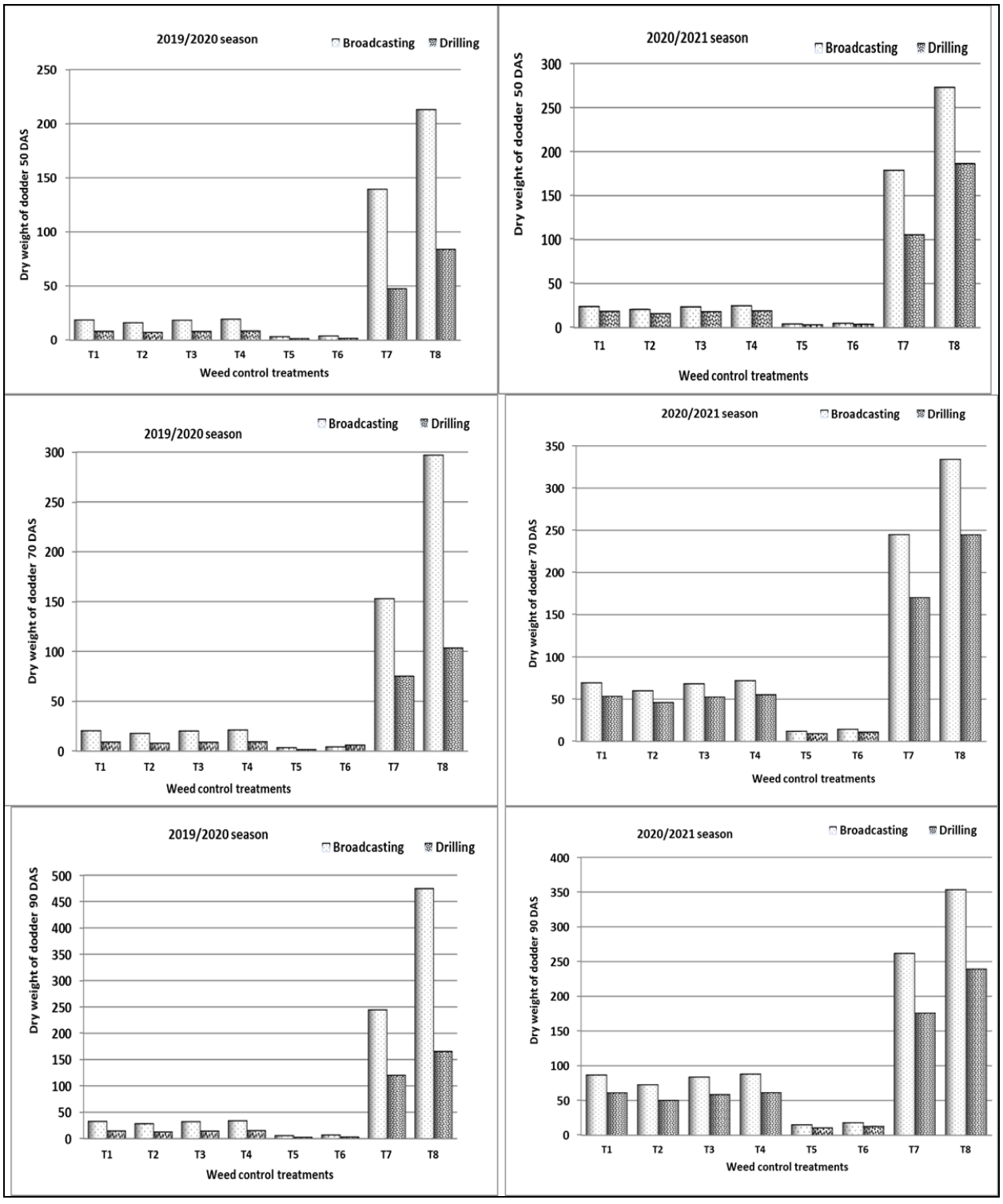

Fig. (3): Interaction between sowing methods and weed control treatments and its effect on dry weight of dodder weed 50, 70 and 90 days after sowing during 2019/2020 and 2020/2021 seasons.

Table (6): Straw yield and its components as affected by sowing methods and weed control treatments during 2019/2020 and 2020/2021 seasons at harvest.

Characters	Plant height (cm)		Technical length (cm)		Steam diameter (mm)		Straw yield plant^{-1} (g)		Straw yield (ton fed^{-1})	
Seasons	**2019/2020**	**2020/2021**	**2019/2020**	**2020/2021**	**2019/2020**	**2020/2021**	**2019/2020**	**2020/2021**	**2019/2020**	**2020/2021**
Sowing methods (S)										
Broadcasting (BC)	86.4	90.4	75.0	76.7	1.6	1.7	0.393	0.444	2.054	2.441
Drilling (D)	89.8	94.1	78.3	82.2	1.3	1.3	0.445	0.501	3.220	2.978
LSD 5% (S)	NS	NS	1.863	4.780	0.176	0.064	0.152	0.045	0.349	0.500
Weed control treatments (T)										
T1	92.3	97.7	80.0	84.0	1.45	1.55	0.464	0.519	2.77	2.91
T2	88.5	95.0	77.2	81.1	1.40	1.48	0.399	0.455	2.99	3.13
T3	87.0	92.2	75.0	79.0	1.70	1.73	0.381	0.437	2.81	2.88
T4	88.0	94.0	75.5	79.5	1.53	1.55	0.392	0.446	2.68	2.84
T5	100.5	104.8	85.5	89.6	1.22	1.33	0.624	0.688	3.24	3.25
T6	97.0	99.5	83.2	86.2	1.31	1.50	0.537	0.631	2.97	3.089
Hand weeding (twice)	83.5	82.7	74.5	72.0	1.58	1.55	0.344	0.399	2.39	2.37
Unweeded control	67.8	71.2	62.7	64.5	1.15	1.28	0.211	0.206	1.11	1.10
LSD 5% (T)	**5.47**	**2.402**	**5.470**	**2.142**	**0.124**	**0.164**	**0.037**	**0.632**	**0.277**	**0.329**
LSD 5% (S X T)	**NS**	**NS**	**NS**	**3.030**	**NS**	**0.234**	**NS**	**NS**	**0.456**	**0.388**

and unwedded control treatments reflected a negative effect of dodder and annual weeds on flax growth, which might occur as a result of competition between flax plants and dodder. Herbicide treatments were necessary to eliminate the dodder and annual weeds to avoid their negative impacts on flax. These results are similar to that obtained by Soliman and El-Kady (2010). The results showed that straw yield (tons/fed.) under the use of Derby followed by Select super (T5) and Zinostar followed by Fusilade super (T2) were (66.2 and 64.8 %), and for Dimo up followed by Select super (T6) and Brominal followed by Traksos (T3) was (64.3 and 61.7%), under drilling method compared to broadcasting method. Similar data were reported by EL-Borhamy (2011) and Shaheen (2017).

3.3. Seed yield and its components

Data in Table (7) indicated that the difference between fruiting zone length under both sowing methods was only significant for the second season. Drilling method recorded the highest fruiting zone (13.4 cm) in the second season. These results are in harmony with the result obtained by Shaheen (2017). Also, it was a significant effect between sowing methods for the number of capsules/ plant^{-1}, seed yield/plant^{-1} as well as seed yield /fed^{-1}. Drilling sowing method gave the highest values for these characters as compared with broadcasting method. Regarding the effect of weed control treatments on seed yield at plant or feddan level, data denoted that weed control treatments had a significant effect on seed yield. The hand weeding treatment recorded the lowest seed yield fed^{-1} (322.5 and 319.0 kg fed^{-1}) for both seasons as compared to seed yield produced after application of Derby followed by Select super (T5) (463.5 and 442.3 kg/ fed^{-1}) for both seasons, respectively. The results in Table (7) agreed with the results obtained by Soliman and Hamza (2010) and Soliman and El-Kady (2010).

Generally, the highest increase in seed yield was achieved for the herbicide treatments of Derby followed by Select super (T5) and Dimo up followed by Select super (T6), followed by treatments of Aonostar followed by Fusilade super (T1) and Zinostar followed by Fusilade super (T2). Hand weeding treatment gave the lowest seed yield as compared with all tested herbicide treatments. It was clear that hand weeding and sowing methods were insufficient to provide the desired weed control which reflected on the limited increase in the crop growth and consequently of seed yield/fed. (Soliman and El-Kady, 2010). These effects might be attributed to the dominant weeds in the hand weeding treatment, and this suggest the important use of the suitable herbicide treatments due to the expected problem of dodder and annual weeds.

Seed yield was significantly affected by the interaction between sowing methods and weed control treatments (Fig.4). The sowing methods only were useful in dodder control in infested soil with

Table (7): Seed yield and its components as affected by sowing methods and weed control treatments during 2019/2020 and 2020/2021 seasons at harvest.

Characters	Fruiting zone length (cm)		Number of capsule plant^{-1}		Seed yield plant^{-1} (g)		Seed yield (kg fed^{-1})	
Seasons	**2019/2020**	**2020/2021**	**2019/2020**	**2020/2021**	**2019/2020**	**2020/2021**	**2019/2020**	**2020/2021**
Sowing methods (S)								
Broadcasting (BC)	11.5	11.8	10.0	12.8	0.360	0.278	314.7	328.8
Drilling (D)	11.4	13.4	12 .0	14.7	0.394	0.365	423.5	385.4
LSD 5% (S)	**NS**	**0.358**	**0.781**	**0.875**	**0.018**	**0.029**	**54.62**	**24.94**
Weed control treatments (T)								
T1	12.3	13.7	12.5	15.5	0.409	0.357	415.4	404.8
T2	11.3	13.8	11.2	14.1	0.409	0.339	406.5	390.3
T3	12.0	13.2	11.3	14.3	0.371	0.323	388.5	368.1
T4	12.5	14.5	10.5	13.8	0.418	0.363	352.3	343.5
T5	15.0	15.2	14.6	17.8	0.454	0.401	463.5	442.3
T6	13.8	13.3	13 ,0	16.2	0.418	0.368	452.4	433.1
Hand weeding (twice)	9.0	10.6	11.0	12.5	0.340	0.289	322.5	319 .0
Unweeded control	5.1	6.7	4.5	6.0	0.113	0.131	151.8	155.5
LSD 5% (T)	**1.128**	**1.35**	**1.121**	**1.388**	**0.342**	**0.311**	**20.67**	**14.89**
LSD 5% (SXT)	**1.59**	**1.91**	**NS**	**NS**	**NS**	**NS**	**29.24**	**21..06**

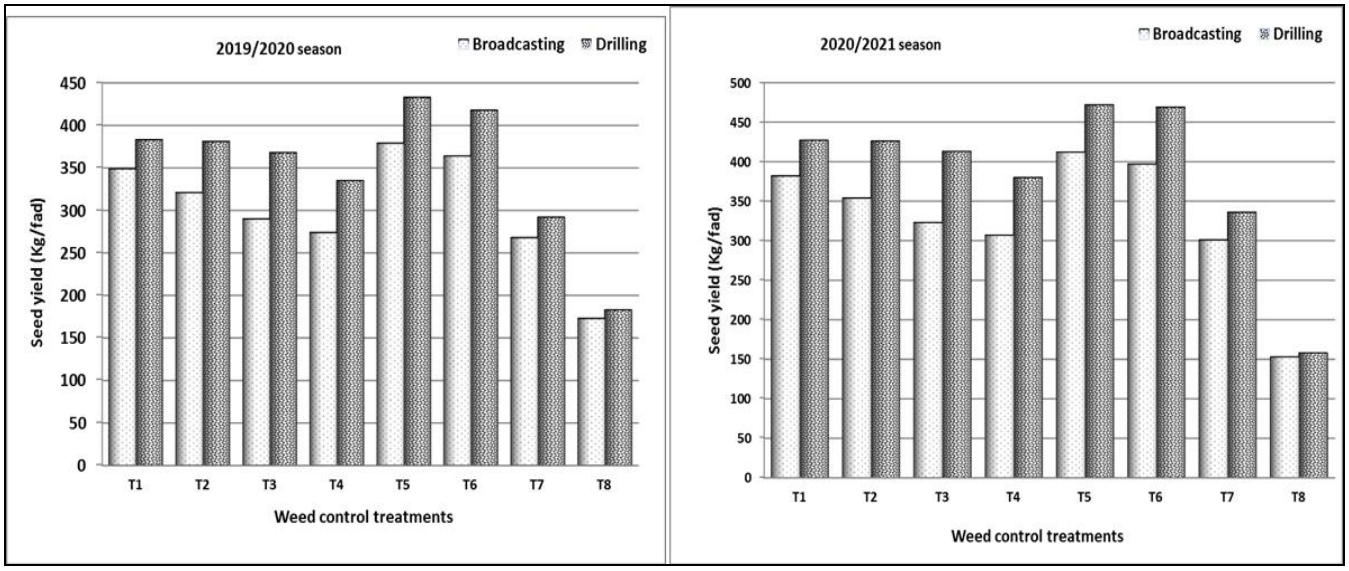

Fig. (4): Interaction between sowing methods and weed control treatments and its effect on seed yield (kg fed^{-1}) during 2019/2020 and 2020/2021 seasons at harvest.

dodder, while they were not useful in the case of the infested crop seeds with dodder. This means that those treatments are suitable to avoid the competition of dodder and annual weeds due to their low weed population density. Tested herbicide treatments increased the seed yield of flax crop with different ratios as compared to unweeded control treatment. All the applied herbicide treatments showed great increases in seed yield (kg/fed^{-1}) as compared to the unweeded control treatment in both seasons. This may be due to that the herbicide treatments can control most of dodder and annual weeds (Soliman and Abd El-Hamid, 2009).

3.4. Fiber characters

Data in Table (8) revealed that sowing methods was not significant concerning fiber percentage in both seasons. Also, the differences between sowing methods and control treatments were significant in both fiber length and fiber yield /fed. Drilling method surpassed in fiber length by (75.9 and 80.0 cm) in both seasons, respectively. It could be attributed to the good distribution in plant number per unit area. While, increased the fiber yield of flax plant by 59.0 and 67.1 kg/fed^{-1} for both seasons as compared to broadcasting method, significantly affected by the interaction between sowing methods and weed control treatments (Fig. **5).** The best interactions were reported between the drilling methods with combination for weed control treatments of Derby followed by Select super (T5) and Dimo up followed by Select super (T6), which increased the fiber yield (kg/fed) by (59.9 and 61.1%), for the first season and by (58.3 and 58.5%), for the second season, respectively as compared with unweeded check treatments of drilling or broadcasting methods. These results are similar to those reported by Soliman and Abd El-

Table (8): Fiber yield (kg fed^{-1}) and its characters as affected by sowing methods and weed control treatments during 2019/2020 and 2020/2021 seasons at harvest.

Characters	Fiber length (cm)		Fiber percentage %		Fiber yield (kg fed^{-1})	
Seasons	**2019/2020**	**2020/2021**	**2019/2020**	**2020/2021**	**2019/2020**	**2020/2021**
Sowing methods (S)						
Broadcasting (BC)	70.6	74.0	18.4	19.5	298.9	304.6
Drilling (D)	75.9	80.0	19.3	19.6	357.9	371.7
LSD 5% (S)	**3.17**	**4.40**	**NS**	**NS**	**14.06**	**40.52**
Weed control treatments (T)						
T1	77.0	82.2	19.2	19.31	330.5	349.7
T2	74.6	78.2	18.8	19.12	346.4	364.1
T3	72.3	76.1	19.8	20.05	343.7	360.2
T4	73.3	76.5	20.2	20.57	336.5	357.7
T5	82.8	87.3	21.6	22.02	418.7	423.3
T6	80.5	82.7	20.3	21.51	401.6	397.3
Hand weeding (twice)	67.6	72.0	17.8	18.18	279.9	287.8
Unweeded control	57.6	61.0	14.6	15.79	167.5	164.8
LSD 5% (T)	**2.96**	**2.77**	**0.952**	**0.619**	**31.46**	**34.92**
LSD 5% (S x T)	**NS**	**3.92**	**NS**	**NS**	**44.49**	**49.38**

respectively. This result might be attributed to the drilling sowing method caused reduction in weed density; hence it is suitable to avoid the strong competition of dodder and annual weeds, consequently to avoid the great exhausting of this weed and its negative impacts on flax plants and quality. Fiber yield (kg/fed^{-1}) was significantly affected by weed control treatments. The reduction in fiber yield values under hand weeding treatment and unweeded control treatment reflected on negative impact of dodder and annual weeds on flax growth which could be occurred as a result of the competition between dodder as well as annual weeds with flax plants.

Herbicide treatments were superior in increasing fiber yield of flax plants than hand weeding treatment as compared with infested control treatment in both seasons. In addition, using the tested herbicide treatments was necessary to eliminate this weed and to avoid the negative impacts on crop plants. Fiber yield/fed was Hamid (2009) and Kenapar *et al.* (2018).

3.5. Oil percentage and oil yield (kg fed^{-1})

A slight difference in oil percentage (%) and significant differences in oil yield between various sowing methods during 2019/20 and 2020/21 season (Table 9) was obtained. Drilling methods achieved the highest oil% and yield, compared to broadcasting methods during both growing seasons. Results indicated that Bromo plus followed by Traksos (T4) and Derby followed by Select super (T5) and Dimo up followed by Select super (T6), followed by Zinostar followed by Fusilade (T2) under drilling sowing method. In contrast, untreated control, recorded the least oil yield as compared to the estimated oil yield from tested herbicide treatments. Regarding the interaction between sowing methods and the effect of the of using different weed control treatments, the oil (%) was not significantly affected. The oil yield (kg/fed$^{-1)}$ was significantly affected in both sowing methods.

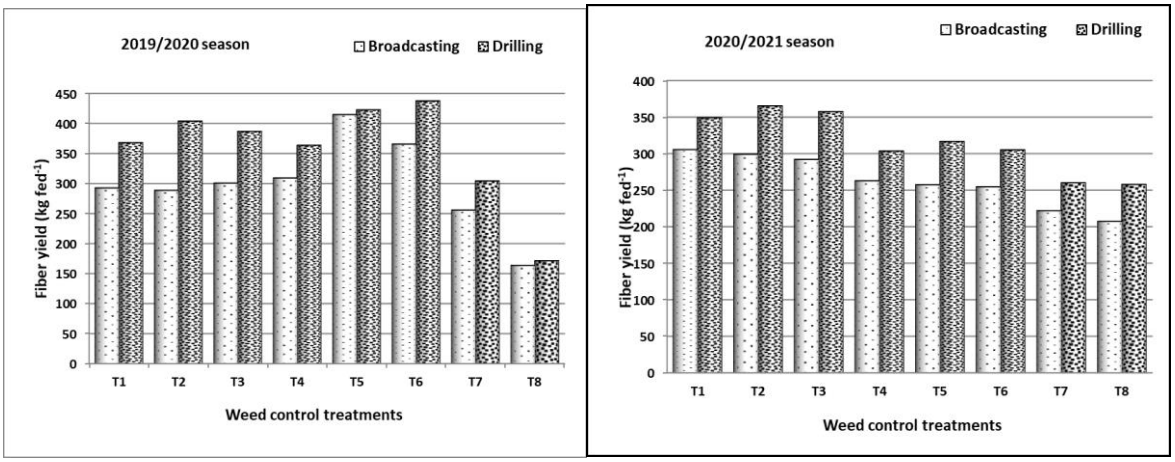

Fig. (5): Interaction between sowing methods and weed control treatments and its effect on fiber yield kg/fed during 2019/2020 and 2020/2021 seasons at harvest.

Table (9): Oil percentage and oil yield (kg fed^{-1}) as affected by sowing methods and weed control treatments during 2019/2020 and 2020/2021 seasons at harvest.

Characters	Oil %		Oil yield (kg fed^{-1})	
Seasons	**2019/2020**	**2020/2021**	**2019/2020**	**2020/2021**
Sowing methods (S)				
Broadcasting (BC)	33.9	33.9	112.6	116.8
Drilling (D)	34.9	35.6	156.6	144.8
LSD 5% (S)	**0.016**	**0.094**	**21.7**	**11.3**
Weed control treatments (T)				
T1	36.5	36.8	152.02	149.2
T2	37.4	37.7	152.44	147.5
T3	37.3	37.6	145.48	138.9
T4	41.9	42.3	148.59	145.6
T5	37.9	38.2	175.83	169.0
T6	37.5	37.8	170.2	164.1
Hand weeding (twice)	35.5	35.7	114.8	114.4
Unweeded control	11.4	11.5	17.3	17.8
LSD 5% (T)	**1.08**	**1.18**	**9.06**	**6.51**
LSD 5% (SxT)	**NS**	**NS**	**12.8**	**9.20**

The highest effect of these treatments in increasing oil yield/fed was may be causing higher seed yield/fed (Fig.6). The least oil yield/fed was due to reduction in seed yield/fed, resulting competition of dodder and total annual weeds of flax plants which agree with the result of Soliman and Hamza (2010). They mentioned that linseed oil content was either increased or decreased, according to the herbicidal treatments and its rate of application.

3.4. Correlation analysis

Data presented in Table (10) indicated the correlation coefficients between the dry weight (g/ m^{-2}) of broad-leaved weeds and their total, dodder weed at 90 days after sowing. Flax yield was statistically significant and inversely proportional by -0.852, -0.845, -0.852, and -0.769 reflection on the yield components reduction, respectively in both seasons. Nevertheless, the correlation coefficients between yield components, *i.e.*, technical length (cm), straw yield plant^{-1} (g), straw yield (t fed^{-1}), number of capsules plant^{-1}, seed yield plant^{-1} (g) and seed (kg fed^{-1}) was direct proportional by 0.825, 0.875, 0.867, 0.826 and 0.837 in 2019/2020 season and 0.930, 0.814, 0.882, 0.919 and 0.810 in 2020/2021 season, respectively. Hence, dodder and weed control play a major role in increasing flax productivity if applied at the suitable time, rate and stage of weed growth.

3.5. Economic evaluation

Results in Table (11) showed the minimum total cost obtained from all weed control treatments under both sowing methods, compared to unweeded control. However, all weed control treatments under drilling method gave the highest values of the studied economic criteria mainly flax yield. Derby followed by Select super (T5) and Dimo up followed by Select super (T6) under drilling sowing methods increased the profitability and benefit/cost ratio, by (167.562 and 2.676%) and (146.1 and 2.461%), respectively.

Profitability and benefit/cost ratios of using Zinostar followed by Fusilade super (T2) and Aonostar followed by Fusilade super (T1) by 157.18 and 2.572% and 136.9 and 2.369%, respectively. Brominal followed by Traksos (T3) and Bromo plus followed by Traksos (T4) under drilling sowing gave the values of 136.19 and 2.362% and 112.74 and 2.127 %, for the first seasons, respectively.

The same trend was obtained for the second season, but the hand weeding twice was very costly. It is necessary to apply an integrated weed control in the flax fields. On the other hand, the use the of herbicide treatments achieved the highest reduction in total annual weeds and dodder as well as increased the flax yield components .

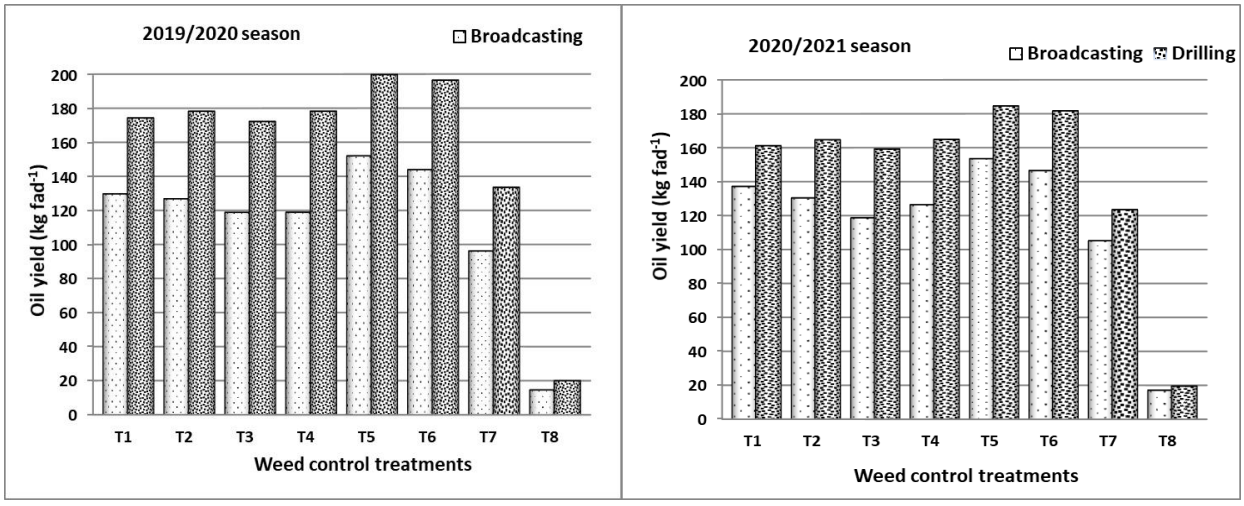

Fig. (6): Interaction between sowing methods and weed control treatments and its effect on oil yield kg/fed^{-1} during 2019/2020 and 2020/2021 seasons at harvest.

Table (10): Correlation coefficient between the studied characteristics and flax yield and its components during 2019/2020 and 2020/2021 seasons.

Characters	Broad-leaved weeds	Total weeds	Dodder weeds	Technical length (cm)	straw yield plant^{-1}	Straw yield fed^{-1}	No of capsules plant^{-1}	Seed yield plant^{-1}	Seed yield kg fed^{-1}
Season 2019/2020									
Grassy weeds	.983*	.995*	.872*	-.607*	-.744*	-.834*	-.742*	-.778*	-.852*
Broad-leaved weeds		.997*	.870*	-.611*	-.746*	-.814*	-.719*	-.776*	-.845*
Total weeds			.875*	-.611*	-.749*	-.826*	-.732*	-.780*	-.852*
Dodder weeds				-.537*	-.688*	-.712*	-.706*	-.754*	-.769*
Technical length (cm)					.736*	.712*	.781*	.780*	.825*
Straw yield plant^{-1}						.769*	.843*	.823*	.875*
Straw yield kg fed^{-1}							.784*	.790*	.867*
No of capsules plant^{-1}								.858*	.826*
Seed yield plant^{-1}									.837*
Season 2020/2021									
Grassy weeds	.955*	.985*	.897*	-.763*	-.701*	-.771*	-.800*	-.846*	-.848*
Broad-leaved weeds		.992*	.872*	-.742*	-.695*	-.755*	-.811*	-.831*	-.843*
Total weeds			.893*	-.759*	-.705*	-.770*	-.816*	-.847*	-.855*
Dodder weeds				-.814*	-.781*	-.754*	-.825*	-.809*	-.827*
Technical length (cm)					.822*	.828*	.861*	.770*	.930*
Straw yield plant^{-1}						.739*	.820*	.671*	.814*
Straw yield fed^{-1}							.826*	.806*	.882*
No of capsules plant^{-1}								.816*	.919*
Seed yield plant^{-1}									.810*

*. Correlation is significant at the 0.01 level.

Table (11): Interaction between sowing methods and weed control treatments and their effect on the economic evaluation of flax crop.

Sowing methods	Weed control treatments	Total income (LE/fed)	Total cost (LE/fed)	Net farm return (LE/fed)	Benefit/Cost ratio (B/C)	Profitability (P)
Season 2019/2020						
Broadcasting	**T1**	13081	7901	5180	1.656	65.56
	T2	12817	7901	4916	1.622	62.22
	T3	12182	8020	4162	1.519	51.90
	T4	12406	8010	4396	1.549	54.88
	T5	15459	7939	7520	1.947	94.72
	T6	14292	7989	6303	1.789	78.90
	Hand weeding (twice)	11324	10710	614	1.057	5.73
	Unweeded control	5621	7710	-2089	0.729	-27.09
Drilling	**T1**	18623	7861	10762	2.369	136.90
	T2	20217	7861	12356	2.572	157.18
	T3	18848	7980	10868	2.362	136.19
	T4	16955	7970	8985	2.127	112.74
	T5	21001	7849	13152	2.676	167.56
	T6	19566	7949	11617	2.461	146.14
	Hand weeding (twice)	15128	10670	4458	1.418	41.78
	Unweeded control	8643	7670	973	1.127	12.69
Season 2020/2021						
Broadcasting	**T1**	15186	8046	7140	1.887	88.74
	T2	14810	8046	6764	1.841	84.07
	T3	14283	8070	6213	1.770	76.99
	T4	14515	7929	6586	1.831	83.06
	T5	16936	8239	8697	2.056	105.56
	T6	16409	8289	8120	1.980	97.96
	Hand weeding (twice)	13425	10710	2715	1.254	25.35
	Unweeded control	6733	7710	-977	0.873	-12.67
Drilling	**T1**	18599	8006	10593	2.323	132.31
	T2	20342	8006	12336	2.541	154.08
	T3	18317	8030	10287	2.281	128.11
	T4	17172	7889	9283	2.177	117.67
	T5	20576	8199	12377	2.510	150.96
	T6	19565	8249	11316	2.372	137.18
	Hand weeding (twice)	13868	10670	3198	1.300	29.97
	Unweeded control	6910	7670	-760	0.901	-9.91

C**onclusion**

The present study indicated clearly the importance of using interaction between seed drilling sowing method and herbicide treatments of Brominal followed by Traksos (T3) to control annual weeds in flax fields. Derby followed by Select super (T5), Dimo up followed by Select super (T6), Zinostar followed by Fusilade super (T2) and Aonostar followed by Fusilade super (T1) were recommended to control dodder and the prevailing annual weeds in flax fields. These practices reflected on higher reduction of dodder and annual weeds coinciding with increasing straw, seed yield productivity of fiber and seed oil of flax crop under the Egyptian conditions. Further studies should be conducted *i.e.,* the effect of those treatments on the quality and composition of the oil and nutrient contents.

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Authors' contributions

All authors contributed in conceptualization, methodology, software, validation, formal analysis investigation, resources, data curtain, writing the original draft preparation, writing, review, editing, supervision and funding acquisition. All authors have read and agreed to the published version of the manuscript.

Competing interests

All authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this manuscript.

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فاعلية طرق الزراعة وبعض مبيدات الحشائش على الحامول والحشائش الحولية المصاحبة لمحصول الكتان

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ملخص

أجريت تجربتين حقليتين خلال موسمي الزراعة 2020/2019 و2021/2020م بهدف دراسة تأثير طريقتى الزراعة (بدار وتسطير) وتسعة مبيدات حشائش على حشيشة الحامول والحشائش الحولية وإنتاجية محصول الكتان. أجري أيضا التقييم الاقتصادي للتأثير بين طريقة الزراعة ومكافحة الحشائش. أجريت توليفات للتسع مبيدات في ست معاملات مكافحة بمبيدات الحشائش بالتوليفات التالية: (أونوستار بمعدل 8 جم/فدان يليه في المعاملة فيوزيليد سوبر بمعدل1 لتر/ف) (T1)، (زينوستار بمعدل 8 جم/ف يليه فيوزيليد سوبر بمعدل1 لتر/ف)(T2)، (بروميناال بمعدل 0,5 لتر/ف يليه تراكسوس بمعدل0,5 لتر/ف)(T3)، (بروموبلس بمعدل 0,5 لتر/ف يليه تراكسوس بمعدل0,5 لتر/ف) (T4), (دربي بمعدل 0,03 لتر/ف يليه سلكت سوبر بمعدل0,25 لتر/ف) (T5)، (ديمو أب بمعدل 0,25 لتر/ف يليه سلكت سوبر بمعدل0,25 لتر/ف)(T6) والنقاوة اليدوية مرتين بالإضافة إلي معاملة الكنترول (بدون معاملة). صممت التجربة في القطع المنشقة مرة واحدة في ثلاثة مكررات حيث وزعت طرق الزراعة في القطع الرئيسية. أما معاملات مكافحة الحشائش فكانت في القطع المنشقة. وأوضحت النتائج أن طريقة الزراعة بالتسطير سجلت زيادة في إنتاجية محصول القش والبذرة والزيت والألياف في كلا موسمي الزراعة مقارنة بطريقة الزراعة البدار. أدي عمل توليفات مبيدات الحشائش (دربي يليه سلكت سوبر) , (ديمو أب يليه سلكت سوبر) , (أونوستار يليه فيوزيليد سوبر), (زينوستار يليه فيوزيليد سوبر), (بروميناال يليه تراكسوس) و (بروموبلس يليه تراكسوس) إلي نقص معنوي في الوزن الجاف لحشيشة الحامول والحشائش الحولية الكلية مقارنة بمعاملة الكنترول عند 90 يوم من الزراعة في كلا موسمي الزراعة. أظهر التفاعل بين طرق الزراعة وتوليفات معاملات مكافحة الحشائش تاثيرا معنويا على الوزن الجاف لحشيشة الحامول والحشائش الحولية وإنتاجية محصول الكتان. وكانت أفضل التفاعلات هى طريقة الزراعة التسطير مع توليفات مكافحة الحشائش (دربي يليه سلكت سوبر)، (ديمو اب يليه سلكت سوبر)، (أونوستار يليه فيوزيليد) و(زينوستاريليه فيوزيليد). حيث أحدثت نقص في الوزن الجاف لحشيشة الحامول والحشائش الحولية الكلية عند 90 يوم من الزراعة مقارنة بمعاملة الكنترول تحت ظروف الزراعة بالتسطير وزيادة في محصول بذورالكتان مقارنة بمعاملة الكنترول تحت ظروف الزراعة البدار. توصي نتائج هذه الدراسة إمكانية مكافحة حشيشة الحامول والحشائش الحولية المصاحبة لنباتات الكتان بعمل توليفات مبيدات الحشائش السابقة مع طريقة الزراعة التسطير. هذه الممارسات تؤدي إلى زيادة إنتاج الألياف وبذور الزيت مما ينعكس على زيادة زيادة دخل المزارع.

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