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# Effect of combination between sowing methods and weed control treatments on growth and yield of wheat (*Triticum aestivum* L.) and associated weeds

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## ABSTRACT

Two experiments were conducted during 2019/20 and 2020/21 winter seasons at Nubariah Research Station, El-Behyra governorate affiliated with Agricultural Research Center, Egypt. The study aimed to identify the effect of three wheat sowing methods i.e. drill, broadcasting and drill on raised beds (RB) and six weed control treatments i.e. "MCPA35%-Florasulam1%" at rate 595cm$^3$/ha (Trigos), Clodinafop-propargyl15% at rate 333g/ha (Hock), Carfentrazone-ethyl40% at rate 36g/ha (Value), "MCPA35%-Florasulam1%" at rate 595cm$^3$/ha (Trigos)+Clodinafop-propargyl15% at rate 333g/ha (Hock), Hand weeding once and untreated check on wheat growth characteristics and yields. A split-plot design with three replications was used. The results showed that the drill sowing method was the best in reducing the infestation of weed species by (35.6 and 17.2% in 2019/20 and 2020/21 seasons, respectively) compared to raised beds method, which was reflected in producing the highest values of grain and straw yields of wheat compared to broadcasting and raised beds sowing methods, under the high infestation rate of weeds (21.4 ton and 13.3 ton fresh weight per hectare in 2019/20 and 2020/21 seasons, respectively). The superior weed control treatment for reducing weed species and increasing both grain and straw yields of wheat was Trigos at rate 595cm$^3$/ha+ Hock at rate 333g/ha followed by Hand weeding, Value at rate 36g/ha and Trigos at rate 595cm$^3$/ha. The interactions between the drill and/or drill on raised beds sowing methods with the four previous weed control treatments gave the highest reduce in the annual weed species, highest grain and straw yields and gave the highest economic values.

**Keywords:** Wheat, Sowing methods, Weed control, Herbicides

## INTRODUCTION

Wheat (*Triticum aestivum* L.) is an important cereal crop in the world. In Egypt, local wheat production does not match the consumption, so improvement of Egyptian wheat productivity is the most important way to minimize the gap between production and consumption (Kishk *et al.*, 2019). The total cultivated area of wheat in Egypt in 2019/2020 reached about 1.332 million hectares and the total production exceeded 8.492 million ton with an average of 6.376 ton/ha (Weshahi *et al.*, 2020). Great losses in wheat yield have been attributed to weeds competition; therefore intensive efforts have been made to reduce weeds effect through adopted crop weed management (Zimdahel, 2013). Many factors affect the production of wheat and its productivity such as weeds, excessive tillage and soil degradation (Kamboj *et al.*, 2017). Some cultural practices i.e. sowing methods could be considered worthful in reducing weeds occurrence (Oad *et al.*, 2007). There are many wheat sowing methods applied in Egypt such as herati, broadcasting, drill, afir drill and afir in ridges, the use of better planting methods such as the raised bed method instead of the old methods caused improvement of wheat yield (Kishk *et al.*, 2019). Density and biomass of weeds were affected by sowing wheat by the methods with spatial regular uniform of wheat plant/unit area, such as drill method (Hassanein *et al.,* 2020) false seedbed, row width (12 and 24 cm), (Rasmussen, 2004; random and uniform patterns, (Olsen *et al.,* 2004; sowing in ridges, Kabesh *et al.,* 2009; Pori sowing method (sowing in hill), terracing and broadcast sowing method, (Khan *et al.,* 2000; and El-Ashmouny *et al.,* 2016).

Integrated weed management has been defined as an approach to managing weeds, which relies on multiple tactics to stress weed populations and increase the competitive ability of the crop (Smith *et al.*, 2010). The losses due to weed/wheat competition ranged from 19.8 to 89.5% compared to weed-free for all of the season, these results were obtained from eleven field experiments over five years and five different locations (IPM, 2005). Pora sowing method with a seed rate 175 kg/ha recorded the highest wheat yield and lowest weed density compared to broadcasting method (Khan, *et al.*, 2000). Stale seedbed sowing method gave higher wheat yield as compared to conventional tillage and among weed control treatments, herbicides + one hand weeding and criss-cross sowing + herbicides + one hand weeding (5.66 t/ha) recorded highest wheat yield (Pandey *et al.*, 2009). Sowing in ridges combined with chemical weeded by Isoproturon herbicide increased most studied characters of wheat yield whereas sowing in ridges with hand weeding increased wheat grains contents of protein; phosphorus and potassium (Kabesh *et al.*, 2009). Sowing wheat cultivar Misr2 with drilling and/or

raised beds methods accompanied by hand weeding plus chemical control Pallas 4.5% OD herbicide at rate of 160 $cm^3$/fed. reduced weed species biomass and produced the highest wheat yield (El- Ashmouny *et al*., 2016). The highest values of the number of spikes/$m^2$, grain weight of spike (g), grain yield and straw yield were reported when sowing wheat with drill method and treated with Clodinafop propargyl accompanied with Isoproturon gave the lowest total dry weight of annual weeds (Hassanein *et al*., 2020). Hand weeding reduced broadleaved weed density, total weed density and dry weight of weeds at all the stages of wheat crop growth followed by Isoproturon at 1.5 kg/ha. However, Clodinafop-propagyl at 0.105 kg/ha gave lower density of grassy weeds in all crop growth stages (Amare *et al*., 2014). Clodinafop propargyl as post-emergence herbicide at 0.045 kg a.i/ha caused an excellent increasing in wheat yield (4.90 ton/ha, 6.60 ton/ha for grain and straw yields, respectively), with increasing percentage 51.02% over control. Also, gave the highest spike bearing tillers (380.7), number of grains/spike (47.3) and 1000-grain weight (49.4 g). Furthermore, the maximum net benefits of Pakistani rupee (Rs) was 136997/ha and maximum marginal rate% at 231316.6 was obtained from Clodinafop propargyl at 0.045 kg a.i/ha followed by Carfentrazone ethyl at 0.015 kg a.i/ha (Shehzad *et al*., 2012). Carfentrazone ethyl 40% at the rate 50 g/ha after 32 days from sowing significantly reduced weeds density (4.0 No./$m^2$) and dry weight (36.5 g/$m^2$) of weeds compared to weedy check (14.9 No./m2 and 241.5 g/$m^2$). This treatment resulted the highest plant height (103.7 cm), dry matter (434.7 g/$m^2$), grain (48.1 q/ha) and straw yield (64.94 q/ha) with higher monetary returns (53782 INR/ha) and benefits/cost ratio (3.2%) (Chauhan *et al*., 2017). Accordingly, the present work was designed to investigate the effect of some sowing methods and some weed control treatments and studying the effect of their integration on wheat growth characteristics, yield and associated weed species.

## MATERIAL AND METHODS

**2.1. Experimental location:**

Two field experiments were conducted at Nubariah Research Station, El-Behyra governorate, Egypt in two successive growing winter seasons of 2019/2020 and 2020/2021 to investigate the effect of some sowing methods and some weed control treatments on wheat characteristics, yield and associated weed species.

**Location:** Latitude: 30.90 longitude: 29.87 Altitude: 54

**Table 1.** Mechanical and chemical analysis of the experimental fields soil of the two studied winter seasons.

| Mechanical analysis % | | | | | Chemical analysis | |
|---|---|---|---|---|---|---|
| **Season** | **Sand** | **Silt** | **Clay** | **Texture** | **PH (1: 2.5)** | **E.C ds/m** |
| **2019/20** | 38.45 | 21.18 | 40.37 | Sand clay loam | 8.15 | 1.74 |
| **2020/21** | 41.25 | 18.46 | 40.29 | Sand clay loam | 7.83 | 1.81 |

Soil analysis had been done in Soil and Water Institute, Agricultural Research Center, Egypt.

**2.2. Climatic data:**

**Table 2.** The climatic data during the two studied winter seasons.

| **2019/20 winter season** | **December 2019** | **January 2020** | **February 2020** | **March 2020** | **April 2020** | **Average and sum** |
|---|---|---|---|---|---|---|
| Average temperature (°C) | 16.50 | 13.80 | 14.27 | 15.89 | 18.22 | 15.74 |
| Average Relative Humidity (%) | 68.01 | 71.90 | 72.06 | 68.93 | 67.27 | 69.63 |
| Precipitation (mm) | 32.90 | 68.00 | 24.40 | 70.0 | 92.07 | 287.37 |
| **2020/21 winter season** | **December 2020** | **January 2021** | **February 2021** | **March 2021** | **April 2021** | **Average and sum** |
| Average temperature (°C) | 17.01 | 15.48 | 15.02 | 15.67 | 18.70 | 16.38 |
| Average Relative Humidity (%) | 67.72 | 70.01 | 69.10 | 67.85 | 62.60 | 67.46 |
| Precipitation (mm) | 2.50 | 15.10 | 44.70 | 192.00 | 1.00 | 255.30 |

Climatic data recorded by Central Laboratory for Agricultural Climate, Agricultural Research Center, Egypt

**2.3. Plant materials:**

Wheat (*Triticum aestivum* L.), cultivar "Giza 171" was sown in two experimental seasons and the previous summer crop was Maize, the wheat seeds offered by Wheat Research Department, Field Crops Research Institute, Agricultural Research Center, Egypt.

**2.4. Experimental design and treatment details:**

A split-plot design in a randomized complete block arrangement was used with three replicates. The plot area was 10.5 $m^2$ (3.5 m length × 3 m width). The main plots were allocated to three sowing methods and six weed control treatments were denoted to sub-plots as follows.

**A- Main plots: Sowing methods:**

1- Drill sowing: Soil was ploughed twice; and levelling, then grain was sown by planter in rows 20 cm apart with seed rate 131 kg/ha.

2- Sowing drilling on raised beds: Soil was ploughed twice; and divided to raised beds 120 cm width then grains were sown drilling in 6–7 rows, the distance between each rows 20 cm with seed rate 107.1 kg/ha.
3- Broadcast: Soil was ploughed twice; grains were broadcasted with seed rate 154.8 kg/ha, then compacted and irrigated.

**B- Sub plots: Weed control treatments**:

1- Trigos 36% OD at the rate of 595 cm3/ha, sprayed at stage 2-4 leaves of weed (21 days from sowing).
2- Hock 15% WP at the rate of 333 g/ha, sprayed during one month after the first irrigation (40 days from sowing).
3- Value 40% WG at the rate of 36 g/ha, sprayed at stage 3-4 leaves of weed (21 days from sowing).
4- Trigos 36% OD at the rate of 595 cm3/ha, sprayed at 2-4 leaves stage of weeds (21 days from sowing) + Hock 15% WP at the rate of 333 g/ha, sprayed during one month of the first irrigation (40 days from sowing).
5- Hand weeding once at 35 days from sowing.
6- Untreated check (control).

**2.5. Cultural practices:**

The seeding rate was used as 119 kg/ha. Herbicides were sprayed by $Cp_3$ knapsack sprayer with 476.2 litter of water/ha. The sowing dates were 1st December and 24th November in the first and second season, respectively. Phosphorus fertilizer was applied as calcium super phosphate (15.5%$P_2O_5$) during soil preparation at the rate of 476.2 kg/ha Nitrogen fertilizer in the form of ammonium nitrate at the rate of 166.7 kg N/ha was divided in two equal parts, the first part applied after 25 days from sowing and the second part was applied at 70 days from sowing date. The other normal agricultural practices of wheat growing were done as recommended. The harvesting dates were 25/4/2020 and 23/4/2021 for the first and second seasons, respectively

**Table 3.** Common, trade, chemical names and mode of action of the herbicides used

| Trade name | Common name | Chemical group | Mode of action |
|---|---|---|---|
| Trigos 36% OD | MCPA 35% + Florasulam 1% | Synthetic auxin + Triazolopyrimidines | Affect cell wall plasticity and nucleic acid metabolism, due to inhibit cell division and growth usually in meristematic. + Acetohydroxy acid synthase (AHAS) inhibitors, due to inhibit the low branched-chain amino acid production. |
| Hock 15% WP | Clodinafop-propargyl 15% | Aryloxyphenoxy-propinate | Inhibition acetyl CoA carboxlyase of fatty acid synthesis presumably blocks the production of phospholipids used in building new membranes required for cell growth. |
| Value 40% WG | Carfentrazone-ethyl 40% | Triazolinone | Inhibition protoporphyrinogen oxidase (PPG oxidase or Protox) due to lipids and proteins are attacked and oxidized, resulting in loss of chlorophyll and carotenoids and in leaky membranes which allows cells and cell organelles to dry and disintegrated rapidly. |

**2.6. Data collection:**

The following data were collected:

**2.6.1 Weed survey:**

After 60 days from sowing, weeds were hand pulled from one square meter which randomly chosen from each plot, then these weeds were classified into broad-leaved and grassy weeds and the following data were recorded:

1- Fresh weight of annual broadleaf weeds (g/$m^2$).
2- Fresh weight of annual grassy weeds (g/m2).
3- Fresh weight of total annual weeds (g/m2).

**2.6.2 Yield and yield components:**

Growth characters of wheat:

1. Plant height (cm) (after about 120 days from sowing).
2. Days from sowing to heading.
3. Days from sowing to maturity.

At harvest time ten plants were randomly taken from each plot to determine the following characteristics:

1. No. of spikes/$m^2$.
2. 1000-grain weight (g).
3. No. of grains/spike.
4. Biological yield (ton/ha).
5. Grain yield (ton/ha).

**Note:** The grain and biological yields of each plot (10.5 $m^2$) were weighted at all and calculated as (ton/ha).

**2.7. Economic feasibility of wheat yield:**

Economic evaluation for wheat yield under sowing methods and weed control treatments by preparing a complete budget (in Egyptian bound LE) including fixed and variable costs and the following formula (Heady and Dillon, 1961).

Gross income = Total grain × yield price (LE) + Straw price (LE)

Net income = Gross income – Total costs

$$\text{Benefit Cost rate} = \frac{\text{Gross income}}{\text{Total costs}}$$

$$\text{Profitability} = \frac{\text{Net income}}{\text{Total costs}} \times 100$$

**2.8. Statistical Analysis:**

Results' data were statistically analyzed according to the analysis of variance technique for the split plot design as mentioned by (Gomez and Gomez, 1984) using "Genstat 18th edition" computer software package and least significant differences revised (L.S.D.) at 5% level of probability was used for compare significant means.

## RESULTS

**3.1. Weed species:**

In both seasons, the infestation percentage of the dominants weeds was *Melilotus indica* L. by 47.7 and 65.5%, *Silybum marianum* (L) Gaertn by 27.5 and 5.4%, as annual broadleaf weeds; and *Avena fatua* L. by 10.2 and 27.0%, as annual grassy weed in 2019/20 and 2020/21 winter seasons, respectively. Whilst, *Beta vulgaris* L. was the second dominant annual broadleaf weeds with infestation rate by 10.6% in the first season. On other hand, *Cichorium pumilum*, *Sonchus oleraceus*, *Malva parviflora* and *Convolvulus arvensis* as annual broadleaf weeds in the two seasons and *Beta vulgaris* as annual broadleaf weeds and *Lolium* spp. as annual grassy weeds in the second season were neglected because their percentage had very low infestation.

Table (4) presents the Scientific name, English name and families of weed species in the experimental fields during 2019/20 and 2020/21 seasons and the percentage of each weed species.

**Table 4.** Scientific name, English name and families of weed species in experimental field in 2019/20 and 2020/21 winter seasons.

| Scientific name | English name | Family | Infestation percentage | |
|---|---|---|---|---|
| **Broadleaf weed species** | | | **2019/2020 season** | **2020/2021 season** |
| *Melilotus indica* L. | Indian melilot–sweet clover | Leguminosae | 47.7 | 65.5 |
| *Silybum marianum* (L) Gaertn | Milk thistle | Compositae | 27.5 | 5.4 |
| *Beta vulgaris* L. | Sea beet, Wild beet | Chenopodiaceae | 10.6 | 0.4 |
| *Convolvulus arvensis* L. | Field bindweed | Convolvulaceae | 2.5 | 0.1 |
| *Malva parviflora* L. | Cheese weed, little mallow | Malvaceae | 1 | 0.3 |
| *Sonchus oleraceus* L. | Sowthistle | Compositae | 0.4 | 0.1 |
| *Cichorium pumilum* Jacq. | Chicory | Compositae | 0.2 | 0.5 |
| **Grassy weed species** | | | | |
| *Avena fatua* L. | Spring wild oat | Gramineae | 10.2 | 27 |
| *Lolium* spp. | Ryegrasses | Gramineae | 0 | 0.7 |

**3.2. Effect of sowing methods:**

***3.2.1. Fresh weight of annual weeds:***

The effect of sowing methods on the fresh weight of weeds (g/m$^2$) is given in Table (5). It was noticed that the drill method significantly reduced the fresh weight of annual weeds more than broadcasting and drill on raised beds methods, in both seasons. Drill method caused reduction in the percentage of the fresh weight (g/m$^2$) of by 38.7 & 15.4% for broadleaf weeds, 14.0 & 24.6% for grassy weeds and 35.6 & 17.2%,for total weeds compared to drill on raised beds method (the lowest reduction%) in 2019/20 and 2020/21 winter seasons, respectively.

**Table 5.** Effect of sowing methods on fresh weight of broadleaf, grassy and total weeds (g/m$^2$) in 2019-20 and 2020-21 winter seasons

| Sowing methods | Fresh weight (g/m$^2$) | | | | | |
|---|---|---|---|---|---|---|
| | 2019-20 season | | | 2020-21 season | | |
| | Broad leaved weeds | Grassy weeds | Total weeds | Broad leaved weeds | Grassy weeds | Total weeds |
| **Drill** | 554.7 | 112.9 | 667.6 | 439.8 | 93.4 | 533.2 |
| **Drill on raised beds** | 904.9 | 131.3 | 1036.2 | 520.1 | 123.8 | 643.9 |
| **Broadcasting** | 698.6 | 65.6 | 764.1 | 432.2 | 210.6 | 642.8 |
| **LSD 0.05** | 49.09 | 22.47 | 38.87 | 66.47 | 35.26 | 67.24 |

***3.2.2. Wheat growth characteristics and yield:***

Table (6) concluded the effect of sowing methods on wheat growth characteristics, yield and yield component of wheat. Sowing methods affected significantly the period from sowing to maturity and grain yield in both seasons and plant height, the number of spikes/$m^2$, number of grains/spike and biological yield in the second season.

**Table 6.** Effect of sowing methods on wheat growth and yield in 2019-20 and 2020-21 winter seasons

| Sowing methods | Plant height (cm) | Days from sowing to heading | Days from sowing to maturity | No. of spikes/ $m^2$ | 1000-grain weight (g) | No. of grains/ spike | Biological yield (ton/ha) | Grain yield (ton/ha) |
|---|---|---|---|---|---|---|---|---|
| **2019-20 season** | | | | | | | | |
| **Drill** | 112.5 | 95.4 | 141.4 | 268.3 | 55.0 | 46.8 | 17.40 | 5.93 |
| **Drill on raised beds** | 110.3 | 94.9 | 139.7 | 256.7 | 53.8 | 45.7 | 16.94 | 5.51 |
| **Broadcasting** | 111.3 | 94.7 | 141.7 | 262.2 | 53.4 | 44.8 | 15.69 | 4.78 |
| **LSD 0.05** | N.S. | N.S. | 0.6 | N.S. | N.S. | N.S. | N.S. | 0.43 |
| **2020-21 season** | | | | | | | | |
| **Drill** | 112.1 | 95.8 | 141.6 | 265.28 | 54.59 | 48.6 | 17.78 | 5.95 |
| **Drill on raised beds** | 108.7 | 95.1 | 139.3 | 255.56 | 54.62 | 42.2 | 15.28 | 4.99 |
| **Broadcasting** | 110.3 | 94.9 | 141.3 | 252.78 | 54.09 | 44.4 | 14.07 | 4.61 |
| **LSD 0.05** | 1.7 | N.S. | 1.0 | 10.3 | N.S. | 3.4 | 1.54 | 0.61 |

Drill sowing method was superior in increasing grain yield by 7.6% than drill on raised beds method and by 24.1% than broadcasting sowing method in 2019/20 season and increased biological and grain yields by 16.4 & 1.9%, respectively, compared to drill on raised beds method and by 26.4 & 29.0%, respectively, compared to broadcasting method in 2020/21 season.

**3.3. Effect of weed control treatments:**

***3.3.1. Fresh weight of weeds:***

Results in Table (7) illustrated that the infestation rate of the total weed species in the untreated check reached to 21.4 and 13.3 ton fresh weight /ha, in both seasons, respectively.

**Table 7.** Effect of weed control treatments on broadleaf weeds, grassy weeds and total weed fresh weight, during 2019-20 and 2020-21 winter seasons

| Weeds control treatments | Fresh weight ($g/m^2$) | | | |
|---|---|---|---|---|
| | Broadleaf weeds | Grassy weeds | Total weeds | Reduction % |
| **2019-20 season** | | | | |
| **Trigos 36% OD at 595 $cm^3$/ha** | 116.9 | 55.8 | 172.7 | 91.9 |
| **Hock 15% WP at 333 g/ha** | 1439.1 | 116.4 | 1555.6 | 27.3 |
| **Value 40% WG at 36 g/ha** | 677.6 | 126.4 | 804.0 | 62.4 |
| **Trigos 36% OD at 595 $cm^3$/ha + Hock 15% WP at 333 g/ha** | 52.4 | 43.8 | 96.2 | 95.5 |
| **Hand weeding once** | 106.7 | 59.6 | 166.2 | 92.2 |
| **Untreated check** | 1923.6 | 217.6 | 2141.1 | 0 |
| **LSD 0.05** | 124.43 | 29.36 | 126.16 | - |
| **2020-21 season** | | | | |
| **Trigos 36% OD at 595 $cm^3$/ha** | 105.1 | 32.4 | 137.6 | 89.7 |
| **Hock 15% WP at 333 g/ha** | 1114.9 | 197.6 | 1312.4 | 1.6 |
| **Value 40% WG at 36 g/ha** | 418.9 | 124.7 | 543.6 | 59.2 |
| **Trigos 36% OD at 595 $cm^3$/ha + Hock 15% WP at 333 g/ha** | 75.1 | 80.2 | 155.3 | 88.4 |
| **Hand weeding once** | 104.9 | 52.9 | 157.8 | 88.2 |
| **Untreated check** | 965.3 | 367.8 | 1333.1 | 0 |
| **LSD 0.05** | 46.76 | 32.92 | 53.64 | - |

All weed control treatments gave significant effect on controlling weeds in both seasons. Trigos at 595 $cm^3$/ha+ Hock 15% WP at 333 g/ha, hand weeding once, Trigos at 595 $cm^3$/ha, Value 40% WG at 36 g/ha and Hock 15% WP at 333 g/ha resulted a reduction percentage of broadleaf weeds by 97.3; 94.5; 93.9; 64.8 and 25.2%, respectively, in the first season, and by 92.2; 89.1; 89.1; 56.6%, respectively, in the second season, whilst, the lowest reduction percentage of broadleaf weeds resulted

from the grassy weed herbicide Hock 15% WP at 333 g/ha which gave 25.2 and 0% in 2019/20 and 2020/21 seasons, respectively, due to this herbicide specific on grassy weeds and had less or no effect on broadleaf weeds. The same previous respective weed control treatments gave reduction percentages on grasses were 79.9, 72.6, 74.4, 41.9 and 46.5%, respectively, in the first season, and were 78.2, 85.6, 91.2, 66.1 and 46.3%, respectively, in the second season. The reduction percentages of total weeds were 95.5, 92.2, 91.9, 62.4 and 27.3%, in the first season, and were 88.4, 88.2, 89.7, 59.2 and 1.6%, in the second season resulted from Trigos at 595 $cm^3$/ha+ Hock 15% WP at 333 g/ha, hand weeding once, Trigos at 595 $cm^3$/ha, Value 40% WG at 36 g/ha and Hock 15% WP at 333 g/ha, respectively. These results due to adding specific herbicide that killed the target weeds as well as the dominant weeds in the experiment fields was follow up broadleaf weeds, so the specific herbicide for grassy weeds (Hock) gave the least reduction of total weeds due to the less infestation of the grassy weeds in the experiment fields in both seasons.

### *3.3.2. Wheat characteristics and yields*

Results in Table (8) showed the effect of weed control treatments on wheat growth characteristics and yields in both seasons.

**3.3.2.1 2019/20 season:**

Weed control treatments had a significant effect on the days from sowing to maturity, 1000-grain weight (g), No. of spikes/$m^2$, biological and grain yields (ton/ha). Value at 36 g/ha, Trigos at 595 $cm^3$/ha+ Hock at 333 g/ha, hand weeding once, Trigos at 595 $cm^3$/ha and Hock at 333 g/ha increased the No. of spikes/$m^2$ by 33.3, 32.8, 32.3, 24.9 and 3.3%, respectively, compared to untreated check. Trigos at 595 $cm^3$/ha+ Hock at 333 g/ha, hand weeding, Value at 36 g/ha, Trigos at 595 $cm^3$/ha and Hock at 333 g/ha increased both biological and grain yields by 40.5 & 58.2%, 34.8 & 61.0%, 39.9 & 52.7%, 36.9& 43.3% and 2.1 & 6.1%, respectively, compared to untreated check.

**3.3.2.2 2020/21 season:**

Weed control treatments had a significant effect on days from sowing to maturity, plant height (cm) 1000-grain weight (g), No. of spikes/$m^2$ and No. of grains/spike, biological and grain yields (ton/ha). Trigos at 595 $cm^3$/ha+ Hock at 333 g/ha, hand weeding once, Value at 36 g/ha, Trigos at 595 $cm^3$/ha and Hock at 333 g/ha significantly increased the No. of spikes/$m^2$ and No. of grains/spike by 37.5 & 15.8%, 36.7 & 24.8%, 37.3 &17.1%, 30.0 & 19.4% and 4.9 & 14.6%, respectively, and increased the biological and grain yields by 66.4 & 60.2%, 53.2 & 69.3%, 59.6 & 64.6%, 62.6 & 56.4% and 8.8 & 8.6%, respectively, compared to untreated check.

**Table 8.** Effect of weed control treatments on wheat characteristics and yield during the 2019/2020 and 2020/2021 winter seasons.

| Weeds control treatments | Days from sowing to heading | Days from sowing to maturity | Plant height (cm) | No. of spikes/$m^2$ | 1000-grain weight (g) | No. of grains/ spike | Biological yield (ton/ha) | Grain yield (ton/ha) | Increment % |
|---|---|---|---|---|---|---|---|---|---|
| **2019-20 season** | | | | | | | | | |
| Trigos 36% OD at 595 $cm^3$/ha | 95.0 | 141.7 | 110.7 | 270.6 | 56.9 | 49.2 | 18.16 | 5.66 | 43.3 |
| Hock 15% WP at 333 g/ha | 95.6 | 140.8 | 110.6 | 223.9 | 50.5 | 45.3 | 13.55 | 4.19 | 6.1 |
| Value 40% WG at 36 g/ha | 95.0 | 139.9 | 112.7 | 288.9 | 56.2 | 43.4 | 18.56 | 6.03 | 52.7 |
| Trigos 36% OD at 595 $cm^3$/ha + Hock 15% WP at 333 g/ha | 94.4 | 141.8 | 110.8 | 287.8 | 55.5 | 47.9 | 18.64 | 6.25 | 58.1 |
| Hand weeding once | 95.1 | 141.2 | 111.3 | 286.7 | 56.7 | 44.6 | 17.89 | 6.36 | 61.0 |
| Untreated check | 95.0 | 140.4 | 112.2 | 216.7 | 48.6 | 44.2 | 13.27 | 3.95 | - |
| LSD 0.05 | N.S. | 0.7 | N.S. | 10.8 | 2.8 | N.S. | 1.75 | 0.43 | - |
| **2020-21 season** | | | | | | | | | |
| Trigos 36% OD at 595 $cm^3$/ha | 95.2 | 140.7 | 109.7 | 269.4 | 55.62 | 46.7 | 18.02 | 5.66 | 56.4 |
| Hock 15% WP at 333 g/ha | 95.3 | 140.8 | 108.2 | 217.4 | 49.13 | 44.8 | 12.06 | 3.93 | 8.6 |
| Value 40% WG at 36 g/ha | 94.9 | 140.9 | 110.3 | 284.4 | 55.78 | 45.8 | 17.68 | 5.96 | 64.6 |
| Trigos 36% OD at 595 $cm^3$/ha + Hock 15% WP at 333 g/ha | 95.2 | 142.3 | 109.6 | 285.0 | 53.26 | 45.2 | 18.44 | 5.80 | 60.2 |
| Hand weeding once | 95.3 | 140.0 | 111.8 | 283.3 | 58.87 | 48.8 | 16.98 | 6.13 | 69.3 |
| Untreated check | 95.6 | 139.7 | 112.7 | 207.2 | 53.94 | 39.1 | 11.08 | 3.62 | - |
| LSD 0.05 | N.S. | 0.6 | 2.5 | 6.0 | 2.4 | 3.7 | 1.39 | 0.46 | - |

These results pointed that, all weed control treatments caused increment in the wheat growth characteristics and grain yield compared to unweeded check. Weed control treatments (Trigos + Hock, Hand weeding and Trigos) improved wheat growth characters and yields of wheat due to the highest reduction in weed biomass and decreased weed/wheat competition in earlier stage of wheat growth in both seasons.

**3.4 Effect of the interactions between wheat sowing methods and weed control treatments on:**
**3.4.1 Fresh weight of weeds:**

The results in Table (9) pointed that the interaction between sowing methods and weed control treatments was affected significantly fresh weight of grassy, broadleaved and total weeds in both seasons. The highest fresh weight of total weeds was obtained from drill on raised beds sowing method with untreated check in the first season and in the second season, it was obtained from drill on raised beds sowing method with hock 15% WP at 333 g/ha. The best integration for decreasing fresh weight of annual weeds resulted from the interaction between drill on raised beds sowing method with the combination of the two herbicides (trigos 36% OD at 595 $cm^3$/ha +hock 15% WP at 333 g/ha) followed by drill on raised beds sowing method with trigos 36% OD at 595 $cm^3$/ha, drill sowing method with hand weeding, drill on raised beds sowing method with hand weeding, broadcasting sowing method with the combination of two herbicides (trigos 36% OD at 595 $cm^3$/ha +hock 15% WP at 333 g/ha), broadcasting sowing method with trigos 36% OD at 595 $cm^3$/ha and broadcasting method with hand weeding in both seasons without any significant difference between the above treatments. The second range of the interaction effect between sowing methods and weed control treatments on fresh weight of annual weeds resulted from the interaction between drill on raised beds sowing method with value 40% WG at 36 g/ha followed by drill sowing method with value 40% WG at 36 g/ha and broadcasting sowing method with value 40% WG at 36 g/ha in both seasons without any significant difference between these treatments. The lowest interaction effect between sowing methods and weed control treatments resulted from broadcasting sowing method with hock 15% WP at rate of 333 g/ha in the first season and drill on raised beds sowing with hock 15% WP at a rate of 333 g/ha in the second season.

**Table 9.** Effect of the interaction between sowing methods and weed control treatments on fresh weight of broadleaf, grassy and total weeds ($g/m^2$) in 2019/20 2020/21 winter seasons.

| Sowing methods | Weeds control treatments | Fresh weight ($g/m^2$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 2019-20 season | | | | 2020-21 season | | | |
| | | Broadleaf weeds | Grassy weeds | Total weeds | Reduction % compared to untreated check | Broadleaf weeds | Grassy weeds | Total weeds | Reduction % compared to untreated check |
| Drill | Trigos 36% OD at 595 $cm^3$/ha | 147.3 | 103.3 | 250.7 | 84.3 | 140.0 | 30.0 | 170.0 | 87.4 |
| | Hock 15% WP at 333 g/ha | 834.7 | 215.3 | 1050.0 | 34.1 | 830.0 | 110.0 | 940.0 | 30.4 |
| | Value 40% WG at 36 g/ha | 801.3 | 102.0 | 903.3 | 43.3 | 300.0 | 131.3 | 431.3 | 68.1 |
| | Trigos 36% OD at 595 $cm^3$/ha + Hock 15% WP at 333 g/ha | 39.3 | 51.3 | 90.7 | 94.3 | 76.0 | 99.3 | 175.3 | 87.0 |
| | Hand weeding once | 65.3 | 52.0 | 117.3 | 92.6 | 92.0 | 39.3 | 131.3 | 90.3 |
| | Untreated check | 1440.0 | 153.3 | 1593.3 | - | 1200.7 | 150.7 | 1351.3 | - |
| Drill on raised beds | Trigos 36% OD at 595 $cm^3$/ha | 30.7 | 42.7 | 73.3 | 98.0 | 76.7 | 16.0 | 92.7 | 90.8 |
| | Hock 15% WP at 333 g/ha | 1440.0 | 61.3 | 1501.3 | 58.3 | 1709.3 | 193.3 | 1902.7 | 0 |
| | Value 40% WG at 36 g/ha | 552.7 | 224.0 | 776.7 | 78.4 | 439.3 | 170.0 | 609.3 | 39.6 |
| | Trigos 36% OD at 595 $cm^3$/ha + Hock 15% WP at 333 g/ha | 22.7 | 42.7 | 65.3 | 98.2 | 69.3 | 36.0 | 105.3 | 89.6 |
| | Hand weeding once | 128.7 | 69.3 | 198.0 | 94.5 | 106.0 | 39.3 | 145.3 | 85.6 |
| | Untreated check | 3254.7 | 348.0 | 3602.7 | - | 720.0 | 288.0 | 1008.0 | - |
| Broadcasting | Trigos 36% OD at 595 $cm^3$/ha | 172.7 | 21.3 | 194.0 | 84.2 | 98.7 | 51.3 | 150.0 | 90.9 |
| | Hock 15% WP at 333 g/ha | 2042.7 | 72.7 | 2115.3 | 0 | 805.3 | 289.3 | 1094.7 | 33.3 |
| | Value 40% WG at 36 g/ha | 678.7 | 53.3 | 732.0 | 40.4 | 517.3 | 72.7 | 590.0 | 64.0 |
| | Trigos 36% OD at 595 $cm^3$/ha + Hock 15% WP at 333 g/ha | 95.3 | 37.3 | 132.7 | 89.2 | 80.0 | 105.3 | 185.3 | 88.7 |
| | Hand weeding once | 126.0 | 57.3 | 183.3 | 85.1 | 116.7 | 80.0 | 196.7 | 88.0 |
| | Untreated check | 1076.0 | 151.3 | 1227.3 | - | 975.3 | 664.7 | 1640.0 | - |
| **LSD 0.05** | | 199.56 | 49.03 | 201.21 | - | 89.31 | 58.01 | 98.35 | - |
| **Standard Error of means** | | 69.3 | 17.06 | 69.8 | | 30.69 | 20.14 | 33.99 | |
| **CV%** | | 18 | 29.5 | 15.9 | | 10.5 | 24 | 9.2 | |

**3.4.2 Wheat growth characters**

Data in Tables (10 and 11) shows that the interaction effect of sowing methods and weed control treatments had no significant effect on wheat growth characters in both seasons except for the number of days from sowing to maturity which

was affected significantly in the second season. The longest period to wheat heading was (96.3 and 96 days after sowing) which resulted from drill sowing method with trigos 36% OD at 595 $cm^3$/ha for weed control in the first season and/or hand weeding in the second season, but the shortest period was (94 and 94.3 days after sowing) which was obtained from broadcasting with weed control by the herbicide value 40% WG at 36 g/ha in both seasons. The highest plant and longest period for maturity resulted from drill sowing method with weed control treatment by (trigos 36% OD at 595 $cm^3$/ha +hock 15% WP at 333 g/ha), but the shortest plant and period for maturity were produced by drill on raised beds sowing method with weed control by hock 15% WP at 333 g/ha in the first season and from drill and/or broadcasting sowing method with (trigos 36% OD at 595 $cm^3$/ha +hock 15% WP at 333 g/ha) or drill on raised beds sowing method with hock 15% WP at 333 g/ha in the second season.

**3.4.3 Wheat yield and its components:**

Tables (10 and 11) indicated that the number of spikes/$m^2$, number of grains/spike, 1000-grain weight (g), biological yield (ton/ha) and grain yield (ton/ha) were affected significantly by the interactions between sowing methods and weed control treatments in both seasons. In the first season, the number of spikes/$m^2$ and number of grains/spike increased significantly by integration between drill sowing method with weed control treatments by (trigos 36% OD at 595 $cm^3$/ha + hock 15% WP at 333 g/ha or value 40% WP at 36 g/ha or hand weeding) and the integration between drill on raised beds with weed control treatments by (trigos 36% OD at 595 $cm^3$/ha + hock 15% WP at 333 g/ha) and the integration between broadcasting sowing method with weed control by (value 40% WP at 36 g/ha or hand weeding or trigos 36% OD at 595 $cm^3$/ha + hock 15% WP at 333 g/ha). The second range was obtained by broadcasting method with weed control by (trigos 36% OD at 595 $cm^3$/ha) and drill on raised beds sowing method with weed control by (value 40% WP at 36 g/ha or hand weeding)

The number of spikes/$m^2$ and number of grains/spike was significantly increased by drill sowing method with weed control treatments (value 40% WP at 36 g/ha or trigos 36% OD at 595 $cm^3$/ha + hock 15% WP at 333 g/ha or hand weeding). The second range of above traits resulted from drill on raised beds sowing method with weed control treatments by (hand weeding or trigos 36% OD at 595 $cm^3$/ha + hock 15% WP at 333 g/ha or value 40% WP at 36 g/ha) and broadcast sowing method with weed control by (value 40% WP at 36 g/ha or trigos 36% OD at 595 $cm^3$/ha + hock 15% WP at 333 g/ha or hand weeding) in the second season.

The interaction between broadcasting sowing method with trigos 36% OD at 595 $cm^3$/ha followed by drill on raised beds sowing with hand weeding, drill sowing with trigos 36% OD at 595 $cm^3$/ha + hock 15% WP at 333 g/ha, drill on raised beds sowing with trigos 36% OD at 595 $cm^3$/ha, drill sowing with value 40% WP at 36 g/ha or hand weeding produced the highest weight of 1000-grain (g), but the lowest weight of 1000-grain (g) resulted from broadcasting with untreated check in both seasons.

**Table 10.** Effect of the interaction between sowing methods and weed control treatments on wheat growth and yield in 2019/20 winter season

| Sowing methods | Weeds control treatments | No. of spikes/$m^2$ | 1000-grain weight (g) | No. of grains/spike | Biological yield (ton/ha) | Grain yield (ton/ha) | Increment % compared to untreated check |
|---|---|---|---|---|---|---|---|
| Drill | Trigos 36% OD at 595 $cm^3$/ha | 286.7 | 51.8 | 49.0 | 16.54 | 5.58 | 14.6 |
| | Hock 15% WP at 333 g/ha | 220.0 | 53.7 | 48.3 | 16.51 | 5.15 | 5.7 |
| | Value 40% WG at 36 g/ha | 296.7 | 57.7 | 44.7 | 19.43 | 6.83 | 40.2 |
| | Trigos 36% OD at 595 $cm^3$/ha + Hock 15% WP at 333 g/ha | 300.0 | 58.1 | 43.7 | 18.13 | 5.92 | 21.6 |
| | Hand weeding once | 290.0 | 56.7 | 47.3 | 19.39 | 7.22 | 48.3 |
| | Untreated check | 216.7 | 51.8 | 48.0 | 14.44 | 4.87 | - |
| Drill on raised beds | Trigos 36% OD at 595 $cm^3$/ha | 265.0 | 58.0 | 56.7 | 18.35 | 5.73 | 54.9 |
| | Hock 15% WP at 333 g/ha | 223.3 | 48.2 | 42.3 | 12.44 | 3.94 | 6.5 |
| | Value 40% WG at 36 g/ha | 270.0 | 55.1 | 42.0 | 20.80 | 6.20 | 67.6 |
| | Trigos 36% OD at 595 $cm^3$/ha + Hock 15% WP at 333 g/ha | 283.3 | 52.7 | 51.7 | 20.00 | 7.11 | 92.2 |
| | Hand weeding once | 276.7 | 60.2 | 40.3 | 16.89 | 6.37 | 72.2 |
| | Untreated check | 221.7 | 48.7 | 41.3 | 13.14 | 3.70 | - |
| Broadcasting | Trigos 36% OD at 595 $cm^3$/ha | 260.0 | 61.0 | 42.0 | 19.60 | 5.68 | 73.2 |
| | Hock 15% WP at 333 g/ha | 228.3 | 49.6 | 45.3 | 11.68 | 3.47 | 5.8 |
| | Value 40% WG at 36 g/ha | 300.0 | 55.9 | 43.7 | 15.47 | 5.07 | 54.6 |
| | Trigos 36% OD at 595 $cm^3$/ha + Hock 15% WP at 333 g/ha | 280.0 | 55.6 | 48.3 | 17.78 | 5.71 | 74.1 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Hand weeding once | 293.3 | 53.3 | 46.0 | 17.40 | 5.48 | 67.1 |
| | Untreated check | 211.7 | 45.3 | 43.3 | 12.22 | 3.28 | - |
| **LSD 0.05** | | 22.4 | 4.5 | 8.6 | 2.96 | 0.75 | |
| **Standard Error of means** | | 7.8 | 1.564 | 2.97 | 1.028 | 0.264 | |
| **CV%** | | 4.3 | 5.3 | 11 | 10.9 | 8.4 | |

In the first season, the highest biological yield was obtained by drill sowing method with weed control treatments (value 40% WP at 36 g/ha or trigos 36% OD at 595 $cm^3$/ha + hock 15% WP at 333 g/ha or hand weeding), drill on raised beds sowing method with weed control treatments (trigos 36% OD at 595 $cm^3$/ha or value 40% WP at 36 g/ha or trigos 36% OD at 595 $cm^3$/ha + hock 15% WP at 333 g/ha) and broadcasting sowing method with weed control treatments (trigos 36% OD at 595 $cm^3$/ha or trigos 36% OD at 595 $cm^3$/ha + hock 15% WP at 333 g/ha or hand weeding) followed by drill sowing method with (trigos 36% OD at 595 $cm^3$/ha or hock 15% WP at 333 g/ha), drill on raised beds with hand weeding and broadcasting with value 40% WP at 36 g/ha, but the lowest biological yield was obtained by broadcasting sowing with weed control treatment by hock 15% WP at 333 g/ha or untreated check.

In the second season, the highest biological yield was obtained by drill sowing method with weed control treatments (value 40% WP at 36 g/ha or hock 15% WP at 333 g/ha or trigos 36% OD at 595 $cm^3$/ha + hock 15% WP at 333 g/ha) and drill on raised beds sowing with hand weeding followed by broadcasting sowing with weed control treatment trigos 36% OD at 595 $cm^3$/ha and drill on raised beds sowing with weed control treatments (trigos 36% OD at 595 $cm^3$/ha + hock 15% WP at 333 g/ha or value 40% WP at 36 g/ha or trigos 36% OD at 595 $cm^3$/ha), but the lowest biological yield was obtained by broadcasting sowing with untreated check.

The highest grain yield was obtained by drill sowing with weed control treatments (hand weeding or value 40% WP at 36 g/ha) and drill on raised beds sowing with weed control treatment (trigos 36% OD at 595 $cm^3$/ha + hock 15% WP at 333 g/ha) followed by drill on raised beds sowing with weed control treatments (hand weeding or value 40% WP at 36 g/ha or trigos 36% OD at 595 $cm^3$/ha), drill sowing with weed control treatment (trigos 36% OD at 595 $cm^3$/ha + hock 15% WP at 333 g/ha) and broadcasting with weed control treatments (trigos 36% OD at 595 $cm^3$/ha or trigos 36% OD at 595 $cm^3$/ha + hock 15% WP at 333 g/ha), but the lowest grain yield was obtained by broadcasting sowing with untreated check in the first season, whereas in the second season, the highest grain yield was obtained by the drill sowing method with weed control treatments (value 40% WP at 36 g/ha or trigos 36% OD at 595 $cm^3$/ha + hock 15% WP at 333 g/ha) followed by drill sowing with weed control treatments (hand weeding or trigos 36% OD at 595 $cm^3$/ha), broadcasting sowing with weed control treatment (hand weeding) and drill on raised beds sowing with weed control treatments (hand weeding or value 40% WP at 36 g/ha or trigos 36% OD at 595 $cm^3$/ha + hock 15% WP at 333 g/ha), but the lowest grain yield was obtained by broadcasting sowing with untreated check.

**Table 11.** Effect of the interaction between sowing methods and weed control treatments on wheat growth and yield in 2020/21 winter season

| Sowing methods | Weeds control treatments | Days from sowing to maturity | No. of spikes/$m^2$ | 1000-grain weight (g) | No. of grains/spike | Biological yield (ton/ha) | Grain yield (ton/ha) | Increment % compared to untreated check |
|---|---|---|---|---|---|---|---|---|
| Drill | Trigos 36% OD at 595 $cm^3$/ha | 142.7 | 276.67 | 54.67 | 49.0 | 14.45 | 6.15 | 29.7 |
| | Hock 15% WP at 333 g/ha | 142.3 | 218.33 | 53.67 | 49.3 | 19.20 | 4.92 | 3.8 |
| | Value 40% WG at 36 g/ha | 140.7 | 300.00 | 54.33 | 49.0 | 21.11 | 7.20 | 51.9 |
| | Trigos 36% OD at 595 $cm^3$/ha + Hock 15% WP at 333 g/ha | 143.0 | 291.67 | 53.13 | 48.3 | 18.89 | 6.38 | 34.6 |
| | Hand weeding once | 140.7 | 296.67 | 57.33 | 49.3 | 13.39 | 6.31 | 33.1 |
| | Untreated check | 140.3 | 208.33 | 54.43 | 46.3 | 19.62 | 4.74 | - |
| Drill on raised beds | Trigos 36% OD at 595 $cm^3$/ha | 138.7 | 268.33 | 55.50 | 40.0 | 16.09 | 5.41 | 52.0 |
| | Hock 15% WP at 333 g/ha | 139.0 | 216.67 | 50.40 | 40.7 | 11.00 | 3.55 | 0 |
| | Value 40% WG at 36 g/ha | 140.0 | 270.00 | 57.00 | 43.3 | 17.33 | 5.76 | 61.8 |
| | Trigos 36% OD at 595 $cm^3$/ha + Hock 15% WP at 333 g/ha | 141.0 | 285.00 | 53.10 | 41.0 | 17.59 | 5.60 | 57.3 |
| | Hand weeding once | 138.7 | 281.67 | 58.07 | 49.3 | 18.73 | 6.03 | 69.4 |
| | Untreated check | 138.3 | 211.67 | 53.63 | 38.7 | 10.95 | 3.56 | - |
| Broadcasting | Trigos 36% OD at 595 $cm^3$/ha | 140.7 | 263.33 | 56.70 | 51.0 | 18.35 | 5.44 | 113.3 |
| | Hock 15% WP at 333 g/ha | 141.0 | 218.33 | 43.33 | 44.3 | 10.73 | 3.31 | 29.8 |
| | Value 40% WG at 36 g/ha | 142.0 | 283.33 | 56.00 | 45.0 | 16.51 | 4.91 | 92.5 |
| | Trigos 36% OD at 595 $cm^3$/ha + Hock | 143.0 | 278.33 | 53.53 | 46.3 | 16.63 | 5.43 | 112.9 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 15% WP at 333 g/ha | | | | | | | |
| | Hand weeding once | 140.7 | 271.67 | 61.20 | 47.7 | 13.33 | 6.05 | 137.3 |
| | Untreated check | 140.3 | 201.67 | 53.77 | 32.3 | 8.89 | 2.55 | - |
| **LSD 0.05** | | 1.2 | 12.36 | 3.8 | 6.4 | 2.5 | 0.86 | |
| **Standard Error of means** | | 0.423 | 4.188 | 1.329 | 2.225 | 0.862 | 0.294 | |
| **CV%** | | 0.5 | 2.4 | 4.6 | 8.6 | 9.3 | 9.2 | |

**3.5. Economic measures:**

Average of two seasons, data in Table (12) showed that the highest gross income, benefit/cost ratio, net income and profitability% were obtained with drill sowing method by 32482 LE/ha, 1.22, 5818 LE/ha and 21.82%, respectively.

The weed control treatments could be ranged in descending order according to their gross income, benefit/cost ratio, net income and profitability% as follows: hand weeding once by 33905 LE/ha, 1.20, 5654 LE/ha and 20.01%, respectively; Value 40% WG at 36 g/ha by 32739 LE/ha, 1.18, 5106 LE/ha and 18.48%, respectively and Trigos 36% OD at 595 $cm^3$/ha + Hock 15% WP at 333 g/ha by 32879 LE/ha, 1.18, 5051 LE/ha and 18.15%, respectively. As for interactions between sowing methods and weed control treatments, the highest values of gross income, benefit/cost ratio, net income and profitability% were achieved in decreasing order by: drill method and each of Value 40% WG at 36 g/ha by 37499 LE/ha, 1.35, 9787 LE/ha and 35.31%, respectively, hand weeding once by 36332 LE/ha, 1.28, 8001 LE/ha and 28.24%, respectively and Trigos 36% OD at 595 $cm^3$/ha + Hock 15% WP at 333 g/ha by 33462 LE/ha, 1.2, 5555 LE/ha and 19.9%, respectively; drill on raised beds method and each of Trigos 36% OD at 595 $cm^3$/ha + Hock 15% WP at 333 g/ha by 34419 LE/ha, 1.26, 7076 LE/ha and 25.88%, respectively, hand weeding once by 33695 LE/ha, 1.19, 5452 LE/ha and 19.31%, respectively and Value 40% WG at 36 g/ha by 32669 LE/ha, 1.18, 5045 LE/ha and 18.26%, respectively; and broadcasting method and each of hand weeding once by 31665 LE/ha, 1.12, 3484 LE/ha and 12.36%, respectively, Trigos 36% OD at 595 $cm^3$/ha by 30709 LE/ha, 1.13, 3611 LE/ha and 13.32%, respectively and Trigos 36% OD at 595 $cm^3$/ha + Hock 15% WP at 333 g/ha by 30755 LE/ha, 1.11, 2998 LE/ha and 10.8%, respectively.

**Table 12.** Effect of sowing methods, weed control treatments and their interactions on economic measure (average of two seasons)

| Treatments | | Grain yield (ton/ha) | Gross income (LE/ha) | Total cost (LE/ha) | Net income (LE/ha) | Benefit/ cost ratio | Profitability % |
|---|---|---|---|---|---|---|---|
| **Sowing methods** | | | | | | | |
| **Drill** | | 5.94 | 32482 | 26664 | 5818 | 1.22 | 21.82 |
| **Drill on raised beds** | | 5.25 | 29262 | 26576 | 2686 | 1.10 | 10.11 |
| **Broadcasting** | | 4.70 | 26672 | 26515 | 157 | 1.01 | 0.59 |
| **Weed control treatments** | | | | | | | |
| **Trigos 36% OD at 595 $cm^3$/ha** | | 5.66 | 31175 | 27168 | 4007 | 1.15 | 14.75 |
| **Hock 15% WP at 333 g/ha** | | 4.06 | 23709 | 27245 | -3536 | 0.87 | -12.98 |
| **Value 40% WG at 36 g/ha** | | 6.00 | 32739 | 27633 | 5106 | 1.18 | 18.48 |
| **Trigos 36% OD at 595 $cm^3$/ha + Hock 15% WP at 333 g/ha** | | 6.03 | 32879 | 27828 | 5051 | 1.18 | 18.15 |
| **Hand weeding once** | | 6.25 | 33905 | 28252 | 5654 | 1.20 | 20.01 |
| **Untreated check** | | 3.79 | 22425 | 26585 | -4160 | 0.84 | -15.65 |
| **Interactions between sowing methods and weed control treatments** | | | | | | | |
| **Drill** | **Trigos 36% OD at 595 $cm^3$/ha** | 5.87 | 32132 | 27248 | 4884 | 1.18 | 17.93 |
| | **Hock 15% WP at 333 g/ha** | 5.04 | 28259 | 27324 | 935 | 1.03 | 3.42 |
| | **Value 40% WG at 36 g/ha** | 7.02 | 37499 | 27712 | 9787 | 1.35 | 35.31 |
| | **Trigos 36% OD at 595 $cm^3$/ha + Hock 15% WP at 333 g/ha** | 6.15 | 33462 | 27907 | 5555 | 1.20 | 19.90 |
| | **Hand weeding once** | 6.77 | 36332 | 28331 | 8001 | 1.28 | 28.24 |
| | **Untreated check** | 4.81 | 27185 | 26664 | 521 | 1.02 | 1.95 |
| **Drill on raised beds** | **Trigos 36% OD at 595 $cm^3$/ha** | 5.57 | 30755 | 27159 | 3596 | 1.13 | 13.24 |
| | **Hock 15% WP at 333 g/ha** | 3.75 | 22239 | 27236 | -4997 | 0.82 | -18.35 |
| | **Value 40% WG at 36 g/ha** | 5.98 | 32669 | 27624 | 5045 | 1.18 | 18.26 |
| | **Trigos 36% OD at 595 $cm^3$/ha + Hock 15% WP at 333 g/ha** | 6.36 | 34419 | 27343 | 7076 | 1.26 | 25.88 |
| | **Hand weeding once** | 6.20 | 33695 | 28243 | 5453 | 1.19 | 19.31 |
| | **Untreated check** | 3.63 | 21702 | 26576 | -4874 | 0.82 | -18.34 |
| **Bro adc** | **Trigos 36% OD at 595 $cm^3$/ha** | 5.56 | 30709 | 27098 | 3611 | 1.13 | 13.32 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Hock 15% WP at 333 g/ha** | 3.39 | 20582 | 27174 | -6592 | 0.76 | -24.26 |
| | **Value 40% WG at 36 g/ha** | 4.99 | 28049 | 27562 | 486 | 1.02 | 1.76 |
| | **Trigos 36% OD at 595 cm³/ha + Hock 15% WP at 333 g/ha** | 5.57 | 30755 | 27758 | 2998 | 1.11 | 10.80 |
| | **Hand weeding once** | 5.77 | 31665 | 28181 | 3484 | 1.12 | 12.36 |
| | **Untreated check** | 2.92 | 18365 | 26515 | -8149 | 0.69 | -30.74 |

## DISCUSSION

The results in this study reported that the drill sowing method had the best affect on weed infestation as drill sowing method has spatial regular uniform distribution of wheat plant/unit area, (Hassanein *et al*., 2020). Drill on raised beds sowing method has spatial regular uniform also, but the spaces between the beds which are free from wheat plants and suitable for the emergence and growth of weed seed bank without any competition from wheat plants which make these weeds have the ability to compete for more than wheat crop, (El-Ashmouny *et al*., 2016).

The present data pointed out that drill or drill on raised beds sowing methods was more suitable to improve the growth characteristics of wheat plants due to the spatial arrangement in rows and these results agree with (Khan *et al*., 2000) and (Hassanein *et al*., 2020). Results indicated that the spatial regular uniform distribution of wheat plants/unit area when wheat is sowed by drill or drill on raised beds sowing methods improved the wheat growth characteristics and that was reflected in increasing the number of grains/spike, 1000-grains weight, biological and grain yields of wheat, (Oad *et al*., 2007; Kishk *et al*., 2019; and Hassanein *et al*., 2020).

From the results, it's clear that using the combination of the two herbicides (trigos 36% OD at 595 cm³/ha + hock 15% WP at 333 g/ha) or the specific herbicide value 40% WG at 36 g/ha or hand weeding to control the two categories of weeds (broad and grassy weeds) was more effective than using specific herbicide on one category of weeds only (hock 15% WP at 333 g/ha for grassy weeds or trigos 36% OD at 595 cm³/ha for broad-leaved weeds), which was not enough for reducing fresh weight of total weeds. Using trigos 36% OD at 595 cm³/ha alone significantly reduced the fresh weight of total weeds more than the use of the herbicide hock 15% WP at 333 g/ha alone as in this study the broad-leaved weeds were the dominant weeds in the field of experiments which reached 72-90% from total weeds, (Hassanein *et al*., 2020).
The earliest plant maturity and the highest biological and grain yields resulted from weed control treatments value 40% WG at 36 g/ha, trigos 36% OD at 595 cm³/ha + hock 15% WP at 333 g/ha and hand weeding, as these treatments decreased weed/wheat competition, improved growth characters of wheat plants and increased the competition ability of wheat plants than weed plants as these treatments killed and/or reduced the growth characters of weed plants by herbicides or pulling of weed plants by hand, (Smith *et al*., 2010; and Amare *et al*., 2014).

The results presented that using specific herbicides which target the two classes of annual weeds (broad-leaved weeds and grassy weeds) such as (value 40% WG at 36 g/ha or a combination of the two herbicides trigos 36% OD at 595 cm³/ha + hock 15% WP at 333 g/ha or hand weeding) were superior in weed control under drill on raised beds and drill sowing methods than broadcasting sowing method. Trigos herbicide which is specific for broad-leaved weeds was superior in reducing the total annual winter weeds than hock herbicide which is specific for grassy weeds with all studied sowing methods as broad-leaved weeds had density more than grassy weeds in the field of experiments. These results were due to weed control under drill and drill on raised beds sowing methods was easier than broadcasting sowing method as well as controlling broad-leaved weeds in a wheat crop is easier than controlling grassy weeds due to the morphological differences between broad-leaved weeds and wheat crop, but grassy weeds were semi- morphological with wheat plant.

The interaction between sowing methods and weed control treatments were affected significantly by the number of days from sowing to the maturity stage in the second season only. The shortest period to maturity (138.3 DAS) which was produced from drill on raised beds sowing method and unweeded control due to the high weed competition of the weeds which grew in the space between the beds, (Smith *et al*., 2010; and Amare *et al*., 2014).

Results indicated that sowing wheat crop by drill method and weed control using value 40% WG at 36 g/ha or combination of the two herbicides trigos 36% OD at 595 cm³/ha + hock 15% WP at 333 g/ha or hand weeding gave the best values of the number of spike/m² and the number of grains/spike followed by drill on raised beds with the pervious respect weed control treatments due to reducing the fresh weight of weeds and improving wheat growth characters, (Smith *et al*., 2010; and Amare *et al*., 2014).

The biological and grain yields of wheat were significantly increased when sowing by drill or drill on raised beds and weed control by (hand weeding or value 40% WG at 36 g/ha or combination of the two herbicides trigos 36% OD at 595 cm³/ha + hock 15% WP at 333 g/ha) more than broadcasting sowing method and unweeded control in both seasons due to improving the growth characters of wheat as a result of systemic distribution of wheat plants regularly in rows and decreasing weed/wheat competition by the herbicides which had an effect on the two groups of weeds (broadleaved and grassy weeds), these results agreed with those obtained by (Shehzad *et al*., 2012).

## CONCLUSION

The drill sowing method was the best in reducing the weeds infestation and that reflected in producing the highest values of wheat yield compared to drill on raised beds and broadcasting sowing methods. All weed control treatments were

significantly effective on reducing the fresh weight of weeds and increasing wheat yields and its components with superiority of "MCPA 35%/Florasulam 1%" at the rate of 595 $cm^3$/ha (Trigos) + Clodinafop-propargyl 15% at the rate of 333 g/ha (Hock). The interactions between the drill sowing method with weed control treatment "MCPA 35%/Florasulam 1%" at the rate of 595 $cm^3$/ha (Trigos) + Clodinafop-propargyl 15% at the rate of 333 g/ha (Hock) gave the lowest fresh weight of weeds and the highest grain and straw yields of wheat in addition to the highest economic values. Further work will be needed for studying the integration between weed control treatments and several agricultural practices such as the ideal date for sowing, irrigation routines, fertilization … etc., and the investigation of whether the herbicides residues are present in wheat grains or not and also test the quality of the grain.

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# تأثير التكامل بين طرق الزراعة ومعاملات مكافحة الحشائش على صفات النمو وانتاجية محصول القمح والحشائش المصاحبة له

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تم إجراء تجربتين حقليتين في الموسمين الشتويين 20/2019 و21/2020 بمزرعة محطة بحوث النوبارية بمحافظة البحيرة التابعة لمركز البحوث الزراعية. هدفت الدراسة إلى التعرف على تأثير ثلاث طرق لزراعة القمح وهي التسطير والبدار والتسطير على مصاطب وستة معاملات لمكافحة الحشائش وهي "MCPA 35%-Florasulam 1%" (مركب جاهز) بمعدل 595سم$^3$/هكتار (تريجوس)، Clodinafop-propagyl 15% بمعدل 333جم/هكتار (هوك)، Carfentrazone-ethyl 40% بمعدل 36جم/هكتار (فاليو)، "MCPA 35%-Florasulam 1%" بمعدل 595سم$^3$/هكتار (تريجوس) +Clodinafop-propagyl 15% بمعدل 333جم/هكتار(هوك)، النقاوة اليدوية للحشائش مرة واحدة وبدون معاملة على صفات نمو القمح وإنتاجيته. تم تنفيذ التجربة في تصميم قطع منشقة مرة واحدة في ثلاث مكررات. أظهرت النتائج أن طريقة الزراعة التسطير كانت الأفضل في الحد من إنتشارأنواع الحشائش بنسبة (35.6 و17.2% في موسمي 20/2019 و 21/2020 على التوالي) وانعكس ذلك على محصول القمح حيث أعطى أعلى انتاجية لمحصولي الحبوب والقش للقمح مقارنة بطريقتي الزراعة البدار والتسطير على مصاطب على التوالي. في ظل المعدل المرتفع للحشائش (21.4 طن و 13.3 طن وزن غض للهكتار للموسمين على التوالي)، كان لمعاملات مكافحة الحشائش وهي:"MCPA 35%-Florasulam 1%" بمعدل 595سم$^3$/هكتار (تريجوس) +Clodinafop-propagyl 15%، والنقاوة اليدوية للحشائش مرة واحدة، Carfentrazone-ethyl 40% بمعدل 36جم/هكتار (فاليو) و "MCPA 35%-Florasulam 1%" بمعدل 595سم$^3$/هكتار (تريجوس) تأثير في مكافحة الحشائش وزيادة محصولي الحبوب والقش في القمح. علاوة على ذلك، أعطت التفاعلات بين طريقتي الزراعة التسطير والتسطير على مصاطب ومعاملات مكافحة الحشائش الأربعة سابقة الذكر أعلى قيم انخفاض للحشائش الحولية وأعلى إنتاجية لمحصولي الحبوب والقش في القمح. بالإضافة إلى ذلك أعطت أعلى قيم اقتصادية.

**الكلمات المفتاحية:** القمح، طرق الزراعة، مكافحة الحشائش، مبيدات الحشائش.