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Integration Between Sowing Methods and Mechanical Weed Control and Their effect on Wheat Productivity

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Abstract: Two field experiments were conducted during, 2010/2011and 2011/2012 seasons at Shandaweel Agriculture Research Station, Sohag Governorate, Egypt, to study the effect of integration between three sowing methods (Afir drill with 15 cm between rows, Afir hills in rows with 10 cm between hills and 15 cm between rows and Afir hills on furrows with 15 cm between hills and 60 cm between furrows) and seven weed control treatments {Hand hoeing once at one day before first irrigation (BFI), Hand hoeing once at one day before second irrigation (BSI), Hand hoeing twice at (BFI+BSI), hand hoeing once at BFI + hand weeding once at BSI, Hand weeding twice at 30 + 45 days after sowing (DAS), Derby at 30 cm fed^{-1}+Topik at 140 g fed^{-1}. and unweeded control} on yield and yield components of wheat. Split plot design with four replications was used. The results reveled that sowing methods reduced significantly affected on dry weight of grassy, broad and total weeds in both seasons. Afir hills on furrows was the best sowing methods in weed control followed by Afir hills in rows compared with Afir drill method in both seasons. Sowing method Afir in furrows was the best in weed control the all spices compared with other methods and hand hoeing twice was the best in weed control the broad-leaved than grassy weeds. Afir hills on furrows gave the tallest of plants, spike length, number of spikelets spike^{-1}, weight of spike, weight of grains spike^{-1}, number of grains spike^{-1}, number of spikes m^{-2}, seed index and grain yield aradeb fed^{-1} in both seasons compared with Afir drill method. Mechanical weed control had reduced significantly dry weight of grassy, broad and total weeds in both seasons. Hand hoeing twice and hand hoeing +hand weeding were best control than other treatments in both seasons. Using of hand hoeing twice at before the first irrigation and before the second irrigation and hand hoeing once at before the first irrigation+ hand weeding once at before the second irrigation gave the tallest plants, tallest of plants, spike length, number of spikelets spike^{-1}, weight of spike, weight of grains spike^{-1}, number of grains spike^{-1}, number of spikes m^{-2}, seed index and grain yield aradeb fed^{-1} in both seasons compared with unweeded treatment. Interactions between sowing methods and weed control had reduced significantly dry weight of grassy, broad and total weeds in both seasons .Interaction was significant effect on plant height, spike length and weight of spike in first season only and on weight grains spike^{-1} and number of spike m^{-2} in two seasons. Economic evaluation of the results indicated that using Afir hills on furrows with hand hoeing twice gave the highest economic values in the average of two seasons for all economic evaluation. Afir hills on furrows with hand hoeing twice increased gross income, net income and profitability, respectively.

Key words: Sowing methods, Mechanical control, herbicides, Hand hoeing, Hand weeding, Topik, Derby and Wheat.

INTRODUCTION

Population of the world is increasing at an alarming rate. According to an estimate, it will become 8.2 billion by the year 2025. Feeding such fastly growing population is becoming a big problem. Wheat is the most important among food cereals in the world. Due to dwindling land resources, the horizontal increase in productivity is becoming difficult day by day. In these circumstances, the only way to have more production is vertical i.e. increase per unit of land area (Robert 1987). In crop production, weeds are one of the major factors reducing crop yield. The losses caused by weeds have been estimated to be much higher than those caused by insect pest and diseases together. Weed losses in wheat may occur from initial stages to the last stage of maturity, harvest, threshing, winnowing and storing of wheat grains. Weed plants are making faster growth than wheat plants. This competition usually causes a reduction in wheat productivity. Maximizing production of wheat requirements to improve production practices i.e. sowing methods, sowing date and weed control such as using of mechanical weed control.

Sowing methods of wheat became necessary to increase productivity, so improving sowing method is important to increase the wheat production. Al-Marsafy *et al*. (1997) found that wet method (Herati) was better than dry method (Afir drilling) in increasing wheat grain yield. Hasssanein *et al.* (1998) noted that sowing methods (Herati and Afir drill) increased grain yield compared to the out demonstration fields. Fakkar (1999) found that Herati method had significant effect on the dry weight of grassy weeds (g m^{-2}) by 35.3 % compared

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to Afir drill method in second season only. Nassar (2003) stated that sowing methods (No-tillage, Herati, Afir drill and Broadcast) had significant effect on dry weight of annual total weeds, number of spikes m^{-2}, 1000-grain weight and grain yield (ardab fed^{-1}). Anaam (2003) stated that drill method decreased significantly the dry weight of grass, broad-leaved weeds and total weeds compared to broadcast method. Abd El-Hamid (2004) revealed that Afir improved (false irrigation, one month before sowing/minimum tillage then Afir broadcast) and Afir drilling sowing methods surpassed Afir broadcasting method in their effect on annual weed population. El-Afandy *et al* (2006) indicated that sowing wheat grains on sloping of furrows or rows significantly increased spike length, No. of spikelets $spike^{-1}$, No. of grains $spike^{-1}$, grain weight $spike^{-1}$, 1000-grain weight, number of spikes m^{-2}, grain yield fed^{-1}, straw yield fed^{-1}, biological yield fed^{-1} and harvest index as compared with broadcast and drill method. Mobarak (2008) noticed that Afir in furrows and Afir drill methods significantly reduced dry weight of broad-leaved weeds, grassy weeds and total weeds compared to Afir broadcast method in both seasons and increased spike length, No. of grains $spike^{-1}$, grain weight $spike^{-1}$, 1000-grain weight, No. of spikes m^{-2} and grain yield fed^{-1} Hussein and El-Desoki (2008) evaluation of sowing methods (Hills with two rows on ridges 60 cm, hills with two rows on ridges 70 cm, hills with three rows on ridges 80 cm and broadcast).

Mechanical hoeing and weeding is a good measure for eradication of weeds during early growth period or during seedling. However, these methods are time consuming and laborious. On large scale these can not be practiced. Hand hoeing is done in upland crop, the entire surface soil is dig to shallow depth with hand hoeing and weeds are uprooted & removed. It also improves soil physical condition.2-3 manual weeding at 25 and 45 DAS in direct seeded wheat and at 15 and 30 DAT in transplanted wheat is the best and most effective way of weed management. The weeds especially *Avena fatua* and *phalaris minor* are very difficult for the farmers to identify due to their resemblance with the wheat plants in early stages. Keeping the importance of these circumstances in view, it is necessary to select the suitable mechanicals capable of controlling effectively and economically all the type of weeds present in wheat crop. Fakkar (1999) showed that the application of Topik 24 % EC at 100 cc fed^{-1}. and hand weeding twice at 30, 45 days after sowing had significant effect on number of tillers $plant^{-1}$, number of spikes $plant^{-1}$, grain weight $spike^{-1}$, spike length, number of grain $spike^{-1}$ number of spikelets $spike^{-1}$, number of spikes m^{-2}, 1000-grain weight, straw yield ton fed^{-1} and grain yield (ardab fed^{-1}) in wheat. Tillet *et al* (1999) noted that mechanical harrowing reduced effectively the weed dry weight compared with an unweeded control. Khan *et al* (2000) stated that hand hoeing and mechanical harrowing increased the 1000-grain weight significantly over control. Mechanical harrowing gave the maximum net returns (Rs.7200 ha^{-1}) over control (Rs.1060 ha^{-1}) where no weed control practice was adopted. Al-Marsafy *et al*. (2001) indicated that the reduction yield of grain wheat due to *Avena fatua* competition for the whole season was 47.7% weedy free for whole season gave the highest significant value of grain yield (17.62 ardab fed^{-1}). Melander *et al* (2002) reveled that hoeing twice beginning in early April was more effective in the other experiment where weed growth over the winter had been vigorous. Compared with unweeded reference treatments, inter-row hoeing reduced total weed biomass by 60–70% and tap-rooted and erect weed species in particular by 50–90%. Nassar (2003) reported that the application of Topik at 100cc fed^{-1}. and hand weeding at 30, 45 days after sowing significantly increased plant height, spike length, number of grains $plant^{-1}$, weight of grains $plant^{-1}$, weight of grains $spike^{-1}$ and grain yield fed^{-1}. Fakkar (2005) indicated that the application of Topik at 100 cc fed^{-1}, hand weeding once at 30 DAS, hand weeding twice at 30-45 DAS and hand weeding thrice 45-60-75 DAS decreased significantly the dry weight of grassy, broad-leaved and total weeds and increased spike length, number of spikelets $spike^{-1}$, number of grains $spike^{-1}$ and grain yield in both seasons. Muhammad *et al* (2006) indicated that herbicide application and hand hoeing had significant effects on fresh and dry weed biomass, and increased number of tillers, spike length, number of spikelets $spike^{-1}$, number of grains $spike^{-1}$ and grain yield of wheat. Hand hoeing once gave the greatest spike length and number of spikelets $spike^{-1}$. The greatest plant height, number of grains $spike^{-1}$ and grain yield were obtained with hand hoeing after the first, second and third irrigation. Sujoy *et al* (2006) found that 2 hand weeding at 21 and 35 DAS, one wheel hoeing at 21 DAS, 2 wheel hoeing at 21 and 35 DAS, one hand weeding at 21 DAS + one wheel hoeing at 35 DAS were the most effective in managing the weeds of all categories and recorded the highest grain yield of wheat. Mobarak (2008) stated that hand weeding twice at 30,45 DAS and Derby 17.5% SC t 30 cc fed^{-1} + Topik 15 % WP at 140 g fed^{-1} gave the highest reduction of weeds and gave highest values of plant height, spike length, 1000-grain weight number of spikes m^{-2}, grain yield fed^{-1}. Ismail *et al*. (2008) found that hand weeding twice reduced dry weight of annual broad, narrow and total weeds compared to unweeded treatment. Hussein and El-Desoki (2008) found that excellent weed control was achieved by hand hoeing twice at 3 and 6 weeks after sowing controlling weeds using two hand hoeing produced the greatest grain yield over unweeded treatment by 51.6 % and surpass the other weed control treatments. The interaction between sowing methods and weed control treatments had significant effect on number of grains per spike and harvest index. It could be concluded that planting wheat in hills on three sides of ridges 80 cm width method and controlling associated weeds by hand hoeing twice produce greatest grain yield.

The present investigation was carried out to study effect integration between of sowing methods and mechanical weed control in wheat crop.

MATERIALS AND METHODS

The experiment was conducted at Shandaweel Agricultural Research Station, Agricultural Research Center, Sohag Governorate in both winter growing seasons of 2010/2011 and 2011/2012. Itis aimed to study the effect of sowing methods and weed control on wheat. In this study, Bred wheat cultivar Giza 168 was sown in both seasons. The preceding summer crop was peanut in both seasons. Physical and chemical analysis of the soil of the experimental sites showed that the soil was clay loam and containing of 35.0, 910 and 307 ppm for N, P and K, respectively with 8.52 PH and total N1.26.

The sowing dates were 30th of November in both seasons. The plot area was 10.5 m^2. Seeding rate was used as recommended (60 kg fed^{-1}). Phosphorus fertilizer was applied as mono-calcium super phosphate (15.5 % P_2O_5) during preparation at the rate of 150 kg fed^{-1}. Nitrogen fertilizer was added in the form of urea (46.5% N) at the rate of 75 kg N fed^{-1} in two equal portions before the first and second irrigation. The other normal agricultural practices of wheat growing in the region were done. A split plot design was used and the arrangement of treatments in a Completely Randomized Block Design with fore replicates.

A-Mien-Plots: Three Sowing Methods:

1. Afar drill: Wheat grains were hand drilled in rows 15 cm apart (AD).
2. Afir hills in rows: Wheat grains were hand sown in hill in flat land with 15 cm apart and 10 cm between hills (AHR).
3. Afir hills in furrows: Wheat grains were hand in hill on double furrows sloping bed and top of the furrow with 15 cm apart and 60 cm between furrows(AHF).

B- Sub-plots: Seven weed control treatments were used as follows:

1. Hand hoeing once at {20 days after sowing (DAS)} one day before 1st irrigation (BFI).
2. Hand hoeing once at (45 DAS) before 2nd irrigation (BSI).
3. Hand hoeing twice at one day before1st irrigation+ Hand hoeing at before 2nd irrigation (BFI+BSI).
4. Hand hoeing once at one day before 1st irrigation + Hand weeding once at before 2nd irrigation.
5. Hand weeding twice at 30-45 days after sowing (Recommended treatment).
6. Derby 17.5 %SC (Florasulam+Flumetsulam) at 30 cm fed^{-1} at one day before 1st irrigation (20 DAS) + Topik 15 %WP Clodinafop-propargyl) at 140 g fed^{-1} at 45 days after sowing (45 DAS).
7. Unweeded (Control).

Table 1: Trade, common and chemical names of the herbicides used in the study.

Trade name	Common name	Chemical name
1-Derby 17.5% SC	A-Florasulam + B- Flumetsulam	A-N-(2,6-difluorophenyl)-8-fluoro-5 ethoxy [1,2,4] triazolo [1,5-c] yrimidine-2-sulfonamide. B-2, 6-difluoro-5-methyl [1, 2, 4]triazolo-[1.5-α] pyrimidine.2-sulfonamide.
2-Topik 15% WP	Clodinafop- propargyl	{2-propnil (®-2-[4-(5-chloro-3-fluoro-2- pyridnyloxy) phenoxy]-propionate}.

Data Recorded: The Following Data Were Recorded:

I-Weed Survey:

Weeds were hand pulled from one square meter randomly of each plot after 75 DAS, then identified into species and classified into the following two groups (Annual grassy weeds), (Annual broad-leaved weeds) and total annual weeds.

Weeds were air dried for 3 days and dried on oven at 70 C$^{\circ}$ for 24 hours. Therefore, the dry weight of total weeds was recorded in gram m^{-2}. Herbicides were sprayed by Cp3 knapsack sprayer with 200 litter of water fed^{-1}.

II-Yield And Yield Components:

At harvest the following characters were recorded: Plant height (cm), spike length (cm.), number of spikelets $spike^{-1}$, weight of spike, number of grains $spike^{-1}$, weight of grain $spike^{-1}$, number of spikes m^{-2},seed index, grain yield (aradeb fed^{-1}) and straw yield (ton fed^{-1}).

III--Economic Analysis:

Economic evaluation for the results by estimating the average of seed yield (ard.fed^{-1}), Total Variable Cost, Gross Income (GI), Gross Margin (GM), Benefit/cost ratio(B/C) and profitability according to Heady and Dillon (1961).

Where: Gross Income (GI) = (price L.E) × Yield (Ardab or ton fed^{-1})

Gross Margin (GM) = Gross Income- Total cost.
Benefit/cost ratio (B/C) = Gross Income/Total cost.
Profitability = Gross Margin/Total cost x100.

Statistical Analysis:

The collected data were statistically analyzed according to the method of Snedecor and Cochran (1981). Least Significant Differences (LSD-Received) test was used for treatments mean separation.

RESULTS AND DISCUSSION

I-Effect of Sowing Methods and Mechanical Weed Control on:

A- Weeds:

Major weed species recorded were grassy weeds as *Avena fatua* (63.73%) and *Phalaris minor* (30.71%) while broad-leaved weeds as *Brassica nigra L.* (55.75%), *Chenopodum albam L.*(33.45%) and *Ammi majus L.* (24.90%) average in both seasons (Table2).

Table 2: Family, scientific name and english name of accompanied weeds in wheat field during 2010/2011and 2011/2012 seasons.

No	Family	Scientific name	English name	Infestation % m^{-2}
1	Gramineae (Poeceae)	*Avena spp.*	Wild oat	63.73
2	Gramineae (Poeceae)	*Phalaris spp.*	Canary grass	30.71
3	Chenopodiaceae	*Chenopodum albam L.*	Lampsquarters	33.45
4	Polygonaceae	*Emex spinosus L.*	Spiny emex	13.44
5	Polygonaceae	*Rumex dentatus L.*	Sheep sorrel	8.05
6	Umbelliferae	*Ammi majus L.*	Common bishop	24.90
7	Cruciferae	*Brassica nigra L..*	Kabar mustrad	55.75
8	Asteraceae	*Sonchus oleraceus L.*	Annual sowthistle	5.95
9	Leguminosae (Fabaceae)	*Melilotus indica L.*	Sweet clover	4.25
10	Leguminosae (Fabaceae)	*Medicago polymorpha*	Toothed medik	4.30

Data in Table 3. Indicated that sowing methods, mechanical weed control were significantly affected dry weight of grassy, broad and total weeds in both seasons.

Sowing methods were significantly affected dry weight of grassy, broad and total weeds in both seasons. Afir hills in furrows and Afir hills in rows methods reduced dry weight of grassy, broad and total weeds by (29.54 and16.12 %), (32.63 and 20.16%) and (31.17 and 17.73%), respectively in the first season and by (33.62 and 19.37%), (36.44 and 30.00%) and (34.79 and 23.74%), respectively in the second season compared to Afir drill method. It may be to essay hoeing and weeding between the hills when we are using sowing methods Afir hills in furrows and rows. Sowing in furrows increased plant tillers and number plants per unit area and decrease size and growth the weeds. On other hand, the competition between weeds and plants crop decrease and increase efficiency sowing methods. These results are in line with those obtained by Hussein and El-Desoki (2008).

Mechanical weed control significantly reduced dry weight of grassy, broad and total weeds in both seasons. Hand hoeing twice at one day before the first irrigation (BFI) + hand hoeing at before the second irrigation (BSI), hand hoeing once at one day before the first irrigation (BFI) + hand weeding once at before the second irrigation (BSI) and hand weeding twice at 30-45 days after sowing (DAS) gave the best weed control to all spaces weeds and reduced the reduced dry weight of grassy, broad and total weeds by (86.95, 84.05 and 83.00%), (94.35, 91.62 and 87.54%) and (90.16, 87.34 and 85.00%), respectively in the first season. While second season, reduced the reduced by (87.51, 85.03 and 82.07%), (96.44, 92.91 and 91.10%) and (91.57, 88.61 and 86.15%), respectively compared with unweeded treatment. On the other hand, hand hoeing once at BFI and hand hoeing once at BSI were lately efficiency in control to weeds with aerag 80.0 and 77.0 % for the total weeds in both seasons. These results indicated that mechanical hoeing and weeding may be good practices for eradication weeds during early growth period of wheat crop or during seedling stage. Mechanical weed control (hoeing between hills) led to a late development of weeds. Hoeing only allowed an acceptable weed control in the early stages while hand weeding was late efficient in controlling weeds because the weeds escape a weeding to likeness the weeds with plants wheat especially in at early stages. These results are in agreement with those of Muhammad *et al* (2006), Sujoy *et al* (2006), Abouziena *et al* (2008) and Hussein and El-Desoki (2008).

Table 3: Effect of sowing methods and mechanical weed control on grassy, broad-leaved and total weeds in 2010/11 and 2011/12 seasons.

Treatments	Dry weight of weeds (g m^{-2})					
	Grassy weeds		Broad-leaved weeds		Total weeds	
	2010/11	2011/12	2010/11	2011/12	2010/11	2011/12
Sowing method:						
A-Afir drill (AD)	94.21	71.51	62.59	50.08	156.80	121.59
B-Afir hills in rows (AHR)	79.02	57.66	49.97	35.06	128.99	92.72
C-Afir hills on furrows (AHF)	66.38	47.47	41.54	31.83	107.92	79.29
L.S.D at $_{0.05}$	6.30	4.64	4.22	4.54	8.21	5.80
Weed control:						
T_1-H.H at BFI	68.54	49.75	40.04	33.12	108.59	82.88
T_2 –H.H at BSI	63.22	43.85	35.32	25.93	98.54	69.79
T_3 –H.H at BFI and BSI	34.31	24.45	11.41	5.82	45.72	30.28
T_4 –H.H at BFI and H.W at BSI	41.91	29.31	16.91	11.58	58.82	40.89
T_5 – H.W at 30,45 DAS	44.57	35.10	25.15	14.53	69.72	49.72
T_6 -Derby + Topik	43.70	33.88	28.85	18.53	72.55	52.41
T_7 -Un-weeded (control)	262.85	195.8	201.88	163.31	464.73	359.11
L.S.D at $_{0.05}$	5.23	6.05	5.71	4.93	7.18	8.70

Data in Tables 4 and 5. shows the effect of sowing methods and weed control treatments on *Avena spp.*, *Phalaris spp.*, *Brassica nigra L.*, *Chenopodum albam L.*, *Ammi majus L.*, *Emex spinosus L.*, *Rumex dentatus L.*, *Sonchus oleraceus L.*, *Medicago polymorpha* and *Melilotus indica L.* in 2010/11 and 2011/12 seasons. Sowing methods decreased significantly dry weight of *Avena spp.*, *Phalaris spp.*, *Brassica nigra L.*, *Chenopodum albam L.*, *Chenopodum albam L.* and *Ammi majus L* in both seasons. But, decreased significantly the *Emex spinosus L.*, *Rumex dentatus L.*, *Sonchus oleraceus L.* and *Medicago polymorpha* in first season only and had not significant effect on *Melilotus indica L.* in both seasons. Mechanical weed control significantly decreased all grassy spices and broad-leaved weeds. Hand hoeing was the best in controlling broad-leaved than grassy weeds. Mechanical weeding redacted weed biomass, the effect being most apparent after weeding, presumably because broad-leaved weeds damaged damage did not recover. These different of results may be due to the different efficiency weed control treatments to control of weeds in the early growth stages of wheat.

Data in Table 6. Showed the efficiency of sowing methods and weed control treatments in 2010/11 and 2011/12 seasons. Sowing method Afir hills on furrows was more efficiency in controling *Avena spp.*, *Phalaris spp.*, *Brassica nigra L.*, *Ammi majus L.*, *Emex spinosus L.*, *Rumex dentatus L.*, *Sonchus oleraceus L.*, *Medicago polymorpha* and *Melilotus indica L.* in 2010/11 and 2011/12 seasons except for *Chenopodum albam L.* in first season compared with Afir drill methods.

Mechanical weed control was more effective in weed control the all weed species in both seasons**.** Hand hoeing twice was more efficiency in weed control than other treatments, hand hoeing once at BFI or Hand hoeing once at BSI supported efficiency on weed control in both seasons. Herbicides Derby+Topik were proximally affected weeds compared with Hand hoeing twice, but the effect of herbicides rhombus with hand weeding twice on all weeds in both seasons. The efficiency of hand hoeing twice on *Avena spp* and *Phalaris spp.* were (86.77, 88.9%) and (87.27, 83.31%) in first and second seasons, respectively. While the efficiency of hand hoeing twice on *Brassica nigra L.*, *Ammi majus L.*, *Emex spinosus L.* and *Rumex dentatus.*, were (96.41, 97.28%), (94.72, 97.22%), (94.39, 98.21%) and (91.65, 94.57%) in for tow seasons, respectively. Dry weight of grassy weeds was higher than dry weight of broad-leaved weed because grassy weeds hers omnipotence on retrieve growth obvert the broad-laved weeds this in Table (3).

B-Growth, Yield and Yield Components:

Data in Tables 7 and 8 revealed that sowing methods and mechanical weed control were significantly affected wheat grain yield and yield component in both seasons.

Sowing methods were increased significantly yield, yield component in both seasons. Afir hills on furrows gave the best grain yield and yield component compared with Afir drill in both seasons. Afir hills on furrows and Afir hills in rows gave the highest plant height, spike length, number of spikelets $spike^{-1}$, weight of spike, number of grains $spike^{-1}$, grain weight $spike^{-1}$, number of spikes m^{-2}, 1000-grain weight and grain yield (aradeb fed^{-1}.) in both seasons. Afir hills on furrows and Afir hills in rows increased number of grains $spike^{-1}$, number of spikes m^{-2}, 1000-grain weight and grain yield (aradeb fed^{-1}.) by (9.16 and 4.86%), (12.22 and 0.14%), (12.92 and 2.00%) and (10.67 and 7.11%),respectively, in the first season and by (10.08 and 3.52%),(2.09 and 0.70%),(18.41 and 3.42%) and (7.47 and 2.85%), in second season, respectively, compared with Afir drill method. These results might be due to the effect of Afir hills on furrows and Afir hills in rows methods were more effective in controlling weeds than Afir drill method, which decreased weeds before the emergence of wheat plants. Decreasing competition between weeds and wheat number of tillers, number of spike m^{-2} and seed index was increased and finally grain gave the highest yield. These results are in agreement with those of Al-Marsafy *et al* (1997), Fakkar (1999) and Nazeer *et al* (2005).

Weed control treatments significantly increased yield and yield component of wheat in both seasons. Hand hoeing twice at before the first irrigation + before the second irrigation and hand hoeing once at before the first irrigation + hand weeding once at before the second irrigation, hand weeding twice at 30-45 days after sowing and Derby at 30 cm^3 fed^{-1} at one day before the first irrigation (20 DAS)+Topik at 140 g fed^{-1} at 45 days after sowing (45 DAS) gave the highest values from plant height, spike length, number of spikelets, weight of spike, weight of grains $spike^{-1}$, number of grains $spike^{-1}$, number of spikes m^{-2}, seed index, grain yield fed^{-1} and straw yield (ton fed^{-1}) in both seasons compared with unweeded treatment.

Hand hoeing twice at BFI+BSI increased weight of spike, weight of grains $spike^{-1}$, number of grains $spike^{-1}$, number of spikes m^{-2}, seed index and grain yield/fed by 33.45, 38.38, 30.62, 32.11, 31.65 and 21.82, in first season and by 42.35, 34.21, 29.07, 5.22,3 3.24 and 25.80%, in second season, respectively, compared with unweeded treatment. The lowest values obtained by hand hoeing once at BFI and hand hoeing once BSI compared with unweeded treatment in both seasons. The effectiveness of hand hoeing treatments might be attributed to the notion that hoeing was most likely more efficient in eradication and growth stunting of the weeds that the other herbicidal treatments. It is argued that both manual and mechanical methods of weed control effectively reduced the weed population which led to better utilization of available resources during photosynthesis and resulted in storage of maximum amount of photosynthesis in grains, thus giving maximum weight of spike, number of grains $spike^{-1}$, grain weight $spike^{-1}$, number of spikes m^{-2} weight of spike, number of grains $spike^{-1}$, grain weight $spike^{-1}$, number of spikes m^{-2} and 1000-grain weight. Similar findings were reported by Fakkar (1999, Nassar (2003), Muhammad *et al* (2006), Sujoy *et al* (2006), (2008) and Hussein and El-Desoki (2008).

2-Effect of Interaction Between Sowing Methods and Mechanical Weed Control on A-Associated Weeds With Wheat:

Data in Table 9. Showed that the interaction between sowing methods and mechanical weed control had a significant effect on dry weight of grassy, broad and total weeds (g m^{-2}) in both season. Hand hoeing twice, hand hoeing once + hand weeding once, hand weeding twice and Derby + Topik gave the highest weight reduction of all weed spices under sowing method of Afir hills on furrows in both seasons. Hand hoeing twice with Afir hills on furrows controlled grassy, broad and total weeds by 84.97, 91.98 and 88.18%in first season and by 86.59, 95.16 and 90.46%in second season, respectively. Whoever, hand hoeing once at 20 DAS and hand hoeing once at 45 DAS came lately under Afir hills on furrows method compared to Afir drill method These results are in line with those obtained by Hussein and El-Desoki (2008).

Table 4: Effect of sowing methods and mechanical weed control on dry weight of weeds in 2010/11 and 2011/12 seasons.

Treatments	*Avena spp.*		*Phalaris spp.*		*Brassica nigra L.*		*Chenopodum albam L.*		*Ammi majus L.*	
	2010/11	2011/12	2010/11	2011/12	2010/11	2011/12	2010/11	2011/12	2010/11	2011/12
Sowing methods:										
Afir drill	62.90	48.95	31.31	22.56	23.47	18.27	11.96	10.91	9.38	8.21
Afir hills in rows	57.00	40.38	22.02	17.28	17.89	11.74	8.97	7.62	6.20	4.89
Afir hills on furrows	43.69	35.05	22.69	12.42	15.12	9.89	9.11	6.89	6.50	5.07
L.S.D at $_{0.05}$	6.27	4.64	4.72	3.14	1.23	1.47	0.99	0.91	1.67	1.32
Weed control:										
T_1-H.H at 20 DAS	50.71	32.94	17.83	16.81	16.15	11.00	7.43	5.65	4.70	4.28
T_2 -H.H at 45 DAS	46.83	29.14	16.39	14.76	12.32	8.80	6.69	4.37	4.64	3.15
T_3 -H.H at 20 and 45 DAS	22.62	16.28	11.69	8.18	2.69	1.64	2.17	1.12	1.80	0.51
-H.H at 20 and H.W at 45 DAS	29.98	20.05	11.93	9.25	5.85	3.00	3.13	2.19	1.83	1.41
T_5 . hand weeding at 30,45 DAS	30.78	23.24	13.79	11.85	9.24	3.75	4.40	2.64	3.00	2.11
T_6 –Derby + Topik	29.78	21.74	13.92	12.13	10.55	4.58	5.12	3.03	3.46	2.38
T_7 Un-weeded (control)	171.03	146.80	91.85	49.00	75.00	60.37	41.13	40.32	32.07	28.55
L.S.D at $_{0.05}$	6.09	6.07	7.14	4.21	2.82	2.40	1.96	1.70	1.32	1.80

Table 5: Effect of sowing methods and mechanical weed control on dry weight in 2010/11 and 2011/12 seasons.

Treatments	*Emex spinosus L.*		*Rumex entatus L.*		*Sonchus oleraceus L.*		*Medicago polymorpha*		*Melilotus indica*	
	2010/11	2011/12	2010/11	2011/12	2010/11	2011/12	2010/11	2011/12	2010/11	2011/12
Sowing methods:										
Afir drill	6.59	4.18	4.19	2.63	2.85	2.22	2.05	1.83	2.10	1.81
Afir hills in rows	5.52	3.11	4.00	2.49	2.94	1.95	2.44	1.74	1.99	1.50
Afir hills on furrows	3.43	3.56	2.50	2.00	1.89	1.52	1.45	1.38	1.53	1.43
L.S.D at0.05%	1.05	NS	0.76	NS	0.36	NS	0.18	NS	NS	NS
Weed control:										
T_1-H.H at 20 DAS	3.64	3.28	2.83	2.81	2.00	2.27	1.78	1.82	1.50	2.01
T_2 -H.H at 45 DAS	4.44	2.64	3.09	2.08	1.58	1.75	1.41	1.52	1.14	1.61
T_3 -H.H at 20 and 45 DAS	1.61	0.73	1.18	0.52	0.98	0.48	0.50	0.48	0.49	0.33
-H.H at 20 and H.W at 45 DAS	1.65	1.20	1.30	1.13	0.93	1.10	1.15	0.70	1.04	0.84
T_5 - hand weeding at 30,45 DAS	2.61	1.89	1.83	1.18	1.42	0.89	1.38	1.21	1.27	0.94
T_6 -Derby + Topik	30.3	2.13	2.32	1.90	1.65	1.63	1.42	1.48	1.25	1.40
T_7 Un-weeded (control)	19.28	13.44	12.41	7.19	9.34	5.15	6.21	4.35	6.43	3.92
L.S.D at $_{0.05}$	1.19	1.05	0.79	0.75	0.72	0.61	0.54	0.48	0.765	0.58

Table 6: Mean efficiency (%) of sowing methods and mechanical weed control on grassy and broad-leaved in 2010/11 and 2011/12 seasons.

Treatments	Mean of efficiency the treatments %									
	Avena spp	*Phalaris spp.*	*Brassica nigra*	*Chenopodum albam*	*Ammi majus*	*Emex spinosus*	*Rumex dentatus*	*Sonchus oleraceus*	*Medicago polymorpha*	*Melilotus indica*
Sowing methods:										
AD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AHR	22.84	22.84	69.98	44.82	0.00	24.15	37.25	41.93	33.74	17.49
AHF	41.68	41.68	18.52	4.53	42.07	54.78	49.55	48.42	50.45	31.91
Weed control treatments:										
T_1	73.96	73.14	80.13	83.97	85.18	78.36	74.69	67.26	64.75	62.70
T_2	76.39	76.02	84.50	86.45	87.25	78.67	68.01	74.55	71.18	70.60
T_3	87.84	85.29	96.85	95.97	96.30	93.11	91.63	90.10	90.46	91.98
T_4	84.41	84.07	93.62	93.48	94.68	91.26	86.9	84.34	82.70	81.20
T_5	83.09	80.41	90.74	91.38	91.63	86.20	84.42	83.76	74.98	78.14
T_6	83.89	458.54	89.17	90.02	90.44	84.22	77.44	75.34	71.56	72.43
T_7	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00	00.00

Table 7: Effect of sowing method and mechanical weed control on yield and yeiled components 2010/11 and 2011/12 seasons.

Treatments	Plant height		Spike length		No. spikelets		Weight of spike		Weight of grains spike^{-1}	
	2010/11	2011/12	2010/11	2011/12	2010/11	2011/12	2010/11	2011/12	2010/11	2011/12
Sowing method:										
Afir drill	113.4	110.4	10.97	10.34	18.50	18.89	3.21	3.54	2.13	2.25
Afir hills in rows	117.3	115.6	11.46	10.37	20.40	20.90	3.33	5.43	2.22	2.41
Afir hills on furrows	118..8	119.6	14.28	11.81	23.53	21.66	3.48	3.64	2.61	2.49
L.S.D at $_{0.05}$	3.07	3.58	1.06	0.53	0.70	0.99	0.19	0.16	0.90	0.03
Weed control:										
T_1-H.H at BFI	122.3	112.6	11.78	9.88	19.52	19.40	3.33	3.61	2.32	2.32
T_2 -H.H at BSI	113.6	113.8	12.06	10.60	20.55	20.98	3.42	3.59	2.40	2.34
T_3 -H.H at BFI and BSI	122.8	123.0	13.14	11.93	22.39	21.70	3.63	3.75	2.55	2.74
-H.H at BFI and H.W at SI	120.9	118.5	13.13	11.57	21.67	21.24	3.53	3.73	2.40	2.55
T_5 - H.W at45 DAS	119.6	117.2	13.02	11.54	21.09	20.57	3.64	3.63	2.39	2.34
T_6 -Derby + Topik	115.7	116.3	12.39	11.12	20.99	20.61	3.45	3.72	2.38	2.43
T_7 -Un-weeded (control)	110.8	105.2	10.14	9.24	19.45	18.90	2.55	2.81	1.90	1.98
L.S.D at $_{0.05}$	3.94	3.01	0.82	0.80	1.21	1.23	0.10	0.09	0.10	0.11

Table 8: Effect of sowing method and mechanical weed control on yield and yeiled components in 2010/11 and 2011/12 seasons.

Treatments	No. grains spike^{-1}		No. spikes m^{-2}		Seed index		Grain yield (arad. fed^{-1})		straw yield (ton fed^{-1})	
	2010/11	2011/12	2010/11	2011/12	2010/11	2011/12	2010/11	2011/12	2010/11	2011/12
Sowing method:										
Afir drill	43.01	42.53	418.2	433.2	43.76	45.06	20.04	20.53	5.14	4.95
Afir hills in rows	44.48	41.70	424.0	432.6	45.30	47.25	20.21	20.08	6.01	5.57
Afir hills on furrows	50.93	47.09	415.3	485.5	48.17	49.19	21.37	22.09	6.34	6.25
L.S.D at $_{0.05}$	5.92	3.54	8.00	8.67	2.13	2.01	0.91	0.92	0.30	0.14
Weed control:										
T_1-H.H at BFI	44.67	41.24	425.0	427.3	44.44	44.60	20.31	21.01	5.80	5.21
T_2 -H.H at BSI	45.27	42.61	427.0	449.6	44.60	48.49	20.65	21.67	5.97	5.18
T_3 -H.H at BFI and BSI	50.87	49.75	441.7	490.0	50.08	52.64	22.67	23.00	6.50	6.07
-H.H at BFI and H.W at SI	49.89	46.64	440.1	477.2	49.00	50.95	21.95	22.74	6.07	5.88
T_5 – H.W at45DAS	48.47	43.61	435.0	469.2	47.92	48.95	21.40	22.47	6.08	5.61
T_6 -Derby + Topik	45.63	44.75	430.0	468.6	45.38	45.14	21.29	22.40	6.05	5.54
T_7 -Un-weeded (control)	38.18	37.79	419.8	370.9	38.80	40.30	15.53	15.37	4.34	4.62
L.S.D at $_{0.05}$	3.46	4.61	6.29	7.95	2.35	2.24	0.96	1.22	0.38	0.41

B- Yield And Yield Components:

Data in Table 10 revealed that all interaction between sowing methods and mechanical weed control was not significant on most yield and yield component in both seasons. The interaction between Afir hills on furrows and Afir hills rows with hand hoeing twice increased yield and yield component compared with Afir drill method. Interaction between sowing methods and weed control treatments significantly affected plant height, spike length and weight of grains in first season and weight of spike and number of spike m^{-2} in both seasons. Hand hoeing twice gave higher plants (128.3 and 126.3 cm), spike length (15.27and 12.70 cm), weight of spike m^{-2} (463.6 and 524.5) and grain yield (23.77 and 24.17 aradeb fed^{-1}) in first and second seasons, respectively under Afie hills on furrows method compared with Afir hills in rows and Afir drill methods. Meanwhile, hand hoeing once at 20 DAS and hand hoeing once at 45 DAS gave the lowest plant height, spike length, weight of grains spike^{-1}, weight of spike, seed index, number of spike m^{-2} and grain yield under Afir hills on furrows compared with Afir hills in rows and Afir drill methods. Similar findings were reported by Hussein and El-Desoki (2008) they found that the interaction between sowing methods and weed control treatments had significant effect on number of grains per spike and harvest index. It could be concluded that planting wheat in hills on three sides of ridges 80 cm width method and controlling associated weeds by hand hoeing twice produced higher grain yield.

Correlation analysis:

The results in Table 11 indicated that number of spikes m^{-2}, seed index and yield fed^{-1}. were negatively highly significantly correlated with broad, narrow and total dry weight of weeds in 2010/11 and 2011/12 seasons. Also, *Avena spp*, *Phalaris spp.*, *Brassica nigra*, *Chenopodum albam* and *Emex spinosus* were negatively highly significantly correlated compared with other weeds**.** Generally, grassy weeds were more effective on spikes m^{-2}, seed index and yield fed^{-1} than broad-leave weeds in both seasons.

Table 9: Effect of interaction between sowing methods and mechanical weed control on grassy, broad-leaved and total weeds (gm^{-2}) in 2010/11and 2011/12 seasons.

Sowing methods	Treatments	Grassy weeds		Broad-leaved weeds		Total weeds	
		2010/11	2011/12	2010/11	2011/12	2010/11	2011/12
Afir drill	T_1-H.H at BFI	80.13	55.47	54.90	43.80	135.03	99.27
	T_2 -H.H at BSI	75.07	51.77	47.53	43.37	122.60	95.13
	T_3 -H.H at BFI and BSI	38.13	34.00	14.37	6.13	52.60	40.13
	-H.H at BFI and H.W at BSI	50.70	38.27	20.90	12.23	71.60	50.50
	T_5 . hand weeding at 30,45 DAS	54.87	45.10	30.07	20.77	84.93	65.87
	T_6 -Derby + Topik	55.17	37.90	35.80	23.90	90.97	61.80
	T_7 -Un-weeded (control)	305.43	238.07	234.57	200.37	540.00	438.43
Afir hills in rows	T_1-H.H at BFI	70.00	51.37	34.40	29.97	104.30	80.33
	T_2 -H.H at BSI	67.20	43.60	31.87	4.40	99.07	48.00
	T_3 -H.H at BFI and BSI	36.43	24.80	10.73	6.90	47.17	34.40
	-H.H at BFI and H.W at BSI	41.50	27.73	16.17	15.97	57.67	43.70
	T_5 . hand weeding at 30,45 DAS	43.90	34.90	27.20	13.00	71.60	47.90
	T_6 -Derby + Topik	39.90	35.53	28.87	17.80	68.377	53.33
	T_7 -Un-weeded (control)	254.33	185.7	200.57	154.67	454.90	340.37
Afir hills on furrows	T_1-H.H at BFI	55.60	42.43	30.83	25.60	87.43	68.03
	T_2 -H.H at BSI	47.40	36.20	26.57	30.03	73.97	66.23
	T_3 -H.H at BFI and BSI	28.37	14.57	9.13	1.73	37.97	16.30
	-H.H at BFI and H.W at BSI	33.53	21.93	13.67	6.53	47.20	28.47
	T_5 . hand weeding at 30,45 DAS	34.93	25.30	18.20	10.10	53.13	35.40
	T_6 -Derby + Topik	36.03	28.20	21.90	13.90	57.93	42.10
	T_7 -Un-weeded (control)	228.80	163.6	170.50	134.90	39930	298.53
L.S.D at $_{0.05}$		9.07	10.49	9.90	8.54	12.44	15.09

Table 10: Effect of interaction between sowing methods and mechanical weed control on yield and yeiled components in 2010/11 and 2011/12 seasons.

Sowing methods	Weed control	Plant height		Spike length		Weight of spike		Weight of grains spike^{-1}		No. spikes m^{-2}	
		2010/11	2011/12	2010/11	2011/12	2010/11	2011/12	2010/11	2011/12	2010/11	2011/12
Afir drill	T_1	111.3	107.9	10.00	9.27	3.33	3.44	2.07	2.24	409.0	417.5
	T_2	111.3	105.0	11.40	10.8	3.43	3.64	2.18	2.25	416.8	435.2
	T_3	118.4	120.4	12.90	11.77	3.64	3.76	2.38	2.65	426.9	463.3
	T_4	116.3	116.8	12.57	11.33	3.49	3.70	2.32	2.30	423.4	456.4
	T_5	112.8	112.1	12.40	10.37	3.47	3.71	2.21	2.28	423.1	456.8
	T_6	113.3	111.3	11.73	10.60	3.39	3.70	2.18	2.28	420.1	446.0
	T_7	110.6	99.6	9.23	8.43	2.56	2.85	1.55	1.78	408.1	353.0
Afir hills in rows	T_1	109.3	113.2	10.57	9.77	3.21	3.49	2.20	2.38	420.0	373.8
	T_2	113.3	116.3	10.57	9.83	3.28	3.45	2.22	2.39	413.8	436.1
	T_3	127.7	122.1	12.40	11.37	3.62	3.65	2.48	2.76	434.5	482.4
	T_4	124.0	118.5	11.47	11.20	3.33	3.64	2.34	2.58	433.8	471.5
	T_5	122.8	116.7	11.37	10.70	3.30	3.64	2.31	2.43	429.8	455.0
	T_6	118.9	118.0	10.67	10.40	3.28	3.62	2.23	2.40	425.2	453.4
	T_7	105.6	104.6	9.77	9.13	2.46	2.55	1.73	1.96	411.0	360.0
Afir hills on furrows	T_1	115.4	116.0	14.10	11.60	3.46	3.68	2.52	2.31	444.1	494.3
	T_2	115.7	119.1	13.87	10.60	3.55	3.72	2.57	2.33	438.1	477.4
	T_3	128.3	126.3	15.27	12.70	3.88	3.84	2.82	2.83	463.6	524.5
	T_4	123.8	122.4	15.50	12.67	3.68	3.84	2.70	2.79	463.4	504.4
	T_5	118.3	120.3	15.03	12.60	3.60	3.83	2.66	2.60	461.0	508.3
	T_6	117.7	121.6	14.77	12.37	3.54	3.76	2.59	2.41	451.6	503.4
	T_7	112.9	111.4	11.43	10.17	2.64	3.05	2.43	2.19	437.4	386.0
L.S.D at $_{0.05}$		6.83	NS	1.42	NS	0.18	0.17	0.18	NS	13.47	10.91

Table 11: Correlation coefficients among No. of spikes m^{-2} Seed index and grain yield with dry weight of single weeds and total weeds 2010/11 and 2011/12 seasons.

Weight of weeds (g m^{-2})	2010/2011 Season			2011/2012 Season		
	No. of spikes m^{-2}	Seed Index	Grain yield fed^{-1}.	No. of spikes m^{-2}	Seed Index	Grain yield fed^{-1}.
Avena spp	-0.268*	-0.475**	-0.680**	-0.696**	-0.646**	-0.645**
Phalaris spp.	-0.298*	-0.411**	-0.664**	-0.670**	-0.639**	-0.627**
Brassica nigra	-0.348**	-0.442**	0.683**	-0.673**	-0.654**	-0.620**
Chenopodum albam	-0.289*	-0.411**	-0.668**	-0.670**	-0.632**	-0.618**
Ammi majus	-0.281*	-0.405**	-0.658**	-0.659**	-0.636**	-0.610**
Emex spinosus	-0.374**	-0.458**	-0.637**	-0.695**	-0.591**	-0.602**
Rumex dentatus	-0.361**	-0.433**	-0.640**	-0.707**	-0.539**	-0.584**
Sonchus oleraceus	-0.383**	-0.438**	-0.625**	-0.723**	-0.526**	-0.529**
Medicago polymorpha	-0.370**	-0.435**	-0.642**	-0.710**	-0.507**	-0.529**
Melilotus indica	-0.336**	-0.379**	-0.616**	-0.649**	-0.449**	-0.497**
Dry weight of grass weeds	-0.350**	-0.462**	-0.690**	-0.705**	-0.659**	-0.655*
Dry weight of broad-leaved weeds	-0.339**	-0.440**	-0.680**	-0.698**	-0.644*	-0.627**
Dry weight of total weeds	-0.346**	-0.453**	-0.687**	-0.704**	-0.654**	-0.644*

Economic analysis:

Table13. shows that the total cost, which calculated as 3285 and 3850 L.E. fed^{-1} for fixed cost (land preparation, sowing, post sowing activities, fertilization, irrigation, insect control, harvesting and rental per feddeen) in 2010/2011and 2011/2012 seasons and average random cost was about 150, 300, 350, 400 and 200 L.E. fed^{-1} for one hand hoeing, tow hand hoeing, one hand hoeing + one hand weeding, tow hand weeding and using of herbicides, respectively. The price of grain yield (ardeab fedden^{-1}) was 185 and 380 L.E and straw yield was 80 and 150 L.E in first and second seasons, respectively. The average of gross income for fedden of wheat yield ranged from 4705.68 L.E. to 7609.83 L.E. with interaction between Afir drill and untreated and with interaction between Afir hills in furrows method and hand hoeing twice at BFI and BSI as lower and higher values. The averages of gross margin of wheat yield fed^{-1} reached about 3584.83 L.E. fed^{-1} with interaction between Afir hills in furrows method and hand hoeing twice at BFI and BSI. While, the lowest values with interaction between Afir drill and untreated about 1137.75 L.E. fed^{-1}. The average benefit/cost ratios for wheat yield/fed reached about 1.891 with interaction between Afir hills on furrows method.

Conclusion:

The highiest grain yield of wheat were obtoined by hand hoeing twice at one day before the first irrigation (BFI) +hand hoeing at before the second irrigation (BSI) and hand hoeing once at one day before the first irrigation (BFI) +hand weeding once at before the second irrigation (BSI) with Afir hills on furrows or rows methods**,** Whoever to best control for weeds.

Table 12: Effect of the interaction between sowing methods and weed control treatments on wheat yield and economic analysis in 2009/2010and 2010/2011 seasons.

Sowing methods	Mechanical weed control	Gross Income	Total cost L.E	Gross Margin L.E	B/C	P %
Afir drill	T_1-H.H at BFI	6623.50	3717.5	2906.00	1.78	78.17
	T_2 -H.H at BSI	6863.44	3717.5	3145.94	1.85	84.63
	T_3 -H.H at BFI and BSI	7431.10	3867.5	3563.60	1.92	92.14
	-H.H at BFI and H.W at BSI	7271.02	3917.5	3353.52	1.86	85.60
	T_5 . hand weeding at 30,45 DAS	7183.92	3967.5	3216.42	1.81	81.07
	T_6 -Derby + Topik	7026.54	3792.5	3234.04	1.85	85.27
	T_7 -Un-weeded (control)	5155.00	3567.5	1587.50	1.44	44.50
Afir hills in rows	T_1-H.H at BFI	7022.92	3837.5	3185.42	1.83	83.01
	T_2 -H.H at BSI	7177.24	3837.5	3339.74	1.87	87.03
	T_3 -H.H at BFI and BSI	7887.63	3987.5	3900.13	1.98	97.81
	-H.H at BFI and H.W at BSI	7527.73	4037.5	3490.23	1.86	86.45
	T_5 . hand weeding at 30,45 DAS	7397.83	4087.5	3310.33	1.81	80.99
	T_6 -Derby + Topik	7254.10	3912.5	3341.60	1.85	85.41
	T_7 -Un-weeded (control)	5167.03	3687.5	1479.53	1.40	40.12
Afir hills on furrows	T_1-H.H at BFI	7266.73	3875	3391.73	1.88	87.53
	T_2 -H.H at BSI	7436.38	3875	3561.38	1.92	91.91
	T_3 -H.H at BFI and BSI	8266.34	4025	4241.34	2.05	105.37
	-H.H at BFI and H.W at BSI	8022.23	4075	3947.23	1.97	96.86
	T_5 . hand weeding at 30,45 DAS	7913.03	4125	3788.03	1.92	91.83
	T_6 -Derby + Topik	7798.62	3950	3848.62	1.97	97.43
	T_7 -Un-weeded (control)	5561.61	3725	1836.61	1.49	49.31

Abbreviations:

H.H= Hand hoeing, H.W=Hand weeding, BFI= before first irrigation and BSI=before second irrigation.

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