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Impact of Plant Spacing and Weed Control Treatments on Yield, Quality of Soybean (*Glycine Max* L.) and Associated Weeds Characters under Middle Egypt Conditions

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Abstract

The present study was carried out on soybean *var*. Giza 111 atthe Experimental Farm of Faculty of Agriculture, El-Minia University during the summer seasons of 2015 and 2016, to study the impact of plant spacing and weed control treatments on weed control, yield and quality of soybean. The treatments include rows and plant spacing (density) as P_1: 60×4cm (175000 plant fed^{-1}), P_2: 60×5cm (140000 plant fed^{-1}), P_3: 70×4cm (150000 plant fed^{-1}) and P_4: 70 × 5cm (120000 plant fed^{-1}) and 10 weed control treatments (W_1: Gesagard 50% FW at 1 L fed^{-1},W_2: Fusilade super 12.5%EC at 1 L fed^{-1}, W_3: Gesagard 50%FW+ Fusilade super 12.5% EC,W_4:Stomp 50%EC at 1.7 L fed^{-1},W_5: Stomp 50%EC + Select-super 12.5% EC at 1 L fed^{-1}, W_6: Select-super 12.5%EC, W_7: Stomp 12.5%EC+ one hand hoeing, W_8: hand hoeing twice, W_9: unweeded check and W_{10}: weed free for whole seasons. This study was carried out in a strip-plot design with three replications. Results showed that increasing of soybean plant density by sowing in the narrow ridge (60 cm) and plant space (4 cm between hills) caused a significant reduction in fresh and dry weight of weeds at 60 days after planting (DAP), compared to wider plant spacing in both seasons. The narrow spacing 60×4 cm led to a reduction in dry weight of total weeds by 26.62 % and 22.90 % and increased soybean seed yield by 5.31% and 4.92% in 2015 and 2016 seasons, respectively. All weed control practices reduced the fresh and dry weight of total weeds, compared to the unweeded check in both seasons. Yield of seeds in unweeded check plots was decreased were about 43.18 and 42.69% due to about 3.5 and 3.3 ton fed^{-1} fresh weight of total weeds in 2015 and 2016 seasons, respectively, compared to weed free for whole season. Protein and oil% of soybean seeds were decreased by (10.56 and 10.60%) and (18.23 and 18.05%) in 1^{st} and 2^{nd} seasons, respectively due to the weed interference. The interaction effect between plant spacing, 60×4 cm (P_1) and weed free followed plant spacing P_1 and weed control by Stomp 50%EC + one hand hoeing (W_7) gave the best weed control efficiency (WCE) 78.9 and 81.0% in 2015 and 2016 seasons, respectively as well as superior in seed yield of soybean and net return.

Keywords: *Soybean, plant spacing, herbicides, weed control treatments, Seed quality, WCE, WI.*

Introduction

Soybean (*Glycine max* L.) is one of the most important summer leguminous crops, extensively successful in many provinces in Egypt and worldwide. Soybean is known as

"Golden bean" and miracle or wonder crop of 21th century. Chemical analysis showed that soybean seed contains almost 20% oil, 40% protein, 30% carbohydrates, 10% total sugar and 5% ash (Gulluoglu *et al*., 2017). It is very rich in mineral, vitamins, riboflavin, thiamins, iron, particularly calcium, phosphorus, salts and essential fatty acids (Acikgz *et al*., 2009). Therefore, Soybean is considered an excellent source of food for human and animal consumption. Soybean hasa versatile and fascinating innumerable possibilities not only in agriculture (*i.e*, fixes atmospheric N from 20 to 25 kg fed^{-1} through root nodules and adds approximately 0.7 ton fed^{-1}organic matter through leaf fall (Kanase *et al*., 2006) but also in the industry. The world harvest of soybean is more than 50% of the total world oil seed production. Soyflour is extensively used in the industry of insecticides, disinfectants, and also in enrichment of media used for testing antibiotics. Soybean reduces the risk of cancers breast and prostate possibly due to the presence of isoflavone (Cassileth and Vickers, 2003).

In Egypt, the area of soybean in 2015 was 33896 fed, produced 46671 ton, with an average productivity of 1.377 ton fed^{-1} (Agriculture Statistics, 2015).

Application of proper agronomic methods is one of the important factors for increasing the yield of soybean per unit area. This includes management of soybean plant spacing and densities, which is one of the important agronomic practices influencing crop growth and productivity (Caliskan *et al*., 2007; El-Far *et al*., 2016; Asmaa *et al*., 2017; Gulluoglu *et al*., 2017 and Matsuo *et al*., 2018). Plant density plays an important role in the competitive balance between weeds and soybean. Suitable plant spacing causes development of branches and increases the node number and pod plant^{-1} (Saitoh, 2011; El-Far *et al*., 2016 and Gulluoglu *et al*., 2017). Narrow row spacing is known to suppress weed growth, increased root activity and vertical distribution of light by closing crop canopy earlier than wider row spacing (Knezevic *et al*., 2003 and Bhagirath *et al*. 2014). Plant density did not effect on seed yield or protein and oil contents, however, at low densities there was an increase in the No. of pods plant^{-1} (Andres *et al*., 2018).

Weeds pose a serious problem for crop production. Weed species include a wide range of plant types ranging from the most simple to the most complex plant forms and they vary in rooting depth, heightand spreading habits. They interfere with crop plants by competing for available light, water, space, nutrient requirements and air. Generally, an increase in 1 kg of weed growth corresponds to 1 kg reduction of crop growth as weeds remove plant nutrients more efficiently than crop plants (Jadhav, 2007). Weeds may increase the cost of production, inhibit crop growth and reduce the quality and marketability of products. Weed infestation decreases soybean yield from 50- 60% (Jadhav, 2007) and removes 21.4 kg N and 3.4 kg P ha^{-1} (Pandya *et al*., 2005). Ariunaa *et al*. (2016) found that Soybean can be infested by many weed species including grassy weeds and broad leaved weeds. Lamptey *et al*. (2015) reported that the mean predominant weed floras at the experimental field were broad leaved weeds (58.62%), sedges (26.93%) and grasses (14.44%). Weed control agriculture practices include inter alia crop manipulation, rotation crop speciesand hand hoeing. However, the control of weeds using herbicides is considered to be a favorable method as it cuts the costs, time and labor. Many authors (Balyan and Malik 2003; Sylvestre *et al*. 2013; Singh *et al*. 2016 and Akter *et al*. 2016) demonstrated that the judicious use of pre-emergence and post-emergence herbicides for controlling grasses and broad leaved weeds increases crop yield, improves crop quality and reduces production cost.

The objective of study is to evaluate the impact of plant density and the integrated weed management using certain herbicides on Soybean yield and its associated weeds under the environmental conditions of Minia Governorate, Egypt.

Materials and Methods

Experimental Farm:

The field experiments were conducted at the experimental farm, Faculty of Agriculture, University of Minia, Egypt, during two successive summer seasons of 2015 and 2016. The soil was salty clay loam (organic matter 2.35%, total N o.14%, available P 18 ppm and pH 7.8). The preceding winter crop was wheat in both seasons. This investigation was carried out in split-block design with three replications. The vertical plots were occupied with weed control treatments, while, the strips plots were assigned for plant spacing treatments. The plot area was 21 m^2 (4.2 m width × 5.0 m length). Plot width allowed for 7 and 6 ridges of soybean when planted in 60 and 70 cm widths, respectively.

Agricultural practices

Soybean was planted in constant spaced hills (4 and 5 cm apart) on one side of the ridge, at nearly 175.000 and 140.000 plants fed^{-1} for ridge 60 cm width and 150.000 and 120.000 plants fed^{-1} for ridge 70 cm width, respectively. Soybean used in the experiment was Giza 111, plots were sown by hand in the 14th April in both seasons [soybean seeds were inoculated with bacteria (*Bradyrhizobium japonicum*) strain just before planting]. All recommended agronomic practices were adopted throughout the two seasons.

Weed control treatment (W): Ten weed control treatments were applied in the experiments as indicated in Table 1.

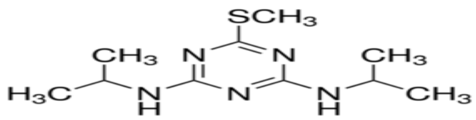
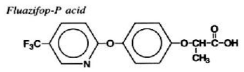
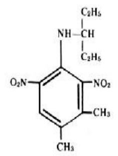
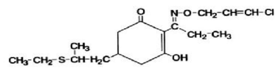
Table 1.Weed control practices applied in the experiments.

No.	Treatments and dose of application
W_1	Gesagard (FW 50%) at rate 1.0 L fed^{-1}
W_2	Fusilade super (EC12.5%) 1.0 L fed^{-1}
W_3	Gesagard (FW 50%) + Fusilade super (EC12.5%)
W_4	Stomp (EC50%) 1.7 L fed^{-1}
W_5	Stomp (EC 50%) + Select-super (EC 12.5%)
W_6	Select-super (12.5% EC) at rate 1.0 L fed^{-1} + hand hoeing at 60 DAP
W_7	Stomp (EC 50%) + hand hoeing at 30 DAP
W_8	Hand hoeing twice at 18 and 30 DAP
W_9	Weed free obtained by continuous hand weeding
W_{10}	Control Unweeded :Allowing weeds to grow with soybean plants

Herbicides used

Table (2) includes the trade name, common and chemical name, chemical structure and time of application of herbicides used in the experiments. Herbicides were sprayed by CP3 knapsack sprayer with a water volume of 200 L fed^{-1}.

Table 2. Trade name, common name, chemical structure and time of application of herbicides.

Trade name	Common name and chemical name	Chemical structure	Time of application
Gesagard (50% FW) 1.0 L fed^{-1}	**Prometryn:**2,4-bis(isopropylamino)-6-(methylthio)-s-triazine		Pre-emergence Soil surface application directly (after planting and before irrigation)
Fusilade super (12.5% EC) 1 L fed^{-1}	**fluazifop-P-butyl:** R-2-[4-[[5-(trifluoromethyl)-2-pyridinyl]oxy]phenoxy]propanate	 **fluazifop-P** (*R*)-2-[4-[[5-(trifluoromethyl)-2-pyridinyl]oxy]phenoxy] propanoic acid	Post-emergence Applied at 30 days after planting (DAP)
Stomp (50% EC) 1.7 L fed^{-1}	**pendimethalin:** [N-(1-ethylpropyl)-3,4 dimethyl-2,6-dinitrobenzen amine]	 **pendimethalin** *N*-(1-ethylpropyl)-3,4-dimethyl-2,6-dinitrobenzene amine	Pre-emergence soil surface application directly (after planting and before irrigation)
Select-super (12.5% EC) 1 L fed^{-1}	**clethodim**:(E)-2[1-[[(3-chloro-2-propenyl)oxy]imino]propyl]-5-[2-(ethylthio) propyl]-3-hydroxy-2-cyclohexen-1-one	 **clethodim** (*E,E*)-(±)-2-[1-[[(3-chloro-2-propenyl)oxy]imino]propyl] -5-[2-(ethylthio)propyl]-3-hydroxy-2-cyclohexen-1-one	Post-emergence applied at 30 DAP

Data collection and measurements:

The following data were recorded during the growing seasons.

1- Weed characteristics:

Weeds survey was conducted randomly using one square meter from each plot after 60 days from planting. Weeds species accounted as plant m^{-2} and hand pulled then identified and classified into three categories (narrow, broad leaved and total weeds) to estimate the following data.

- Weed density (No. of weeds m^{-2}).
- Dry weight of total weeds (g m^{-2}): all weed species m^{-2} were air dried for 3 days then oven dried at 70°C for 24 hours then weighted to estimate dry weight of total weeds.
- Weed control efficiency (%): weed control efficiency (WCE) was calculated according to Sawant and Jadav(1985) as follows:

$$WCE(\%) = \frac{\text{Dry weight of weeds in m}^2\text{ unweed control} - \text{Dry weight of weeds in m}^2\text{ treated}}{\text{Dry weight of weeds in m}^2\text{ unweed control}} \times 100$$

- Weed index (WI): was calculated by using the following formula according to Gill and Vijaykumar, 1969.

$$WI(\%) = \frac{X - Y}{X} \times 100$$

Where:

X=Seed yield from maximum yield treatment.

Y=Seed yield from treatment for which weed index is to be calculated.

2- Soybean yield and its components:

Five plants from each plot were selected randomly and harvested separately. The following assessments on yield components were recorded: Plant height (cm), weight of seeds plant^{-1} (g), 100-seeds weight (g), number of pods plant^{-1}, number of seeds pod^{-1}and seed yield plant^{-1} (g plant^{-1}). Seed and straw yield from each plot were estimated by harvesting, tying in bundles and sun dried. The bundles were weighted for biological yield. The weight of seeds obtained from each plot after threshing was converted into kg fed^{-1}.Straw yield for each plot was calculated by subtracting the seed yield from the biological yield of the respective plot.

3- Seed chemical composition:

- Oil and protein content of soybean seeds from all experimental plots were determined according to (AOAC, 1990).
- Oil and protein yield of seeds (kg fed^{-1}): were calculated by the following formulas:

$$\text{Seed oil yield (kg fed}^{-1}) = \frac{(\text{Seed yield x seed oil \%})}{100}$$

$$\text{Seed protein yield (kg fed}^{-1}) = \frac{(\text{Seed yield x seed protein \%})}{100}$$

4- Economic evaluation of soybean production:

The economics of all treatments were calculated by considering the prevailing prices of inputs and produce (Table 3). The various formulas used were according to Heady and Dillon (1961) as follow:

1. Total Cost of cultivation (L.E) = The cost of cultivation was calculated by considering the prevailing market price of inputs, wages and the actual cost involved in various aspects during the investigation.
2. Gross income (L.E) = price of soybean × seed yield (ton fed^{-1})
3. Net income (L.E) = Gross income - Total cost.
4. Benefit Cost ratio (B/C) = Gross income / Total cost.

Table 3. Parameters used to calculate the cost-benefit for the various inputs.

Parameters	Actual values
Price of herbicides L fed^{-1}	
Constant cost without cost of treatment under study	2281 L.E fed^{-1}
Price of Gesagard (50%FW)	232 L.E
Price of Fusilade super (12.5%EC)	265 L.E
Price of Stomp (50%EC)	230 L.E
Price of Select-super (12.5%EC)	360 L.E
Lobar wage (day), 5 farmers fed^{-1}	5×50 = 250 L.E time^{-1}
Price of grain (ton fed^{-1})	4336 L.E ton^{-1}
Price of straw (Heap of hay) Heml=250 kg	43 L.E haml^{-1}

5- Statistical analysis:

According to strip plot design, the data were statistically analyzed using MSTAT-C computer package program. Mean differences between treatments were evaluated by Least Significant Difference (LSD) test at 5% as suggested by Gomez and Gomez (1984).

Results and Discussion

1- Weed Survey:

Table (4) demonstrates the english and scientific names and families of dominant weed species presented in field experiments in both growing seasons at Minia region.

Table 4. Weed species found in the experimental plots of soybean.

No	English name	Scientific name	Family	Types
1	Jungle rice	*Echinochloacolonum* L.	Poaceae	Annual narrow-leaved
2	Green bristle grass	*Setariavirids*	Poaceae	
3	Nett leaf	*Chenopodium albam L.*	Chenopodiaceae	Annual broad-leaved
4	Common purslane	*Portulaceoleraceae* L.	Portulaceae	
5	Cocklebur	*Xanthium strumarium* L.	Compositae	
6	Black night shade	*Solanumnigram* L	Solanaceae	
7	Pig weed	*Amaranthusascendens* L.	Amaranthaceae	
8	Nut-grass	*Corchorusolitorius* L.	Cyperaceae	
9	Bermuda grass	*Cynodondactylon* L.	Poeceae	Perennial narrow-leaved
10	Purplenutsedge	*Cyperusrotundus* L	Poeceae	
11	Field bindweed	*Convolvulus arvensis* L.	Convolvulaceae	Perennial broad-leaved

2- Effect of plant spacing and weed control treatments on weeds:

Table (5) shows the effect of soybean plant spacing and weed control treatments on total dry weight of weeds at 60 DAP in 2015 and 2016 seasons. Plant spacing had a significant effect on weed density and total weeds at 60 DAP in 2015 and 2016 seasons. Narrow plant spacing 60×4cm (P_4) reduced weed density and dry weight of total weeds by 27.50 and 26.68% in 2015 season and 26.38 and 22.91% in 2016 season compared to plant spacing 70×5cm (P_1), respectively. These results might be due to increase soybean plants/ unit increasing the ability of soybean plants to benefit from light, waterand nutrients, which prevents seedling growth of weeds. Similar results were recorded by EL-Gizawy *et al*. (2012) and Soliman *et al*. (2015). It is observed from data in table 5 that weed parameters including weed density and dry weight of total narrow and broad leaved weeds at 60 DAP were highly significantly decreased by using weed control treatments compared with the unweeded control in both seasons. The best treatment was W_{10} (weed free) in which all types of weeds were removed. Among other treatments Stomp EC50% + one hand hoeing (W_7) followed by Stomp EC50% + Select super EC 12.5 % (W_5) was the most effective treatment, while W_4 and W_1 were the least effective ones. Similar results were reported by Chandraker and Paikra (2015), Soliman *et al*. (2015), Manjunath and Hosmath (2016), Paudel *et al*. (2017). The effect of plant spacing was significant in WCE in the second season only, while insignificant on weed index% in both seasons. P_1 gave the highest WCE value (70.7 and 71.3%) in both seasons, respectively. All weed control treatments effectively increased the WCE, whereas weed index was decreased as compared to unweeded check. Again, among all other weed control practices, weed free treatment was superior in reducing the growth parameters of weeds compared to all other treatments, which is reflected in WCE (100%) and in weed Index (0.0) at 60 DAP. It is followed by the treatment with Stomp EC 50% + hand Hoeing (W_7) and Stomp EC50 % + Select super EC 12.5% (W_5).W_7 gave WCE 78.26 and 79.77% and weed index 2.74 and 2.44% in 2015 and 2016 seasons, respectively.

Table 5. Effect of soybean plant spacing and weed control treatments on weed growth parameters at 60 DAP in 2015 and 2016 seasons.

Treatments	weed density (no. m^{-2})		Total dry weight of weeds (g m^{-2})		Weed control efficiency (%)		Weed index (%)	
	2015	1016	2015	2016	2015	2016	2015	2016
P- Plant Spacing (cm):								
P_1: 60 cm × 4 cm 1 side = 175.000 plant fed^{-1}	70.43	68.12	30.52	28.34	70.70	71.32	11.03	10.94
P_2: 60 cm × 5 cm 1 side = 140.000 plant fed^{-1}	86.07	83.44	37.11	31.08	70.32	71.81	11.42	11.65
P_3: 70 cm × 4 cm 1 side = 150.000 plant fed^{-1}	77.72	73.92	33.36	31.24	70.02	72.47	11.09	11.01
P_4: 70 cm × 5 cm 1 side = 120.000 plant fed^{-1}	97.14	92.53	41.59	36.76	70.53	69.63	12.40	11.74
LSD $_{(0.05)}$	**0.94**	**1.19**	**0.19**	**0.57**	**NS**	**1.11**	**NS**	**NS**
W- Weed control treatments (L fed^{-1}):								
W_1: Gesagard (50% FW) at the rate 1.0 L	71.06	67.75	30.74	27.07	67.74	68.77	11.02	10.77
W_2:Fusilade super (12.5% EC) at the rate 1.0 L	85.42	81.98	36.85	34.28	61.33	60.46	13.30	13.15
W_3: Gesagard + Fusilade super	56.09	53.70	24.80	21.25	73.97	75.49	5.14	4.93
W_4: Stomp (50% EC) at the rate 1.7 L	68.52	65.65	29.14	27.45	69.49	68.34	8.17	7.71
W_5: Stomp + Fusilade	52.47	49.51	23.60	20.32	75.23	76.56	4.51	3.40
W_6: Select-Super (12.5% EC) at the rate 1.0 L	84.00	81.18	36.45	33.42	61.75	61.45	12.74	12.36
W_7: Stomp + 1 hand hoeing	47.60	44.41	20.72	17.54	78.26	79.77	2.74	2.44
W_8: Hand hoeing (2)	55.89	52.83	24.18	21.32	74.62	75.41	4.57	4.42
W_9: Unweeded check	224.54	218.54	95.29	86.69	0.0	0.0	43.18	42.69
W_{10}: Weed free	0.0	0.0	0.0	0.0	100	100	0.0	0.0
LSD $_{(0.05)}$	**0.58**	**0.91**	**0.66**	**0.57**	**0.69**	**0.62**	**2.79**	**2.04**
F-test	*	*	*	*	*	*	**NS**	**NS**

The lowest WCE and weed Index were obtained after treatment with Fusilade super EC 12.5% giving (61.3 and 60.5 %) and (13.3 and 13.2%) in 2015 and 2016 seasons, respectively. Nandini Devi *et al*. (2016) reported that weed index was high in the control treatment (42.10%) followed by the pre-emergence application of pendimethalin (19.09%). Our results are in line with those of Sylvestre *et al*. (2013), Chandraker and Paikra (2015),Thakare *et al*. (2015), Akter *et al*. (2016), Aradhana Bal *et al*.(2016), Manjunath and Hosmath (2016), Singh *et al*. (2016) and Paudel *et al*. (2017).

3- Effect of plant spacing and weed control treatments on soybean yield and its components:

a- Plant height, weight of seeds plant^{-1} and 100-seeds weight:

Results in Table 6 show that the plant height increased significantly from 88.03 to 95.74 cm and from 89.20 to 96.81 cm in 2015 and 2016 seasons when plant density was increased from 120.000 to 175.000 plant fed^{-1} respectively. This increase in plant height with closer spacing might have resulted due to competition among plants for sunlight. Similar results were observed by other researchers Akond *et al*. (2013), Chaunhan and Opena (2013), El-Far *et al*. (2016), Asmaa *et al*. (2017) and Gulluoglu *et al*. (2016 and 2017).

On the contrary, the highest values of weight of seeds plant^{-1} (20.37 and 20.59 g) and 100-seeds weight (19.05 and 19.20 g) were obtained from P_4 in 2015 and 2016 seasons, respectively. This is attributed to the increase in distance between ridges and hill which reduced the competition among plants and consequently gave the chance for them to grow properly, then an increase in the weight of seeds plant^{-1} and 100-seeds weight could be expected. These results are supported by the results of Saitoh (2011), Akond *et al*. (2013) and Gulluoglu *et al*. (2016 and 2017).

As shown in Table 6, the different weed control treatments remarkably affect plant height, weight of seeds plant^{-1} and 100-seeds weight .The three parameters were significantly improved by weed control treatments compared to the unweeded check. Maximum plant height (101.39 and 102.52 cm), weight of seeds plant^{-1} (24.78 and 25.22 g) and 100-seeds weight (21.26 and 21.44g) were recorded by weed free treatment (W_{10}) in 2015 and 2016 seasons, respectively. It is followed in a descending order by W_7,W_5,W_8,W_3,W_4,W_1,W_6 and W_2. The unweeded control gave the least values. Sylvesre *et al*.(2013); Hassan(2015); Thakare *et al*.(2015); Nandini Devi *et al*.(2016) and Rajkumari *et al*.(2017a) found similar results.

b- Number of pods plant^{-1}, number of seeds pod^{-1} and weight of pods plant^{-1}:

Number of pods plant^{-1}, number of seeds pod^{-1} and weight of pods plant^{-1} were estimated for each treatment and included in Table 6. The distance between plants had a significant effect on pod characters. No. of pods plant^{-1}increased from 40.24 to 49.18 and from 40.94 to 50.49 pod plant^{-1}, No. of seeds pod^{-1}from 2.0 to 2.53 and from 2.11 to 2.70 seed and weight of pods plant^{-1} from 22.86 to 26.91 g and from 23.19 to 28.26 g, as plant spacing increased from 60×4cm (P_1) to 70×5cm (P_4) in 2015 and 2016 seasons, respectively. The increase in same characters due to increase space between ridges and hills may be attributed to the increased availability of nutrients and sunlight for soybean plants than narrowing ridges and plant spacing. These results are in agreement with findings of Seadh and Abido (2013), Hassan (2015), Asmaa *et al*. (2017), Gulluoglu *et al*. (2016 and 2017), Andres *et al*. (2018) and Matsuo *et al*. (2018).

Concerning the effect of weed control treatments on these characters (Table 6), it has been found that the weed free treatment (W10) was superior in No. of pod plant^{-1} indicating 62.43 and 62.63, No. of seeds pod-1 2.90 and 3.00 and weight of pods plant^{-1} 34.5 and 34.7 g in 2015 and 2016 seasons, respectively, which is statistically at par with using Stomp EC50% + one hand hoeing (W7) (No. of pod plant^{-1} were 56.49 and 57.35, No. of seeds pod-1 2.82 and 2.91 and weight of pods plant^{-1}33.45 and 33.63 g in 2015 and 2016 seasons, respectively).

Both treatments were followed by Stomp EC50% + Select-super EC12.5% (W5) and hand hoeing twice (W8) which was superior to weed control by using Fusilade super EC 12.5% (W2) that was the least effective one among treatments, followed by the unweedwed check. These results are similar to those obtained by Seadh and Abido (2013), Akter *et al*. (2016) and Hosseini *et al*. (2016).

c- Seed, straw and biological yield.

Data in Table (6) indicate that the yields of soybean increased steadily by increasing plant density from 120.000 (P_4) to 175.000 (P_1) plant fed^{-1}. Seed yield, straw yield and biological yield have been gradually raised from 1.22, 2.33 and 3.56 (P4) to 1.31, 2.46 and 3.80 (P_1) ton fed^{-1} in 2015 season and from 1.25, 2.36 and 3.61 (P_4) to 1.32, 2.48 and 3.80 (P1) ton fed^{-1} in 2016 season, respectively. The same results were reported by Seadh and Abido (2013), Hassan (2015), El-Far *et al*. (2016) Asmaa *et al*. (2017), Gulluoglu *et al*. (2017) and Matsuo *et al*. (2018).

Regarding the effect of weed control treatments on the seeds yield, straw yield and biological yield (Table 6), data reported that the three parameters have been increased by all weed control treatments. The best results were obtained by W10 followed by W7, W5, W8, W3, W4, W1, W6 and W2 treatments in both seasons.

This increase is reflected on soybean yields compared to the unweeded control (Table 7). The highest increasing % of seed yield (106%), straw yield (50%) and biological yield (66%) resulted from W10 followed by W7, W5, W8, W3, W4, W1, W6 and W2 treatments. These results are in line with those obtained by Chandraker and Paikra (2015), Soliman *et al*. (2015), Manjunath and Hosmath (2016), Paudel *et al*. (2017) and Kulal *et al.* (2017).

4- Effect of plant spacing and weed control treatments on quality studies:

Protein content % and protein yield:

Protein % and protein yield of soybean seeds were significantly influenced due to different plant spacing (Table 8). The highest protein content % was obtained by using plant spacing of 70×5 cm (P_4) followed by 60×5 cm (P_2), 70×4 cm (P_3) and 60 ×4 cm (P_1) in decreasing order. P_4 gave a superiorityof protein yield when compared with other spacing in the two seasons. These results could be attributed to that in wider spacing the plants were able to from more metabolites to synthesize more protein in the seeds and the activity of protein synthesis was higher than at closer spacing. Similar results were obtained by Galal (2004), Ibrahim and Kandil (2007), Seadh and Abido (2013) and Andres *et al*. (2018).

The data regarding the protein percent and protein yield in soybean seed as influenced by weed control treatments are presented in (Table 8). The results indicated significant highest protein content in treatment W_{10} (38.61 and 38.69 %), followed by treatment W_7 (38.33 and 38.51 %), W_5 (38.04 and 38.24 %) and W_8 (37.86 and 38.03 %) in 2015 and 2016 seasons, respectively. Significantly lowest protein content was estimated in unweeded treatment (34.61 and 34.68 %) in both seasons. These results could be attributed to the better N utilization by soybean plants under these treatments that favored by effective elimination of weeds. Weed infestation for whole growing season in unweeded plots was instrumental in reduced protein content in same plots. This result supports the results of Shaikh *et al*. (2010), Peer *et al*. (2013), Singh (2015), Soliman *et al*. (2015) and Rajkumari *et al*. (2017a). The same data showed that all treatments increased protein yield kg fed^{-1} when compared with the unweeded treatment (Table 8). This may be probably due to the better weed control practices resulting improvement in seed yield. However, Singh *et al*. (2014) did not find significant variation in protein content of the seed soybean due to the weed control practices.

Oil content % and oil yield:

Data presented in (Table 8) show that increasing plant spacing 60×4 cm (P_1) to 70×5 cm (P_4) significantly decreased the seed oil % in soybean. The oil % values varied between 20.76 to 20.11 % in 2015 and 20.89 to 20.37 % in 2016, as well as oil yield fed^{-1} 335.54 to 308.61 kg fed^{-1} in 2015 and 340.72 to 316.78 kg fed^{-1} in 2016. The highest value of the seed oil % (20.76 and 20.89 %) was obtained when the plant spacing of 60×4 cm (P_1) was used followed by plant spacing 70×5 cm (P_4). The highest values of oil yield fed^{-1} at the closer spacing may be due to the highest seed yield fed^{-1} with the same spacing. These results are in harmony with those recorded by Galal (2004), Ibrahim and Kindil (2007), Gulluoglu *et al*. (2016) and Andres *et al*.(2018). On the other hand, Gulluoglu *et al*. (2017) found that the oil content of soybean was insignificant in plant spacing in two seasons.

All the weed control practices gave significantly higher oil content and oil yield compared to the un-weeded treatment. The maximum oil content was recorded to W_{10} (22.51 and 22.71%) and W_7 (22.23 and 22.43%) in both seasons. It was at par with W_5 (22.01 and 22.20%) and W_8 (20.95 and 21.17%) followed by W_3 (20.48 and 20.66%) in 2015 and 2016 seasons, respectively. Meanwhile, the lowest oil content was obtained from the unweeded treatment. Oil yield losses from weed infestation reached 211.10 and 212.35 kg oil fed^{-1} (48.50 and 48.30%) as compared to the oil estimated from usingweed free for whole season W_{10} (356.89 and 364.27 kg fed^{-1}) in 1st and 2nd seasons, respectively. Therefore, elimination of weeds which increased oil yield may be due to effectiveness of the used weed control treatments. Increased oil content and oil yield fed^{-1} in soybean under weed control treatments has also been reported by Shaikh *et al*. (2010), Peer *et al*. (2013), Singh (2015), Soliman *et al*. (2015) and Rajkumari *et al*. (2017a).

Table 8. Effect of plant spacing and weed control treatments on protein and oil content of soybean crop in 1st and 2nd seasons.

Treatments	Protein %		Protein yeild (kg fed^{-1})		Oil content %		Oil yeild (kg fed^{-1})	
	2015/2016		2015/2016		2015/2016		2015/2016	
P- Plant Spacing (cm):								
P_1: 60 cm × 4 cm 1 side = 175.000 plant fed^{-1}	36.91	37.05	594.51	603.77	20.76	20.89	335.54	340.72
P_2: 60 cm × 5 cm 1 side = 140.000 plant fed^{-1}	37.38	37.57	585.58	593.38	20.31	20.48	317.86	324.50
P_3: 70 cm × 4 cm 1 side = 150.000 plant fed^{-1}	37.12	37.34	589.29	597.51	20.55	20.75	326.99	333.15
P_4: 70 cm × 5 cm 1 side = 120.000 plant fed^{-1}	37.60	37.78	575.87	586.22	20.11	20.37	308.61	316.78
LSD $_{(0.05)}$	**0.09**	**0.06**	**8.35**	**6.15**	**0.18**	**0.06**	**4.13**	**3.65**
W- Weed control treatments (L fed^{-1}):								
W_1: Gesagard (50% FW) at the rate 1.0 L	36.95	37.11	575.18	584.09	19.49	19.65	296.34	301.18
W_2:Fusilade super (12.5% EC) at the rate 1.0 L	36.49	36.69	554.16	562.43	19.08	19.27	297.14	303.32
W_3: Gesagard + Fusilade super	37.49	37.68	618.52	629.59	20.48	20.66	340.12	346.44
W_4: Stomp (50% EC) at the rate 1.7 L	37.32	37.54	599.69	609.27	19.72	19.91	301.43	307.82
W_5: Stomp + Fusilade super	38.04	38.24	641.87	653.57	22.01	22.20	368.14	374.27
W_6: Select-Super (12.5% EC) at the rate 1.0 L	36.89	37.09	569.44	572.39	19.40	19.63	311.97	319.50
W_7: Stomp + 1 hand hoeing	38.33	38.51	652.83	662.90	22.23	22.42	371.78	382.10
W_8: Hand hoeing (2)	37.86	38.03	632.27	643.42	20.95	21.17	356.89	364.27
W_9: Unweeded check	34.53	34.68	343.29	350.27	18.44	18.61	183.79	188.31
W_{10}: Weed free	38.61	38.79	675.89	684.30	22.55	22.71	394.89	400.66
LSD $_{(0.05)}$	**0.40**	**0.46**	**26.65**	**24.03**	**0.56**	**0.56**	**15.60**	**15.09**
F-test	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

5- Effect of interaction:

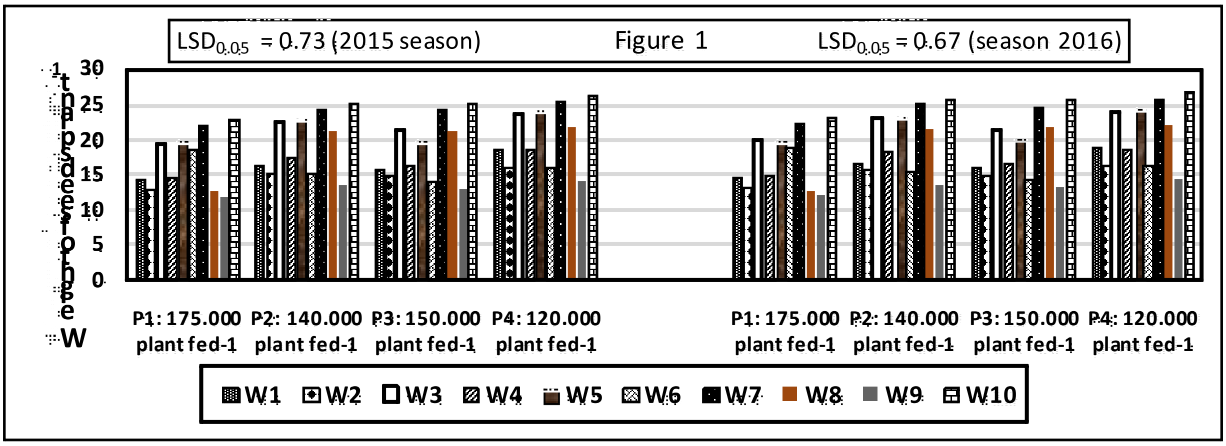
Data in Table 9 presents the interaction effect between plant spacing and weed control treatments. It was a significant effect on weed density, total dry weeds and weed control efficiency (WCE) at 60 DAP in both seasons. All weed control treatments caused significant reductions in No. of weeds, compared to the unweeded check. The greatest reduction in weed density and dry weight of total weeds was produced from plant spacing P_1 and weed control treatment W_7 followed by P_3 with W_7 as compared to the low plant density P_4 with W_7 in both seasons. This may be due to increasing competition ability of soybean in utilization nutrients, water and sunlight due to increasing soybean plants units^{-1} and decreased weed plants. Weed free plots (W_{10}) in all plant space treatments recorded the greatest WCE followed by $P_1 \times W_7$.

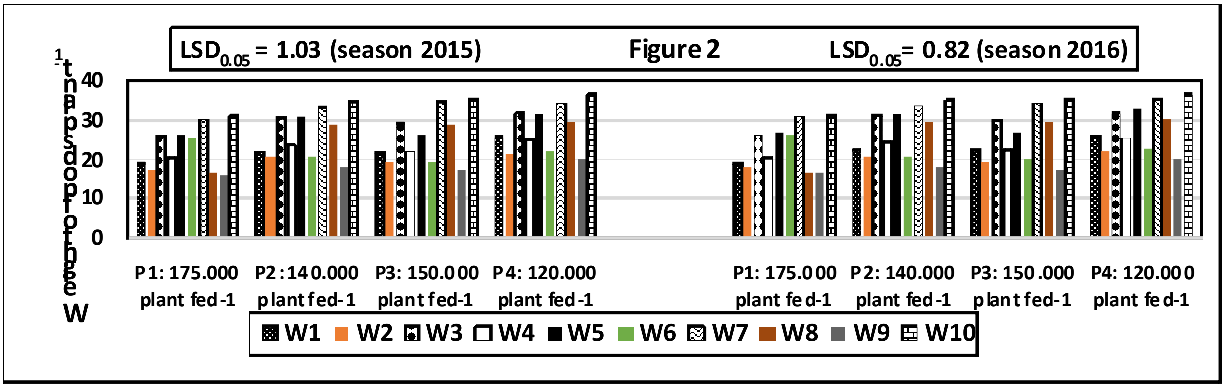
Table 9. Effect of interaction between plant spacing and weed control treatments on weed density, total dry weight of weeds and weed control efficiency at 60 DAP in 2015 and 2016 seasons.

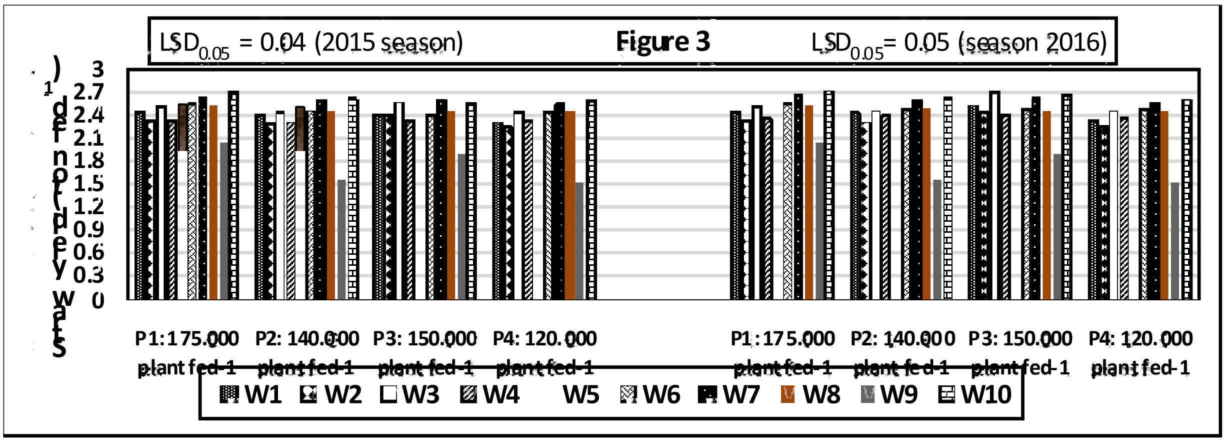
Treatments		Weed density		Total dry weight of weeds(g m^{-1})		Weed control efficiency %	
Plant spacing	Weed control treatments	2015	2016	2015	2016	2015	2016
P_1: 60×4cm 175.000 Plant fed^{-1}	W_1: Gesagard (50% FW) at the rate 1.0 L	58.27	56.00	25.53	23.68	59.10	59.92
	W_2:Fusilade super (12.5% EC) at the rate 1.0 L	76.78	73.47	33.60	31.04	68.92	69.41
	W_3: Gesagard + Fusilade super	47.26	44.33	21.19	19.33	75.28	77.36
	W_4: Stomp (50% EC) at the rate 1.7 L	58.07	56.20	25.24	24.53	62.31	61.31
	W_5: Stomp + Fusilade super	43.35	41.84	18.36	16.88	77.64	78.21
	W_6: Select-Super (12.5% EC) at the rate 1.0 L	71.64	69.90	30.96	29.95	69.27	68.32
	W_7: Stomp + 1 hand hoeing	39.31	37.73	17.33	14.70	78.91	81.02
	W_8: Hand hoeing (2)	46.89	45.67	20.31	17.53	74.20	75.03
	W_9: Unweeded check	192.33	187.90	82.15	77.45	0.0	0.0
	W_{10}: Weed free	0.0	0.0	0.0	0.0	100	100
P_2: 60×5cm 140.000 Plant fed^{-1}	W_1: Gesagard (50% FW) at the rate 1.0 L	78.55	76.67	34.39	26.42	62.50	63.53
	W_2:Fusilade super (12.5% EC) at the rate 1.0 L	86.14	83.10	37.42	32.71	62.32	68.93
	W_3: Gesagard + Fusilade super	58.11	56.93	25.25	20.12	74.56	76.56
	W_4: Stomp (50% EC) at the rate 1.7 L	70.62	66.87	29.80	27.14	62.32	61.54
	W_5: Stomp + Fusilade super	54.86	52.62	23.30	19.07	75.84	77.58
	W_6: Select-Super (12.5% EC) at the rate 1.0 L	85.16	82.63	37.20	31.01	69.96	68.09
	W_7: Stomp + 1 hand hoeing	49.79	46.37	22.22	18.23	77.60	78.56
	W_8: Hand hoeing (2)	56.91	54.50	25.24	19.93	74.54	76.34
	W_9: Unweeded check	234.50	231.27	99.19	85.05	0.0	0.0
	W_{10}: Weed free	0.0	0.0	0.0	0.0	100	100
P_3: 70×4cm 150.000 Plant fed^{-1}	W_1: Gesagard (50% FW) at the rate 1.0 L	63.21	60.95	27.04	25.78	61.13	63.31
	W_2:Fusilade super (12.5% EC) at the rate 1.0 L	84.64	81.23	36.35	33.17	69.69	71.13
	W_3: Gesagard + Fusilade super	51.00	46.80	23.94	20.65	75.61	77.36
	W_4: Stomp (50% EC) at the rate 1.7 L	60.69	56.17	26.77	25.35	58.86	62.21
	W_5: Stomp + Fusilade super	52.58	49.43	21.56	19.88	74.16	77.40
	W_6: Select-Super (12.5% EC) at the rate 1.0 L	80.62	77.37	34.34	32.21	69.40	70.64
	W_7: Stomp + 1 hand hoeing	53.39	50.54	19.03	16.49	72.89	76.48
	W_8: Hand hoeing (2)	44.46	41.10	22.81	19.84	78.46	81.22
	W_9: Unweeded check	208.89	201.73	88.36	87.80	0.0	0.0
	W_{10}: Weed free	0.0	0.0	0.0	0.0	100	100
P_4: 60×5cm 120.000 Plant fed^{-1}	W_1: Gesagard (50% FW) at the rate 1.0 L	86.72	82.17	36.27	32.79	62.09	59.74
	W_2:Fusilade super (12.5% EC) at the rate 1.0 L	98.15	94.00	42.25	38.82	67.46	66.01
	W_3: Gesagard + Fusilade super	66.78	62.77	28.32	23.96	74.14	74.20
	W_4: Stomp (50% EC) at the rate 1.7 L	82.20	78.57	35.57	32.35	63.17	60.75
	W_5: Stomp + Fusilade super	60.69	56.77	26.20	22.92	76.49	76.23
	W_6: Select-Super (12.5% EC) at the rate 1.0 L	94.44	90.97	41.05	37.86	68.09	66.45
	W_7: Stomp + 1 hand hoeing	56.84	52.43	24.32	20.75	78.19	78.49
	W_8: Hand hoeing (2)	66.00	61.84	28.83	24.89	74.59	75.16
	W_9: Unweeded check	262.45	253.27	111.47	96.47	0.0	0.0
	W_{10}: Weed free	0.0	0.0	0.0	0.0	100	100
L.S.D $_{0.05}$		1.17	1.81	1.32	1.13	1.38	1.24

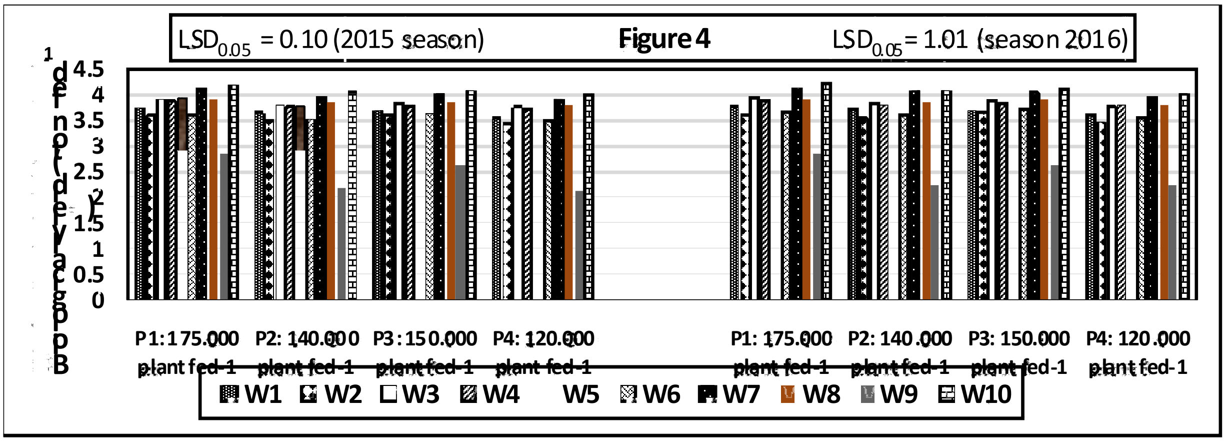
Figures (1&2) illustrate that the interaction between plant spacing and weed control treatments have a significant effect on weight of seeds plant-1, weight of pods plant^{-1}, straw yield and biological yield in both seasons. The combination of the low plant density (P_4=120.000 plant fed^{-1}) and weed free treatment (W_{10}) recorded the highest values of weight of seeds plant^{-1} (26.25 and 26.61 g)and weight of pods plant^{-1} (36.67 and 36.60 g) in 1st and 2nd seasons, respectively.

$P_1 \times W_{10}$ gave the greatest values of straw and biological yields (2.70 and 2.72 ton fed^{-1}) and (4.19 and 4.22 ton fed^{-1}), in 2015 and 2016 seasons respectively,(figures 3&4). The second best interaction treatment was $P_1 \times W_7$, followed by $P_3 \times W_{10}$ in both seasons, while planting 120.000 plant fed^{-1} with unweeded control treatment gave the lowest straw and biological yields in two seasons. These results are coincidence with those obtained by Asmaa *et al.* (2017).









Figures (1, 2, 3 and 4): Weight of seeds plant^{-1}, weight of pods plant^{-1}, straw yield (ton fed^{-1}) and biological yield (ton fed^{-1}) as affected by the interaction between plant spacing and weed control treatments during 2015 and 2016 seasons.

6- Economic of soybean crop:

Data in Table 10 show that the total cost (L.E fed^{-1}), which includes land preparation, sowing, fertilization, irrigation, insect control, harvesting and rental cost of land fed^{-1} (2281 L.E fed^{-1}) + cost of different weed control treatments. The average of gross income L.E fed^{-1} of soybean yield ranged from about 2950.512 to about 7077.708 L.E fed^{-1} with interaction between $P_2\times W_9$ and with interaction between $P_1\times W_{10}$ as lower and higher values. Moreover, net income of soybean yield fed^{-1} reached about 4205.300 L.E fed^{-1}with interaction between $P_1\times W_7$, while, the lowest values with interaction between $P_2\times W_9$about 669.512 L.E fed^{-1}. The higher net income was due to highest weed control efficiency recorded in these treatments, highest growth attributes and highest seed yield of soybean. Application of weed free (W_7) + plant spacing 60×4 cm (P_1) recorded higher B: C ratio (2.521), and $P_1\times W_6$ (2.456) followed by $P_3\times W_7$ (2.454) than other treatments. These results are in conformity of those of Sylvestre *et al.* (2013); Thakare *et al.* (2015) and Rajkumari *et al.* (2017b).

Table 10. Effect of plant spacing and weed control treatments on economics of soybean crop as seasons average.

Treatments		Yield (ton fed^{-1})		Total cost (L.E fed^{-1})	Gross income (L.E fed^{-1})	Net income (L.E fed^{-1})	B: C Ratio
Plant spacing	Weed control treatments	Seed	Straw				
P$_1$: 60×4 cm 175.000 Plant fed^{-1}	W$_1$: Gesagard (50% FW) at the rate 1.0 L	1.300	2.450	2513.000	6058.200	3545.200	2.411
	W$_2$:Fusilade super (12.5% EC) at the rate 1.0 L	1.025	2.301	2546.000	4840.172	2294.172	1.901
	W$_3$: Gesagard + Fusilade super	1.422	2.511	2778.000	6597.684	3819.684	2.375
	W$_4$: Stomp (50% EC) at the rate 1.7 L	1.410	2.352	2672.000	6518.304	3846.304	2.439
	W$_5$: Stomp + Fusilade super	1.424	2.550	2776.000	6613.064	3837.064	2.382
	W$_6$:Select-Super (12.5% EC) at the rate 1.0 L	1.392	2.613	2641.000	6485.148	3844.148	2.456
	W$_7$: Stomp + 1 hand hoeing	1.499	2.713	2761.000	6966.300	**4205.300**	**2.521**
	W$_8$: Hand hoeing (2)	1.417	2.531	2781.000	6579.444	3798.444	2.366
	W$_9$: Unweeded check	0.792	2.050	2281.000	3786.712	1505.712	1.660
	W$_{10}$: Weed free	1.523	2.715	**3281.000**	**7070.708**	3789.708	2.155
Mean of P$_1$		1.310	2.479	2743.900	6106.548	3362.648	2.225
P$_2$: 60×5 cm 140.000 Plant fed$^{-1}{}_2$	W$_1$: Gesagard (50% FW) at the rate 1.0 L	1.272	2.401	2513.000	5558.364	3045.364	2.212
	W$_2$:Fusilade super (12.5% EC) at the rate 1.0 L	1.068	2.301	2546.000	5026.620	2480.620	1.974
	W$_3$: Gesagard + Fusilade super	1.362	2.450	2778.000	6327.032	3549.032	2.278
	W$_4$: Stomp (50% EC) at the rate 1.7 L	1.335	2.351	2672.000	6192.932	3520.932	2.318
	W$_5$: Stomp + Fusilade super	1.387	2.550	2776.000	6014.032	3238.032	2.166
	W$_6$: Select-Super (12.5% EC) at the rate 1.0 L	1.219	2.500	2641.000	5715.584	3074.584	2.164
	W$_7$: Stomp + 1 hand hoeing	1.422	2.621	2761.000	6616.604	3855.604	2.396
	W$_8$: Hand hoeing (2)	1.350	2.507	2781.000	6284.804	3503.804	2.260
	W$_9$: Unweeded check	0.617	1.600	2281.000	**2950.512**	**669.512**	1.294
	W$_{10}$: Weed free	1.468	2.614	2881.000	6814.856	3933.856	2.365
Mean of P$_2$		1.250	2.390	2743.900	5831.080	3088.080	2.126
P$_3$: 70×4 cm 150.000 Plant fed^{-1}	W$_1$: Gesagard (50% FW) at the rate 1.0 L	1.227	2.451	2513.000	5741.844	3228.844	2.285
	W$_2$:Fusilade super (12.5% EC) at the rate 1.0 L	1.173	2.411	2546.000	5500.820	2954.820	2.161
	W$_3$: Gesagard + Fusilade super	1.247	2.714	2778.000	5856.600	3078.600	2.108
	W$_4$: Stomp (50% EC) at the rate 1.7 L	1.364	2.352	2672.000	6318.848	3646.848	2.369
	W$_5$: Stomp + Fusilade super	1.450	2.513	2776.000	6719.436	3943.436	2.421
	W$_6$: Select-Super (12.5% EC) at the rate 1.0 L	1.224	2.511	2641.000	5739.156	3098.156	2.173
	W$_7$: Stomp + 1 hand hoeing	1.459	2.612	2761.000	6775.488	4014.488	2.454
	W$_8$: Hand hoeing (2)	1.427	2.501	2781.000	6617.644	3836.644	2.380
	W$_9$: Unweeded check	0.724	1.912	2281.000	3468.128	1187.128	1.520
	W$_{10}$: Weed free	1.487	2.650	2881.000	6903.432	4022.432	2.396
Mean of P$_3$		1.278	2.453	2743.900	5963.324	3220.324	2.174
P$_4$: 70×5 cm 120.000 Plant fed^{-1}	W$_1$: Gesagard (50% FW) at the rate 1.0 L	1.265	2.302	2513.000	5990.984	3367.984	2.384
	W$_2$:Fusilade super (12.5% EC) at the rate 1.0 L	1.075	2.254	2546.000	5048.888	2508.888	1.983
	W$_3$: Gesagard + Fusilade super	1.294	2.451	2778.000	6032.356	3254.356	2.171
	W$_4$: Stomp (50% EC) at the rate 1.7 L	1.308	2.350	2672.000	6075.688	3403.688	2.274
	W$_5$: Stomp + Fusilade super	1.384	2.500	2776.000	6431.024	3655.024	2.317
	W$_6$:Select-Super (12.5% EC) at the rate 1.0 L	1.192	2.450	2641.000	5583.276	2942.276	2.114
	W$_7$:Stomp + 1 hand hoeing	1.400	2.550	2761.000	6509.000	3748.000	2.357
	W$_8$: Hand hoeing (2)	1.372	2.501	2781.000	6379.164	3598.164	2.294
	W$_9$: Unweeded check	0.647	1.502	2281.000	3063.736	782.736	1.343
	W$_{10}$: Weed free	1.410	2.602	2881.000	6561.304	3680.304	2.277
Mean of P$_4$		1.235	2.346	2743.900	5758.472	3015.472	2.099

Conclusion

From this study, it could be recommended that weed control by Stomp 50% EC+one hand hoeing, Gesagard 50% FW + Fusilade super (12.5%EC) and hand hoeing twice and sowing soybean plants *var*. Giza 111 by 175000 plant fed^{-1} (60×4 cm between plants) produce the highest grain yield and quality under the environmental conditions of Minia Governorate, Egypt.

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تأثير مسافات الزراعة ومعاملات مقاومة الحشائش على جودة ومحصول فول الصويا وصفات الحشائش المصاحبة له تحت ظروف مصر الوسطى

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الملخص

أجريت تجربتان حقليتان بمزرعة كلية الزراعة – جامعة المنيا خلال موسمى الزراعة لصيف ٢٠١٥ ، ٢٠١٦ بهدف دراسة تأثير مسافات الزراعة ومعاملات مكافحة الحشائش على جودة ومحصول فول الصويا والحشائش المصاحبة له. نفذت التجارب باستخدام تصميم الشرائح المتعامدة فى ثلاث مكررات.

اشتملت الدراسة على ٤٠ معاملة تمثل التوافقات بين مستويات العاملين تحت الدراسة وهما مسافات الزراعة {٦٠×٤سم (١٧٥٠٠٠ نبات للفدان)، ٦٠×٥سم(١٤٠٠٠٠ نبات للفدان)، ٧٠×٤سم (١٥٠٠٠٠ نبات للفدان) و ٧٠×٥سم (١٢٠٠٠٠نبات للفدان)}و زعت على الشرائح الرئيسية وعشر معاملات لمكافحة الحشائش وهى (الجيساجارد ، فيوزيليد سوبر ، جيساجارد/فيوزيليد سوبر ، ستومب ، ستومب/سيلكت سوبر ، سيلكت سوبر ، ستومب/عزيق ، عزيق مرتين ، كنترول ، وإزالة الحشائش طوال الموسم) وزعت على الشرائح الأفقية.

أظهرت النتائج أن زيادة الكثافات النباتية أدت إلى نقص جوهرى فى الوزن الغض والجاف للحشائش العريضة والضيقة الأوراق والعدد والوزن الجاف للحشائش الكلية بعد ٦٠ يوماً من الزراعة. وقد أدت الزراعة على مسافات ضيقة بين نباتات فول الصويا إلى انخفاض بلغ ٢٦,٦٢% بالموسم الأول و ٢٢,٩٠ % بالموسم الثانى فى الوزن الجاف للحشائش الكلية ، وزيادة فى نمو المحصول. كما سجلت الزراعة بإستخدام ١٧٥ ألف نبات للفدان أعلى محصول حبوب بالمقارنة بزراعة ١٢٠ ألف نبات للفدان. وسجلت صفات عدد القرون لكل نبات ، وعدد البذور لكل قرن ، وزن قرون لكل نبات للفول الصويا عند الزراعة ١٢٠ ألف نبات للفدان أعلى القيم مقارنة بالكثافات الأخرى.

جميع معاملات الحشائش أدت إلى نقص الوزن الغض للحشائش العريضة والضيقة الأوراق وأعداد والوزن الجاف للحشائش الكلية مقارنة بمعاملة الكنترول. وكانت نسبة النقص فى محصول بذور فول الصويا فى معاملة الكنترول (٣,٥ ، ٣,٣ طن حشائش للفدان) بمقدار ٤٣,١٨% بالموسم الأول ، ٤٢,٦٩ % بالموسم الثانى مقارنة بمعاملة إزالة الحشائش طول الموسم (٠,٠ طن حشائش للفدان).

إزالة الحشائش طوال الموسم أو مكافحة الحشائش بإستخدام مبيد ستومب مع عزقة واحدة بعد ٣٠ يوماً من الزراعة أعطت كفاءة عالية فى تقليل أعداد ووزن الحشائش الجاف وزيادة فى محصول بذور فول الصويا بنسبة ٧٥,٩٨،٧١,١٦ بالموسم الأول ٧٤,٤٨، ٧٠,٢٣ % بالموسم الثانى على التوالى مقارنة بمعاملة الكنترول (بدون مكافحة الحشائش). النسبة المئوية للبروتين والزيت لبذور الفول نقصت بنسبة (١٠,٥٦ ، ١٠,٦٠%) و (١٨,٢٣، ١٨,٠٥%) خلال الموسمين على التوالى نتيجة لتداخل الحشائش.

أحدث التداخل بين الكثافة النباتية بزراعة ١٧٥ ألف نبات للفدان وإزالة الحشائش طوال الموسم (معاملة ١٠) وكذلك تطبيق مبيد ستومب مع عزقة واحدة (معاملة ٧) أعلى كفاءة فى مكافحة الحشائش وصلت ٧٨,٩١% بالموسم الأول ، ٨١,٠٢ % بالموسم الثانى .