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Study the influence of preceding crops and weed control treatments on nodules, weeds and soybean production

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Abstract

The present work was conducted at Shandaweel Research Station (Sohag Governorate, Egypt) Farm during 2017 and 2018 seasons to investigate the effects of preceding crop (wheat, clover, barley and faba bean) and weed control treatments (butralin at the rate of 2.5 l/fed (fed= 4200 m^2), flauzifop-p-butyl at the rate of 1.5 l/fed + metribuzin at the rate of 300 cm^3/fed, clethodim at the rate of 500 cm^3/fed + metribuzin, hand hoeing twice at 30 and 45 days after sowing and untreated) on nodules, weeds and yield of soybean crop during 2017 and 20018 seasons. Using clover as preceding crop significantly decreased the dry weight of grassy, broad-leaved and total weeds (g/m^2) compared to unweeded treatment and increased the number and weight of nodules in the both seasons. Also, it increased significantly plant height, number of branches, number and weight of pods/plant, seeds/pod and plant, seed index, seed yield (ton/fed) seed oil and protein % of soybean in the both seasons. Weed control treatments reduced the dry weight of grassy weeds, broad-leaved and total weeds compared with unweeded control in the both seasons. Amex, flauzifop-p-butyl and bentazon decreased the activity of nodules and weight of nodules in comparison with hand hoeing and unweeded treatments. Application of weed control treatments highly increase plant height, number of branches/plant, number and weight of pods/plant, seeds/pod, seed index, seed yield (ton/fed) seed oil and protein % of soybean crop and as well as seed yield (ton/fed) in the both seasons. The interaction between preceding crop and weed control treatments had a significant effect on the all studied traits in both seasons. Thus, dry weight weeds (g/m^2), number and weight of nodules were decreased under planting of soybean after clover and wheat compared with planting of soybean after barely and faba bean in 2017 and 2018 seasons. Fusilade super + Sencor, Select super + Sencor and hand hoeing twice gave the highest reduction on number and weight of nodules, dry weight of grassy, broad-leaved and total weeds (g/m^2) under planting of soybean after clover and wheat compared with planting of soybean after barely and faba bean and unweeded treatments in both seasons. Fusilade super + Sencor, Select super + Sencor and hand hoeing twice gave increased number and weight of pods/plant, weight of seeds/pod and plant, seed index, seed yield (ton/fed), seed oil % and protein % under planting of soybean after clover and wheat compared with planting of soybean after barley and faba bean and unweeded treatments in the both seasons.

Keywords: proceeding crop, weed control, flauzifop-p-butyl, butralin, metribuzin, clethodim, hand hoeing, soybean.

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1. Introduction

Egypt is one of the largest countries imported oil on the world level, where it is importing more than 90% of the needs of the oil from abroad. Therefore, care must be taken to increase the production of oil crops. Soybean (*Glycine max* (L.) Merrill) is considering one of the most important oil crops. Soybean is significant on worldwide level nourishment and mechanical yields due to high protein content with a dietary benefit industrial crops and nutritional value close to the value of animal protein. Soybean seeds contain about 20% oil, 35% carbohydrate and about 35-40% protein. Decrease in soybean yield because of weed circulation changes from 20 to 77% (Tiwari and Kurchania, 1990), they found that many t factors affecting on the yield of soybean such as type of weed, soil, seasons and weed infestation intensities. Weed invasion removed 21.4 kg N and 3.4 kg P ha^{-1} in soybean (Pandya *et al.*, 2005). Preceding crop can be utilized effectively to manage weeds, in any event, when herbicide utilization is decreased. Abou-Kresha *et al*. (1998) indicated that preceding crop significantly affected on grain yield of maize specially, after faba bean or berseem while, sowing maize after winter wheat decrease the grain yield (Stymiest *et al.,* 2000), Katsvairo *et al.* (2002) found that corn yield can increase more than 40% in a winter wheat-corn soybean rotation compared with corn-soybean, which was attributed to winter wheat improving soil structure over time. Mohler *et al.* (2006) demonstrated that field disposition practices affect weed seedling emergence pattern. Gibson *et al*. (2006) indicated that weeds with comparable life cycles have propagated in the corn-soybean rotation and are increasing weed control costs. Anderson *et al.* (2006) indicated that using various crops to this rotation will likely help control these pests. Stanger and Lauer (2008) showed that these rotations can play an important role for management insects, weeds, diseases and microorganism. Anderson (2011) noted that differentiated crop revolutions can simultaneously improve soybean profitability and reduce weed pressure over redundant planting of single crop or commonly planted soybean–corn rotations, are in development. Bennett *et al.* (2012) indicated that crops grown in short rotations or monoculture often suffer from yield decline contrasted to crops grown in longer rotations or for the first time. Lundgren *et al.* (2017) indicated that preceding crop had a significant effect on yield of soybean. Today, there is an incredible physical work deficiency and an ascent in pay scale. So, chemical weed control plays an important role in decrease the cost and increase soybean productivity. This crop is a large herbicide consumer, and almost 100% of the planted area in Egypt is herbicide-treated. The upsides of herbicide use are high proficiency in weed control, the nearness of items soybean at the least cost, contrasted with other accessible weed control strategies. Pandya *et al*. (2005) recorded that hand weeding at 20 and 40 days after sowing, fenoxaprop-p + one hand weeding at 40 DAS and fenoxaprop-p at 75 kg/ha increased the pods/plant, seeds/pod, seed weight/plant, seed, straw and biological

yields and significant reduced weed dry matter. Abdelhamid and El-Metwally (2008) indicated that all the three herbicides (Prometryn, oxadiargyl, butralin) decreased the number, fresh and dry weight of nodules. While two hand hoeing and unweeded treatments significantly increased these traits. Herbicides and two hand hoeing gave the highest values of number of pods per plant^{-1}, weight of pods per plant^{-1} and number of seeds per plant^{-1} by 140.7, 150.0 and 59.8%, respectively, compared to the nonweeded treatment. Fakkar *et al.* (2010) revealed that flauzifop-p-butyl and bentazon decreased the activity of nodules in comparison with hand hoeing and unweeded treatments. Flauzifop-p-butyl, bentazon and hand hoeing twice reduced the dry weight of grassy weeds, broad-leaved and total weeds compared with unweeded control in both seasons. Fakkar *et al*. (2014) stated that pendimethalin at the rate of 1.7 l/fed, prometryn at the rate of 1.0 l /fed, metolachlor at the rate of 1.0 l /fed significantly decreased dry weight of grassy, broad-leaved weeds, number and dry weight of nodules/plant and increased pods number / plant, pods weight / plant (g), seeds weight / plant (g), seed yield/fed (fed= 4200 m^2). Imoloame (2014) showed that the application of metolachor, pendimethalin metolachlor + diuron, pendimethalin + diuron significantly reduced weed invasion compared to the weedy check. Also, this methods of weed control resulted in significantly improve growth and highest yield. Lamptey *et al.* (2015) recorded that two hand-hoeing followed by that of bentazon+clethodium, oxadiargyl, butralin and metribuzin treatments gave height reduction dry weeds and increased yield and yield components of soybean. Soliman *et al.* (2015) indicated that weed control treatments reduced dry weight of broadleaved, grassy and total weeds compared with unweeded treatments. Ibrahim *et al.* (2017) showed that oxadiargyl, butralin, metribuzin, bentazone +clethodium, and two hand-treatment decreased dry weight of grassy and broad-leaved and produced greater yield, yield attributes and chemical composition of soybean seeds. The target of this investigation is to assess the effect of preceding crop and weed crop management on nodules, weeds and yield of summer soybean. Our goal is to provide guidance for producers with summer soybean production choices.

2. Materials and methods

The experimental work was carried out during 2017 and 2018 seasons at Shandaweel Research Station (Sohag Governorate, Egypt) Farm to investigate the effect of preceding crop and weed control treatments on nodules, weeds, yield and yield components of soybean (*Glycine max* L cv. Giza 111). After soil preparation, the experiment area was divided into 10.5 m^2 Strip plot consisted of five rows of 3.5 m long and 0.6 m apart. Seeds were planted after inoculation with the appropriate treatments. Seeds were planted in 12th and 18th of June in both seasons, respectively**.** The field experiment was carried out in a randomized complete block design (RCBD) using a strip plot arrangement

with three replications. The four proceeding crop sequence (Clover, Wheat, Barley and Faba bean) were arranged vertically and five weed control treatments were allocated horizontally as follow:

1. Amex at the rate of 2.5 cm3/fed (feddan (fed) = 4200 m² = 0.420 hectares = 1.037 acres).
2. Fusilade super at rate of 1.5 l/fed + Sencor at the rate of 300 cm^3/fed.
3. Select super at rate of 1.0 l/fed + Sencor at the rate of 300 cm^3/fed.
4. Hand hoeing twice at 30 and 45 days after sowing.
5. Unweeded treatment.

All tested herbicides were applied by knapsack sprayer equipped with a single nozzle boom was used and spray solution volume was 200 litters water/fed in all cases (Table 1). Grassy and broad-leaved of wheat were controlled by using Topik 24 % WP at the rate of 140 g/fed and Brominal 24 % EC at the rate of 1.0 l/fed at 30 days after planting in both seasons. Grassy and broad-leaved weeds of clover and faba bean controlled using Select super 12.5 % EC at the rate of 500 cm^3/fed and Basagran 48 % AS at the rate of 500 cm^3/fed, at 30 days after planting in both seasons. While, Grassy and broad-leaved weeds of barely were controlled by using Axial 4.5 % EC at the rate of 500 cm^3/fed and Brominal 24 % EC at the rate of 1.0 l/fed, at 30 days after planting in the both seasons.

Table (1): Trade and chemical names, rate and time of application of herbicides used.

Trade name	Common name	Chemical name	Time of application
Amex 48% EC	Butralin	[4-(1, 1dimethylethyl)-N-1-methyl propyl)-2, 6-dinitrobenzenamine]	After planting and before irrigation
Sencor 70% WP	Metribuzin	[4-Amino-6-(1, 1-dimethylethyl)-3-(methylthio)-1, 2, 4-triazin-5(4H)-one]	After planting and before irrigation
Fusilade super 12.5 % EC	fluazifop-p-butyl	(R)-2-[4-[5-(trifluoromthyl)-2-Pyridinyl] Phenoxy Propanoic.	After 30 days of planting
Select super 12.5% EC	Clethodim	[2-[1-[[(3-Chloro-2-propen-1-yl) oxy] amino] propyl]-5-[2-(ethylsulfonyl) propyl]-3, 5-dihydroxy-2-cyclohexen-1-one]	After 30 days of planting

Soil characterization for the experimental sites is shown in Table (2). All the others agricultural practices as a recommended for soybean crop were carried out throughout the two growing seasons. Wheat, barley, faba bean and clover were sown in previously season 2016/17 and 2017/18 in winter seasons (Table 3).

Table (2): Soil characterization for the experimental sites.

Seasons	Texture	$CaCO_3$%	Soil pH	O.M%	Available nutrients in soil (ppm)		
					N	P	K
2017	Sandy loam	7.57	7.8	0.7	14	19	12
2018	Sandy loam	7.52	7.6	0.8	15	18	13

Table (3): Showing planting seasons, (planting, harvest and seeding rate) and variety of crops.

Crop sequences	Sowing seasons		Sowing date		Harvest date		Seeding rate	Variety
	First	Second	First	Second	First	second		
Clover	2017	2018	22/11/2016/17	28/11/2016/17	18/5/2017/18	23/5/2017/18	20 kg/fed	Giza 6
Wheat							60 kg/fed	Sids 12
Bearly							60 kg/fed	Giza 6
Faba bean							50 kg/fed	Giza 843

Feddan (fed) = 4200 m² = 0.420 hectares = 1.037 acres.

2.1 Recorded data

2.1.1 Weeds

Weeds from one m^2 in each experimental unit were pulled out 60 days after sowing, separated to grassy and broad-leaved and oven dried at 70 C° until a constant weight to record the following traits:

1. Dry weight of grassy weeds (g/m^2).
2. Dry weight of broad-leaf weeds (g/m^2).
3. Dry weight of total grassy and broad-leaf weeds (g/m^2).

The dominant weed species were counted in the experimental plots in both seasons is shown in Table (4).

Table (4): Scientific names, English names and families for weeds accompanied soybean crop in the experimental site during 2017 and 2018 seasons, survey in Shandaweel Research Station.

Weeds type	Scientific name	English name	Family
Broad-leaved weeds	*Xanthium spinosum* L.	Spiny cocklebur	Asteraceae
	Portulaca oleracea L.	Common purslane	Protulacaceae
	Euphorbia peplus L.	Leafy spurge	Euphorbiaceae
	Corchorus olitorius L.	Malta jute	Tiliaceae
	Amaranthus hybridus L.	Pigweed	Amaranthaceae
	Datura stramoniumL.	Jimsonweed	Solanaceae
Grassy weeds	*Echinochloa colonum* L.	Jungle rice	Poaceae

2.1.2 Soybean characteristics

2.1.2.1 Nodulation

Sixty days after planting, soybean root samples were collected and washed from soil particles on 1 mm sieve holes. Nodules were counted and number of nodules/plant, fresh weight nodules/plant (g) and number of active nodules were recorded.

2.1.2.2 Yield and its attributes

At harvest, the following parameters were determined in a sample of 10 random guarded plants from each sub plot: plant height (cm), number of branches/plant, number of pods/plant, weight of pods/plant (g), weight of seeds/plant (g) and number of seed/plant. A bulk seed sample from each plot was chosen to determine the seeds index. Seed yield (ton/fed) was calculated on plot basis.

2.1.2.3 Chemical analyses

Oil content of soybean seeds was determined by Soxhlet apparatus and petroleum ether (bp 40 – 60 °C) as

solvent according to A.O.A.C. (2000). Protein was determined as total nitrogen by Micro-Kjeldahl method according to A.O.A.C. (1975), then N was multiplied by 6.25 (Tripathi *et al.*, 1971) to obtain protein content in soybean seeds.

2.2 Statistical analysis

The collected data were statistically analyzed according to the method described by Snedecor and Cochran (1981). Least Significant Differences (LSD-received) test at 5 % level of probability was used for comparison between means.

3. Results and Discussion

3.1 Influence of preceding crop and weed control treatments

3.1.1 Weeds

Using clover as a preceding crop caused a significant decrease of the grassy dry weight, broad-leaved and total weeds (g/m^2) in both seasons. Planting of soybean after clover or wheat or barley reduced the dry weight of grassy weeds by (57.26, 49.03 and 34.98%) and (54.88, 47.10 and 46.68%), broad-leaved weeds by (51.26, 40.63 and 37.75%) and (54.43, 50.74 and 35.26%) and total weeds by (43.54, 33.19 and 22.94%) and (52.52, 44.65 and 36.76%) in 2017 and 2018 seasons, respectively, compared to planting of soybean after faba bean. While, planting of soybean after clover or after wheat caused a reduction in dry weight of grassy was (34.27 and 21.62%) and (8.21 and (1.00%), broad-leaved (21.70 and 4.63%) and (29.61 and 23.91%) and total weeds (26.89 and 13.38%) and (24.92 and 12.48%) in 2017 and 2018 seasons, respectively, compared with planting of soybean after barely (Table 5). The reduction in dry weight of the above mentioned weeds in soybean fields might be due to the role of allelopathic compounds in inhibitors of the growth of weeds in the summer season through which sweat by clover and wheat plants in soil that lead to weeds germination. Similar results obtained by Anderson *et al.* (2006), Gibson *et al.* (2006), Stanger and Lauer (2008), Anderson (2011) and Lundgren *et al.* (2017). Weed control treatments decreased significant the dry weight of grassy, broad-leaved and total weeds (g/m^2) in both seasons. Fusilade super at the rate of 1.5 l/fed after 30 days after sowing + Sencor at 300 g/fed applied post sowing, Select super at the rate of 500 cm^3/fed at 30 post emergence + Sencor and hand hoeing twice at 30 and 45 days after sowing (DAS) decreased significantly grassy weeds by (72.15, 84.72 and 86.83%) and (76.66, 85.37 and 90.76%), broad-leaved by (76.82, 79.57 and 84.34%) and (73.62, 86.49 and 92.08%) and total weeds by (74.23, 85.02 and 88.64%) and (75.54, 82.35 and 93.43%) in first and second seasons, respectively, compared to unweeded treatment (Table 5). Efficiency of hand hoeing treatments against weeds could be attributed to the destroying effect of hoeing on annual weeds since these weeds were not capable of regrowth from the underground parts. Similar results were obtained by Fakkar *et al.* (2010), Imoloame (2014), Lamptey *et al.* (2015),

Soliman *et al.* (2015) and Ibrahim *et al.* (2017).

Table (5): Dry weight of weeds (g/m^2) affected by preceding crop and weed control tratments in 2017 and 2018 seasons.

Treatments	Grassy weeds		Broad-leaved weeds		Total weeds	
	2017	2018	2017	2018	2017	2018
Preceding crop						
Clover	66.32	56.81	96.87	59.81	123.13	156.68
Wheat	79.09	66.61	117.98	64.65	145.70	182.63
Barley	100.90	67.15	123.71	84.97	168.05	208.68
Faba bean	155.18	125.91	198.73	131.25	281.09	329.98
L.S.D. $_{0.05}$	15.46	16.33	82.41	85.84	76.34	93.25
Weed control treatments						
Butralin	144.67	107.68	147.20	82.77	252.35	229.97
Fluazifop+ metribuzin	63.96	45.65	81.42	62.12	109.61	143.54
Clethodim + metribuzin	35.10	28.62	71.78	31.82	63.72	103.60
Hand hoeing twice	30.25	18.07	19.88	18.65	48.32	38.53
Un-weeded	229.68	195.58	351.32	235.50	425.26	586.82
L.S.D. $_{0.05}$	43.67	37.12	34.38	28.96	103.45	120.21

3.1.2 Nodules

Data in Table (6) and Figure (1-8) represented the significant impact of preceding crop and weed control on number and fresh weight of active nodules of soybean roots in both seasons. Planting of soybean after wheat or baerly gave the highest mean values of nodules number /plant (53.74 and 61.67) and (53.58 and 55.41) as well as weight of nodules (2.46 and 2.61 g) and (2.44 and 2.46 g) in 2017 and 2018 seasons, respectively. Planting of soybean after clover or faba bean gave the lowest mean values of nodules numbers /plant (22.89 and 28.59) and nodules weight /plant (1.16 and 1.96 g) in 2017 season being (30.34 and 34.36) and (1.71 and 1.21) in 2018 in the same order. These increases in number and fresh weight of nodules were due to preceding crop effect, which caused more atmospheric nitrogen fixation is that required for crop growth and stimulate microorganism activities in the soil to produce more organic compounds. The results are in harmony with those obtained by Stanger and Lauer (2008). Table (6) shows that number and dry weight of nodules/plant significantly increased with two hand hoeing and non-weeded treatments, compared to the other tested weed control treatments. Weed control treatments significantly decreased the number and fresh weight of nodules /plant in both seasons as compared to unweeded (Table 6). Amex at the rate of 2.5 l/fed, Fusilade super + Sencor and Select super + Sencor decreased number of nodules by (22.10, 14.79 and 26.70%) and by (23.62, 19.57 and 28.34%) and fresh weight of nodules by (15.00, 4.55 and 25.00%) and (11.21, 10.76 and 21.97%) in 2017 and 2018 seasons, respectively, compared with unweeded treatments. Hand hoeing twice gave the height mean values of nodules number /plant (46.93 and 47.05) and fresh weight

of nodules/plant (2.11 and 2.17 g) as compared with herbicides treatments.

Figure 1: Photographs show the effect of preceding crop of clover under hand hoeing on soybean nodules.

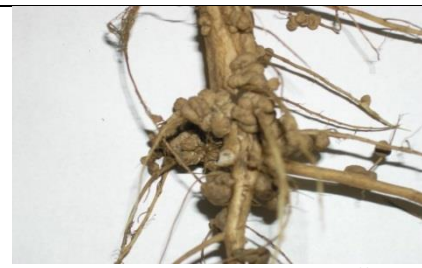

Figure 2: Photographs show the effect of preceding crop of faba bean under hand hoeing on soybean nodules.

Figure 3. Photographs show the effect of preceding crop of wheat under hand hoeing on soybean nodules.

Figure 4. Photographs show the effect of preceding crop of barley bean under hand hoeing on soybean nodules.

Figure 5: Photographs show the effect of fluazifop + metribuzin under clover on soybean nodules.

Figure 6: Photographs show the effect clethodim + metribuzin under clover on soybean nodules .

Figure 7: Photographs show the effect of butralin under clover on soybean nodules.

Figure 8: Photographs show the effect of hand hoeing under clover on soybean nodules.

Table (6): Influence of preceding crop and weed control treatments on nodules in 2017 and 2018 seasons.

Treatments	Nodules/plant			
	Number of active nodules		Fresh weight of active nodules (g)	
	2017	2018	2017	2018
Preceding crop				
Clover	22.50	28.50	1.96	1.16
Wheat	53. 57	53.84	2.44	2.46
Barley	61.67	5541	2.46	2.61
Faba bean	30.34	34.36	1.21	1.71
L.S.D. $_{0.05}$	10.13	11.64	0.17	0.12
Weed control treatments				
Butralin	38.07	38.99	1.87	1.98
Fluazifop+ metribuzin	41.64	41.06	2.10	1.99
Clethodim + metribuzin	35.82	36.58	1.65	1.74
Hand hoeing twice	48.87	51.12	2.20	2.17
Unweeded	46.39	47.05	2.11	2.23
L.S.D. $_{0.05}$	6.12	4.40	0.05	0.07

Our results showed that nodulation of soybean plants is delicate to the prescribed rates and rates higher than the suggested of the three tried herbicides, this in a similar pattern by Gonzalez *et al.* (1996), the dangers of herbicide toxicity to microorganisms might be higher since the metabolism products can inhibit biochemical processes related to symbiosis between plants and micro-organisms. Also, our results additionally demonstrated that there was no noteworthy impact between hand hoeing twice and unwedded treatment on dry weight and number of nodules per plant^{-1}. Similar results were obtained by Attia (2002), Singh and Wright (2002), El-Metwally and Shalby (2007). AbdelAleem *et al*. (2008) indicated that herbicides applied at higher rates significantly reduced fresh and dry weight of nodules compared to hand hoeing and unweeded treatments.

3.1.3 Yield and its attributes of soybean

The results in Tables (7) and (8) showed preceding crops could increase significantly soybean yield and its attributes, *i.e.* plant height, number of branches /plant, number of pods /plant , number and weight of pods /plant, number and weight of seeds/pod, weight of seeds /plant, seed index and seed yield t/fed in the both seasons. Planting of soybean after clover or wheat give the highest mean values of the previously mentioned parameters compared with planting of soybean after barley or faba bean in the both seasons. planting of soybean after clover, barley and wheat increased the weight of pods/plant by (47.26, 17.50 and 9.36%) and by (25.43, 22.93 and 18.45%), Weight of seeds /pod by **(**45.74, 20.21 and 17.02%) and by (45.63, 18.45 and 5.83%), weight of seeds/plant (49.19, 22.65 and 10.26%) and by (51.17, 32.92 and 9.63%) seed index (17.73, 7.41 and 3.46%) and by (27.05, 21.06 and 15.36%) and seed yield (81.25, 48.21 and 29.46%) and by (137.78, 76.52 and 37.39%) in 2017 and 2018 seasons, respectively, compared with planting of soybean after faba bean.

While, planting of soybean after clover and wheat increased the weight of pods/plant by (19.91 and 3.32%) and by (27.80 and 9.13%), Weight of seeds /pod by (24.55 and 2.73%) and by (37.61 and 11.93%), weight of seeds /plant (37.61 and 11.93%) and by (37.89 and 21.24%) seed index (13.79 and 3.82%) and by (10.14 and 4.94%) and seed yield (40.00 and 14.48%) and by (70.89 and 28.48%) in 2017 and 2018 seasons, respectively, compared with planting of soybean after barley. This in turn, accelerated the vegetative development, improves the photosynthetic exhibitions which eventually form the carbohydrate pools, yield and yield components were accordingly expanded. The previously mentioned outcomes showed that hand hoeing treatment favors the growth of soybean plants. Superiority of these treatments is correlated with their efficiency for controlling soybean associated weeds limiting weeds invasion and limiting weeds competition. Similar conclusions were obtained by Bhattacharya *et al*. (2004) and Pandya *et al*. (2005).

Table (7): Effect of preceding crop and weed control on plant height, number of branches, pods and seed /pod and weight of pods and number of seeds/pod (g) in 2017 and 2018 seasons.

Treatments	Plant height (cm)		Number of branches /plant		Number of pods /plant		Weight of pods /plant (g)		Number of seeds /pod	
	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
Preceding crop										
Clover	89.70	94.27	2.29	2.44	85.63	80.29	102.77	57.66	2.53	3.08
Wheat	87.64	93.00	2.21	2.36	66.90	71.34	82.00	56.51	2.18	2.63
Barley	79.71	92.10	1.86	1.53	59.36	67.63	76.32	54.45	2.11	2.51
Faba bean	78.44	76.97	1.58	1.20	54.23	57.48	69.79	45.97	1.86	2.41
L.S.D. $_{0.05}$	15.9	12.1	0.03	0.24	6.71	6.46	13.6	7.22	0.39	0.03
Weed control treatments										
Butralin	80.70	78.21	2.12	1.92	62.29	60.56	74.30	48.07	1.81	2.58
Fluazifop+ metribuzin	85.89	94.58	2.02	2.03	68.94	64.74	82.94	51.18	1.99	2.59
Clethodim + metribuzin	88.62	94.81	2.00	2.07	69.72	82.15	89.020	61.09	2.56	2.79
Hand hoeing twice	93.11	103.33	2.14	1.79	84.4	91.38	100.65	69.05	2.89	3.19
Unweeded	71.28	74.49	1.64	1.61	47.27	47.11	66.79	38.85	1.53	2.13
L.S.D. $_{0.05}$	7.21	6.54	0.18	0.15	5.03	6.33	5.24	4. 45	0.29	0. 19

Table (8): Impact of preceding crop and weed control on weight of seeds/pod g, weight of seeds /plant (g), seed index, seed yield ton /fed, oil (%) and protein (%) in 2017 and 2018 seasons.

Treatments	Weight of seeds /pod g		Weight of seeds /plant (g)		Seed Index		Seed yield ton /fed		Oil (%)		Protein (%)	
	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
Preceding crop												
Clover	1.37	1.50	77.80	82.25	21.45	21.18	2.03	2.70	22.80	21.88	37.68	32.78
Wheat	1.13	1.22	63.96	72.32	19.57	20.18	1.66	2.03	21.43	20.31	36.45	31.11
Barley	1.10	1.09	57.50	59.65	18.85	19.23	1.45	1.58	20.95	19.17	34.99	29.86
Faba bean	0.94	1.03	52.15	54.41	18.22	16.67	1.12	1.15	20.65	18.37	34.95	28.68
L.S.D. $_{0.05}$	0.27	0.05	4.61	3.30	2.50	2.17	0.35	0.96	2.45	1.67	0.07	0.17
Weed control treatments												
Butralin	1.09	1.17	57.27	63.21	19.00	18.59	1.21	1.78	20.10	18.89	35.11	28.92
Fluazifop+ metribuzin	1.14	1.19	63.14	66.25	18.42	18.54	1.50	1.93	20.82	19.14	36.01	31.08
Clethodim + metribuzin	1.20	1.27	68.06	75.58	20.50	19.31	1.82	2.04	22.44	20.91	36.78	31.89
Hand hoeing twice	1.24	1.39	80.08	86.58	22.39	22.16	2.15	2.22	25.10	22.34	38.15	33.52
Un-weeded	1.02	1.03	45.71	49.25	15.26	16.77	1.09	1.41	18.38	18.30	34.07	27.63
L.S.D. $_{0.05}$	0.03	0.09	1.08	1.57	0.89	1.98	0.19	0.55	1.36	1.35	1.74	2.59

Data in Tables (7) and 4indicated that weed control treatments caused an increase in plant height, number of branches /plant, number of pods /plant, weight of pods/plant g, number of seed/pod and weight of seeds/pod g, weight of seeds/plant g, seed index and seed yield (ton/fed,), oil% and protein% of soybean in the both seasons. Fusilade super + Sencor, Select super + Sencor and hand hoeing twice increased of plant height by (20.22, 24.33 and 30.63%) and by (26.97, 27.28 and 38.72%), number of branches/plant by (29.27, 23.17 and 30.49%) and by (67.62, 74.06 and 28.06%), number of pods/plant by (45.84, 47.49 and 78.55%) and by (37.43, 74.39 and 94.00%), weight of pods/plant by (24.18, 33.28 and 50.70%) and by (31.74, 57.25 and 77.73%), number of seed/pod by (30.07, 67.32 and 88.90%) and by (21.60, 31.00 and 49.77%) in the first and second seasons, respectively, compared with control treatment. Addition to, Fusilade super + Sencor, Select super + Sencor and hand hoeing twice increased, weight of seeds /pod g by (117.26,176.47 and 215.69%) and by (15.53, 23.30 and 34.95%), weight of seeds /plant g by (38.13, 48.9 and 75.19%) and by (34.52, 53.46 and 75.80%), seed index by (20.71, 34.34 and 46.72%) and by (10.55,15.15 and 32.14%) and seed yield (ton/fed) by (37.61, 66.97 and 97.25%) and by (36.88,44.68 and 57.45%) in both seasons compared with unweeded. The increase in yield attributes by various weed control treatments may be due to good control of soybean weeds and reducing weed competition which gave a decent possibility of soybean development and increase the yield as well as seed yield. The results of the present investigation are in the same trend with those finding by Pandya *et al.* (2005), Fakkar *et al.* (2014), El-Metwally (2016) and El-Metwally and Dawood (2016).

3.1.4 Chemical characteristics

3.1.4.1 Seed oil content (%)

The results in Table (8) Showed that inoculation of soybean seeds by preceding crop treatments especially planting of soybean after clover or wheat caused a significant increase in the seed oil content compared with planting of soybean after barley or faba bean in the both seasons. Planting of soybean after clover, wheat or barley increased oil percentage by 10.41, 3.78 and 1.45% in the first season and by 19.11, 10.56 and 4.35% in the second seasons in the same order, compared with planting of soybean after faba bean. Weed control treatments significantly increased oil content in 2017 and 2018 seasons. Fusilade super + Sencor, Select super + Sencor and hand hoeing twice increased oil content by (13.28, 22.09 and 36.56%) and by (4.59, 14.26 and 22.08%) in both seasons, respectively, compared with unweeded treatment. The increase in oil content due to application of herbicides may be attributed to increasing phospholipids

formation which is considered one of oil constituents. The positive effect of weeded practices on chemical analysis of soybean seeds has been confirmed by Ahmed *et al.* (2001), Abd El-Hamed and El-Metwally (2008) and El-Metwally (2016).

3.1.4.2 Seed protein (%)

The protein content of treated and untreated soybean seeds was analyzed and data are presented in Table (8). The results showed that the preceding crop significantly increased in the protein content in 2017 and 2018 seasons. Planting of soybean after clover, wheat and barley increased seed protein content by 7.81, 4.29 and 0.11% in the first season and by 14.30, 8.47 and 4.11 %, in the second seasons, respectively, compared with planting of soybean after faba bean. Weed control treatments significantly increased oil content in 2017 and 2018 seasons. Fusilade super + Sencor, Select super + Sencor and hand hoeing twice increased oil content by (5.69, 7.95 and 11.98%) and by (12.49, 15.42 and 21.32%) in the first and second seasons, respectively, compared with unweeded. These results agree with Rezvani *et al.* (2012) and Soliman *et al.* (2015).

3.2 Effect of the interaction between preceding crop and weed control treatments

3.2.1 Weeds

Data in Table (9) indicated that the interaction between preceding crop and weed control treatments was powerfully effected dry weight of grassy, broad-leaved and total weeds in both seasons**.** Fusilade super +Sencor, Select super + Sencor and hand hoeing twice gave the highest reduction on dry weight of grassy, broad-leaved and total weeds (g/m^2) under planting of soybean after clover or wheat compared with planting of soybean after barley or faba bean in both seasons. Harmony results were finding by Morrison and Devine (1994) and Jukka *et al*. (2005).

3.2.2 Nodules

Data in Table (9) showed that the interaction between preceding crop and weed control treatments was pronouncedly effected significantly on the nodules number and fresh weight /plant in the both seasons**.** The highest reduction on nodules number and fresh weight /plant under planting of soybean after clover or wheat compared with planting of soybean after barley or faba bean resulted from using Fusilade super + Sencor, Select super + Sencor and hand hoeing twice in the both seasons. These results are in the same trend with those obtained by Morrison and Devine (1994) and Jukka *et al*. (2005).

Table (9): Influences of interaction between preceding crop and weed control treatments on dry weight of weeds and nodules in 2017 and 2018 seasons.

Preceding crop	Weed control	Grassy weeds g/m^2		Broad-leaf weeds g/m^2		Total dry weeds g/m^2		Number of nodules/plant		Weight of nodules/plant	
		2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
Clover	T_1	131.60	115.67	126.13	135.33	247.27	261.46	21.03	48.27	1.16	2.20
	T_2	22.70	44.03	47.03	87.07	66.73	134.10	24.13	51.90	1.20	2.37
	T_3	13.60	29.03	34.87	24.07	42.63	58.94	18.47	46.73	0.95	2.10
	T_4	6.53	18.26	13.20	13.47	24.79	26.67	26.50	70.60	1.26	2.83
	T_5	155.17	128.77	263.10	164.90	283.94	428.00	24.33	59.57	1.23	2.81
Wheat	T_1	125.70	78.83	141.07	29.47	204.53	170.54	57.70	45.50	2.39	2.49
	T_2	35.87	32.97	56.60	23.70	68.84	80.30	59.30	52.27	2.07	2.10
	T_3	24.67	16.03	36.90	27.63	40.70	64.53	51.20	45.63	2.84	2.53
	T_4	15.33	13.03	15.93	25.03	28.36	40.96	71.57	62.73	2.94	2.58
	T_5	193.83	143.17	368.07	183.23	337.00	551.30	68.57	61.73	2.83	2.51
Barley	T_1	114.08	101.20	150.10	54.63	215.28	204.73	47.60	33.03	2.36	1.86
	T_2	74.47	42.03	66.37	43.77	116.50	110.14	50.50	33.33	1.98	1.15
	T_3	45.13	16.93	45.27	18.87	62.06	64.14	48.07	29.23	2.69	2.41
	T_4	32.30	13.80	16.13	11.30	46.10	27.43	62.57	40.03	2.68	2.05
	T_5	237.93	159.10	382.03	193.67	397.03	575.70	59.97	36.17	2.62	1.87
Faba bean	T_1	204.37	135.04	171.50	111.63	339.41	283.13	25.93	29.17	1.57	1.37
	T_2	122.90	63.57	155.70	93.92	186.47	249.62	32.63	26.73	1.78	1.21
	T_3	57.00	52.47	170.10	56.73	109.47	226.83	25.57	24.73	1.63	1.10
	T_4	64.83	27.21	34.23	24.77	92.04	59.00	34.87	31.10	1.89	1.23
	T_5	331.80	351.30	462.07	389.20	247.27	851.27	32.70	30.73	1.70	1.17
L.S.D. $_{0.05}$		32.46	52.49	91.03	65.28	46.43	52.73	8.27	6.80	0.21	0.25

T_1: Amex at the rate of 2.5 cm^3/fed. T_2: Fusilade super at rate of 1.5 l/fed +Sencor at the rate of 300 cm^3/fed. T_3: Select super at rate of 1.0 l/fed + Sencor. T4: Hand hoeing twice at 30 and 45 days after sowing. T5: Unweeded treatment.

Table (10): Interaction between preceding crop and weed control treatments affected on yield and its attributes traits in 2017 and 2018 seasons.

Preceding crop	Weed control	Plant height (cm)		Number of branches/plant		Number of pods/plant		Weight of pods/plant (g)		Number of seeds/pod	
		2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
Clover	T_1	81.46	84.60	2.10	2.40	83.37	57.37	98.10	43.13	2.27	2.93
	T_2	88.70	97.23	2.43	2.70	89.60	71.93	103.30	56.07	2.28	3.17
	T_3	100.33	101.53	2.33	2.57	84.33	104.00	101.97	66.47	2.93	3.35
	T_4	100.27	113.40	2.67	2.33	105.10	115.03	122.13	81.97	2.20	3.80
	T_5	77.73	74.57	1.90	2.20	65.67	53.13	88.63	40.67	2.07	2.18
Wheat	T_1	79.93	76.23	2.50	2.57	56.27	64.70	71.93	53.30	1.73	2.44
	T_2	94.47	93.47	2.10	2.50	72.40	68.67	88.80	55.43	2.07	2.45
	T_3	90.43	98.26	2.47	2.67	71.70	79.43	92.23	61.33	2.56	2.74
	T_4	96.57	113.30	2.43	2.17	85.77	96.30	96.87	73.07	3.00	2.35
	T_5	76.80	83.73	1.53	1.90	48.37	47.60	60.17	39.43	1.53	2.16
Barely	T_1	77.17	78.30	2.27	1.55	54.87	65.47	66.93	51.60	1.67	2.38
	T_2	82.20	105.70	1.83	1.70	61.47	61.17	75.03	47.17	1.97	2.33
	T_3	79.83	103.40	1.67	1.80	65.63	77.33	84.27	62.30	2.63	2.43
	T_4	86.07	102.53	1.93	1.40	77.27	89.17	93.80	72.27	2.87	2.95
	T_5	66.97	70.57	1.60	1.20	37.57	44.80	61.60	38.93	1.43	2.16
Faba bean	T_1	83.27	73.73	1.63	1.18	54.67	54.70	60.23	44.23	1.63	2.58
	T_2	78.20	81.93	1.70	1.23	52.30	57.00	64.90	46.07	1.67	2.60
	T_3	83.90	76.07	1.53	1.23	57.20	67.81	77.63	54.27	2.20	2.66
	T_4	89.53	84.10	1.53	1.25	69.47	65.00	89.83	48.90	2.50	2.65
	T_5	63.63	69.10	1.50	1.13	37.50	42.90	56.37	36.37	1.30	2.03
L.S.D. $_{0.05}$		14.4	12.7	0.37	0.29	10.1	12.7	10.5	8.91	0.57	0.37

T_1: Amex at the rate of 2.5 cm^3/fed. T_2: Fusilade super at rate of 1.5 l/fed +Sencor at the rate of 300 cm^3/fed. T_3: Select super at rate of 1.0 l/fed + Sencor. T4: Hand hoeing twice at 30 and 45 days after sowing. T5: Unweeded treatment.

3.2.3 Yield and its attributes

The results in Tables (10) and (11) show that the interaction between preceding crop and weed control treatments was significantly on soybean yield and its attributes in 2017 and 2018 seasons. Fusilade super + Sencor, Select super + Sencor and hand hoeing twice gave the highest mean values of plant height, number of branches /plant, weight of pods/plant, number and weight of seeds /pod, weight of seeds /plant g, seed index and seed yield t/fed under planting of soybean after clover or wheat compared with planting of soybean after barley or faba bean in the both seasons.

3.2.4 Chemical characteristics

Data in Table (11) indicate that the interaction between preceding crop and weed control treatments significantly affected the chemical properties (Oil % and Protein %) in the both seasons.

Table (11): Effect of the interaction between preceding crop and weed control treatments on yield and its components as well as oil and protein percentage of soybean in 2017 and 2018 seasons.

Preceding crop	Weed control	Weight of seeds/pod g		Weight of seeds/plant		Seed Index		Seed yield ton/fed		Oil (%)		Protein (%)	
		2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
Clover	T_1	1.20	1.37	73.50	78.35	20.43	19.10	1.65	2.60	21.17	20.63	37.80	29.63
	T_2	1.37	1.53	79.27	53.65	22.07	19.50	1.98	2.80	22.57	20.60	37.83	33.93
	T_3	1.54	1.56	81.20	87.45	21.47	22.00	2.53	2.83	24.80	24.10	38.50	34.63
	T_4	1.64	1.86	96.27	105.1	26.53	26.93	2.55	2.98	26.17	24.83	40.17	38.20
	T_5	1.12	1.17	58.77	66.54	16.73	18.37	1.43	2.28	19.30	19.23	34.10	27.50
Wheat	T_1	1.11	1.19	60.47	64.45	18.37	18.90	1.34	1.98	20.37	19.53	35.33	28.60
	T_2	1.13	1.20	66.00	74.25	19.10	19.83	1.60	2.04	20.33	19.53	35.90	30.53
	T_3	1.17	1.28	68.07	79.65	21.97	20.87	1.81	2.14	23.17	21.17	36.93	33.23
	T_4	1.23	1.36	79.60	84.52	22.40	24.27	2.27	2.33	25.20	22.73	38.63	34.00
	T_5	1.03	1.08	45.67	52.21	16.03	17.03	1.23	1.62	18.07	18.60	35.47	29.20
Barley	T_1	1.04	1.12	51.17	57.41	18.30	18.30	1.16	1.44	19.40	18.17	33.40	29.66
	T_2	1.12	1.05	53.47	59.65	15.00	18.60	1.29	1.70	20.03	18.10	34.37	31.57
	T_3	1.16	1.14	65.27	69.58	19.10	18.30	1.63	1.72	21.07	20.20	35.97	29.47
	T_4	1.13	1.19	75.30	82.21	20.20	19.60	2.13	2.01	24.41	21.50	37.20	31.67
	T_5	1.07	0.98	42.30	48.65	13.90	21.37	1.05	1.05	18.10	17.87	34.03	26.93
Faba bean	T_1	0.99	1.04	43.93	46.54	18.90	17.87	0.84	0.95	19.50	17.23	33..90	27.77
	T_2	0.92	0.98	53.83	58.54	17.53	16.47	1.11	1.14	20.37	18.33	35.93	28.30
	T_3	0.94	1.08	57.70	62.21	19.86	16.07	1.31	1.46	2.73	18.17	35.73	30.23
	T_4	0.98	01.15	69.17	74.65	20.43	18.63	1.66	1.55	24.60	20.30	36.60	30.20
	T_5	0.86	0.92	36.10	45.36	14.37	14.33	0.62	0.69	19.07	17.50	32.70	26.90
L.S.D. $_{0.05}$		0.07	0.09	1.53	2.22	1.26	2.80	0.27	0.77	2.72	2.71	3.47	5.17

T_1: Amex at the rate of 2.5 cm^3/fed. T_2: Fusilade super at rate of 1.5 l/fed +Sencor at the rate of 300 cm^3/fed. T_3: Select super at rate of 1.0 l/fed + Sencor. T4: Hand hoeing twice at 30 and 45 days after sowing. T5: Unweeded treatment.

The highest mean values of oil and Protein% resulted from using Fusilade super + Sencor, Select super + Sencor and hand hoeing twice under planting of soybean after clover or wheat compared with Planting of soybean after barley or faba bean in the both seasons.

4. Conclusions

In this study, we observation that preceding crop play an important role in decreased the dry weight of grassy, broad-leaved and total weeds (g/m^2) compared to unweeded treatment and increased the

number and weight of nodules whoever, increased plant height, number of branches, number and weight of pods/plant, seeds/pod and plant, seed index, seed yield (ton/fed) seed oil and protein % of soybean in both seasons. Also, weed control treatments reduced the dry weight of grassy weeds, broad-leaved and total weeds compared with unweeded control in both seasons. Amex, flauzifop-p-butyl and bentazon decreased the activity of nodules and weight of nodules in comparison with hand hoeing and unweeded treatments but increase plant height, number of branches, number and weight of pods, seeds/pod, seed index, seed yield (ton/fed) seed oil and protein % of soybean plant and seed yield (ton/fed).

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