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Competition Effect of Common Cocklebur (*Xanthium strumarium* L.) on Soybean (*Glycine max* L.) productivity

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Abstract: Two field experiments were conducted at Mallawy Agric. Res. Station, El-Minia Governorate, Middle Egypt, during two growing summer seasons 2015 and 2016 to study the effect of interference common cocklebur (*Xanthium strumarium* L.) densities i.e., zero, 2, 4, 6 and 8 plant/m^2 on two soybean (*Glycine max* L.) varieties (Giza 111 and Giza 82) productivity. A split plot design with four replicates was used. Results indicated that Giza 111 decreased common cocklebur LAI by 10.4 and 6.8% in the first and second season, respectively and dry weight (g/m^2) by 8.3% in the second season only as compared to Giza 82. Giza 111 surpassed Giza 82 in all soybean-studied characteristics. Results revealed that increasing common cocklebur densities up to 8 plants /m^2 increased common cocklebur dry weight (g/m^2) and LAI by 58.29 and 39.78 in the first season and 55.81 and 37.78 in the second season respectively as compared to 2 common cocklebur plants /m^2. Increasing common cocklebur density from zero to 8 plant/m^2 decreased soybean LAI, no. of branches/plant, no. of pods/ plant, pods weight (g)/ plant, seed yield (g)/ plant and 100-seed weight (g) in both seasons. Common cocklebur densities of 2, 4, 6 and 8 plants/m^2 significantly decreased soybean seed yield by 19.19, 37.86, 59.32 and 79.52 in the first season and 22.19, 41.46, 61.56 and 79.68% in the second season respectively as compared common cocklebur free plots. The highest gross income, net income, profitability and benefit/cost ratio were resulted from common cocklebur free plots. Soybean seed yield negatively highly significant correlated with common cocklebur dry weight/m^2 and LAI- whereas positively highly significant correlated with soybean LAI, no. of branches/plant, no. of pods/plant, pods weight (g)/plant, seed yield (g)/plant, 100-seed weight (g). Effects of interaction between soybean varieties and common cocklebur densities were not significant on common cocklebur traits in both seasons but were significant on soybean LAI, plant height (cm) and no. branches/plant in the second season only.

Key word: Common cocklebur (*Xanthium strumarium* L.) · Densities · Soybean (*Glycine max* L.) and soybean varieties

INTRODUCTION

Soybean (*Glycine max* L.) is the most important oil seed crop. Special attention should be directed toward the proper choice of cultivars and management practices to increase both seed yield and oil production.

Many weed species interfere with soybean but common cocklebur is the worst weed in soybeans [1]. Common cocklebur (*Xanthium strumarium* L.) is a large-seeded annual broadleaf weed that has been reported to reduce soybean yields up to 80% [2]. Yousefi *et al*. [3] showed that biological and seed yield, pods /plant, weight of pods /plant as well as main stem height were significantly affected by densities of either common cocklebur or red root pigweed. Maximum soybean yield loss ranged from 39 to 86%, depending upon total density of weeds. Presence of common of cocklebur and red root pigweed reduced soybean biomass, number and weight of pods/plant 79.9, 76 and 82% respectively. McWhorter and Hartwig [4] found that common cocklebur (*Xanthium pensylvanicum* Wallr.) reduced the average yields of soybean by 63 to 75%. Bozsa and Oliver [5] reported that common cocklebur interference reduced total soybean seed weight by 48%. Henry and Bauman [6] reported that soybean and common cocklebur seedlings often emerge

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simultaneously, their growth rate is similar until mid-season, when common cocklebur surpasses soybeans in height and forms a dense canopy over the soybeans. A single common cocklebur plant may occupy a root profile area with a radius of 4.3 m and a depth of 2.9 m, grow to a height of 152 cm and have a top growth dry matter weight of 590 g [7].

To produce 454 g of dry matter, common cocklebur requires approximately 150 kg of water [8]. Rushing and Oliver [9] reported that interference of one common cocklebur plant per 1.8, 0.9 and 0.3 m of row reduced soybean yields by 16, 33 and 65%, respectively. Mosier and Oliver [10] reported that total leaf area index (LAI), LAI within the soybean canopy, crop growth rate and seed yield of soybean were decreased more by common cocklebur. Jones and Walker [11] reported that common cocklebur water uptake was two times that of soybean. Regnier *et al*. [12] reported that interference of common cocklebur with soybeans resulted primarily from shoot interference and competition for light within the soybean canopy implicated as the major factor causing the soybean yield reduction. Soybean yield was decreased by 58, 73 and 80% at densities of 4, 8 and 12 plant m^{-2} [13]. Dubey [14] reported that weed competition increased the plant height of soybean. On the other hand, Kuruchania *et al*. [15] observed progressive decrease in plant height with increased weeds competition; this is attributed to growth habit of a variety. Weed interference significantly reduced soybean LAI, total above ground soybean dry weight and crop growth rate [16]. Weed competition reduces the leaf area index, which ultimately decides the photosynthetic efficiency of the plant [17]. Dry matter accumulation in soybean plants was inversely proportional to total weed dry matter [18]. Therefore this this work was conducted to study the effect of common cocklebur competition on soybean (*Glycine max* L.) productivity.

MATERIALS AND METHODS

Two field experiments were carried out at Mallawy Agric. Research Station A.R.C El-Minia Governorate, Middle Egypt, during two growing summer seasons 2015 and 2016 to study the effect of common cocklebur (*Xanthium strumarium* L.) competition on two soybean (*Glycine max* L.) varieties productivity. Each experiment included ten treatments, which were the combination of two soybean (*Glycine max* L.) varieties (Giza 111 and Giza 82) and five common cocklebur (*Xanthium strumarium* L.) densities i.e., zero, 2, 4, 6 and 8 plant/m^2. The proceeding winter crop was wheat (*Triticum durum* L.) in both seasons. Soybean was planted in the 1st week of June and harvest in the 2nd week of October in both seasons. After soil preparing, the experiment area was divided into 10.5 m^2 sub-plots, which consisted of five rows of 3.5 m long and 0.6 m apart, soil texture was clay in both seasons.

A split plot design with four replicates was used in both seasons and the treatments arranged as follows:

A– The main plots (soybean varieties).
- Giza 111.
- Giza 82.

B– The sub- plots included common cocklebur densities:
- Zero common cocklebur plant /m^2. (common cocklebur free)
- 2 common cocklebur plant /m^2.
- 4 common cocklebur plant /m^2.
- 6 common cocklebur plant /m^2.
- 8 common cocklebur plant /m^2.

The experimental sites were naturally infested with common cocklebur which thinned mannually at 2 weeks after emergence to obtained the required densities. All other weeds has been removed manually at 2 weeks after emergence; the plots were kept free of any other weed allover the growing season by hand pulling.

Phosphorus fertilizer applied as super phosphate (15.5% P_2O_5) at rate of 100 Kg/fed. applied in one dose during land preparation. Nitrogen fertilizer was applied in the form of ammonium nitrate at rate of 15 Kg N/fed. before planting. All soybean agricultural practices were done as recommended.

Data Recorded

Common Cocklebur Characteristics: A sample of ten common cocklebur plants was taken at 90 days after planting from each plot to estimate the following characteristics:
- Common cocklebur dry weight (g/m^2).
- Common cocklebur LAI was calculated according to Sestak *et al.* [19] as follow: common cocklebur LAI = LA/GA, Where, LA is common cocklebur leaf area and GA is ground area. To estimate common cocklebur leaf area fifty leaf discs of known size were taken using the cork borer from randomly selected fifty leaves from ten plants. Both discs and remaining leaf blades were oven dried at 80°C to constant weight and the leaf area was calculated by the following formula:

$$LA = \frac{W_a \ X \ A}{W_d}$$

where, LA = leaf area (cm^2/plant), W_a= weight of all leaves (inclusive of 50 discs weight) in g, W_d = weight of discs in g and A = Area of the disc [20].

Soybean Characteristics: At 90 days after planting, ten soybean plants from the central row of each plot were taken to estimate soybean LAI using the above-mentioned method used in common cocklebur suggested by Sestak *et al.* [19] and Vivekanandan *et al.* [20].

At harvest, A sample of 10 plants from the central row of each sub plot were taken randomly to estimate the following traits: Plant height (cm), number of branches/plant, number of pods/ plant, pods weight (g/plant) and seed yield (g/plant). The seed yield (ton/fed.) was calculated from seed yield/plot and converted to ton/fed. A bulk seed sample from each plot was taken to determine the weight of 100-seed (g).

Economic Analysis: Economic evaluation for seed yield (t/fed), Gross income (GI), profitability (P) and Benefit/cost ratio (B/C) according to Heady and Dillon [21], where:

Gross income (GI) = 4000 L.E x seed yield (t/fed).
Net income (NI) = Gross income – Total costs.
Profitability (P) = (Net income/Total costs) x 100.
Benefit/Costs Ratio (B/C) = Gross income/Total costs.

Statistical Analysis: The data were statistically analyzed according to Gomez and Gomez [22], using the computer "MSTAT-C" statistically analysis package by Freed *et al.* [23]. The least significant differences (LSD) treatment at probability level at 0.05 was manually calculated to compare the differences among means.

For regression, studied data were plotted and regression analyses were conducted. Linear $\hat{Y} = a + b X$, quadratic $\hat{Y} = a + b X - c X^2$ and logistic $\hat{Y} = a + b X + c X^2 + d X^3$ models were estimated to describe the relationship between the measured dependent variable of common cocklebur densities (no/m^2) and independent variables soybean seed yield (ton fed^{-1}). Y, variables and X common cocklebur densities, a, b, c and d parameters represent intercept and slope of regression of variables and a regression models. The suitable model which fitted for prediction between above mentioned variables quadratic regression analysis according to Snedecor and Cochran [24] which is the correlation coefficient (R^2) was greater than other studied models and standard estimate error values (SE) were smaller than those of the other models.

RESULTS AND DISCUSSION

Effect of Soybean Varieties On Common Cocklebur Traits: Data in Table (1) indicated that soybean verities had a significant influence on common cocklebur dry weight (g/m^2) in second season only. Giza 111 decreased common cocklebur dry weight (g/m^2) by 8.3% as compared to Giza 82. Also, Giza 111 decreased common cocklebur LAI significantly by 10.4 and 6.8 % in the first and second season, respectively as compared to Giza 82. This may be attributed to the vigor growth of this variety, which gave it the ability to compete with common cocklebur plants.

Effect on Soybean Traits: Results in Table (2) indicated that soybean varieties significantly influenced plant height, no. of branches/plant, seed yield (g)/plant, no. of pods/plant and pods weight/plant in both seasons-expect- no. of pods/plant and pods weight/plant in the second season. Giza 111 plants were taller than Giza 82 by 22.9 and 20.6% in first and second season, respectively. Concerning no. of branches/plant Giza 111 increased this trait by 12.7 and 22.3% in first and second season, respectively as compared to Giza 82 variety. Seed yield (g)/plant increased in Giza 111 by 16.18 and 15.3% in first and second season, respectively. No. of pods/plant and pods weight (g)/plant increased by 21.3 and 10.5% in Giza 111 respectively, as compared to Giza 82 variety. Concerning soybean seed yield ton/fed reached to significant at 0.05 level in both seasons. Giza 111 gave the highest values of seed yield ton/fed. by 11.3 and 16.8 % in first and second season, respectively. The increase in soybean seed yield may be attributed to the increase in yield component as plant height, no. of branches/plant, seed yield/plant, no. of pods/plant and pods weight/plant.

Effect of Common Cocklebur Densities (plant/m^2)
Common Cocklebur Traits: Results in Table (3) indicated that common cocklebur densities/m^2 significantly affected the common cocklebur dry weight (g/m^2) and LAI. Increasing common cocklebur densities from up to 8 plants /m^2 increased common cocklebur dry weight (g/m^2) by 58.29 and 55.81% and LAI by 39.78 and 37.78% in first and second season, respectively compared to the 2 plant/m^2.

Table 1: Effect of Soybean (*Glycine max* L.) varieties on dry weight (g/m^2) and LAI of common cocklebur plants in 2015 and 2016 seasons

	Common cocklebur dry weight (g/m^2)		LAI of common cocklebur	
Varieties (A)	2015	2016	2015	2016
Giza 111	1423	1335	3.53	3.85
Giza 82	1559	1456	3.94	4.13
F. test $_{0.05}$	NS	**	**	**

NS = not significant

Table 2: Effect of common cocklebur (*Xanthium strumarium* L.) densities on some Soybean (*Glycine max* L.) Varieties traits in 2015 and 2016 seasons

Varieties (A)	LAI of Soybean	Plant height (cm)	No. of branches/plant	No. of pods/ plant	Pods weight/ plant (g)	Seed yield/ plant (g)	100 seed weight (g)	Seed yield (ton/fed.)
				2015 season				
Giza 111	2.59	118.7	3.14	39.49	45.76	17.87	21.33	1.49
Giza 82	2.37	91.5	2.74	31.08	40.97	15.38	19.95	1.32
F. test $_{0.05}$	NS	**	**	**	**	**	NS	**
				2016 season				
Giza 111	2.74	112.2	3.32	45.47	49.97	18.68	20.79	1.50
Giza 82	2.48	89.11	2.58	42.69	38.19	16.20	19.79	1.25
F. test $_{0.05}$	NS	**	**	NS	NS	**	NS	**

NS = not significant

Table (3): Effect of common cocklebur (*Xanthium strumarium* L.) densities on dry weight (g/m^2) and LAI of common cocklebur plants in 2015 and 2016 seasons.

	Common cocklebur dry weight (g/m^2)		LAI of common cocklebur	
CC Density (B)	2015	2016	2015	2016
0	0.0	0.0	0.00	0.0
2	1026	1004	3.56	3.91
4	1760	1652	4.11	4.43
6	2208	2048	4.99	5.30
8	2460	2272	5.91	6.29
LSD $_{0.05}$	151.6	95.72	0.42	0.34

Soybean Traits: Data in Table (4) indicated that all soybean traits affected significantly by increasing common cocklebur densities in both season. Common cocklebur densities at zero plant/m^2 gave the highest values of all soybean traits and 8 plant/m^2 gave the lowest value of these traits. Increasing common cocklebur density from up to 8 plant/m^2 decreased soybean LAI, no. branches/plant, no. pods/ plant, pods weight (g)/ plant, seed yield (g)/ plant and 100-seed weight (g) by 60.16, 60.98, 60.51, 62.53, 68.55 and 16.92% in the first season and 63.07, 59.52, 62.30, 65.53, 72.65 and 14.63% in the second season, respectively, compared with zero common cocklebur plant/m^2. This may be attributed to the increases in common cocklebur LAI that intercept the light and compete with soybean plants on water and nutrients. These results in agreement with those obtained by Jones and Walker [11] who found that common cocklebur water uptake was two times that of soybean. When common cocklebur surpasses soybeans in height and forms a dense canopy over the soybeans. A single common cocklebur plant may occupy a root profile area with a radius of 4.3 m and a depth of 2.9 m, grow to a height of 152 cm and have a top growth dry matter weight of 590 g [7]. Weed competition reduces the leaf area index, which ultimately decides the photosynthetic efficiency of the plant [17]. Meanwhile, Plant height (cm) increased by 25 and 27 % in the first and second season, respectively when common cocklebur densities increased from zero to 8 plants/m^2. This may be due to the competition on light, which make soybean plant to increase in height to reach the light over common cocklebur canopy. These results in agreement with those obtained by Yousefi *et al*. [3] and Bozsa and Oliver [5].

Estimation of Soybean Seed Yield Losses Due to Common Cocklebur Densities: It is clear from Table (4) and Figure (1) that relationship between common cocklebur densities and soybean seed yield (ton/fed.) was significant and fit as quadratic according the equation ($Y_{2015} = -0.002x^2 - 0.2145x + 2.3133$, $R^2 = 0.99$

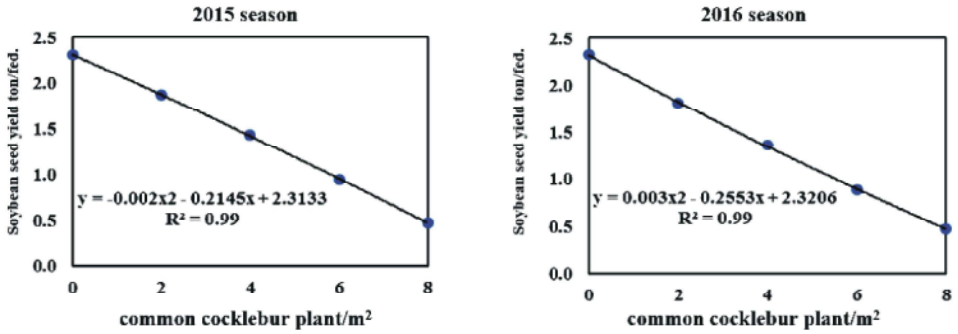

Fig. 1: Relationship between common cocklebur densities (plant/m^2), soybean seed yield (ton/fed.) in 2015 and 2016 seasons

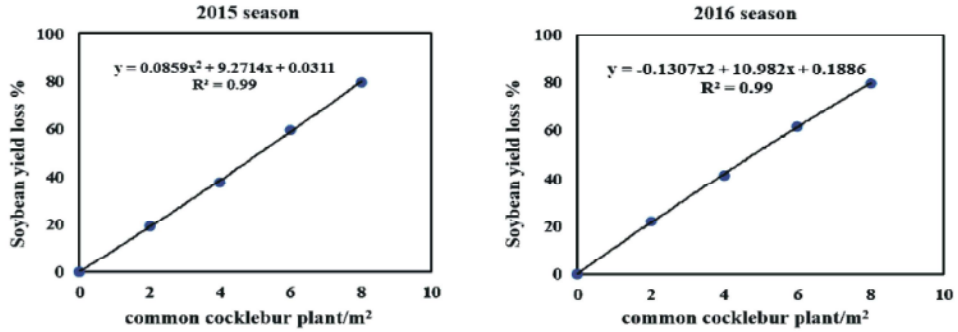

Fig. 2: Relationship between common cocklebur densities (plant/m^2) and soybean yield loss % (relative to weed free) in 2015 and 2016 seasons

Table 4: Effect of common cocklebur (*Xanthium strumarium* L.) densities on some Soybean (*Glycine max* L.) Varieties characteristics in 2015 and 2016 seasons.

CC Density (B)	LAI of Soybean	Plant height (cm)	No. Branches/ plant	No. Pods/ plant	Pods weight (g)/plant	Seed yield (g)/plant	100 Seed weight (g)	Seed yield (ton/fed.)	Predicted yield (ton/fed.)	Yield reduction
					2015 season					
0	3.614	92.80	4.10	52.97	62.15	25.56	22.63	2.31	2.31	0.00
2	3.050	97.38	3.50	41.94	54.15	21.40	21.64	1.87	1.88	19.19
4	2.350	107.2	3.05	33.40	41.94	15.59	20.46	1.44	1.42	37.86
6	1.950	112.2	2.45	27.17	35.35	12.54	19.66	0.94	0.95	59.32
8	1.440	116.0	1.60	20.92	23.29	8.04	18.8	0.47	0.47	79.52
LSD 0.05	0.33	5.73	0.334	4.41	5.09	2.02	1.29	0.18	--	--
					2016 season					
0	3.780	89.45	4.15	57.83	66.05	27.46	22.01	2.33	2.32	0.00
2	3.529	93.14	3.49	48.38	58.05	23.28	21.10	1.81	1.82	22.19
4	2.354	97.97	3.05	35.10	41.64	16.62	20.29	1.36	1.35	41.46
6	2.003	109.0	2.38	26.70	31.89	12.33	19.24	0.89	0.90	61.56
8	1.396	113.6	1.68	21.80	22.77	7.51	18.79	0.47	0.47	79.68
LSD 0.05	0.27	4.75	0.28	4.64	4.13	1.86	1.43	0.16	--	--

and $Y_{2016} = 0.003x^2 - 0.2553x + 2.3206$, $R^2 = 0.99$). Increasing common cocklebur densities from zero to 8 plants/m^2 significantly decreased soybean seed yield by 19.19, 37.86, 59.32 and 79.52 in the first season and 22.19, 41.46, 61.56 and 79.68% in the second season, In common cocklebur densities of 2, 4, 6 and 8 respectively, as compared to common cocklebur free plots.

Figure (2) showed that the relationship between seed yield losses% and common cocklebur densities was significant and fitted as quadratic according the equation ($Y_{2015} = 0.0859x^2 + 9.2714x + 0.0311$, $R^2 = 0.99$ and $Y_{2016} = -0.1307x^2 + 10.982x + 0.1886$ $R^2 = 0.99$. soybean yield losses at 2, 4, 6 and 8 common cocklebur plants/m^2 were 19.19, 37.86, 59.32 and 79.52 in the first season and

Table 5: Effect of common cocklebur (*Xanthium strumarium* L.) densities on Economic analysis

CC Density (B)	Gross income L.E	Net income L.E	Profitability	Benefit/cost ratio
		2015 season		
0	9256	4496	94.45	1.94
2	7480	2720	57.14	1.57
4	5752	992	20.84	1.21
6	3765	-995	-20.90	0.79
8	1895	-2865	-60.18	0.40
		2016 season		
0	9300	4540	95.38	1.95
2	7236	2476	52.02	1.52
4	5444	684	14.37	1.14
6	3575	-1185	-24.89	0.75
8	1890	-2870	-60.29	0.40

Table 6: Effect of interaction between common cocklebur (*Xanthium strumarium* L.) densities and soybean varieties on dry weight (g/m^2) and LAI of common cocklebur plants in 2015 and 2016 seasons

Treatment		Common cocklebur dry weight (g/m^2)		LAI of common cocklebur	
Varieties (A)	CC Density (B)	2015	2016	2015	2016
Giza 111	0	0.0	0.0	0.00	0.00
	2	996	939	3.53	3.75
	4	1695	1535	3.80	4.20
	6	2042	1979	4.65	5.13
	8	2380	2223	5.73	6.15
Giza 82	0	0.0	0.0	0.00	0.00
	2	1056	1070	3.75	4.08
	4	1824	1769	4.48	4.65
	6	2375	2118	5.33	5.48
	8	2540	2322	6.10	6.43
LSD 0.05		NS	NS	NS	NS

NS = not significant

22.19, 41.46, 61.56 and 79.68% in the second season, respectively. The reduction in soybean seed yield with common cocklebur densities was due to the competition with soybean on light, water, nutrients and space. These results was in line with those obtained by [9] and [13].

Economic Analysis: Economic analysis data presented in Table (5) reported that the gross income, net income profitability and benefit/cost ratio decreased by increasing the common cocklebur densities. The highest gross income (9256.0 and 9300.0 L.E), net income (4496.0 and 4540.0 L.E), profitability (94.45 and 95.38) and the benefit/cost ratio (1.94 and 1.95) were resulted from common cocklebur free plots in first and second season respectively. This increased of gross income and net income due to increase seed yield of soybean due to decreased the weed-soybean interference.

Effect of Interaction Between Soybean Varieties and Common Cocklebur Densities On

Common Cocklebur Traits: Data in Tables (6) indicated that the effect of interaction between soybean varieties and common cocklebur densities on common cocklebur traits were not significant in both seasons.

On Soybean Traits: It is clear from Table (7) that the effect of interaction between soybean varieties and common cocklebur densities on soybean traits were not significant in both seasons-except soybean LAI, plant height (cm) and no. branches/plant in the second season only. LAI of Giza 111 and Giza 82 varieties and no. of branches/plant decreased significantly by increasing common cocklebur densities. The highest value of soybean LAI (4.02) and no. branches/m^2 (4.8) obtained from the absence common cocklebur with Giza 111 variety. Whereas, the lowest values of soybean LAI (1.4) obtained

Table 7: Effect of interaction between common cocklebur (*Xanthium strumarium* L.) densities and soybean varieties on some Soybean (*Glycine max* L.) varieties characteristics in 2015 and 2016 seasons

Treatment		LAI of Soybean	Plant height (cm)	No. Branches/ plant	No. Pods/ plant	Pods weight (g)/ plant	Seed weight (g)/ plant	100 Seed weight (g)	Seed yield ton/fed.
Var. (A)	CC Density (B)				2015 season				
Giza 111	0	3.75	109.3	4.4	56.9	65.1	26.5	23.5	2.42
	2	3.24	112.9	3.9	48.6	57.6	23.5	22.2	2.01
	4	2.45	118.8	3.3	38.4	43.2	16.5	21.4	1.55
	6	2.01	124.9	2.4	31.3	37.5	14.5	20.2	0.96
	8	1.52	128.1	1.7	22.4	25.4	8.4	19.4	0.47
Giza 82	0	3.48	76.3	3.8	49.1	59.2	24.7	21.8	2.16
	2	2.87	81.9	3.1	35.3	50.6	19.3	21.1	1.73
	4	2.25	95.5	2.8	28.5	40.7	14.7	19.5	1.33
	6	1.89	100.0	2.5	23.1	33.3	10.6	19.2	0.92
	8	1.36	103.9	1.5	19.5	21.2	7.7	18.2	0.48
LSD 0.05		NS	NS	NS	NS	NS	NS	NS	NS
					2016 season				
Giza 111	0	4.02	106.4	4.8	61.5	68.5	28.7	22.5	2.57
	2	3.85	108.9	4.1	53.5	60.4	25.8	21.5	1.93
	4	2.47	110.3	3.4	36.4	42.2	17.1	21.1	1.51
	6	1.97	115.6	2.6	29.7	32.9	13.8	19.5	1.00
	8	1.40	119.7	1.8	21.4	23.5	7.9	19.4	0.49
Giza 82	0	3.54	72.5	3.5	54.2	63.6	26.2	21.6	2.08
	2	3.21	77.4	2.9	43.3	55.8	20.7	20.7	1.69
	4	2.24	85.7	2.7	33.9	41.1	16.1	19.5	1.22
	6	2.03	102.5	2.2	23.8	30.9	10.9	19.0	0.79
	8	1.40	107.5	1.6	22.2	22.0	7.1	18.2	0.46
LSD 0.05		0.38	6.72	0.40	NS	NS	NS	NS	NS

Table 8: Correlation analysis between studied traits in 2015 and 2016 seasons

	No. of branches/plant	No. of pods/ plant	Pods weight/ plant	Seed yield/ plant	100 Seed weight	Soybean LAI	CC LAI	CC dry weight/ m^2	Seed yield/fed
				2015 season					
Plant height	- 0.257	- 0.157	- 0.325 *	- 0.305	- 0.048	- 0.362 *	0.387 *	0.129	- 0.365 *
No. of branches/plant		0.879 **	0.918 **	0.915 **	0.702 **	0.896 **	- 0.820 **	- 0.320 *	0.925 **
No. of pods/plant			0.880 **	0.912 **	0.738 **	0.863 **	- 0.865 **	- 0.439 **	0.883 **
Pods weight/plant				0.936 **	0.721 **	0.920 **	- 0.864 **	- 0.350 *	0.923 **
Seed weight/plant					0.722 **	0.944 **	- 0.873 **	- 0.392 *	0.951 **
100 Seed weight						0.706 **	- 0.701 **	- 0.302	0.746 **
Soybean LAI							- 0.859 **	- 0.387 *	0.933 **
CC LAI								0.694 **	- 0.880 **
CC dry weight/m^2									- 0.359 *
				2016 season					
Plant height	- 0.166	- 0.382 *	- 0.469 **	- 0.407 **	- 0.135	- 0.368 *	0.435 **	0.047	- 0.379 *
No. of branches/plant		0.865 **	0.877 **	0.914 **	0.684 **	0.881 **	- 0.805 **	- 0.313 *	0.920 **
No. of pods/plant			0.942 **	0.932 **	0.698 **	0.909 **	- 0.850 **	- 0.371 *	0.948 **
Pods weight/plant				0.943 **	0.671 **	0.942 **	- 0.866 **	- 0.306	0.961 **
Seed yield/plant					0.745 **	0.932 **	- 0.874 **	- 0.327 *	0.948 **
100 Seed weight						0.689 **	- 0.663 **	- 0.294	0.726 **
Soybean LAI							- 0.808 **	- 0.264	0.909 **
CC LAI								0.671 **	- 0.888 **
CC dry weight/m^2									- 0.361 *

CC = Common cocklebur * Correlation is significant at the 0.05 level

** Correlation is significant at the 0.01 level.

from the presence of 8 common cocklebur plants/m^2 with Giza 111 and Giza 82 variety and no. of branches/m^2 (1.6) obtained from the presence of 8 common cocklebur plants/m^2 with Giza 82.

On the other hand, increasing common cocklebur density with both varieties increased plant height. The tallest soybean plants (119.7 cm) obtained from Giza 111 variety the competed with 8 common cocklebur plants/m^2 and the shortest soybean plants obtained from Giza 82 variety in the absence of common cocklebur competition (zero common cocklebur plant/m^2).

Correlation Analysis Between Studied Traits: Data in Table (8) indicated that common cocklebur dry weight (g) was negatively and significant correlated with all studied soybean trait (i.e soybean LAI, no. of branches/plant, no. of pods/plant, pods weight (g)/plant, seed yield (g)/plant, 100-seed weight (g)) in both seasons. Meanwhile, soybean seed yield negatively highly significant correlated with common cocklebur dry weight (g)/m^2 and common cocklebur LAI and positively highly significant correlated with soybean LAI, No. of branches/plant, no. of pods/plant, pods weight (g)/plant, seed yield/plant, 100-seed weight.

CONCLUSION

Results obtained from this study revealed that soybean should be kept free of common cocklebur competition to obtain maximum yield (ton/fed.) and maximize the net income.

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