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EFFECT OF INTERCROPPING PATTERNS AND LASER LAND LEVELING ON SOYBEAN AND MAIZE CROP ASSOCIATION

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ABSTRACT

Two field experiments were carried out in two growing seasons (2001 and 2002) to investigate the response of the effect of the different laser land leveling (0.00%, 0.03% and traditional) and two intercropping patterns (2:2 and 2:4) on water use efficiency, plant growth, yield and total net return for soybean and maize crops. Results showed that using 0.03% slope laser land leveling resulted in highest soybean yield under intercropping pattern 2:4. Meanwhile water use efficiency in the pattern 2:2 was 0.79, 0.82 and 0.71 kg/m^3 under 0.00%, 0.03% and traditional land leveling respectively, in case of maize. Water use efficiency in the pattern 2:4 was 0.88, 1.06 and 0.66 kg/m^3 under 0.00%, 0.03% and traditional land leveling respectively, in case of soybean. On the other hand, The highest value of Land equivalent ratio (LER) was 1.67 in (2:4) pattern under 0.03% slope . The highest total income was 3745 LE/fed in (2:4) pattern under 0.03% slope.

Key word: Soybean, Maize, Intercropping patterns, Laser land leveling, Water use efficiency, Land equivalent

INTRODUCTION

Egypt is mainly an agricultural country in which agricultural of irrigation technologies play an important role in supporting national economy. Irrigation water consumes about 80% of the country's water budget for cultivating approximately 8 million feddan with an annual crop area about 15 million feddan. About 6 million feddan in the old land are irrigated by surface irrigation methods with low on- farm water application efficiency (40-60%).

Laser land leveling has a positive effect on increasing agricultural crop yields and total net return. Agricultural intensification is also considered the main approach to achieve the economic growth. It is also known that intercropping generally produces more total yields of the mixed crops per unit area than growing each component solely in a single stand. **El-Yazal and Ismail (1986)** stated that the leveled land showed significant water saving over unleveled land, by about 1000 m^3 /fed, while maize yield increased about 140 kg/ fed (8%).

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Youssef (1991) found that the laser leveling increased the grain yield by 19 % and 22 % at 80% soil field capacity and 70% soil field capacity respectively. **Mostafa *et al* (1993)** concluded that the cost per unit earth work volume manually is 5.4 LE/ m^3, while for laser land leveling is 1.54 LE/ m^3. **El-Haddad *et al* (1993)** revealed that laser leveling with manual broad casting gave minimum production estimated by 565.86 L.E./ fed, while laser leveling with mechanical seeding gave the maximum net margin, (1311.80 L. E./fed). **Kamel *et al* (1990)** revealed that efficiency of land use reached maximum (1.44) when two rows of maize were alternated with four rows of soybean in the intercrop patterns. On the other hand, increasing the alternating rows of maize in the intercrop patterns contributed lower advantage in land use (1.17). **Prasad and Prasad (1991)** reported that maize and potato intercrops resulted in a maximum net return of Rs 15394 /ha with 7 irrigation, while a sole crop of potato fetched a return of Rs. 12684 / ha with the same number of irrigation. **Kusumo and Sutater (1993)**, reported that intercropping potato with maize increased land productivity as measured by land equivalent ratio. The data also revealed that there was no significant difference in total return between intercropping and potato monoculture. **Sharma *et al* (1995)** examined new multiple systems for higher production and profit. They reported that among eight intensive annual cropping systems, relay cropping of maize and potato followed by wheat gave the highest productivity.

El-Marhomey (1999) revealed that using laser leveling system gave the highest values of net benefit since it offered best seedbed preparation for plant growth. The highest value of net benefit was 1053.16 L.E / fed which was obtained by using laser leveler as a leveling system after chisel plough (one pass) followed by rotary plough. The lowest value of net benefit (457.825 L.E /fed) was obtained by using wooden leveler as a leveling system after chisel plough (one pass) followed by rotary plough. **Osman (2000)** concluded that precision of landleveling and using gated pipes are the main tools for improving surface irrigation systems.

MATERIAL AND METHODS

Two field experiments were carried out at SIDS Agricultural Farm Research Station, Bani-Suif governorate, during 2001and 2002 growing seasons, to study the effect of laser land leveling and intercropping patterns on total net return for unit area, the amount of the applied water, water use efficiency and the crop yield of maize and soybean.

The experiments were designed in a split plot design having four replicates each. The treatments were as follow:

The land leveling

1- Zero level.
2- 0.03 % slope.
3- Traditional leveling.

The intercropping treatments

The treatments involved a combination of two intercropping patterns versus solid planting of either maize or soybean. The two intercropping patterns were

1- Maize was grown on two ridges alternated with two ridges of soybean (2:2).

2- Maize was grown on two ridges alternated with four ridges of soybean (2:4).

Soybean cv. (Clark) was seeded immediately after inoculation with Rhizobium bacteria to stimulate nodulation and irrigated at once. Seeding was carried out on 22 and 29 of May, in 2001 and 2002 seasons respectively. Maize cv. (Three way cross 310) was seeded with the first irrigation of soybean. It was seeded on 17th and 24 of June in the two seasons, respectively and received 7.0 irrigations, at 14-day interval. The water was supplied through a perforated pipe having orifice of 0.60 m apart. The discharge rate of each orifice was measured before the beginning of the irrigation. The water applied was measured for each furrow of maize and soybean in the intercropping system. All the experimental treatments received the same agricultural practices as recommended. Before starting the experimental work soil analysis was recorded. Table (1) shows the results of the mechanical analysis and the bulk density of soil. Field capacity was found 39.6 % by weight and the wilting point was found 18% by weight.

Methods of calculations

Water use efficiency:

WUE = yield (kg/fed) / total applied water (m^3/fed)

Where: WUE = irrigation water use efficiency (kg/ m^3)

Competitive relationships

Land equivalent ratio (LER)

LER was determined as the sum of the fractions of the yield of the inter crops relative to their sole crop yields **(Willey, 1979)**. LER was determined according to the following formula:

$$LER = \frac{Yab}{Yaa} + \frac{Yba}{Ybb}$$

Where: Yaa = Pure stand yield of species a .
Ybb = Pure stand yield of species b.
Yab = Mixture yield of a (when combined with b).
Yba = Mixture yield of b (when combined with a)

Net return and monetary advantage

Net return was calculated according to prices given by the Ministry of Agriculture for all land preparation practices and production articles and tools. Prices of main products were also taken according to official prices issued by the Ministry of Agriculture. (L.E.640/ton of maize and L.E.1100 / ton of soybean according to the prices of 2002.)

Monetary advantage (M.A) suggests that the economic assessment should be in terms of the value of land saved. This could probably be most assessed on the basis of the rentable value of this land. M.A. was calculated according to the formula: **(Willey, 1979)**.

M.A. = value of combined intercrop yield x [LER – 1 / LER]

The basis of irrigation data for each season was collected, maize and soybean yields were recorded and the net return was also calculated.

Statistical analysis

Data of the two seasons were statistically analyzed according to **Snedecor and Cochron (1988)** using Mstatc computer V_4 (1986). L.S.D. test at 0.05 level, was used to compare the differences between treatments.

Table 1. Mechanical analysis and the bulk density of the different Layers of the experimental area

Depth Cm	Coarse sand %	Fine sand %	Silt %	Clay %	Texture class	Organic mater %	$CaCo^3$	Bulk density gm/cm^3
(0−15)	4.67	15.96	18.5	60.48	Clayey	5.50	3.50	1.10
(15−30)	4.50	13.50	19.0	63.00	Clayey	5.00	4.00	1.09
(30−45)	4.90	14.00	18.6	62.50	Clayey	2.00	3.90	1.15
(60-45)	3.50	15.50	16.0	65.00	Clayey	2.00	3.50	1.15

RESULTS AND DISCUSSIONS

1- Effect of laser leveling on WUE, yield components and yield of maize and soybean

The data in both seasons showed the same trend for maize and soybean crops under 0.00%, 0.03% slope compared with traditional leveling. Data present in Tables (2 and 3) and Figs. (1 and 2) indicated that the water use efficiency (kg/m^3) of maize and soybean has the higher value when using laser leveling with 0.03% slope than zero level and the traditional leveling. They were 0.94, 0.87 and 0.73 kg/m^3 for the 0.03% slope, zero level and traditional leveling, respectively for maize yields. The yield of soybean were 1.59, 1.33 and 1.18kg/m^3 for 0.03% slope, zero level and traditional leveling, respectively. The yield of maize increased by 9% and 15.4% for zero level plot and 0.03% slope plot, respectively as compared with traditional leveling. The yield of soybean increased by 7.66% and 22.60% for zero level plot and 0.03% slope plot, respectively, as compared with traditional leveling.

2- Effect of intercropping patterns on WUE, yield characters and yield of maize crop

It is evident from Table (4) and Fig (3) that growth of maize in monoculture was significantly higher than that of the other intercropping combinations. These results were supported by **Kamel *et al*** (1990). The detrimental effect of intercropping on growth characters of maize plants might be due to the increase in plant densities / unit area of both components. Maize density was estimated to 67% of maize population in solid planting when maize was oriented with soybean in (2:4) pattern in the intercropping system. The adverse effects appeared more conspicious when maize was grown in (2:2) intercropping pattern. This might attribute more inter and intra competition between plants as a result of the heavy density of plants per unit area. Maize height greatly varied according to the intercropping combinations. Height of plants, height of first ear and yield kg/fed were significantly higher in (2:2) pattern than those grown in (2:4) pattern.

Table 2. Effect of laser leveling on WUE, yield and yield components of maize intercropped with soybean

	Season 2001			
	0.00% slope	0.03% slope	Tradi. leveling	L.S.D 5%
Plant Height (m)	210.0	215.0	202.0	N. S
Height of first ears (m)	85.5	88.60	84.00	N. S
Ear diameter (cm)	5.08	5.25	5.00	N. S
No. of rows	13.00	13.60	12.00	0.881
No. of kernels / row	40.15	43.30	41.30	2.74
Water Applied m^3/fed	2520	2460	2740	181.11
W. U. E. Kg /m^3	0.87	0.94	0.73	0.121
Yield Kg/fed	2200	2320	2010	153.2

Table 2. Cont.

	Season 2002			
	0.00% slope	0.03% slope	Tradi. leveling	L.S.D 5%
Plant Height (m)	212.0	225.0	204.0	N. S
Height of first ears (m)	85.5	89.0	84.5	N. S
Ear diameter (cm)	5.10	5.20	5.00	N. S
No. of rows	13.10	13.50	12.10	0.876
No. of kernels / row	42.00	45.30	40.10	3.35
Water Applied m^3/fed	2530	2490	2660	182.0
W. U. E. Kg /m^3	0.87	0.95	0.76	0.123
Yield Kg/fed	2210	2360	2010	147.5

Table 3. Effect of laser leveling on WUE, yield and yield components of soybean intercropped with maize

	Season 2001			
	0.0% slope	0.03% slope	Tradi. leveling	L.S.D 5%
Plant Height (m)	46.50	55.30	46.50	2.537
No. of branches / plant	2.80	3.40	2.60	0.415
No f. Pods / plant	19.50	23.00	16.50	0.887
Weight 100 Seeds (g)	19.00	19.20	19.00	N. S
Shelling percent. %	28.80	25.70	23.70	N. S
Water Applied m^3/fed	2120	2010	2200	149.6
W. U. E. Kg /m^3	1.33	1.59	1.18	0.194
Yield Kg/fed	2720	3050	2510	195.7

Table 3. Cont.

	Season 2002			
	0.00% sloe	0.03% sloe	Tradi. leveling	L.S.D 5%
Plant Height (m)	48.50	53.30	46.50	2.335
No. of branches / plant	2.85	3.30	2.65	0.411
No f. Pods / plant	19.90	22.70	18.10	1.130
Weight 100 Seeds (g)	19.00	19.20	19.00	N S
Shelling percent. %	28.70	26.60	25.60	N. S
Water Applied m^3/fed	2030	1995	2210	143.5
W. U. E. Kg /m^3	1.37	1.55	1.17	0.150
Yield Kg/fed	2790	3100	2580	183.6

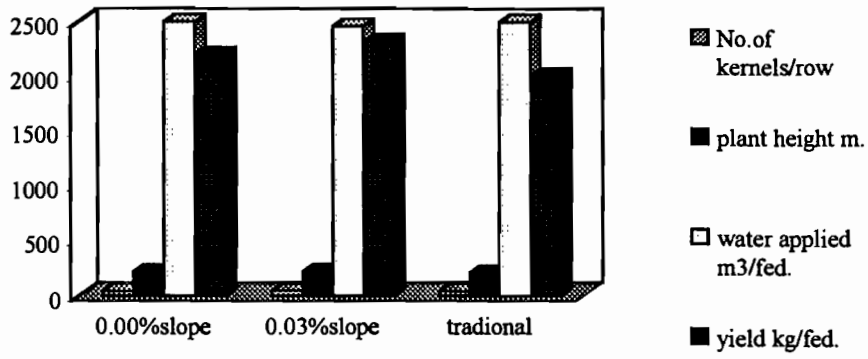

Fig. 1. Effect of laser leveling on No. of kernels, plant height, water applied and yield of maize intercropped with soybean

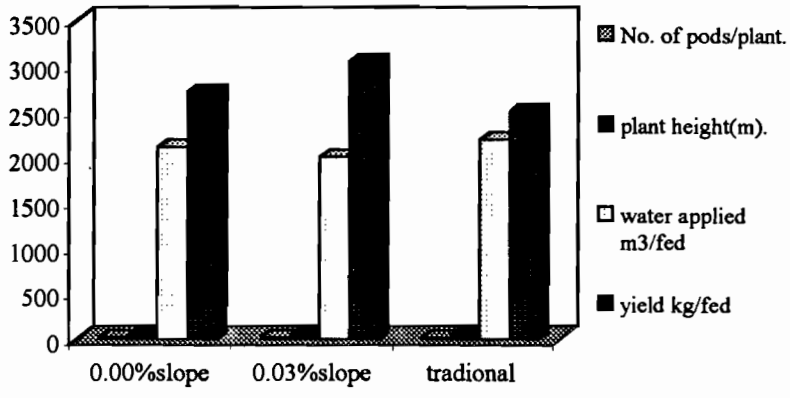

Fig. 2. Effect of laser leveling on No. of pods, plant height, water applied and yield of soybean intercropped with maize

Table 4. Effect of intercropping patteerns on WUE, yield and yield components of maize intercropped with soybean

	Season2001			
	2:2	2:4	s. maize	L.S.D 5%
Plant Height (m)	205.5	215.8	222.0	10.50
Height of first ears (m)	82.00	85.50	91.00	0.66
Ear diameter (cm)	4.30	4.70	5.25	0.51
No. of rows	11.60	12.70	13.70	1.30
No. of kernels / row	39.10	42.60	45.90	4.50
Water Applied m^3/fed	2530	2460	2760	159.98
W. U. E. Kg /m^3	0.78	0.77	0.79	0.068
Yield Kg/fed	1980	1890	2190	125.10

Table 4. Cont.

	Season2002			
	2:2	2:4	s. maize	L.S.D 5%
Plant Height (m)	201.3	210.3	223.0	10.33
Height of first ears (m)	80.50	86.00	90.00	0.61
Ear diameter (cm)	4.00	4.50	5.35	0.45
No. of rows	11.50	13.00	13.75	1.44
No. of kernels / row	40.90	42.50	45.60	3.60
Water Applied m^3/fed	2670	2350	2750	153.66
W. U. E. Kg /m^3	0.74	0.72	0.77	0.031
Yield Kg/fed	1980	1690	2105	110.50

Fig. 3. Effect of intercropping patterns on No. of kernels, plant height, water applied and yield of maize intercropped with soybean

Data on maize yield clearly indicated that ear diameter, number of rows / ear number of kernel / row of solid maize plants were superior to these of other intercropping associations. However, estimated values for all traits of maize plants grown in (2:4) pattern were significantly higher than plants grown in (2:2) pattern. Data on ears yield / fed showed that none of the intercropping pattern was able to give yield equal or exceeding that of the solid maize treatment. **Kamel *et al* (1990)** found that yield of maize grown in (2:2) pattern was higher than that grown in (2:4) pattern. It seemed that maize yield in the intercrop combinations was closely parallel to maize density interpreting superiority of maize yield in (2:2) pattern over that in (2:4) pattern. On other hand data revealed that the highest water use efficiency and the highest water applied were obtained when the maize was grown in pure stand, the excesses in the WUE were slightly higher than those of the intercrop pattern. The WUE were 0.77, 0.74 and 0.72kg / m^3 for solid maize, (2:2) and (2:4) treatments, respectively.

3- Effect of intercropping patterns on WUE, yield characters and yield of soybean crop

In Table (5) and Fig. (4) statistical analysis revealed significant effects on plants height, and shelling percentage, However, data analysis showed that most of the growth parameters of soybean plants grown in any intercrop combination was more than those of the solid growth. In addition, values of the growth characters of soybean plants grown in (2:4) pattern were higher than those obtained from the (2:2) intercropping pattern in most cases. Data indicated that soybean height grown in (2:2) pattern possessed maximum value, while it was insignificant with solid soybean. The treatment effects on the average number of fruiting branches/plant, number of pods, weight of 100-seeds and shelling percentage within the intercrop

Table 5. Effect of intercropping patterns on WUE, yield and yield components of soybean intercropped with maize

	Season2001			
	2:2	2:4	s. soybean	L.S.D 5%
Plant Height (m)	58.90	46.60	56.60	6.50
No. of branches / plant	2.30	2.65	3.10	N. S
No of. Pods/ plant	15.60	21.20	26.00	N. S
Weight of 100 Seeds(g)	19.20	19.20	19.00	N. S
Shelling percent. %	23.00	30.10	34.90	5.50
Water Applied m^3/fed	2490	2290	2100	145.60
W. U. E. Kg /m^3	0.69	0.94	1.21	0.135
Yield Kg/fed	1720	2150	2560	720

Table 5. Cont.

	Season 2002			
	2:2	2:4	s. soybean	L.S.D 5%
Plant Height (m)	50.30	46.50	54.60	5.33
No. of branches / plant	2.30	2.80	3.40	N. S
No of. Pods/ plant	14.50	19.80	25.00	N. S
Weight of 100 Seeds(g)	19.20	19.20	19.00	N. S
Shelling percent. %	22.80	32.20	35.70	4.33
Water Applied m^3/fed	2670	2350	2150	161.10
W. U. E. Kg /m^3	0.60	0.89	1.17	0.124
Yield Kg/fed	1604	2100	2516	675

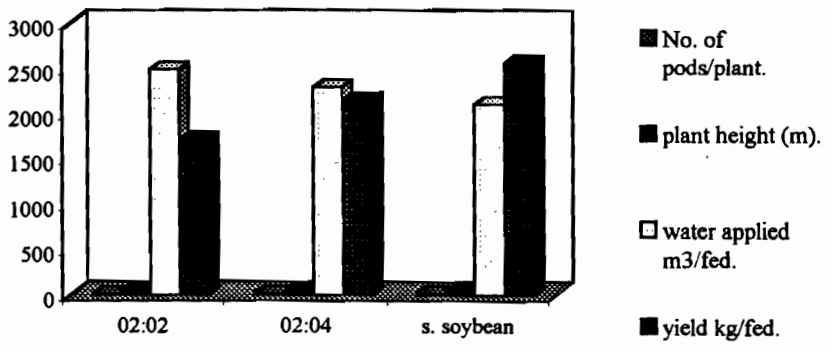

Fig. 4. Effect of intercropping patterns on No. of pods, plant height, water applied and yield of soybean intercropped with maize

combinations followed a regular course of change. Growing two rows of maize alternated with four rows of soybean (2:4) had the highest values, whereas two rows of soybean alternated with two rows of maize (2:2) possessed the least values. These results are in agreement with those obtained by **Kamel *et al*** **(1990)** which revealed a general tendency towards more growth vigor and weight when grown in row strips alternated with two rows of maize. However, the general increase in growth characters of soybean plants grown in (2:4) pattern might be due to more light intercepted by foliage as well as the low below and above ground competition between both components in the mixture. On the other hand the minimum growth vigor associated with (2:2) pattern might be due to low light intensity owing to the shade of maize plants. Similarly, intercropping patterns significantly affected soybean yield/fed. Yield of soybean plants grown in (2:4) pattern was notably higher than the plants grown in (2:2) pattern, but still less than the pure soybean stand. Analysis of data indicated significant difference between (2:4) and (2:2) patterns. On the other hand, yield of soybean grown in pure stand was significantly higher than that grown in (2:2) pattern, but it was insignificant when compared with (2:4) pattern. In this respect, **Kamel *et al*** **(1990)** reported that the significant increase in yield of soybean plants were closely parallel with the increase of soybean ratio in the intercrop pattern. Increases in soybean yield associated with (2:4) pattern might be related to the increase in soybean population in the mixture compared with the (2:2) pattern. The data also indicated that the highest water use efficiency and the highest water applied were obtained when the soybean was grown in pure stands. The excesses in the WUE was slightly higher than the WUE in (2:4) pattern and higher than the WUE in (2:2) pattern. The WUE values were 1.17, 0.89 and 0.60 kg/m^3 for solid soybean, (2:4) and (2:2) treatments, respectively.

4- Interaction effect of intercropping patterns and laser land leveling on WUE, plant characters and yield of maize crop

The interaction effect of laser land leveling and intercropping pattern on WUE, yield components and yield of maize plants is presented in Table (6). Data indicated that statistical analysis showed that differences were not great enough to reach 5% significance level, except in the case of plant height. On other hand, maximum plant height and height of first ear were obtained when maize plants were grown in pure stand in 0.03% slope plot. Whereas, minimum values were obtained when maize plants were grown in (2:2) pattern and related with traditional leveling. The average number of ears / plant, ear diameter, No. of rows and No. of kernel / row reached their maximals when plants were orientated in (2:4) pattern in the 0.03% slope plot. Nevertheless, these parameters almost exceeded those grown in pure stands in the 0.03% slope plot. On the other hand, the minimum value that coupled these traits were associated with maize plants were grown at (2:2) pattern in the traditional leveling plot. Maize population within the intercropping patterns as well as laser land leveling relatively influenced the interaction effect on maize yield per fedden. However, none of the intercropping systems exceeded those grown in pure stand. It was also interesting to notice that the excess in yield of maize grown in pure stands over those grown in (2:2) in 0.03% slope plot was 19.52% .The excess in yield of maize crop in 0.03% slope plot and grown at (2:2) pattern over those grown at (2:2) in traditional leveling was 12.90%. Data presented in Table (6) indicated that, maximum value of WUE was obtained when maize plants were grown in pure stand in 0.03% slope plot. While the WUE value of maize plants grown in pure stands in zero level ranked second. It is evident that the values of WUE of maize plants grown in (2:2) pattern were higher than those grown in (2:4) pattern. Whereas, minimum values of WUE were obtained when plants were grown at (2:4) pattern in traditional leveling. The values of WUE for soiled maize were 0.96, 0.91 and 0.79 kg/m^3 for 0.03%slope, zero level and traditional leveling, respectively. The values in (2:2) were 0.82, 0.79 and 0.71 kg/m^3 for the same plots, respectively. While the values in (2:4) were 0.81, 0.78 and 0.70 kg/m^3 in the same plots, respectively. The data obtained in the second season followed the same trend.

5- Interaction effect of intercropping patterns and laser land leveling on WUE, plant characters and yield of soybean crop

The interaction effect of laser land leveling and intercropping pattern on WUE, yield components and yield of soybean plants were not significant as presented in Table (7). Data indicated that maximum plant height and No. of fruiting branches/plant were obtained when soybean plants were grown in pure stand in 0.03% slope plot. Whereas, minimum values were obtained when soybean plants were grown in (2:2) pattern in the traditional leveling. The average number of pods/plant, weight of 100seeds, and shelling percentage reached maximum when plants were orientated in (2:4) pattern in the 0.03% slope plot. Nevertheless, these parameters almost exceeded those grown in pure stands in

Table 6. Interaction effect of laser leveling and intercropping patterns on WUE, yield and yield components of maize intercropped with soybean

		Season 2001							
		Plant height (cm)	Height of first ears (cm)	Ear diameter (cm)	No. of rows	No. of kernels / row	Water Applied m^3/fed	W. U. E. Kg /m^3	Yield Kg/fed
Zero level	2 : 2	195.0	81.1	5.00	13.30	39.00	2520	0.79	1990.00
	2 : 4	210.0	81.5	4.95	13.10	41.60	2430	0.78	1900.00
	s. maize	218.0	81.8	5.20	13.70	46.00	2640	0.91	2400.00
	mean	207.7	81.5	5.05	13.36	42.20	2555	0.82	2103.33
0.03% slope	2 : 2	207.0	85.2	5.00	14.00	45.00	2560	0.82	2100.00
	2 : 4	219.0	86.3	5.00	14.10	47.00	2410	0.81	1950.00
	s. maize	222.0	85.5	5.50	14.50	49.00	2605	0.96	2510.00
	mean	216.0	85.7	5.16	14.20	47.00	2525	0.86	2186.67
Tradi. leveling	2 : 2	191.0	82.5	4.5	12.50	36.00	2610	0.71	1860.00
	2 : 4	209.0	82.5	4.70	12.50	36.00	2540	0.70	1790.00
	s. maize	210.0	81.5	5.20	13.30	45.00	2750	0.79	2180.00
	mean	203.0	82.2	4.73	12.76	40.00	2666.66	0.72	1936.67
LSD(5%)		13.5	N. S	N. S	N. S	N. S	158.10	0.1150	112.50

Table 6. Cont.

		Season 2002							
		Plant height (cm)	Height of first ears (cm)	Ear diameter (cm)	No. of rows	No. of kernels / row	Water Applied m^3/fed	W. U. E. Kg /m^3	Yield Kg/fed
Zero level	2 : 2	197.0	82.5	4.90	13.05	38.0	2460	0.81	2000.00
	2 : 4	215.0	82.1	4.95	13.00	41.0	2360	0.79	1880.00
	s. maize	224.0	82.5	5.20	13.65	46.0	2670	0.91	2435.00
	mean	212.0	82.4	5.02	13.23	42.0	2497	0.84	2105.00
0.03% slope	2 : 2	210.0	86.1	5.00	14.00	45.0	2430	0.86	2090.00
	2 : 4	222.0	88.5	5.10	14.15	47.0	2280	0.84	1920.00
	s. maize	227.0	88.4	5.35	14.35	49.0	2600	0.90	2495.00
	mean	220.0	87.7	5.15	14.17	47.0	2437	0.87	2168.00
Tradi. leveling	2 : 2	190.0	82.5	4.60	12.80	37.0	2590	0.72	1865.00
	2 : 4	207.0	85.5	4.70	12.60	39.0	2510	0.70	1775.00
	s. maize	211.0	86.5	5.15	13.10	44.0	2720	0.75	2030.00
	mean	203.0	84.8	4.82	12.83	40.0	2607	0.72	1890.00
LSD (5%)		16.0	N. S	N. S	N. S	N. S	156.30	0.1120	111.20

Table 7. Interaction effect of laser leveling and intercropping patterns on yield and yield components of soybean intercropped with maize

		Season 2001							
		Plant height (cm)	No. of f. branches / plant	No. of Pods/ plant	Weight of 100 Seed (g)	Shelling percent. %	Water Applied m^3/fed	W. U. E. Kg /m^3	Yield Kg/fed
Zero level	2 : 2	47.70	2.77	18.60	18.90	31.10	2320	0.81	1890
	2 : 4	49.00	2.83	19.30	19.00	31.90	2230	0.88	1970
	s. soy	48.00	2.90	23.00	19.50	34.20	2100	1.00	2100
	mean	48.23	2.83	20.30	19.13	32.40	2216.7	0.90	1986.7
0.03% slope	2 : 2	55.10	3.15	22.45	17.90	35.30	2280	0.85	1935
	2 : 4	55.90	3.28	26.10	18.00	35.90	2170	1.06	2310
	s. soy	56.90	3.90	27.90	19.10	36.40	2020	1.48	2990
	mean	55.97	3.44	25.48	18.33	35.87	2156.7	1.13	2411.7
Tradi. leveling	2 : 2	58.00	1.82	16.60	19.20	29.00	2410	0.53	1290
	2 : 4	60.10	2.25	17.30	18.10	29.80	2300	0.66	1510
	s. soy	59.90	2.95	18.10	19.20	30.70	2200	0.81	1790
	mean	59.33	2.34	17.33	18.83	29.83	2303.3	0.67	1530
LSD (5 %)		N. S	N. S	N. S	N. S	N. S	167.10	0.1312	683.00

Table 7. Cont.

		Season 2002							
		Plant height (cm)	No. of f. branches / plant	No. of Pods/ plant	Weight of 100 Seed (g)	Shelling percent. %	Water Applied m^3/fed	W. U. E. Kg /m^3	Yield Kg/fed
	2 : 2	45.70	2.70	18.10	18.80	30.30	2390	0.79	1880
Zero	2 : 4	46.60	2.80	19.40	18.70	32.40	2230	0.87	1950
level	s. soy	47.30	2.90	22.20	20.00	34.00	2130	0.98	2090
	mean	46.50	2.80	19.90	19.20	32.20	2250	0.88	1970
	2 : 2	53.70	3.10	22.30	17.80	35.20	2340	0.82	1920
0.03%	2 : 4	54.90	3.30	24.10	17.50	35.60	2180	1.04	2270
slope	s. soy	55.30	3.90	28.60	17.30	36.20	2080	1.43	3150
	mean	54.60	3.40	25.00	17.50	35.70	2200	1.10	2446.6
	2 : 2	57.60	1.70	13.40	20.10	27.10	2440	0.63	1520
Tradi.	2 : 4	60.80	2.10	14.40	17.60	27.80	2280	0.73	1670
leveling	s. soy	63.10	3.10	15.50	19.80	28.40	2180	0.85	1850
	mean	60.30	2.30	14.50	19.20	27.77	2300	0.74	1680
LSD (5%)		N. S	N. S	N. S	N. S	N. S	162.50	0.1223	651.00

the 0.03% slope plot. On the other hand, the minimum values of these traits were associated with soybean plants grown at (2:2) pattern in the traditional leveling plot. However, none of the intercropping systems exceeded those grown in pure stand. It was also interesting to notice that the excess in yield of soybean grown in pure stand over those grown in (2:4) in 0.03% slope plot was 38.77%. The excess in yield of soybean crop in 0.03% slope plot and grown in (2:4) pattern over those grown in (2:4) in traditional leveling was 35.93%.

Data presented in Table (7) indicated that, maximum value of WUE was obtained when soybean plants were grown in pure stand in 0.03% slope plot. While the WUE value of soybean plants grown in pure stands in zero level ranked second. It is also clear that the values of WUE for soybean plants grown in (2:4) pattern were higher than those grown in (2:2) pattern. Whereas, minimum values of WUE were obtained when plants were grown in (2:2) pattern in traditional leveling. The values of WUE for solid soybean were 1.48, 1.00 and 0.81 kg/m^3 for 0.03% slope, zero level and traditional leveling, respectively. Also the values in (2:4) were 1.06, 0.88 and 0.66 kg/m^3 for the same plots respectively. While the values in (2:2) were 0.85, 0.81 and 0.53 kg/m^3 for the same plots, respectively. The data in the second season followed the same trend.

6- Interaction effect of intercropping pattern and laser land leveling on LER and total income for maize and soybean crops

Data on LER values in Table (8) indicated that intercropping resulted in more yields advantages in both intercrop combinations compared with growing both crops in monoculture. Results also indicated that the highest LER value was obtained when both crops were in (2:4) pattern, while (2:2) pattern possessed the least value. The reduction in LER in the (2:2) pattern were estimated to 1.28, 5.69 and 1.29% lower than LERs values of (2:4) in the zero level, 0.03% slope and traditional leveling respectively. The data indicated also that the highest value of total income was appeared by maize intercropped with soybean compared with both crops in monoculture. The (2:4) pattern in the 0.03% slope gave the highest total income and the (2:2) with the same plot ranked second, while the (2:4) in the zero level plot ranked the third. On the other hand the (2:2) in the traditional leveling gave the lowest total income. The (2:4) pattern gave 3745, 3219.8 and 2916.6 LE/fed for 0.03%slope, zero level, and traditional leveling plots, respectively, while the (2:2) pattern gave 3522, 3154.6 and 2849.6 LE/fed for 0.03% slope, zero level, and traditional leveling plots, respectively. The total income of maize grown in pure stand gave 1606.4, 1536 and 1395.2 LE/fed for 0.03% slope, zero level, and traditional leveling plots, respectively. While the yield of soybean grown in pure stand gave 2794, 2563 and 2365 LE/fed for 0.03% slope, zero level, and traditional leveling plots, respectively.

CONCLUSIONS

From the above results and discussion it can be concluded that

The WUE was 0.94, 0.87 and 0.73 kg/m^3 for 0.03% slope, zero level and traditional leveling, respectively for

Table 8. Interaction effect of laser leveling and intercropping on yield and yield component of maize and soybean crops

		Yield of maize Kg/fed	Yield of soybean Kg/fed	Income of maize LE/fed	Income of soybean LE/fed	L.E.R	Total income LE/ fed
	2 : 2	1990	1710	1273.6	1881.0	1.56	3154.6
Zero	2 : 4	1920	1810	1228.8	1991.0	1.58	3219.8
level	s. maize	2400	--------	1536.0	---------	--------	1536.0
	s. soy	-------	2330	--------	2563.0	--------	2563.0
	2 : 2	2010	1980	1344.0	2178.0	1.58	3522.0
0.03%	2 : 4	1950	2270	1248.0	2497.0	1.67	3745.0
slope	s. maize	2510	--------	1606.4	----------	--------	1606.4
	s. soy	--------	2540	---------	2794.0	--------	2794.0
	2 : 2	1840	1520	1177.6	1672.0	1.55	2849.6
Tradi.	2 : 4	1790	1610	1145.6	1771.0	1.57	2916.6
leveling	s. maize	2180	-------	1395.2	-------	-------	1395.2
	s. soy	--------	2150	--------	2365.0	--------	2365.0

maize yield. They were 1.52, 1.28 and 1.14 kg /m^3 for 0.03% slope, zero level and traditional leveling respectively, for soybean yield. The yield of maize increased by 9% and 15.4%. The yield of soybean increased by 7.66% and 22.60% for zero level and 0.03% slope respectively, compared with the traditional leveling. The WUE values were 0.77, 0.74 and 0.72 kg/m^3 for the solid maize, (2:2) and (2:4) treatments, respectively. The WUE values were 1.17, 0.89 and 0.60 kg/m^3 for the solid soybean, (2:4) and (2:2) treatments, respectively. The excesses in the yield of solid maize treatment were estimated to as much as 22.8 and 62.4% over (2:2) and (2:4) treatments, respectively. Yield of soybean in (2:4) pattern recorded a yield reduction of only 15% compared with solid soybean yield, reduction in (2:2).

Pattern augmented to as much as 38.60%. The excess in yield of maize grown in pure stands over those grown in (2:2) in 0.03% slope plot was 19.52%. The excess in yield of maize crop in 0.03% slope plot and grown in (2:2) pattern over those grown at (2:2) in traditional leveling was 12.90%. The highest values of WUE for maize intercropped with soybean was 0.82 kg/m^3 in (2:2) pattern under 0.03% slope. The excess in yield of soybean grown in pure stand over those grown in (2:4) in 0.03% slope plot was 38.77%. The excess in yield of soybean crop in 0.03% slope plot and grown in (2:4) pattern over those grown in (2:4) in the traditional leveling was 35.93%.

The highest values of WUE for soybean intercropped with maize was1.06 kg/m^3 in (2:4) pattern under 0.03% slope plots, while the values in (2:2) patterns were 0.85, 0.81 and 0.53 kg/m^3 in the same plots respectively. The highest value of LER was 1.67 in (2:4) pattern under 0.03% slope. The data also showed that highest total income was 3745 LE/fed in (2:4) pattern under 0.03% slope.

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تأثير نظم التحميل والتسوية باستخدام أشعة الليزر على محصولي فول الصويا مع الذرة الشامية

[٣٤]

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تعتبر مصر من الدول الزراعية التى تلعب تكنولوجيا الزراعة والرى دورا هاما فى الاقتصاد القومى لها وتستهلك الزراعة حوالى ٨٠% من إجمالي حصة المياه المقررة لمصر لزراعة ٨ مليون فدان أى ١٥ مليون فدان سنويا ، كما يتم رى ٦ مليون فدان رى سطحى ذات كفاءة رى منخفضة (٤٠% – ٦٠%). ولقد أجريت تجربتان حقليتان خلال موسمى ٢٠٠١ و٢٠٠٢ فى محطة بحوث سدس بمحافظة بنى سويف وذلك لدراسة تأثير التسوية باستخدام أشعة الليزر (٠,٠٠% ، ٠,٠٣% وتسوية تقليدية) ونظم التحميل المختلفة (٢:٢ و ٤:٢) على المحصول وكفاءة استخدام الرى والعائد الاقتصادى للفدان ونسبة استغلال الأرض (LER) لمحصولى فول الصويا والذرة الشامية .

ويمكن تلخيص النتائج كما يلى

استخدام التسوية بالليزر بميول ٣ سم/١٠٠م أعطى أعلى إنتاجية لمحصول فول الصويا فى نظام تحميل(٤:٢) بنسبة ٣٨,٧٧% بالمقارنة بالتسوية العادية . كذلك فإن استخدام التسوية بالليزر بميول ٣ سم/١٠٠م أعطى أعلى إنتاجية لمحصول الذرة الشامية فى نظام تحميل (٢:٢) بنسبة ١٢,٩٠% بالمقارنة بالتسوية العادية ، كما أظهرت النتائج أن كفاءة الاستخدام المائى كجم/م^3 فى نظام تحميل (٢:٢) كانت ٠,٧٩، ٠,٨٢ و ٠,٧١ كجم/م^3 تحت نظم تسوية (٠,٠٠% ، ٠,٠٣% وتسوية تقليدية) على التوالى لمحصول الذرة الشامية ، كذلك كانت كفاءة الاستخدام المائى كجم/م^3 فى نظام تحميل (٤:٢) ، ٠,٨٨ و١,٠٦ و٠,٦٦ كجم/م٣ تحت نظم تسوية (٠,٠٠% ، ٠,٠٣% وتسوية تقليدية) على التوالى لمحصول فول الصويا .

كما أظهرت النتائج أن التسوية باستخدام الليزر والتحميل قد أديا إلى زيادة نسبة استغلال الأرض (LER) فى جميع نظم الزراعة المطبقة حيث بلغت القيم المتحصل عليها أقصاها عندما طبق نظام (٤:٢) بنسبة

١,٢٨ ، ٥,٦٩ و ١,٢٩% بالمقارنة بنظام تحميل (٢:٢) تحت نظم تسوية (٠,٠٠% ، ٠,٠٣% وتسوية تقليدية) على التوالى . كما أظهرت النتائج أن التسوية باستخدام أشعة الليزر والتحميل قد أديا إلى زيادة قيمة العدد الاقتصادي فى جميع النظم المطبقة حيث تحقق أعلى عائد اقتصادي عندما تم تطبيق نظام (٤:٢) فى قطعة الأرض التى تم تسويتها بميول ٣سم/١٠٠ متر حيث حقق هذا النظام ٣٧٤٥,٠٠ جنيها مصريا ، فى حين حقق نظام (٢:٢) عائدا من زراعة الذرة الشاميه منفردة قدره ١٣٩٥,٢٠ جنيها مصريا وذلك فى قطعة الأرض التى تم تسويتها تسوية عادية ، بينما حقق فول الصويا المنفرد عائدا قدره ٢٣٦٥,٠٠ جنيها مصريا .

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