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PRODUCTIVITY AND QUALITY OF AUTUMN SUGAR CANE RATOON INTERCROPPED BY WHEAT OR BARLEY UNDER MIDDLE EGYPT CONDITIONS

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ABSTRACT

Sometimes under Middle Egypt conditions , intercropping wheat with sugar cane could be delayed due to the delay of cutting the cane but intercropping barley with sugar cane in this case would be appropriate. Therefore, four field experiments were conducted at Mallawi Agric. Res. Station, El- Minia – Egypt (intercropping wheat or barley on cane, third ratoon) during the two seasons 2009/2011 and 2010/2012 to study the effect of intercropping one, two and three rows of wheat or barley on the productivity, quality and profitability of sugar cane in a complete randomized blocks design.

The obtained results could be summarized as follows: Intercropped yield of sugar cane with one, two and three rows of wheat was 99.94, 99.24 and 98.39% in the 1st season, 99.80, 82.37 and 80.92% in the 2nd season compared with sugar cane alone, respectively. The intercropped yield of sugar cane with one, two and three rows of barley was 98.31, 97.00 and 94.93% in the 1st season , 98.03, 95.86 and 92.31% in the 2nd season compared with pure stand of sugar cane, respectively.

The intercropping patterns of wheat or barley with sugar cane had a significant effect on sugar recovery% of intercropped sugar cane with wheat and purity% of intercropped sugar cane with barley in the 1st season.

The highest values of land equivalent ratio LER are 1.33 and 1.50 obtained by intercropping three rows of wheat or barley with sugar cane in the 1st and the 2nd seasons, respectively. Aggressivity (Agg) values of autumn sugar cane were negative (dominated) while those of wheat or barley were positive (dominant) by intercropping one, two or three rows of wheat or barley with sugar cane in the 1st and the 2nd seasons , except intercropping three rows of wheat with sugar cane in the 2nd season.

The economic return of output of intercropping wheat or barley on sugar cane was profitable for growers compared to the single cane, as well as an increase for cultivated area and productivity of wheat crop, which represents one of the strategic crops of El-Minia Governorate.

From these results, it could be concluded that intercropping cane with wheat and intercropping cane with barley if sugar cane was cut early and if sugar cane was delayed, respectively under the Middle Egypt conditions.

Key words: *barley – intercropping – LER - Pol% - sugar cane- TSS% - wheat yield (ton/ fed).*

1. INTRODUCTION

Intercropping is considered one of the important means of solving or reducing the large gap between the production and consumption of different crops such as cereals. Autumn sugar cane ratoon occupies the land for more than one year and hence the farmers have no chance to grow another crop. During winter season and early spring, sugar cane grows slowly due to the prevailing low temperature. Therefore , attention was focused on some annual winter crops with short duration.Wheat (*Triticum aestivum*, L.) is the most important cereal grown in the world and is a staple food of the people in Egypt. Some sugar cane growers in El-Minia Governorate, after early cutting of sugar cane, in such case, intercropping wheat with sugar cane in the last week of Nov the ember or the first week of December would help growers getting additional income during the growing season of sugar cane. But, the late cutting of sugar cane in the last week of December or first week of January is not suitable for intercropping wheat with sugar cane. (CCSC, 2012). El.Gergawi *et al.* (1995) and Eweida *et al.* (1996) reported that yields of sugar cane and other intercropped crops were

significantly reduced under intercropping conditions compared with pure stand of sugar cane. They mentioned that intercropping wheat with sugar cane increased land usage, LER (Land Equivalent Ratio) and relative crowding coefficient. Zohry (1997) showed that sugar cane yield ton/fed slightly decreased by intercropping , the highest reduction values of cane yield were 9.9 and 8.4 % in the two seasons , respectively when intercropped with 5 rows of onion. He added that, most sugar cane quality parameters (Brix, sucrose and purity percentages) were unaffected by intercropping. Hussein *et al.* (2000) pointed out that the maximum value of sugar cane tillers /stump was scored in sole sugar cane , while , intercropping gave the lowest value . Some investigators such as Nazir, *et al*. (2002) found that sucrose % of cane juice was not significantly affected by different intercrops (sarsoon, sunflower, wheat, gram, lentil, peas and garlic). Farghaly (2003) demonstrated that planting one row of sugar beet at a distance of 30 cm between hills on cane ridges was successful and profitable compared with 20 and 25 cm hill spacing. Zohry and Abd El.Aal (2003) showed that intercropping three rows of mung bean with sugar cane is successful and profitable, which reduced the cost of weed control and in some instances increased sugar yield (ton/fed). Huger, (2006) studied the intercropping cowpea, French bean and coriander) with maize and found that overall performance of the cropping system was largely enhanced when maize and vegetables were intercropped compared to their sole performance.

The present investigation was carried out to define precisely the competition effect of intercropping wheat or barley on productivity, quality and profitability of sugar cane under Middle Egypt conditions.

2. MATERIALS AND METHODS

Four field experiments were conducted at Mallawi Agric. Res. Station, Minia Governorate, Egypt, during 2009/2011 and 2010/2012 seasons to study the effect of intercropping wheat or barley on the productivity, quality and profitability of sugar cane (Third ratoon). Sugar cane variety namely G.T.54-9 (the commercial variety) was used.

A randomized complete blocks design (RCBD) with four replicates was applied including five treatments as follows:

1-Sugar cane + one row of wheat or barley (15% of sole wheat or barley).
2-Sugar cane + two rows of wheat or barley (30% of sole wheat or barley).
3-Sugar cane + three rows of wheat or barley (45% of sole wheat or barley).
4- Sole stand of wheat or barley.
5- Sole stand of sugar cane.

Sowing and cutting, or harvesting dates of sugar cane, wheat and barley crops are recorded in Table (A).

Plot area was 25 m^2; it consisted of 5 ridges, 5 m length x 1m width. Sugar cane was planted in ridges, one meter apart, while wheat or barley was planted in hills, 15 cm apart. Distances between rows of wheat or barley were 15 cm where intercropping with two and three rows of wheat or barley. Phosphorus fertilizer was added in the form of calcium super-phosphate (15.5% P_2O_5) at the rate of 60 kg/fed, which was broadcasted after ridging in furrows after sowing wheat or barley and before irrigation. Recommended fertilization of 60 kg N/fed as Urea (46%) was applied in three equal doses before each of the first, second and third irrigations. Potassium fertilizer was added as potassium sulphate (48% K_2O) at the rate of 48 kg K_2O/fed after full emergence for the third ratoon after harvesting wheat or barley. Nitrogen fertilizer was added as Urea (46%) at the rate of 210 kg/fed in two equal doses as side dressing in cane rows, the first one after harvesting wheat or barley and one month later. All the required agricultural practices were done as followed by sugar cane growers in the region. Some chemical and physical properties of the soil of the experimental site were determined before seed bed

Table (A): Sowing and cutting or harvesting dates of sugar cane, wheat and barlely crops during 2009 / 2011 and 2010 / 2012 seasons.

Crops	Sowing dates	Grown cultivar	Cutting or harvesting dates
2009 / 2011 season			
Sugar cane	**3 / 12 /2009**	**G.T. 54-9**	**18 / 1 /2011**
Wheat	**7 / 12 /2009**	**Beni Suef**	**28 / 4 /2010**
Barley	**2 / 1 /2010**	**G.129**	**18 / 4 /2010**
2010 / 2012 season			
Sugar cane	**2 / 12 /2010**	**G.T. 54-9**	**13 / 1 /2012**
Wheat	**5 / 12 /2010**	**Beni Suef**	**26 / 4 /2011**
Barley	**3 / 1 /2011**	**G.129**	**22 / 4 /2011**

preparation according to the procedures outlined by Jackson (1967). The physical analysis of the experimental site showed that the soil was silty clay loam. Its chemical analysis cleared that the soil contained 21.1 and 19.35 ppm N, 8.50 and 7.85 ppm P, 175 and 180 ppm K with pH of 8.10 and 8.00 in the 1st and the 2nd seasons, respectively.

2.1.The recorded data

2.1.1.For sugar cane: At harvest time 20 guarded plants of sugar cane were harvested at the age of 13 months were taken from each plot to estimate the following traits:

- Stalk height (cm): It was measured from soil surface to the top visible dewlap.
- Stalk diameter (cm): It was measured at the middle part of the stalk.
- Stalk weight (kg.).Number of stalks / m^2 was counted.
- Total soluble solid percentage (TSS %), which was determined using "Brix hydrometer" standardized at 20 C^0 as shown by A.O.A.C. (2005).
- Sucrose %, was determined using "Sacharemeter" accoding to A.O.A.C. (2005).
- Juice purity %, was estimated according to Satisha *et al.* (1996) using the following equation:Purity %= sucrose % x 100 / TSS %. .
- Pol % of cane stalks, which was calculated using the following equation, after the determination of sucrose % in the cane juice, according to Satisha *et al.* (1996).

Pol % = [Brix % - (Brix % – sucrose %) 0.4]* 0.73.

- Sugar recovery % (rendment) was calculated using the following equation, according to the procedures used by the Sugar and Integrated Industries Co.

Sugar recovery = [(pol- 0.8)/ Purity]*(Purity % – 40)/100-60.

- Reducing sugars of cane juice was determined according to A.O.A.C. (2005). Millable cane yield (ton/fed): cane stalks of the guarded rows were harvested at age of 12 months, topped, cleaned, weighed and cane yield was calculated as ton/fed.
- Recoverable sugar yield (ton/fed), was estimated according to the following equation reported by Mathur (1981):

Recoverable sugar yield (ton/fed) = millable cane yield (ton/fed) x Sugar recovery %.

2.1.2.For wheat and barley: At harvest time 20 guarded plants were taken randomly from each plot to estimate plant height (cm_), spike length (cm), weight of grains/ spike (g), weight of 100 grains (g) , number of grains/ spike , grain yield (ardab /fed)and straw yield (ton/fed) .

2.1.3. Light intensity: The light transmission by the canopies of sole sugar cane, sole intercrops (wheat and barley) and intercropping system was measured by Lux meter. The light intensity above canopy (I_0) and the ground level (I) was recorded between 12:30 and 1:00 pm and light transmission ratio (LTR) was averaged for the system based on row proportions. LTR = I / I_0 X 100, where, I = Light intensity received at the ground level and I_0 = light intensity received at the top of crop canopy by TES 1330 Digital according to Mendoza (1986).

2.1.4.Competitive relationships and yield advantage

1.Land Equivalent Ratio (LER) according to Willey (1979) using 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)

2.Relative crowding coefficient K (RCC) according to Hall (1974).

$$K = k_{ab} \times kba$$

Where: $k_{ab} = (Y_{ab} \times z_{ba}\ \%) / (Y_{aa} - Y_{ab}) \times z_{ab}\ \%$
$k_{ba} = (Y_{ba} \times z_{ab}\ \%) / (Y_{bb} - Y_{ba}) \times z_{ba}\ \%$
Z_{ba} %= Area occupied by sugar cane
Z_{ab}% = Area occupied by wheat or barley.

3. Aggressivity (Agg) according to Mc-Gilchrist (1965).

$$A_{ab} = \frac{y_{ab}}{y_{aa} \times z_{ab}\%} - \frac{y_{ba}}{y_{bb} \times z_{ba}\ \%}$$

2.1.5. Economic analysis of different intercropping patterns of wheat or barley with sugar cane was carried out according to Nazir *et al*. (2002).

The proper statistical analysis of the data was done according to Gomez and Gomez (1984). The differences between means of the studied treatments were compared using least significant difference (LSD) at 5% level.

3. RESULTS AND DISCUSSION

3.1. Wheat and Barley

The results in Tables (1 & 2) indicated that intercropping patterns had a significant effect on plant height, grain yield(ardab/ fed) , straw yield(ton/fed)and light transmission% of wheat and barley, spike length , wt of grains/spike , wt.of 100-grain , No. of grains/spike of barley in the

two growing seasons, and wt. of 100-grains of wheat in the 1st season. Pure stand of wheat and barley scored the highest values of plant height, No. of grains/spike, grain yield and straw yield. While, intercropping one row of wheat or barley with sugar cane recorded the lowest values of these characters. Intercropping one row of wheat or barley with sugar cane recorded the highest values of light transmission% among the studied intercropping patterns. Grain yield of wheat or barley was consistently reduced with intercropping patterns. These data are in agreement with those reported by El-Gergawy *et al.* (1995), Eweida *et al.* (1996), Zohry (1997), Hussein *et al*. (2000); Nazir *et al*. (2002) and Hugar (2006).

Intercropping wheat and sugar cane with three rows resulted the greatest yield reduction% by 1.61% and 19.08% in the 1st season and in the 2nd seasons, respectively. The highest value of light transmission % was found with intercropping one row of wheat with sugar cane in both seasons. Low availability of light for a component crop in the mixtures reduced the photosynthetic rate and crop growth rate, finally leading to a drastic reduction in grain and straw yields of component crops. Reduction in cane yield as a result of wheat or barley intercropping was attributed to exhaustive competition between the component crops for essential nutrients, water and other growth factors. The aforementioned findings are correlated with those recorded by El-Gergawy *et al.*(1995) and Eweida *et al.* (1996).

A diminished significant effect on the sugar yield ton/fed of sugar cane in the case of intercropping wheat with sugar cane was recorded in the 2nd season. The highest values of lack for the sugar yield of sugar cane were with intercropping three rows of wheat, where the reduction rate of sugar yield ton/fed was 21.31% in the case of intercropping wheat with sugar cane in the 2nd season. It is worth to mention that lowering stalks number and cane yield are due to intra and inter-specific competition between wheat or barley and sugar cane plants especially under the high population density of wheat which consequently affect the sugar cane yield (Tables 3 & 4). These results are in agreement with those found by Hussein *et al*. (2000) and Zohry and Abd El. Aal (2003). Intercropping if properly managed and looked after can go a long way to solve the problems of low productivity per unit area and sustainability of a production system. It helps in maintaining the soil fertility and making efficient use of nutrients.

3.2. Juice quality

Data in Tables (5&6) revealed that intercropping patterns of wheat or barley with sugar cane had a significant effect on sugar recovery% of intercropped sugar cane with wheat and purity% of intercropped sugar cane with barley in the 1st season. These results might be due to that these traits are the output of the late part of the growing season well after the harvest of wheat or barley. However, sugar yield increased in the sole cane mainly due to the effect of yield rather than its quality .Similar findings were reported by Zohry (1997). He reported that, most sugar cane quality parameters (Brix, sucrose and purity percentages) were unaffected by intercropping. Here too, Nazir *et al*.(2002) found that sucrose % of cane juice was not significantly affected by different intercrops (sarsoon, sunflower, wheat, gram, lentil, peas and garlic).

3.3. Competitive relationships

Data of competitive relationships and yield advantages for intercropping wheat or barley with sugar cane under three different patterns are presented in Tables (7 & 8). The results showed that intercropping wheat or barley with sugar cane resulted in an advantage in land equivalent ratio (LER). The value of LER is greater than one; which means increasing the land productivity .The highest values of LER are 1.33 and 1.50 obtained by intercropping three rows of wheat and barley with sugar cane in the 1st and the 2nd seasons, respectively. The lowest values of LER are 1.10 and 1.36 obtained from intercropping two rows of wheat or one row of barley in the 2nd and the 1st seasons, respectively. Relative yield (RY) of sugar cane was the largest at low plant density of wheat or barley, whereas, RY of wheat or barley decreased with increasing the density of wheat or barley plants.

Data of the relative crowding coefficient (RCC) presented in Tables (7&8) show that there was decrease in RCC with increasing plant density of wheat or barley. It could be concluded that the product of the coefficient showed that intercropping sugar cane with wheat or barley increased the land use efficiency. Aggressivity (Agg) values of sugar cane were negative (dominated) while those of wheat or barley were positive (dominant) by intercropping one , two or three rows of wheat and barley with sugar cane in the 1st and the 2nd seasons, except for intercropping three rows of wheat with sugar cane in the 2nd season . This result might be due to that during the winter season; sugar cane grows slowly due to prevailing low temperature, while wheat

Table (1): Effect of intercropping patterns of wheat with sugar cane on the yield and its components of wheat in 2009/2011 and 2010/2012 seasons.

Intercropping Patterns	Plant height (cm)	Spike length (cm)	Wt of grains/ spike (gm)	Wt of 100 grains (gm)	No. of grains/ spike	Grain yield (ardab/fed)	Straw yield (ton/fed)	Light transmission
2009-2011 Season								
One row of wheat	73.53	12.00	2.30	4.63	47.33	4.67	1.33	87.00
Two rows of wheat	67.67	12.43	2.20	4.73	46.67	6.33	2.17	72.50
Three rows of wheat	73.67	12.53	2.30	4.87	47.33	7.10	2.15	69.67
Sole wheat	83.67	12.67	2.40	4.47	48.33	20.23	4.96	74.00
F value	**	Ns	Ns	*	Ns	**	**	**
LSD at 0.05	2.37	-	-	0.22	-	0.41	0.31	8.39
2010 – 2012 Season								
one row of wheat	68.20	10.97	1.90	4.63	45.00	4.23	1.09	92.17
Two rows of wheat	67.47	11.40	2.23	4.90	44.00	5.44	2.00	74.17
Three rows of wheat	72.00	12.13	2.07	4.87	44.00	7.07	1.97	71.17
Sole wheat	82.33	11.67	1.60	4.33	46.00	19.30	4.61	79.33
F value	**	Ns	Ns	Ns	Ns	**	**	**
LSD at 0.05	6.86	-	-	-	-	1.41	0.21	5.99

Table (2): Effect of intercropping patterns of barley with sugar cane on the yield and its components of barley in 2009/2011 and 2010/2012 seasons.

Intercropping patterns	Plant height (cm)	Spike length (cm)	Wt of grains/ spike (gm)	Wt of 100 grains (gm)	No.of grains/ spike	Grain yield (ardab/fed)	Straw yield (ton/fed)	Light transmission
2009-2011 Season								
One row of barley	60.20	7.60	2.03	4.33	52.00	6.73	2.01	77.83
Two rows of barley	63.07	7.63	2.17	4.47	48.00	7.63	2.27	68.67
Three rows of barley	68.37	8.03	2.10	4.57	46.33	8.80	2.80	66.17
Sole barley	82.00	8.30	3.00	4.37	46.00	17.73	6.00	70.67
F value	**	**	**	*	*	**	**	**
LSD0.05	1.53	0.30	0.37	0.12	3.41	0.31	0.36	5.36
2010 – 2012 Season								
One row of barley	58.80	7.20	1.93	4.50	43.70	4.13	1.55	84.83
Two rows of barley	61.00	7.80	1.80	4.30	40.33	5.10	1.24	70.50
Three rows of barley	62.70	8.20	1.60	4.20	40.33	5.95	2.09	70.83
Sole barley	82.00	8.10	2.93	3.90	47.00	12.17	4.03	74.83
F value	**	**	**	*	*	**	**	**
LSD0.05	6.30	0.38	0.65	0.25	1.29	0.89	0.61	2.18

Table (3): Effect of intercropping patterns of wheat with sugar cane on the yield and its components of sugar cane in 2009/2011 and 2010/2012 seasons.

Intercropping patterns	Stalk height (cm)	Stalk diameter (cm)	Stalk weight (kg)	No. of stalks/ m^2	Cane yield (ton/fed)	Sugar yield (ton/fed)	Light transmission
2009-2011 Season							
One row of wheat	290.00	2.10	1.73	9.50	52.28	5.80	91.83
Two rows of wheat	288.70	2.50	1.57	7.60	51.91	5.60	82.50
Three rows of wheat	290.70	2.30	1.77	7.30	51.47	5.20	88.00
Sole sugar cane	288.30	2.20	1.53	7.50	52.31	5.80	86.83
F value	Ns	*	Ns	Ns	**	Ns	**
LSD at 0.05	-	0.35	-	-	0.77	-	1.42
2010-2012 Season							
One row of wheat	224.00	2.70	1.33	9.70	50.20	6.20	92.17
Two rows of wheat	217.00	2.60	1.21	9.80	41.43	5.10	83.50
Three rows of wheat	215.00	2.50	1.31	7.80	40.70	4.80	87.67
Sole sugar cane	223.00	2.70	1.40	8.60	50.30	6.10	87.17
F value	**	Ns	Ns	Ns	**	**	**
LSD at 0.05	3.07	-	-	-	0.63	1.94	1.12

Table (4): Effect of intercropping patterns of barley with sugar cane on the yield and its components of sugar cane in 2009/2011 and 2010/2012 seasons.

Intercropping patterns	Stalk height (cm)	Stalk diameter (cm)	Stalk weight (kg)	No. of stalks/ m^2	Cane yield (ton/fed)	Sugar yield (ton/fed)	Light transmission
2009-2011 Season							
One row of barley	272.30	2.33	1.50	8.10	52.40	6.13	86.00
Two rows of barley	267.30	2.70	1.60	7.90	51.70	5.70	86.00
Three rows of barley	265.30	2.50	1.50	7.80	50.60	5.60	87.67
Sole sugar cane	276.70	2.50	1.50	8.50	53.30	6.50	87.89
F value	**	**	Ns	Ns	Ns	Ns	**
LSD at 0.05	5.32	0.13	-	-	-	-	0.93
2010-2012 Season							
One row of barley	215.70	2.50	1.37	8.60	49.70	6.30	85.67
Two rows of barley	210.70	2.80	1.37	8.50	48.60	5.90	85.17
Three rows of barley	213.70	2.90	1.43	7.80	46.80	5.80	86.67
Sole sugar cane	220.30	2.60	1.40	8.80	50.70	6.23	87.33
F value	**	**	Ns	**	Ns	Ns	Ns
LSD at 0.05	3.42	1.67	-	0.39	-	-	-

Table (5): Effect of intercropping patterns of wheat with sugar cane on the quality parameters of sugar cane in 2009/2011 and 2010/2012 seasons.

Intercropping patterns	TSS %	Sucrose %	Purity %	Pol %	Reducing sugars %	Sugar recovery %
2009-2011 Season						
One row of wheat	20.33	16.90	83.13	13.83	0.41	11.28
Two rows of wheat	20.00	16.43	82.10	13.53	0.41	10.90
Three rows of wheat	20.00	16.40	81.70	13.51	0.46	10.50
Sole sugar cane	19.37	16.40	83.40	13.40	0.37	11.60
F value	Ns	Ns	Ns	Ns	Ns	*
LSD at 0.05	-	-	-	-	-	0.96
2010-2012 Season						
One row of wheat	21.70	18.50	85.30	14.90	0.30	12.50
Two rows of wheat	21.30	18.20	85.20	14.70	0.30	12.20
Three rows of wheat	20.80	17.60	84.40	14.30	0.40	11.80
Sole sugar cane	21.00	17.90	85.30	14.40	0.33	12.10
F value	Ns	Ns	Ns	Ns	Ns	Ns
LSD at 0.05	-	-	-	-	-	-

Table (6): Effect of intercropping patterns of barley with sugar cane on the quality parameters of sugar cane in 2009/2011 and 2010/2012 seasons.

Intercropping patterns	TSS %	Sucrose %	Purity %	Pol %	Reducing sugars %	Sugar recovery %
2009-2011 Season						
One row of barley	21.00	17.70	84.10	14.33	0.47	11.70
Two rows of barley	20.20	16.40	81.30	13.63	0.43	10.90
Three rows of barley	19.80	16.60	83.40	12.65	0.33	11.04
Sole sugar cane	21.50	18.00	83.60	14.68	0.40	12.10
F value	Ns	Ns	**	Ns	Ns	Ns
LSD at 0.05	-	-	4.54	-	-	-
2010-2012 Season						
One row of barley	21.20	18.80	84.70	15.20	0.27	12.70
Two rows of barley	21.30	18.10	84.80	14.60	0.27	12.20
Three rows of barley	21.50	18.30	85.30	14.80	0.27	12.40
Sole sugar cane	21.50	18.30	85.30	14.80	0.30	12.40
F value	Ns	Ns	Ns	Ns	Ns	Ns
LSD at 0.05	-	-	-	-	-	-

Table (7): Calculated data of competitive relationships and yield advantage for cropping patterns of wheat with sugar cane in 2009/2011 and 2010/2012 seasons.

Intercropping patterns	Land equivalent ratio (LER) $L_C + L_W = LER$	Relative crowding coefficient (RCC) $K_C * K_W = K$	Aggressivity (Agg) A_C	A_W
2009-2011 Season				
One row of wheat	1.0 + 0.23 =1.23	260 * 2.01 =522.6	-0.63	+.63
Two rows of wheat	0.99 + 0.31 = 1.30	36.60 * 1.60 =58.93	-0.07	+0.07
Three rows of wheat	0.98 + 0.35 = 1.33	27.54 * 1.20 = 33.16	+0.30	-0.30
2010-2012 Season				
One row of wheat	0.99 + 0.22=1.21	57.06 * 1.88 =141.12	-0.53	+0.53
Two rows of wheat	0.82 + 0.28 = 1.10	1.40 * 1.31 =1.83	-0.16	+0.16
Three rows of wheat	0.81 + 0.37= 1.18	1.91 * 1.29 = 2.46	-0.01	+0.01
Lc : LER Sugar cane L_W: LER wheat		K_C :RCC Sugar cane K_W : RCC wheat	A_C : Agg Sugar cane A_W : Agg wheat	

Table (8): Calculated data of competitive relationships and yield advantage for cropping patterns of barley with sugar cane in 2009/2011 and 2010/2012 seasons.

Intercropping patterns	Land equivalent ratio (LER) $L_C + L_W = LER$	Relative crowding coefficient (RCC) $K_C * K_W = K$	Aggressivity (Agg) A_C	A_W
2009-2011 Season				
One row of barley	0.98 + 0.38 =1.36	8.73 * 4.10 =35.79	-1.80	+1.80
Two rows of barley	0.97 + 0.43 = 1.40	9.67 * 2.53 =24.47	-0.61	+0.61
Three rows of barley	0.95 + 0.50 = 1.45	8.44 * 2.19 = 18.48	-0.22	+0.22
2010-2012 Season				
One row of barley	0.98 + 0.39 =1.37	7.43 * 4.24 =31.50	-1.84	+1.84
Two rows of barley	0.96 + 0.51 = 1.47	6.90 * 3.43 =23.67	-0.93	+0.93
Three rows of barley	0.92 + 0.58 = 1.50	5.39 * 3.03 = 16.33	-0.50	+0.50
Lc : LER Sugar cane L_W: LER wheat		K_C :RCC Sugar cane K_W : RCC wheat	A_C : Agg Sugar cane A_W : Agg wheat	

and barley grow strongly. These results of competition relationship and yield advantage are in agreement with those obtained by El- Gergawi *et al*. (1995) and Zohry *et al.* (2003).

3.4. Economical evaluation and net profit

It is evident from Tables (9&10) that intercropping one, two or three rows of wheat and barley with sugar cane led to increase the total income and net profit LE/fed compared with pure stand of sugar cane, wheat or barley. The results indicated that intercropping one, two or three rows of wheat with sugar cane led to increasing net profit LE/fed by 32.36, in the 1st season and 29.40, 8.77 and 8.65% in the 2nd season, respectively. However, intercropping one, two or three rows of barley with sugar cane led to increasing net profit LE/fed by 44.53, 45.52 and 49.55 % in the 1st season and 31.48, 23.21 and 28.10% in the 2nd season, respectively. Intercropping sugar cane planted with wheat or barley gave the highest net profit compared with sole cropped treatments.

It could be concluded that the higher values of net profit LE/fed were scored from intercropping barley with sugar cane than intercropping wheat with sugar cane. This means that intercropping barley with sugar cane achieved net profit LE/fed better than intercropping wheat with sugar cane. Also, intercropping two rows of wheat with sugar cane in the 1st season and one row of wheat with sugar cane in the 2nd season, achieved the highest value of net profit LE/fed. On the other hand, intercropping three rows of barley with sugar cane in the 1st season and one row of Wheat with sugar cane in the 2nd season, achieved the highest value of net profit LE/fed. These results are in a good agreement with those found by Zohry (1997) and Farghaly (2003).

Finally, it could be recommended to intercropping one or two rows of wheat with sugar cane if sugar cane was harvested early, but if for any reason, cutting of sugar cane delayed, in this case, the intercropping of barley with sugar cane is appropriate and best under Middle Egypt conditions.

Table (9): Economic analysis of different intercropping patterns of wheat with sugar cane in 2009/2011and 2010/2012 seasons.

Intercropping patterns	Crop yield			Income (LE/fed)			Total income (LE/fed)	Total expenditure (LE/fed)	Total profit (LE/fed)
	Sugar cane ton/fed	Wheatar dab/ fed	Straw ton/ fed	Sugar cane	Wheat	Straw			
2009-2011 Season									
One row of wheat	52.28	4.67	1.33	17513.8	1634.5	1596	20744.3	8800	11944.3
Two rows of wheat	51.91	6.33	2.17	17389.9	2215.5	2604	22209.4	9100	13109.4
Three rows of wheat	51.47	7.10	2.15	17242.5	2485	2580	22307.5	9400	12907.5
Sole wheat	-	20.23	4.96	-	7080.5	5952	13032.5	6500	6532.5
Sole sugar cane	52.31	-	-	17523.9	-	-	17523.9	8500	9023.9
2010-2012 Season									
One row of wheat	50.20	4.23	1.09	16817	1480.5	1308	19605.5	8800	10805.5
Two rows of wheat	41.43	5.44	2.00	13879.05	1904	2400	18183.1	9100	9083.1
Three rows of wheat	40.70	7.07	1.97	13634.5	2474.5	2364	18473	9400	9073
Sole wheat	-	19.30	4.61	-	6755	5532	12287	6500	5787
Sole sugar cane	50.30	-	-	16850.5	-	-	16850.5	8500	8350.5

Table (10): Economic analysis of different intercropping patterns of barleuy with sugar cane in 2009/2011 and 2010/2012 seasons.

Intercropping patterns	Crop yield			Income (LE/fed)			Total income (LE/fed)	Total Expenditure (LE/fed)	Total profit (LE/fed)
	Sugar cane ton/ fed	Barley ardab/ fed	Straw ton/ fed	Sugar cane	Barley	Straw			
2009-2011 Season									
One row of barley	52.40	6.73	2.01	17554	2355.5	2412	22321.5	8800	13521.5
Two rows of barley	51.70	7.63	2.27	17319.5	2670.5	2724	22714	9100	13614
Three rows of barley	50.60	8.80	2.80	16951	3080	3360	23391	9400	13991
Sole barley	-	17.73	6.00	-	6205.5	7200	13405.5	6000	7405.5
Sole sugar cane	53.30	-	-	17855.5	-	-	17855.5	8500	9355.5
2010-2012 Season									
One row of barley	49.70	4.13	1.55	16649.5	1445.5	1860	19955	8800	11155
Two rows of barley	48.60	5.10	1.24	16281	1785	1488	19554	9100	10454
Three rows of barley	46.80	5.95	2.09	15678	2082.5	2508	20268.5	9400	10868.5
Sole barley	-	12.17	4.03	-	4259.5	4836	9095.5	6000	3095.5
Sole sugar cane	50.70	-	-	16984.5	-	-	16984.5	8500	8484.5

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إنتاجية وجودة خلفة قصب السكرالخريفى المحملة بالقمح أوالشعير تحت ظروف مصر الوسطى

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ملخص

في بعض الأحيان يحدث تحت ظروف مصر الوسطى تأخر تحميل القمح على قصب السكر بسبب تأخر كسر القصب لكن في هذه الحالة يكون الأنسب تحميل الشعير على القصب ، لذا أقيمت أربع تجارب حقلية بمحطة البحوث الزراعية بملوى – محافظة المنيا – مصر(تحميل قمح او شعير على قصب خلفه ثالثة)خلال موسمي ٢٠٠٩ / ٢٠١١ م – ٢٠١٠ / ٢٠١٢ م لدراسة تأثير تحميل سطر ،سطرين وثلاثة سطور من القمح أو الشعير على إنتاجية ،جودة وربحية قصب السكر في تصميم قطع كاملة العشوائية.

ويمكن تلخيص النتائج المتحصل عليها كالاتى

١- سجلت الزياده فى ناتج المحصول من خلف قصب السكر الخريفى المحمل بالقمح(طن/ فدان) ٩٩.٩٤، ٩٩.٢٤ و٩٨.٣٨ % في الموسم الأول، و٩٩.٨٠ ،٨٢.٣٧ و٨٠.٩٢ % عن القصب المنفرد في الموسم الثاني . بينما وجدت قيم ناتج محصول قصب السكر المحمل بالشعير٩٨.٣١ ، ٩٧.٠٠ و٩٤.٩٣% في الموسم الأول، و٩٥.٨٦،٩٨.٠٣ و٩٢.٣١% عن القصب المنفرد في الموسم الثاني عند تحميل سطر، سطرين وثلاثة سطور على القصب على التوالي.

٢- أظهرت النتائج عدم وجود تأثير لنماذج تحميل سطر ،سطرين و ثلاثة سطور من القمح او الشعير على صفات جودة عصيرالقصب (مثل نسبة المواد الصلبة الذائبة الكلية ، نسبة السكروز ، نسبة النقاوة ،نسبة الحلاوة، نسبة السكريات المختزلة ونسبة استخراج السكر) عدا نسبة استخراج السكر في الموسم الاول للقصب المحمل بالقمح و نسبة النقاوة في الموسم الاول للقصب المحمل بالشعير.

٣- حدث زيادة فى كفاءة استغلال الأرض (LER)عند تحميل القمح أو الشعير على قصب السكر وسجلت القيم الأعلى لهذه الصفة (١.٣٣و ١.٥٠) عندما حمل القمح في الموسم الأول او الشعير فى الموسم الثاني بثلاثة صفوف على القصب على التوالي.

٤-لوحظ ان قيم العدوانية (Agg) بين القصب المحمل والقمح او الشعير سلبية للقصب وموجبة للقمح او الشعير مما يشير الى سيادة كلا من القمح والشعير على محصول القصب الخريفي فى كلا الموسمين الزراعيين، عدا القصب المحمل بثلاثة صفوف في الموسم الثاني

٥- كان العائد الاقتصادي الناتج من تحميل القمح او الشعير على قصب السكر مربح للمزارع مقارنة بالزراعة المنفردة للقصب، علاوة على زيادة المساحة المنزرعة و الإنتاجية من محصول القمح الذي يمثل احد المحاصيل الإستراتيجية للدولة.

يتم من النتائج المتحصل عليها التوصية بتحميل القمح على القصب إذا تم كسره مبكرا خلال شهرى نوفمبر وديسمبر، لكن إذا تأخر الكسر حتى شهر يناير لاى سبب يكون فى هذه الحالة تحميل الشعير على القصب الأنسب والأفضل تحت ظروف مصر الوسطى.