New agro-techniques in intensive crop rotations under marginal conditions of Upper Egypt

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Abstract

Two intensive experiments were carried out in Toshky region in upper Egypt to adapt two crop rotations to cover most of the year under torrid, arid and hyperthermic conditions of this region. First rotation was cotton followed by tomato intercropped with sorghum. The second rotation was sugar beet followed by cotton. Both rotations proved success, particularly, when new agro-techniques were used when raising these crops to avoid sharp waves of heat which frequently occurred coupled with windy storms or the very cold nights in winter or in the short spring. The results obtained from the first rotation (cotton- tomato) revealed that mechanically transplanted cotton yielded more than the direct seeding method. When raising the second crop, heat tolerant variety of tomato was used to avoid heat waves, which frequently occurred during summer. Tomato intercropped with grain sorghum as the shade crop yielded more than pure stand tomato, with little loss of sorghum yield. The Land Equivalent Ratio of the tomato-sorghum intercrop ranged from 2.58 to 2.99. In the second rotation, sugar beet was followed by cotton grown in a multi-seasonal system. Transplanting gave higher number of dual roots in sugar beet than direct seeding, but tuber yields were not significantly different. Late summer planting of cotton resulted in high yield, but the yield was depressed when planting was delayed to July.

Media Summary

To adapt intensive cropping by growing more than one crop per year under very sharp and fluctuated weather in Toshky region (upper Egypt), transplanting crops and intercropping as protective measure was studied. The result obtained evidenced that both methods were positive and effective.

Introduction

Toshky region is located far in the south of Egypt, south of Aswan, in an area estimated to be 3 million acres. It is considered torrid, arid and hyperthermic. The soil is sandy with limestones. But the most striking effect on agriculture, there, is the sharp, marginal and fluctuated weather. Toshky area is very dry with long hot summer. Maximum air temperatures ranges from 40 ^{o}C- 50 ^{o}C (June- August), whereas, minimum air temperature ranges from 4 ^{o}C - 25 ^{o}C (December- February). Humidity of air ranges from 13-45%, with lower humidity in winter. Evapotranspiration is estimated at about 30m per day. Under these condition, cropping during summer is difficult. However, the inclusion of some new agrotechniques may help to provide a green cover most of the year, increasing agricultural production and diversification of cropping.

In the old land, new agrotechniques in transplanting cotton in Egypt were studied (Kamel et al. 1991). These included seeding in plastic bags or in separate paper pots with different sizes or in trays filled with peat moss or clay. The results indicated poor stand, lower yield and uneasiness as compared with direct seeding method. Some factors affecting transplanting cotton was studied by (Kamel et al. 1994). Young transplants (30 day old) and increasing transplant density in field up to 64600/acre yielded the best. Delaying time of transplanting diminished yield of cotton (Sherif et al. 1995), revealed that same factors affected seeds, fiber properties of transplanting cotton in the same pattern. Serag El-Din (2000), studied transplanting sugar beet. He revealed that this method impaired beet quality, although, yielding was as in direct seeding methods. (El-Sahrigi et al. 2001), found that cotton transplanted by semi-mechanical transplanter out-yielded manual transplanting and consumed irrigation water less than direct seeding. (Abd El- Aal and Zohry 2003) intercropped tomato with maize as a protective measure from summer heat in upper Egypt. They also revealed increases in land utilization and improved tomato yield and fruit quality.

Methods

Two crop rotations were carried out in horticultural farm in Toshky region in 2002 and 2003 year to study the possibility of growing two crops per year instead of the conventional cropping system (one crop/year).

First crop rotation:

Cotton cv.Giza 83 as early summer crop was followed by tomato intercropped with grain sorghum as a shade crop in the late summer. Cotton was grown by transplanting and direct seeding methods at three dates, i.e, 1st February, 15th February and 1th March. The design of the experiment was split plot design. Method of planting was arranged in the main, whereas, date of planting occupied the sub-plots. Sub-plot area was 40 $m^{2.}$ After picking cotton, all plots were seeded by grain sorghum cv. Giza 15 at 20cm apart on ridges one week befor transplanting tomato at each date. Tomato transplants cv. Strain B were transplanted at three dates, i.e, 1 st Juny 15 th June and 30 th June on other side of ridges. Intercropped treatments were checked with pure stand grain sorghum and tomato and were assigned in complete randomize block system. Intercropping was evaluated by land equivalent rate (total LER) according to (Willey and Osiru 1981)

Second crop rotation:

Sugar beet cv Gitan as the winter crop was followed by cotton cv. Giza 83 in the late summer. Resemblance to the first rotation was the techniques that followed in this rotation. Sugar beet was grown by both methods; transplanting and direct seeding method at three dates of planting 1st November, 15 th November and 15 th December. Transplanting by paper pot in expanda was used in seedbeds under tunnel. After harvesting the beet, cotton was planted in the field plots at three dates; 1 st June, 1 st July and 15 th July. Yield of cotton, and grain sorghum, and marketable yield of sugar beet and tomato were determined on plot basis, and converted to t/ha the combined data of the two seasons. Data obtained were statistically analyzed according to the procedures outlined by (Snedecor and Cochran 1981).

Results

First rotation

Data in table 1 showed regular and consistent trend in cotton yield per ha as well as the yield components as affected by date and method of planting. There were gradual decreases in values of all these traits with delaying time of seeding, except the average number of unopened bolls which increased in the later planting dates. Earliest date of transplanting resulted in highest values of these traits with significant differences compared with the other two dates. Earliest date of direct seeding method ranked the second. Interpretation of these results might owe much to the increases in the total growing degree (GDD) until picking cotton whether in case of direct seeding or transplanting (Kamel et al.1994 and CIPR 2001) supports these results. Cotton when transplanted at 1st February yielded more than grown by direct seeding. Weather fluctuation may have had deleterious effect on cotton germination and seedling survival when grown by direct seeding.

Table 1. Effect of method and date of planting on yield and some yield components of cotton grown at early summer season(Av. of 2002and 2003)

Methods	Direct Seeding				Transplanting			
?	No of bolls/plant	Plant	Yield	Stand	No of bolls/plant	Plant	Yield	Stand

Date	Opened	Closed	weight (g)	t/ha	%	Opened	Closed	weight (g)	t/ha	%
1st Feb.	19	7	2.6	2.300	79	24	8	2.5	2.943	90
15th Feb	12	8	2.4	2.105	82	22	7	2.4	2.748	95
1st March	14	11	2.3	1.570	92	13	12	2.6	1.373	96
L. S. D (p=0.05) of interaction date of planting X method of planting										
	5.8	NS				NS	0.59			

Data in table 2 indicate the beneficial effect of intercropping tomato with grain sorghum as a shade crop. Intercropping resulted in yield advantage at any date of planting. The shade crop reduced air temperatures surrounding intercropped tomato canopy to as less 5-7 ^{o}C as compared with the pure stand tomato. These observations were in agreement with those obtained by (Sahar-Ibrahim 2000). Decreases in yield of both the over and under story crops were also evident with delaying time of transplanting tomato. It is also evident that intercropped tomato yielded more than tomato grown soley at any date of transplanting tomato. The data also revealed that highest value of land utilization was associated with the second date (approximately 3 fold sole cropping). These results might be due to the favourable micro-environmental factor (particularly the thermal index) which prevailed at this period. Intercropping tomato as protective measure from heat waves in summer was also demonstrated by (Abd El-Aal and Zohary 2003).

Table 2. Yields and yield advantage of marketable tomato intercropped with grain sorghum in summer season (Averages of 2002 and 2003)

Date	Intercropped		Pure Stand		Land Equivalent Ratio (LER)
	Tomato t/ha	Sorghum t/ha	Tomato t/ha	Sorghum t/ha	
1st June	38.925	5.250	19.525	5.600	2.93
15th June	29.525	4.200	15.550	3.850	2.99
30th June	22.100	3.325	13.538	3.500	2.58
L. S. D (p=0.05) of interaction date of planting X method of planting					
	10.575				NS

Second rotation

Direct seeding and transplanting method did not result in significantly different sugar beet yield as compared with method. Serag El-Din (2000) results were concordant with these results. The data also evidenced that planting sugar beet in 15th November (the moderate date of planting) resulted in highest yield/ ha owing the favourest micro environmental factors which led to the highest yield of tuber/ ha as compared with the other two dates of planting. The effect of method and date of planting on other yield components followed the same trend as the yield was influenced. From another angle of data higher values of tuber weight were associated with lower values of total soluble sugars, which led to impair tuber quality. The data revealed that all values of total soluble sugar were below the standard (16%). It seemed that the nature of virgin soil as well as the relatively high dose of nitrogen in fertilization rate could be the cause and effect (Zohary 1994). The data also revealed that transplanting increased the average number of dual roots as compared with direct seeding method, over all three planting dates. Root injury owing to trans planting might be also the cause and effect. However, transplanting might be more beneficial when growing sugar beet as early as possible to enable more intensive cropping (3 crops per year), i.e., add another crop between beet harvest and plan ting cotton. Growing cotton at late summer was distinctive and different from the early summer crop.

Table 3. Effect of method and date of planting on yield and some yield componants of sugar beet grown in winter season (Av. of 2002/2003)

Method	Direct seeding							Transplanting						
Date	Dual root/plot	RD (cm)	RL (cm)	RW (Kg)	MY (t/ha)	TSS (%)	Stand %	dual root/plot	RD (cm)	RL (cm)	RW (Kg)	MY (t/ha)	TSS (%)	Stand %
1st Nov.	10	10.5	16.5	0.8	44.0	11.2	85	25	11.0	22.5	0.9	52.0	10.6	91
15th Nov.	5	13.0	23.0	0.9	68.3	10.0	90	20	14.0	24.0	1.2	64.5	9.4	98
1st Dec.	4	11.5	19.5	1.1	52.0	11.5	93	26	12.0	20.5	0.8	51.5	9.8	94
L. S. D (p=0.05) of interaction date of planting X method of planting														
	11.8	NS	3.6	0.27	21.8		NS							

RD: Root diameter RL: Root length RW: Root weight MY: Marketable yield of tubers

TTS: Total soluble sugar

The objective of growing cotton at the late summer was to establish the basic vegetative structure of the crop prior to virtual cessation of growth during the very cold winter season (from December to February) and hence the crop was expected to enter the fruiting stages, flower and produce bolls ready for

harvesting before the onset of excessively high temperatures. Good yield was obtained when the crop was planted in June. However, delaying the planting resulted in yield losses. Delaying planting to June resulted in yield reduction by one third to half, as number of bolls that failed to open increased in the later planting. Transplanting did not have significantly different effects from direct seeding.

Table 4. Effect of method and date of planting on yield and some yield components of cotton grown at late summer season (Av. of 2002/2003

Method	Direct seeding					Transplanting				
	Av. No. of bolls/ plant		Weight of Boll /plant	Yield t/ha	Stand %	Av. No. of bolls/ plant		Weight of boll / plant	Yield t/ha	Stand %
Date	Opened	Closed				opened	Closed			
15 th June	23.5	7.4	3.0	3.275	98	25.5	8.1	3.3	3.700	97
1th July	21.3	6.4	2.8	2.525	93	23.0	7.5	3.1	3.075	96
15st July	13.1	8.1	2.5	2.075	95	16.5	12.2	3.1	1.875	92
L. S. D (p=0.05) of interaction date of planting X method of planting										
	2.6	3.2	1.1	0.92						

Conclusion

This study has found that there are many ways to improve crop productivity in an area with marginal condition of upper Egypt. The data obtained indicate that transplanting cotton in early summer season is advisable, since there are frequent cold nights and storms at the beginning of the season. Thence it is recommended that cotton transplants be raised in protected seedbeds instead of direct seeding. Although, data revealed that growing cotton at late summer season out yielded the early season, however, the area time equivalent ratio should be considered. In concern with trans planting sugar beet, the data indicate that transplanting early in the winter season enable the farmers to increase the rate of intensification. Intercropping gave advantage in yield and fruit quality to the under-story crop of tomato. Good yield was also obtained from late summer planting of cotton. However, delaying planting after June resulted in yield losses because of the number of bolls that failed to open. There was no significant difference between the effects of transplanting and direct seeding of the later summer cotton.

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