Crop Interference Effects of Some Winter and Summer Field Crops on Egyptian Cotton Characters

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Abstract

A two-year study was carried out at Sids Agricultural Research Station, Beni Sweif government, Agricultural Research Center (ARC), Egypt, during 2015/2016 and 2016/2017 seasons to evaluate the crop interference of Egyptian clover, faba bean, onion, wheat, cowpea and sesame crops on Egyptian cotton characters for maximizing land usage with economically efficient cropping system and good fiber quality. The treatments were the combinations between four winter cropping systems (double cropping systems of Egyptian clover and cotton, relay intercropping cotton with faba bean, onion or wheat) and three summer cropping systems (sole cotton, intercropping cowpea or sesame with cotton). The treatments were compared in a split plot design with three replications. Egyptian clover, faba bean and onion had positive effects on seed cotton yield, yield attributes and fiber quality traits. Summer crops affected significantly seed cotton yield, yield attributes and fiber quality traits. Crop interference effects of cotton+cowpea pattern improved cotton fiber quality compared with sole cotton, meanwhile cotton +sesame pattern had the opposite trend. The interaction between winter and summer cropping systems was significant for seed cotton yield plant^{-1} and lint in the first season, boll weight and 100-seed weight in the second season. Egyptian clover/cotton+cowpea achieved the highest LER and ATER followed by onion+cotton/cotton +cowpea. Onion+cotton/cotton+cowpea had higher net return and fiber quality for spinning the stronger and silkier yarns that can be woven into luxury cotton clothing than the conventional cropping system (Egyptian clover/cotton).

Keywords: Crop interference; Cropping systems; Seed cotton yield; Fiber quality; Competitive relationships; Farmers' bene ft

Introduction

Always, population growth is considerable pressure on available environmental resources. About half of Egypt's residents live in urban areas, with most people spread across the densely populated centers of greater Cairo, Alexandria and other major cities in the Nile Delta. Egypt's fertile area totals about 3.3 million ha, about one-quarter of which is land reclaimed from the desert. However, the reclaimed lands only add 7% to the total value of agricultural production [1]. Even though only 3% of the land is arable, it is extremely productive and can be cropped two or even three times annually [2]. Fortunately, Egypt had four seasons during the year, but generally there are only two familiar seasons for Egyptian agriculture that is a mild winter from November to April and a hot summer from May to October. T e most di ferences between the seasons are variations in light intensity, daytime temperatures and prevailing winds. Consequently, there are some strategic crops such as wheat (*Triticum aestivum* L.), faba bean (*Vicia faba* L.) and onion (*Allium cepa* L.) in addition to Egyptian clover (*Trifolium alex omom mo l* included four stages of growth (initiation, primary elongation, secondary wall formation and maturation). It known that cotton plant store substantial amounts of photo-assimilate as starch in stems and roots prior to f owering [14]. T erefore, it is expected that environment surrounding cotton seedling and growth could be have substantial e f ects on boll formation. Certainly, environmental conditions can be playing a vital role in cotton growth and development stages. T e e f ects of climatic factors such as evaporation, sunshine duration, humidity, surface soil temperature and maximum air temperature are the important factors that a f ect signi f cantly f ower and boll production of cotton [15].

For edaphic factors, the mobility in soil is dependent on the chemical form of the element used. T e availability of nitrogen (N), phosphorus (P), potassium (K) and water are the major constraints in cotton production in most cotton producing environments [16]. T erefore, the allelopathic e f ect of the winter and summer f eld crops on seed cotton yield and its attributes were

Crop	Season			
	First Season		Second Season	
	Sowing Date	Harvest Date	Sowing Date	Harvest Date
Egyptian clover	21st October	11th March	18th October	7th March
Faba bean	21st October	29th April	18th October	26th April
Onion	21st October	14th April	18th October	12th April
Wheat	21st October	8th May	18th October	5th May
Cotton	22nd March	16th September	18th March	13th September
Cowpea	14th May	27th July	11th May	24th July
Sesame	14th May	30th August	11th May	28th August

Table 2: Sowing and harvest dates of all the studied field crops in the two seasons.

The experiment included twelve cropping systems as follows:

- Egyptian clover seeds were broadcasted at the rate of 47.6 kg ha^{-1}. After the third cutting of Egyptian clover, cotton seeds were grown in two sides of the bed, two plants together distanced at 25 cm. This cropping system was expressed as Egyptian clover/cotton in the winter season and sole cotton in the summer season (conventional cropping system).
- Egyptian clover seeds were broadcasted at the rate of 47.6 kg ha^{-1}. After the third cutting of Egyptian clover, cotton seeds were grown in two sides of the bed, two plants together distanced at 25 cm. Two rows of cowpea seeds were grown in middle of cotton beds, two plants together distanced at 20 cm. This cropping system was expressed as Egyptian clover/cotton in the winter season and cotton+cowpea in the summer season.
- Egyptian clover seeds were broadcasted at the rate of 47.6 kg ha^{-1}. After the third cutting of Egyptian clover, cotton seeds were grown in two sides of the bed, two plants together distanced at 25 cm. One row of sesame seeds were grown in middle of cotton beds, two plants together distanced at 20 cm. This cropping system was expressed as Egyptian clover/cotton in the winter season and cotton+sesame in the summer season.
- Two rows of faba bean seeds were grown in middle of the bed, two plants together distanced at 15 cm.

(Egyptian clover, faba bean and wheat) had signifcant efects on number of open bolls plant^{-1} and seed cotton yield unit area^{-1}. On the

Onion	26.0	30.0	44.0	48.0	330.0	366.0
Wheat	14.0	20.0	30.0	36.0	262.0	292.0
L.S.D. 0.05	**14.08**	**11.66**	**3.83**	**3.**		

Although content of ferulic acid was found in rhizosphere of

Summer Cropping Systems	Characters											
	Intercepted Light Intensity at Middle of the Plant (%)	Plant Height (cm)	Nodal Position of the First Sympodium	Monopodia $Plant^{-1}$ (no.)	Sympodia $Plant^{-1}$ (no.)	Open Bolls $Plant^{-1}$ (no.)	Seed Cotton Yield $Plant^{-1}$ (g)	Boll Weight (g)	100-Seed Weight (g)	Lint (%)	Seed Cotton Yield ha^{-1} (t)	Lint Cotton Yield ha^{-1} (t)
	First Season											
Sole cotton	13.45	122.55	7.83	1.60	17.00	14.40	33.53	2.41	8.43	41.53	2.87	1.19
Cotton+cowpea	13.26	124.03	7.90	1.62	16.68	14.57	34.02					

Wheat	**Sole cotton**	31.96	40.43	2.24	9.28
	Cotton + cowpea	31.92	40.09	2.21	9.17
	Cotton + sesame	31.50	40.24	2.15	9.00
L.S.D. 0.05		**2.06**	**0.44**	**0.13**	**0.28**

T erefore, the advantage of Egyptian clover/cotton pattern could be attributed to the last date of Egyptian clover cutting furnished available normal climatic resources for cotton fber growth compared with the relay intercropping cotton with faba bean or wheat. T e light environment surrounding plants afected seedling growth [86]. Moreover, the minimum, optimum, and maximum temperatures for cotton vary depending on growth and developmental processes [87]. T ese results reveal that Egyptian clover/cotton pattern produced good fber quality for high upper half mean, uniformity index and fber elongation compared with the other cropping systems.

Clearly, growing cotton afer Egyptian clover received relatively lower solar radiation than those of onion+cotton pattern which refected on dry matter accumulation of cotton during fber growth and development. It is expected that canopy structure of cotton plant afer Egyptian clover was relatively greater than that of onion+cotton pattern as a result of Egyptian clover residues. In other words, growing cotton plants afer Egyptian clover may be received relatively lower solar radiation and higher warmer temperature than those of onion +cotton pattern. In this concern, Pettigrew et al. [88] showed that reduced photosynthetic rates and the modulation of other metabolic factors, in association with lower light intensities, may result in lower micronaire and fber strength which explained lower fneness and strength for cotton fbers that followed Egyptian clover.

Conversely, higher cotton fber length (upper half mean, uniformity index and fber elongation) afer Egyptian clover cutting may be due to this copping system furnished relatively warmer night temperature environment that accelerated fber growth and development compared with onion+cotton pattern. Fiber length (upper-half mean length) was correlated negatively with the diference between maximum and minimum temperature [89]. Fibers grown at 15°C took 3 to 5 d longer to reach 2 mm in length than did control fbers grown at 24°C [90].

Under-ground conditions: Upper half mean, uniformity index and fber elongation were enhanced as a result of soil N, P and K availabilities afer Egyptian clover cutting, faba bean harvest or onion uprooting compared with those afer wheat harvest in the two growing seasons (Table 4). T e results could be attributed to soil N availability was sufcient to maintain good fber quality. Soil N availability may be promoted some proteins synthesis such as IAA before boll maturing. According to Gialvalis and Seagull [91], external application of IAA promoted quality [107]. Also, Guo et al. [108] indicated that soil P defciency inhibited completely fber elongation.

Summer crop interference efects on cotton fber quality

Upper half mean, uniformity index, fber strength, fber elongation, micronaire reading and color-refectance were afected signifcantly by summer cropping systems (Table 8). Cotton+cowpea pattern had the highest values of upper half mean, uniformity index, fber strength, fber elongation and color-refectance compared with the other treatments in the two growing seasons. On contrary, the lowest micronaire was observed in cotton+cowpea pattern compared with the others in the two growing seasons.

Summer Cropping Systems	Characters				
	Fiber Length Parameters	Fiber Strength (g/tex)	Fiber Elongation (%)	Micronaire Reading	Color-Reflectance

delay in reproductive growth of cotton. Fiber quality is mainly associated with nutritional and environmental conditions during the boll development [112].

T e interaction between winter and summer cropping systems

T e interaction between winter and summer cropping systems had no signifcant efects on upper half mean, uniformity index, fber strength, fber elongation, micronaire reading and color-refectance in the two growing seasons. T ese

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Onion	**Cotton+cowpea**	34.46	3.06	26.52	0.73	0.80	0.53	2.06	0.72
	Cotton+sesame	34.46	2.80	0.599	0.73	0.74	0.53	2.00	0.68
Mean		**34.46**	**2.93**	**---**	**0.73**	**0.77**	**0.53**	**2.03**	**0.70**
Wheat	**Cotton+cowpea**	5.65	2.92	26.08	0.67	0.77	0.52	1.96	0.68
	Cotton+sesame	5.65	2.78	0.593	0.67	0.73	0.52	1.92	0.65
Mean		**5.65**	**2.85**	**---**	**0.67**	**0.75**	**0.52**	**1.94**	**0.66**

	Cotton+cowpea	789	924	263	1976	778
	Cotton+sesame	789	850	372	2011	740
Mean		**789**	**912**	**317**	**1913**	**701**
Second Season						
Egyptian clover	**Sole cotton**	508	1493	---	2001	910
	Cotton+cowpea	508	1462	278	2248	1117
	Cotton+sesame	508	1371	383	2262	1058
Mean		**508**	**1442**	**330**	**2170**	**1028**
Faba bean	**Sole cotton**	532	1288	---	1820	652
	Cotton+cowpea	532	1256	270	2058	850
	Cotton+sesame	532	1169	378	2079	798
Mean		**532**	**1237**	**324**	**1985**	**766**
Onion	**Sole cotton**	1791	1264	---	3055	2026
	Cotton+cowpea	1791	1209	265	3265	2196
	Cotton+sesame	1791	1106	368	3265	2124
Mean		**1791**	**1193**	**316**	**3195**	**2115**
Wheat	**Sole cotton**	777	1213	---	1990	822
	Cotton+cowpea	777	1153	260	2190	992
	Cotton+sesame	777	1098	365	2240	969
Mean		**777**	**1154**	**317**	**2143**	**927**

Table 10: Financial advantages of cotton under diferent cropping systems in the frst and second seasons.

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ə.ɕ} Prices of main products are that of 2016: US$ 395.2 ha^{-1} for ton of seed cotton, US$ 615.8 ha^{-1} for ton of sesame seeds, US$ 259.6 ha^{-1} for ton of faba bean seeds, US$ 169.3 ha^{-1} for one cut of Egyptian clover, US$ 137.6 ha^{-1} for ton of wheat grains, US$ 52.0 ha^{-1} for ton of onion and US$ 10.0 ha^{-1} for one ton of cowpea.

Conclusion

Our results reveal that onion had positive crop interference efects on cotton and this efect was improved by intercropping cowpea with cotton in the summer season and can be helpful to understand p. mk_ er seasonR ŭב on in the onanŏpmko ʌn!

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