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Effect of Crop Sequence and Nitrogen Fertilization on Productivity of Wheat

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ABSTRACT

Two field experiments were carried out at Arab El-Awammer Research Station, Agric. Res. Center Assiut Governorate during winter seasons of 2013/2014 and 2014/2015. The present study assessed the effect of crop sequence and nitrogen fertilization on productivity of wheat. The experimental treatments were four crop sequences with three nitrogen fertilizer rates. Treatments were arranged in a factorial experiment 3×4 based on a RCBD with four replications. These results suggest that the sequence of cowpea / clover / wheat and the sequence of cowpea + maize / clover / wheat produced the maximum yield and its components of wheat as compared with the other sequences. Naturally Occurring Biological Control Agents (NOBCA) the maximum number of agents was existed in the sequences of cowpea / clover / wheat and cowpea + maize / clover / wheat. The lowest number was existed in the sequence of maize / wheat. The present research proved that the two promising sequences contributed so much in increasing the cropping area. Therefore, the cropping index was increased to be 2.87 or 3.39 in the year for the two sequences of cowpea / clover / wheat and cowpea + maize / clover / wheat, respectively. These values are considered to be more than the traditional index in Egypt which is 1.73. The net return from the sequence of cowpea + maize / clover / wheat was the highest when compared with the other sequences. Thus increasing the cropping area which increased the cropping index caused an increase in the net return.

Introduction

The most important target for the Egyptian Agriculture is the increase of food production in order to bridge or reduce the "food gap" resulting from the continuous increase of the population. Land reclamation is an important solution to solve this problem. Also, raising the cropping index of the agricultural area by means of crop sequence inclusion of catch crops to adopt growing three crops per year will certainly help to increase land use efficiency and raising the cropping index.

Understanding crop sequences is necessary in determining the productivity and sustainability of a long-term rotation. Well sequenced crops may improve soil quality and crop production.

Wheat (Triticum aestivum L.) is one of the most important staple food crop. Wheat generally follows crops viz., rice, maize, sorghum and pearl millet, which are highly nutrients exhaustive. The cultivation of cereals in a year on the same piece of land leads to imbalance in the soil fertility, resulting in decline in yield of both the crops. To obtain an optimum yield, use of more and more fertilizers every year affects the soil fertility. Using of crop sequence has been found to be quite promising in maintaining higher productivity. Hence the present experiment was made to find out the effect of crop sequence and nitrogen fertilization on productivity of wheat crop. Previous studies indicated that, all growth and yield-contributing characters of wheat were significantly improved by different cropping systems compared with maize-wheat system and maximum values were recorded in the cowpea (fodder)-wheat system expect 1000-grain weight which was the highest in the cowpea-wheat system. Such increase can be attributed according to beneficial residual effect of legume on the succeeding wheat crop Kumpawat (2002). Plant height at harvest, grain, straw yield and seed index tended to be increased when wheat planting was after clover and as nutrients rates were increased as compared with the sequence of corn-fallow-wheat. Linear increases in all grain yield and its components except the seed index were observed as nutrients rates were increased Said (2007). There were significant differences between crop sequences with wheat for plant height, number of spikes/ m^2, number of grain/spike, 1000-grain weight, grain and straw yields/feddan economic evaluation in the two seasons. The highest values of attributes all the studied were found from wheat plants grown after berseem followed by wheat plants grown after fallow and difference between berseem as a catch crop them reach the level of significance in the two seasons. Also, Results showed that application of 56.25 Kg N/Fed + 20 m^3 farmyard manure gave the highest values for all attributes studied, followed by addition of 75 Kg N/Fed. There were significant interaction effects between crop sequences and fertilizer treatments on all attributes studied. Sowing wheat after berseem in the crop sequence and fertilized with 56.25 Kg N/Fed. + 20 m^3 FYM/fed. Gave the highest values of all characters studied in both seasons as compared with the sequence wheat planting was after fallow and sowing wheat after darawa Hefny (2012). The crop

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sequence of wheat / maize produced the maximum values of number of spikes/m^2, grain yield and straw yield in the first year only. The values of yield and yield components in the second and third crop sequences of wheat + faba bean / maize + cowpea / fahl berseem and wheat + fahl berseem / maize + cowpea were higher than the crop sequence, wheat / maize in the second and third years. The increased in yield and its components in the two crop sequences of wheat + faba bean / maize + cowpea / fahl berseem and wheat + fahl berseem / maize + cowpea was due to residual effects of crop sequences and inclusion of legume crops which improved soil fertilizer in the second and third years compared with the crop sequences of wheat / maize Abou-Keriasha and Eissa (2014). The overall conclusion is that an improved crop residue management, combined with application of fertilizer N or incorporation of legumes greatly improves the N economy of cereal cropping systems and enhances crop productivity in soils with a low N content on the short term Pandiaraj et al. (2015). Increasing nitrogen fertilizer (100 kg N/fed.) increased significantly plant height at harvest, days to 50% heading, total chlorophyll, grain yield and its components such as, spike length, number of spikelets/spike, number of grains/spike, grain weight/spike, number of spikes/m^2 straw, biological yield and seed index of wheat Nassar (2007). Nitrogen content influenced from presence and ratio mineral elements in the soil. Nitrogen content was close link with chlorophyll content Biljana Bojović and Aca Marković (2009). Number of spikes/m^2, 1000- kernel weight and grain yield were increased with the increments of nitrogen application levels up to 75kg N/fed. Abdel Nour and Fateh (2011). Plants with higher N content not only had higher chlorophyll content but also had thicker, flatter and more turgid leaves, which enhances visible light absorption while stimulating near-infrared reflection Yuh-Jyuan Lee et al. (2011). Plant height, yield and its components were significantly affected by nitrogen fertilizer rates. Increasing nitrogen fertilizer rate up to 180 kg ha^{-1} significantly increased plant height, yield and its components in the combined analysis compared with 45 kg N and the other nitrogen rates (90 and 135 kg ha^{-1}) Abd El-Razek and El-Sheshtawy (2013). Plant height, yield and yield traits of wheat were significantly increased with increasing the levels of nitrogen fertilization (120 kg N/fed.) on sandy calcareous soils Hassanein et al. (2014). Different N levels had significant influence on plant height, 1000 grain weight and straw and grain yields. The maximum plant height, weight of 1000 grain and straw and grain yields were found with 120 kg N ha^{-1} and the minimum these traits were observed with 00, 80, 100 kg/ha Shirazi et al. (2014).

Material and method

The current study was conducted in research field, Arab El-Awammer Research Station, Agric. Res. Center Assiut Governorate, Egypt during the winter seasons of 2013/2014 and 2014/2015. The field site is located between latitude 27° 05′ and longitude 31° 64′. The soil of such experiment was sandy calcareous as presented in Table 1.

Each field experiment was executed in winter seasons of 2013/2014 and 2014/2015. bread wheat cv. Sids 1. The fertilization requirements ware calculated based on area of feddan, this is 4200 m^2. The feddan fertilization requirements were P_2O_5 (200 kg fed^{-1}) and K_2O (50 kg fed^{-1}) were applied during land preparation.

A- The crop sequences were as follows

1-(S1) = Cowpea / clover (Fahl) / wheat.
2-(S2) = Intercropping cowpea with maize / clover (Fahl) /wheat.
3-(S3) = Maize / clover (Fahl) / wheat.
4-(S4) = Maize / wheat.

B- Nitrogen Fertilizer rates were as follows

1- 60 Kg/fed (F1).
2- 90 Kg/fed (F2).
3- 120 Kg/fed (F3). The recommended rates

Ammonium nitrate 33.5 %N used as mineral N-fertilizer, was added at the tested level in five equal doses, after 20- 40- 55-70 and 85 days from sowing.

Agronomic characters

Plant height

At harvest, measured in cm from surface of the soil to the top of the spike of the main stems.

Total chlorophyll (mg/m^2)

Total chlorophyll (Chl "a+b") was determined in blades of wheat flag leaves at heading stage by Chlorophyll Meter SPAD-502Plus reported by (Dash et al. 2007).

SPAD calibration equations:

$$y = 0.118\,x^2 + 0.919\,x + 7.925$$

Where,

y represents chlorophyll concentration in mg/m^2,

x represents SPAD value.

Grain yield and its components

Ten plants were chosen randomly from each of the experimental plot to determine the following characters:

1. Number of spikes/m^2.
2. Number of grains/spike.
3. 1000- grain weight (g).
4. Grain yield (Kg/fed.).
5. Straw yield (Kg/fed.)

Naturally Occurring Biological Control Agents (NOBCA)

It well known that legume crops are considered a reservoir for the Naturally Occurring Biological Control Agents (NOBCA). Therefore, observation in this respect for every sequence was done in season 2014/2015. The sweeping net method was commonly used for the practical response. Twenty-five double sweeps (per 21 m^2) was the standard sample size. Each collected sample was emptied into a labeled collecting cloth bag and transferred to the laboratory. Then identified and counted by using Stereomicroscope.

Farmers benefit

Cropping index

The cropping index was calculated using the following formula:

Cropping index = (crop area/ land area)

According to Shafshak and Debaby (1975).

Economic evaluation

To calculate the net return of the four crop sequences, the following market prices with Egyptian currency (L.E.) were used: 2.58 L.E./kg for wheat grain, 0.62 L.E./kg for wheat straw, 2 L.E./kg for maize grain, 0.12 L.E./kg for maize straw,120 L.E./ton for fresh forage of cowpea and 100 L.E./ton for fresh forage of clover (Bulletin of The Agriculture Statistics, 2012/2013)

Statistical analysis

All the obtained data for the experiment of each season were subjected to the statistical analysis of factorial experiment 3×4 in a randomized complete blocks design (RCBD) with four replications according to Gomez and Gomez (1984).

Table 1. Some physical and chemical properties of experimental site

Chemical analysis				Mechanical analysis (%)			Soil Texture
CaCO3 (%)	O.M. (%)	pH	ECdSm $^{-1}$	Sand	Silt	Clay	
30.9	0.19	8.37	0.33	89.9	7.1	3.0	Sandy

Table 2. Some chemical properties of experimental site

Type of soil	2013/2014	2014/2015
	Total N (%)	Total N (%)
Before cultivation	0.008	-
After cowpea (S1)	0.016	0.019
After cowpea+maize (S2)	0.014	0.017
After maize (S3)	0.012	0.015
After maize (S4)	0.011	0.009
After clover (S1)	0.018	0.020
After clover (S2)	0.015	0.018
After clover (S3)	0.013	0.017
After wheat (S1)	0.015	0.017
After wheat (S2)	0.012	0.015
After wheat (S3)	0.010	0.014
After wheat (S4)	0.009	0.007

Revised Least Significant Differences (LSD') at 5% levels of probability was used for comparing means according to Waller and Duncan (1969).

Result and discussion

Agronomic characters

a. Plant height at harvest in cm: the results demonstrated in Table 3 revealed that crop sequences studied affected significantly this trait in favour of the sequence of cowpea / clover / wheat (S1) & cowpea + maize / clover / wheat (S2) in the two growing seasons. This trend could be ascribed to the effect of the one or two legumes crop in the sequences for their property in fixation of nitrogen as indicated in Table 2. The lowest value in this respect was from the sequence of maize / wheat (S4). Several workers confirmed this trend such as Said (2007) and Hefny (2012). The results indicated a significant increase in these traits as nitrogen level was increased up to the recommended rate (120 kg N/fed) in the two growing seasons. This is to be expected since the mechanical analysis of the studied soil was sandy calcareous. The present trend was in general agreement with those obtained by Said (2007), Hefny (2012), Abd El-Razek and El-Sheshtawy (2013), Hassanein et al. (2014) and Shirazi et al. (2014).

b. Total chlorophyll (mg/m^2): data in Table 3 cleared that crop sequences studied affected significantly this trait. The crop sequence of cowpea / clover / wheat (S1) produced the maximum value of total chlorophyll (Chl "a+b") in flag leaves of wheat in the two growing seasons. This trend is to be expected since that sequence included two legume crops which have great effect in fixing nitrogen. This in turn may increase the chlorophyll because nitrogen was close link with chlorophyll content as indicated by Biljana Bojović and Aca Marković (2009) and Yuh-Jyuan Lee et al. (2011). The results indicated a significant increase in these traits as nitrogen level was increased up to the recommended rate (120 kg N/fed) in the two growing seasons. The present trend could be due to that nitrogen is an essential part of the chlorophyll molecule as indicated by Nassar (2007).

Grain yield and its components

1. Number of spikes/m^2: data presented in Table 4 showed that the crop sequences studied affected significantly in favour of the sequence of cowpea / clover / wheat (S1) followed by the sequence of cowpea + maize / clover / wheat (S2). The lowest value in this respect was obtained from the sequence of maize / wheat (S4) in the two growing seasons. This trend could be ascribed to the effect of the one or two legume crops in the sequences for their property in fixation nitrogen as indicated in Table 2. This in turn may enhance the photosynthesis process and consequently increasing the metabolites synthesized in wheat plant. Similar trends were obtained by Hefny (2012) and Abou-Keriasha and Eissa (2014). Rate of nitrogen affected significantly this trait in the two growing seasons. The number of spikes/m^2 tended to be increased as nitrogen rate was increased. The results may be due to the fact that increasing nitrogen rates caused an increase in number of fertile tillers/plant which resulted in higher number of spikes/m^2. Here, too these data could be attributed to the important role of nitrogen in building up new tissues used in producing the highest number of spikes/m^2. Such findings are in general accordance with those obtained by Nassar (2007) and Hefny (2012).

2. Number of grains/spike: data in Table 4 declared that this trait was reacted significantly to crop sequences studied in the two growing seasons. The crop sequence of cowpea / clover / wheat (S1) produced the highest number of grains/spike followed by the sequence of cowpea + maize / clover / wheat (S2). The lowest value in this respect was from the sequence of maize / wheat (S4). This trend could be attributed to the better nitrogen supply as a result of the biological fixation of nitrogen with organic matter in the soil from the residual effect of legume crops. These findings are in harmony with those obtained by Hefny (2012) and Abou-Keriasha and Eissa (2014). The nitrogen rates studied affected significantly number of grains/spike in the two growing seasons. Number of grains per spike tended to be increased as nitrogen rate was increased up to 120 kg N/fed. The same trend was detected by Nassar (2007) and Hefny (2012).

3. 1000- grain weight (g): data in Table 4 revealed that 1000-grain weight (g) reacted significantly to the crop sequences studied in the two growing seasons. The data showed that the sequence of cowpea / clover / wheat (S1) produced the heaviest seeds as compared with the sequence of maize / wheat (S4).

Table 3. Effect of crop sequence and nitrogen fertilization on agronomic characters (plant height (cm) and total chlorophyll (mg/m^2) of wheat, 2013/2014 and 2014/2015 seasons

Treatments		Plant height (cm)		Total chlorophyll (mg/m^2)	
Crop sequence	Nitrogen fertilization rates	2013/2014	2014/2015	2013/2014	2014/2015
(S1) cowpea / clover / wheat	(F1) 60 Kg N/fed	86.58	95.25	300.25	331.68
	(F2) 90 Kg N/fed	89.43	101.73	366.38	401.08
	(F3) 120 Kg N/fed	95.05	105.68	429.11	455.87
	Mean	90.35	100.88	365.25	396.21
(S2) cowpea + maize / clover / wheat	(F1) 60 Kg N/fed	84.60	92.38	276.38	306.43
	(F2) 90 Kg N/fed	90.28	96.75	323.14	355.74
	(F3) 120 Kg N/fed	94.78	99.13	375.32	410.43
	Mean	89.88	96.08	324.91	357.53
(S3) maize / clover / wheat	(F1) 60 Kg N/fed	82.35	85.63	238.00	265.99
	(F2) 90 Kg N/fed	85.65	88.43	296.11	327.33
	(F3) 120 Kg N/fed	90.40	93.25	342.37	375.91
	Mean	86.13	89.10	292.16	323.08
(S4) maize / wheat	(F1) 60 Kg N/fed	82.08	81.00	188.37	173.77
	(F2) 90 Kg N/fed	85.28	83.63	232.76	211.04
	(F3) 120 Kg N/fed	87.80	85.95	263.17	237.41
	Mean	85.05	83.53	228.10	207.41
L.S.D′ 0.05	Crop sequence (S)	2.75	1.88	8.26	10.10
	Fertilization (F)	2.19	1.71	7.16	8.75
	S × F	N.S.	N.S.	17.38	22.56

Table 4. Effect of crop sequence and nitrogen fertilization on grain yield and its components of wheat, 2013/2014 and 2014/2015 seasons

Treatments		Number of spikes/m^2		Number of grains/spike		1000- grain weight (g)		Grain yield (Kg/fed.)		Straw yield (Kg/fed.)	
		2013/2014	2014/2015	2013/2014	2014/2015	2013/2014	2014/2015	2013/2014	2014/2015	2013/2014	2014/2015
S1	**F1**	385.00	399.00	56.25	57.50	37.54	39.49	1545.00	2365.00	2944.50	4415.00
	F2	404.00	419.00	63.25	65.00	41.48	43.61	1657.75	2537.50	3232.50	4922.00
	F3	410.00	428.00	67.25	70.00	42.08	44.42	1896.15	2910.25	3801.35	5695.25
	Mean	399.67	415.33	62.25	64.17	40.37	42.51	1699.63	2604.25	3326.12	5010.75
S2	**F1**	372.00	381.00	53.50	55.50	36.39	37.92	1445.75	2252.50	2684.27	4003.75
	F2	397.00	410.00	58.25	60.00	38.76	40.84	1604.00	2487.50	2978.53	4540.25
	F3	408.00	422.00	63.75	66.00	40.35	42.72	1868.00	2522.50	3604.50	4705.00
	Mean	392.33	404.33	58.50	60.50	38.50	40.49	1639.25	2420.83	3089.10	4416.33
S3	**F1**	358.00	370.00	50.50	53.50	35.27	37.13	1369.50	1655.00	2478.00	2887.00
	F2	385.50	393.00	55.75	57.25	37.34	39.25	1550.80	1927.75	2874.20	3469.20
	F3	394.00	403.00	60.50	62.75	39.01	40.15	1785.50	2287.50	3339.50	4206.50
	Mean	379.17	388.67	55.58	57.83	37.20	38.84	1568.60	1956.75	2897.23	3520.90
S4	**F1**	322.00	317.00	46.50	45.25	35.24	35.17	1150.25	1102.50	1942.31	1744.56
	F2	340.00	336.00	50.50	49.00	37.24	37.12	1351.00	1437.50	2381.50	2381.00
	F3	363.00	361.00	55.00	54.00	38.57	38.28	1543.00	1552.50	2757.00	2700.25
	Mean	341.67	338.00	50.67	49.42	37.02	36.86	1348.08	1364.17	2360.27	2275.27
L.S.D′ 0.05	**(S)**	0.79	2.47	0.45	0.63	0.31	0.32	4.64	5.85	2.63	5.64
	(F)	0.69	2.14	0.39	0.55	0.27	0.27	4.02	5.10	2.28	4.88
	S × F	1.37	4.90	0.89	1.26	0.67	0.63	8.04	10.14	4.56	9.76

Table 5. Effect of crop sequence and nitrogen fertilization on Number of Naturally Occurring Biological Control Agents (NOBCA) of wheat, 2014/2015 season.

Treatments		Number of Naturally Occurring Biological Control Agents (NOBCA)
Crop sequence	**Nitrogen fertilization rates**	**2014/2015**
(S1) cowpea / clover / wheat	(F1) 60 Kg N/fed	15.00
	(F2) 90 Kg N/fed	17.75
	(F3) 120 Kg N/fed	20.50
	Mean	17.75
(S2) cowpea + maize / clover / wheat	(F1) 60 Kg N/fed	11.75
	(F2) 90 Kg N/fed	17.25
	(F3) 120 Kg N/fed	20.00
	Mean	16.33
(S3) maize / clover / wheat	(F1) 60 Kg N/fed	11.50
	(F2) 90 Kg N/fed	13.50
	(F3) 120 Kg N/fed	16.25
	Mean	13.75
(S4) maize / wheat	(F1) 60 Kg N/fed	3.00
	(F2) 90 Kg N/fed	4.00
	(F3) 120 Kg N/fed	4.25
	Mean	3.75
L.S.D′ 0.05	Crop sequence (S)	0.76
	Fertilization (F)	0.69
	S × F	1.51

Table 6. Average cropping index obtained from the different sequences studied.

Crop sequence	Cropping index
Cowpea / clover / wheat (S1)	2.87
Cowpea + maize / clover / wheat (S2)	3.39
Maize / clover / wheat (S3)	2.64
Maize / wheat (S4)	2.00

Table 7. Average net return obtained from the different sequences studied.

Crop sequence	Total costs of production L.E./fed.	Total income L.E./fed.	Net return L.E.
Cowpea / clover / wheat (S1)	6183	11357	5174
Cowpea + maize / clover / wheat (S2)	9393	15147	5754
Maize / clover / wheat (S3)	9133	12658	3525
Maize / wheat (S4)	8518	9885	1367

This is to be expected since that system improved soil fertility due to growing two legumes crops such as cowpea and clover. This in turn may enhance the photosynthetic process and increase the metabolites synthesized in wheat plants. General agreements in this respect were declared by Kumpawat (2002), Said (2007), Hefny (2012) and Abou-Keriasha and Eissa (2014). As nitrogen rate was increased up to the recommended rate (120 kg N/fed.) This effect was significant in the two growing seasons. The increase here may be due to the fact that nitrogen rate increased the plant height as shown before. This in turn may increase the photosynthetic rate and consequently the metabolites synthesized by plants which contributed in increasing the seed index. These findings agreed with those obtained by Nassar (2007), Said (2007), Hefny (2012), Hassanein et al. (2014) and Shirazi et al. (2014).

4. Grain yield (Kg/fed.): the results in Table 4 indicated that crop sequences studied affected significantly the grain yield/fed. in the two growing seasons. The data showed that the average yields obtained were 1699.63, 1639.25, 1568.60 and 1348.08 kg/fed. in 2013/2014 season for the sequences of cowpea / clover / wheat (S1), cowpea + maize / clover / wheat (S2), maize / clover / wheat (S3) and maize / wheat (S4), respectively. The corresponding means in 2014/2015 were 2604.25, 2420.83, 1956.75 and 1364.17 kg/fed. in the same order. Here, the data emphasized that average grain yield in sandy calcareous soil as reported in Table 2 was maximized as number of legume crops was increased in the sequence. Thus the lowest grain yield was produced from the sequence of maize / wheat (S4). This is to be expected since yield components of wheat took the same trend as previously discussed. Furthermore, this may be due to better nitrogen supply and less weed competition under these treatments and besides, these treatments also experienced additional legume yields during both the years. The present findings confirmed with those obtained by Kumpawat (2002), Said (2007), Hefny (2012) and Abou-Keriasha and Eissa (2014). Rate of nitrogen affected significantly the grain yield kg/fed. in the two growing seasons. Consistent increase in grain yield was observed as nitrogen rate was increased in the two growing seasons. The present trend is to be expected for two reasons. The first is due to the type of the soil under study which was sandy calcareous as shown in Table 2. The second reason is that agronomic characters and yield components of wheat took the same trend. The present results are in general accordance with those obtained by Nassar (2007), Said (2007), Abdel Nour and Fateh (2011), Hefny (2012), Abd El-Razek and El-Sheshtawy (2013), Hassanein et al. (2014) and Shirazi et al. (2014).

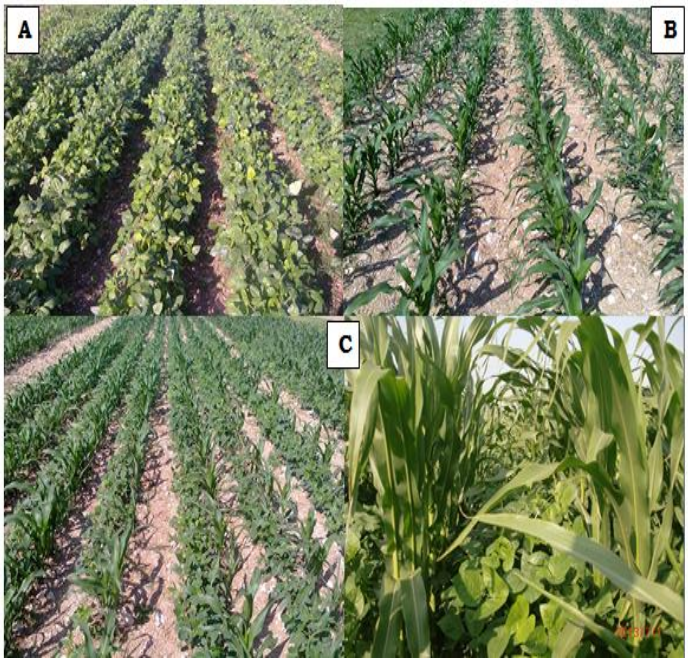

Figure 1. Crop sequence; (A) Sole cowpea; (B) Sole maize; (C) Intercropping cowpea with maize

Figure 2. (A) Clover (Fahl); (B) Fallow (without cultivation)

5. Straw yield (Kg/fed.): the results in Table 4 revealed that crop sequences studied affected significantly the straw yield/fed. through the two growing seasons. The crop sequence of cowpea / clover / wheat (S1) produced the heavier weight of straw yield as compared with the crop sequence of maize / wheat (S4). These results are logic since plant height the main constituents of straw took the same trend as previously stated. Here, it could be concluded that the residual effect of the two legume crops were clearly demonstrated. Such findings were proved by Said (2007) and Hefny (2012). Rate of nitrogen affected significantly the straw yield kg/fed. in the two growing seasons. Consistent increase in straw yield was observed as nitrogen rate was increased up to the recommended rate (120 kg N/fed). The present findings are the resultant of the favor effect of nitrogen on the plant height Therefore, the present response to the nitrogen rate could be due to the lower rate of such nitrogen in the experimental as presented in soil Table 2. The present trend agreed with those obtained by Nassar (2007), Said (2007), Hefny (2012), Abd El- Razek and El-Sheshtawy (2013), Hassanein et al. (2014) and Shirazi et al. (2014).

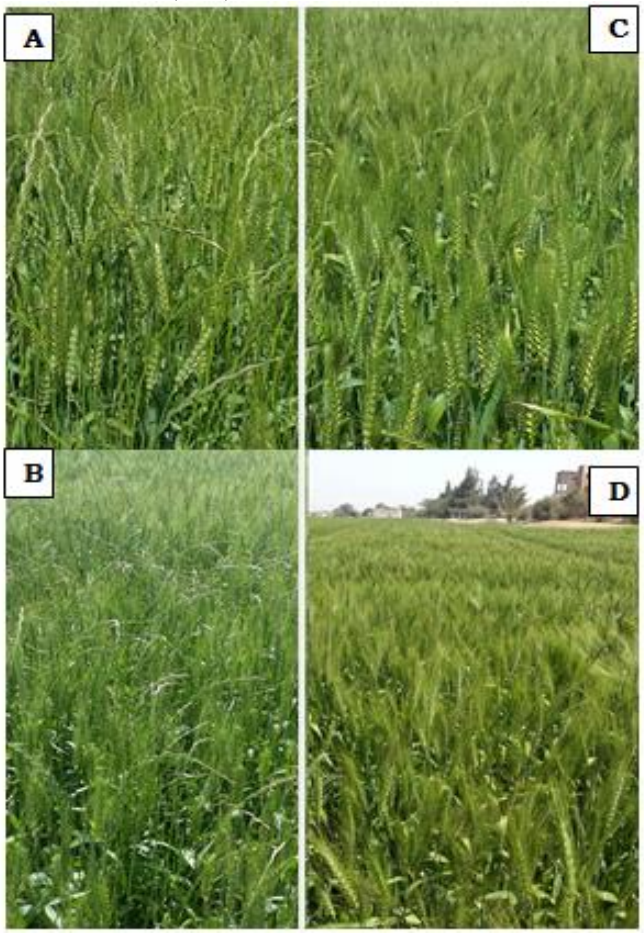

Figure 3. (A) and (B) Wheat after fallow (without cultivation); (C) and (D) wheat after clover (Fahl)

Naturally Occurring Biological Control Agents (NOBCA)

The data reported in Table 5 revealed that the maximum number of agents was existed in the sequences of cowpea / clover / wheat (S1) and cowpea + maize / clover / wheat (S2). The lowest number was existed in the sequence of maize / wheat (S4). That relation was significant. Here, it should be noted that the sequence which contained legume crops was characterized with the increase of (NOBCA). This means that legume crops are reservoir for those insects. The number of (NOBCA) was contained *Chrysopyrla vulgaris*, *Coccinella undecimpunctata*, *Coccinella setempunctata*, *Paederus alfierii* and *Syrphus corolla*. The present trend agreed with those obtained by Abdel-Galil and Amro (2002) and Abdel-Galil et al. (2006).

Farmers benefit

Cropping index

Here it should be noted that the two promising sequences in Table 6 contributed so much in increasing the cropping area. Therefore the cropping index was increased to be 2.87 or 3.39 in the year for the two sequences of cowpea / clover / wheat and cowpea + maize / clover / wheat, respectively. These values are considered to be more than the traditional index of Egypt which is 1.73 as shown by Bulletin of The Agriculture Statistics (2012/2013)

Figure 4. Naturally Occurring Biological Control Agents (NOBCA)

Economic evaluation

Table 7 revealed that the net return from the sequence of cowpea + maize / clover / wheat (S2) was the highest when compared with the other sequences. Thus increasing the cropping area which increased the cropping index caused an increase in the net return.

Conclusions

Crop sequence in order to increase the cropping area and the cropping index in the newly reclaimed soils is a must. The transition period between summer and winter crops could be utilize of short age crops for example planting of clover Fahl which could help in growing three crops a year in maize, sorghum and rice areas. The clover Fahl grown before wheat is considered a reservoir for the Naturally Occurring Biological Control Agents (NOBCA). Moreover it improves the fertility of the soil and help in weed control. This in turn must increase the productivity of the wheat. This practice could be prevents using the chemical herbicides in the first stage of wheat growth. The sequence of cowpea / clover / wheat and the sequence of cowpea + maize / clover / wheat produced the maximum yield and its components of wheat as compared with the other sequences. (NOBCA) revealed that the maximum number of agents was existed in the sequences of cowpea / clover / wheat and cowpea + maize / clover / wheat. The lowest number was existed in the sequence of maize / wheat. The present research proved that the two promising sequences contributed so much in increasing the cropping area. Therefore, the cropping index was increased to be 2.87 or 3.39 in the year for the two sequences of cowpea / clover / wheat and cowpea + maize / clover / wheat, respectively. These values are considered to be more than the traditional index in Egypt which is 1.73. The net return from the sequence of cowpea + maize / clover / wheat was the highest when compared with the other sequences. Thus increasing the cropping area which increased the intensification index caused an increase in the net return.

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References

[1] A. R.Abdel Nour, Nadya and Hayam, S. A. Fateh. “Influence of sowing date and nitrogen fertilization on yield and its components in some bread wheat genotypes” Egypt. J. Agric. Res., 89 (4):1413-1433, 2011.

[2] Agricultural statistics. “Study of indicator of the agricultural statistics. Ministry of Agricultural and land Reclamation, Economics, Affairs Sector” vol. 1and 2, Egypt, 2012/2013.

[3] B. S. Kumpawat. “Effect of cropping systems on production potential of succeeding wheat (Triticum astevum)” Indian J. of Agron. 47 (2) 196-198, 2002.

[4] Biljana, Bojović and Aca, Marković. “Correlation between Nitrogen and chlorophyll content in wheat (Triticum aestivum L.)” Kragujevac J. Sci. 31: 69-74, 2009.

[5] F. A. Abdel-Galil and M. A. Amro. “High lights on the naturally occurring biological control agents of order Hemiptera-Heteroptera in Egypt” Int. Conf. for Develop. and the Env. in the Arab World. 89-99, 2002.

[6] F. A. Abdel-Galil, M. A. Amro; K. S. M. Osman and M. A. Badawy. “Population fluctuations and flight activities of certain Heteropteran species inhabiting semi-arid ecosystems at Qena Governorate, Upper Egypt” Assiut Unvi. J. of Zoology 35(1): 1-13, 2006.

[7] G. H. Hassanein, M. A. Gameh, M. M. A. El- Koliey and M. M. Hefzy. “Effect of drip irrigation and nitrogen fertilization on the growth of wheat plants grown on sandy calcareous soils” 11th International conference of Egyptian soil science society and 1st International conference of soil and water Sc. Dept., fac. of Agriculture, Kafr El-Sheilkh Uni., 5-7 May Kafr El-Sheilkh, Egypt, 2014.

[8] J. Dash, P. J. Curran, M. J. Tallis, G. M. Llewellyn, G. Taylor and P. Snoeij. “The relationship between the meris terrestrial chlorophyll index and chlorophyll content” Proc. Envisat Symposium, Montreux, Switzerland, 23–27, 2007.

[9] K. A. Gomez and A. A. Gomez. “Statistical procedures for agriculture research 2nd ed” John Wiley and Sons. New York, 317-333, 1984.

[10] Lee Yuh-Jyuan, Chwen-Ming, Yang, Kuo-Wei, Chang and Yuan shen. “Effects of nitrogen status on leaf anatomy, chlorophyll content and canopy reflectance of paddy rice” Botanical Studies 52: 295-303, 2011.

[11] M. A. Abou-Kerisha and Nadia, M. A. Eissa. “Mineral nitrogen fertilizer and compost effects on wheat and maize yields crop sequences including intercropped legumes” Egypt J. Agron. 36 (2): 147-163, 2014.

[12] M. T. Said. “Effect of different systems of intensification and fertilization on some wheat cultivars” M. Sc. Thesis, Fac. Agric., Assiut Univ., Egypt, 2007.

[13] R. A. Waller and D. B. Duncan. “A bays rule for the symmetric multiple comparison problem” Amer. State. Assoc. J. Dec., 1458-1503, 1969.

[14] S. E. Shafshak and A. A. El-Debaby. “Crop rotation and agriculture intensification” Agron. Dept., Moshtohor, Agric. College, Zagazig Univ. Press, 1975.

[15] S. M. A. Nassar. "Response of wheat to nitrogen fertilizer and water stress at different growth stages" M. Sc. Thesis, Fac. Agric., Assiut Univ., Egypt, 2007.
[16] S. M. Shirazi, Zulkifli ,Yusop, N. H. Zardari, and Z. Ismail. "Effect of irrigation regimes and nitrogen levels on the growth and yield of wheat" Advances in Agriculture, 1-6, 2014.
[17] T. Pandiaraj, S. Selvaraj and N. Ramu. "Effects of crop residue management and nitrogen fertilizer on soil nitrogen and carbon content and productivity of wheat (triticum aestivum l.) in two cropping systems" J. Agr. Sci. Tech. 17: 249-260, 2015.
[18] U. A. Abd El-Razek, and A. A. El-Sheshtawy "Response of some wheat varieties to bio and mineral nitrogen fertilizers" Asian Journal of Crop Science 5 (2): 200-208, 2013.
[19] Y. A. Hefny. "Effect of crop sequence and mineral, organic and bio nitrogen fertilization on productivity of wheat" Ph. D. Thesis, Fac. Agric., Cairo, Al-Azhar Univ., Egypt, 2012.