J. Plant Production, Mansoura Univ., Vol. 7(12):1401 -1410, 2016

Effect of Crop Sequenceof Rice, Maize and Fahll Berseem Residues on Wheat Productivity and Soil Fertility

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ABSTRACT

A two years' field trial was conducted at Gemmaiza Agricultural Research Station, during 2013/14 and 2014/15 seasons to study the effect of plant residues; rice straw, corn stover and fahal berseem as a cash crop on wheat production and soil properties. The experimental design was strip-plot design in three replications. Where rice and maize were occupied the vertical stripplots, while the plant residues were occupied the horizontalstrip plots. Rice straw treatments were: untreated soil with rice straw, treated soil with chopped rice straw output of 33 % from the previous crop and fahal berseem one cut residues incorporated in soil followed by wheat. The same treatments were repeated with corn residues. Results showed that available N, P and K in soil were increased resulting from the decomposition of rice straw and corn stover. This improved soil fertility which is reflected in increasing the productivity of wheat crop compared with the other treatments. Also, application of different treatments significantly influenced the yield and its attributes of wheat crop in both seasons. The highest values of cereal units, economic evaluation and net return were resulted from the crop sequence corn followed by fahal berseem one cut followed by wheat, compared to other treatments in both seasons, respectively.

Keywords: rice straw, corn stover, wheat, cereal units, economic evaluation, net return.

INTRODUCTION

Wheat is one of the principal cereal crop in the world, so it is growing on a large scale globally, and in Egypt wheat of the most important grain crops for humans. Wheat needs to fertile soil rich nutritional elements in order to give the highest yield, to achieve that fore the piece of work by many researchers to increase the production of wheat crop from increasing soil fertility and improving natural and chemical properties by using different crop sequence. Plant residues have an important role as soil and water protecting factors. El-Sodany and Abou-Elela, (2010)revealed that legumes have benefited cereals in crop rotation through improving soil physical properties. Selim and Gouda(1998)revealed that yield of summer crop tended to be more after legumes than after non-legumes. Shaalan *et al*.(2014)found that when clover preceded maize, plant height, leaf area, and grain yield of maize was superior to that of maize grown after non-legumes they reported that the sequence terminating with berseem clover was more beneficial than faba bean regarding that traits. Khalil *et al* (2000) and Nawar (2004) found that maize growth, yield and yield attributes increased with maize planting after legumes, whereas, the reverse was obtained when maize was preceded by wheat. Khalil (2003) and Nawar (2004), Nawar *et al*. (2009) and Khalil *et al*. (2011) found that Increases in plant height with increasing N levels may be attributed to N–stimulating effect on the internode elongation through meristematic activity during vegetative growth stage. Also, nitrogen supply causes an increase in leaf number and ear leaf area in addition to leaf expansion. Kumar and Goh (1999). And Blanco-Canqui and Lal (2009) reported that removal of residues not only causes a direct loss of nutrients in soils, but also deprives the soil of carbon or organic matter that is important for improving soil structure and providing life to the soil by acting as a substrate for various microbes and biota. In addition, Lal (2004) and Johnson *et al*. (2010) found that the removal of crop residues from an agricultural system would increase the potential for increased soil erosion and/or negative effects on environmental quality. Thus, many studies have shown that management of a crop residue can contribute to increased nutrient cycling and greater crop yields and also has an important role in reducing soil erosion and maintaining yield such as Lal (2000), Al-Sheikh *et al*. (2005), Delgado *et al*.(2007), Cruse and Herndl (2009)and Ghimire *et al*.(2012) they reported that by selecting crop rotation and / or management practices such as minimum tillage to reduce soil disturbance and / or increase the amount of residue returned to the soil, soil organic carbon and nitrogen can be increased in the system. Experiments conducted by Sall *et al*. (2003) and Jensen *et al*.(2005)showed that the rate of decomposition and N mineralization increases by increasing the quality of a plant residue. Smith and Sharpley (1990) reported that the quality of a residue is an important factor to determine the C and N mineralization rate, residue management is a factor affecting this process. Effective management of post-harvest rice straw is perhaps the biggest challenge facing intensive rice production in Egypt. Samra *et al*.(2003) clarified that rice remains contain large amounts of silica and burning is the most cost-effective and the prevalent method of elimination in areas under combined harvesting. Ebid *et al*., 2008; Kumar and Goh (1999) reported that disposal of rice residues by chopping is often increased of soil organic matter and nutrients. Beri *et al*. 1995) and Ghoneim *et al*. (2008) observed that incorporation of rice residues in soil causes lower yields in the following crop due to N immobilization, a problem that is attributable to the slow rates of residue decomposition. Other potential problems associated with residue incorporation was observed by Grace *et al*. (2003) such as accumulation of phenolic acids in soil and increased CH_4 emissions under flooded conditions. Witt *et al*. (2000) reported that traditional method of wet incorporation shortly before planting of the next rice crop, the potential benefits of shallow incorporation shortly after crop harvest include accelerated aerobic decomposition of crop residues (about 50% of the C within 30-40 days), leading to increased N availability. While burning of crop residues must be avoided at all costs for environmental reasons, farmers will probably incorporate crop residues only if legislation forces them to, or if there is a clear yield increase that cannot achieved through the application of additional fertilizer. Nitrogen from crop residues and soil N mineralization potential are usually not taken into consideration when fertilizer applications are made. Hood *et al*(2000) and Bijay-Singh *et al* (2001) clarified that decomposing crop residues may release significant amounts of N and influence the availability of N by affecting mineralization–immobilization processes in the soil. The quantity of N derived from crop residues by a succeeding crop is highly variable and depends largely on residue characteristics and the synchronization between N release and crop N uptake.

The aim of this study was to determine the effects of various plant residual, including chopped rice straw or fahal berseem cultivation one cut as a catsh crop and chapped corn stover or fahal berseem cultivation one cut as a catsh crop on wheat (Gemmaiza 11 cultivar) productivity as well as soil properties.

MATERIALS AND METHODS

A field experiment was carried out in Agricultural Research Station of Gemmaiza during two successive seasons (2013/2014 and 2014/2015) to study the effect of rice straw and corn stover as remnants of plants on wheat production (Germaniza 11wheat cultivar). Data of the site climatic conditions were taken from El-Gharbiameteorological station according to the formal data from the Ministry of Agriculture during the two growing seasons are presented in Table 1.

Table 1. The average of temperature and relative humidity in 2013/14 and 2014/15 seasons.

Months	2013/14 Season		2014/15 Season	
	Temperature C°	Relative humidity % humidityhumidity %	Temperature C°	Relative humidity %
May	27.66	63.62	28.46	61.35
June	28.56	66.48	29.45	68.1
July	29.91	70.89	29.84	71.06
August	29.71	71.57	29.52	69.75
Septamber	26.88	68.53	26.58	66.25
October	22.93	69.26	23. 57	70.82
November	21.17	71.70	20.22	72.63
December	18.13	74.89	18.64	75.48
January	15.88	71.96	16.31	74.23
February	16.96	79.84	15.92	72.84
Marsh	18.82	68.79	19.67	68.82
April	22.74	61.24	22.55	60.45

Before cultivation the experiment, soil samples were collected and analyzed. The physical and chemical properties of the investigated soil were determined according to USDA (1954), Jackson (1967)and Van Reeuvijk (2002) are shown in Table 2.

The experimental design was strip- plot design in three replications. Where rice and maize were occupied the vertical strip-plots, while the plant residues were occupied the horizontal-strip plots. Rice straw treatments were: untreated soil with rice straw, soil treated with chopped rice straw output of 33% from the previous crop and soil treated with fahal berseem cultivation one cut followed by wheat cultivation. The same former treatments were repeated with corn stover, therefore the experiment six treatments during the two growing seasons were detected as follows:

A-Vertical strip-plots includestwo treatments:

1- Rice. 2–Maize.

B-Horizontal strip - plots includes six treatments:

1-Untreated soil with rice straw (T1).

2 -Soil treated with chopped rice straw output of 33 % from the previous crop (T 2).

3 -Soil treated with residues of fahal berseem cultivation one cut after harvested rice, followed by wheat cultivation (T3).

4 -Untreated soil with corn stover (T4).

5-Soil treated with chopped corn stover output of 33 % from the previous crop (T5).

6-Soil treated with residues of fahal berseem cultivation one cut' after harvested corn, followed by wheat cultivation (T6).

Table 2. Physical and chemical characteristics of the experimental soil site.

Properties	Studied Soil
Texture class	Clay
Organic matter%	1.48
EC and pH	
EC, dSm^{-1} [soil extract paste]	0.98
pH [suspension 1:2.5]	7.98
Soluble ions ($mmol_c\ l^{-1}$) Cations (meq /100 g.soil)	
Ca^{2+}	3.90
Mg^{2+}	2.00
Na^{+}	8.26
K^{+}	0.08
Anions (meq/100 g. soil)	
$Co_3^{=}$	-
HCO_3^{-}	4.81
$SO_4^{=}$	2.18
Cl^{-}	7.25
SAR	2.18
Available N, ppm	25.00
Available P2O5 , ppm	10.6
Available K2O, ppm	450

Table 3. The chemical analysis of the samples of rice straw and corn stover in the first and the second seasons.

Treatments		Crude protein	Crude fat	Dry ash	Dry matter	Crude fiber	Hemicellulose	Cellulose
Rice straw	First season	1.90	0.80	16.00	18.00	7.30	21.00	35.00
	Second season	1.92	0.78	16.20	18.20	7.20	21.60	34.80
Corn stover	First season	4.60	1.10	8.10	22.40	23.50	19.10	21.20
	Second	4.61	1.11.	8.00	22.20	23.10	19.12	21.40

Corn stover and rice straw were applied from output of 33% from the previous crop with sup plotre spectively. Chopped corn stover or chopped rice straw were treated and irrigation directly to make up for what has been exhausting of the soil content of nitrogen facilitator (NO_3 and NH_4) as a result of microorganism's activity in the analysis of the waste and build their bodies.

Wheat was sown in sup plots, in 5thand 3^{ed} December in the first and second seasons, respectively, at a seeding rate of 60 kg $fed^{-1.}$ Sowing was made after treated each plot with former treatments in both seasons. Phosphorus as ordinary super phosphate (67.7 g P kg^{-1}) was hand places at a level of 15.5 kg P_2O_5 fad^{-1} during soil preparation. Flood irrigation was practiced by the environmental conditions during all stages of growth. Harvest was made during 9th and 7ed May in the first and the second seasons, respectively. Nitrogen fertilizer was added to wheat in two equal doses in the form of ammonium nitrate (33.5 % N) as the aforementioned rates. The other usual agricultural practices were carried out as recommended for each crop according to the recommendations of Ministry of Agriculture.

Wheat traits:

At harvest; ten guarded plants were chosen randomly from each sub plot to estimate growth parameter and yield components of wheat as follows:

1-Plant height (cm). 2- Flag leaf area (cm^2).
3-Number of spikelets $spike^{-1}$. 4- Number of plants per m^2.
5-Spike length (cm). 6-Number of grains per spike.
7-1000-grain weight (g). 8-Grain yield (ardab fad^{-1}).
9-Strew yield (ton fad^{-1}). 10-Biological yield (ton fad^{-1}).

Grain yield per Fadden expressed as Arab fad^{-1} straw yield expressed as ton fad^{-1}biological yield expressed as ton fad^{-1}.

Soil attributes were determined according to USDA (1954), Jackson (1967),ASTM (1980) and Van Reeuvijk (2002), which as follows:

1-Bulk density: It was calculated by dividing the soil weight in grams by soil volume in cubic centimeter.

2-Soil porosity=$(1 - \text{bulk density})/\text{real density} \times 100$

3-Sodium adsorption ratio(SAR) is a ratio of the concentration of sodium ions to the concentration of calcium plus magnesium ions, which were determined by using the following formula as follows:

$$SAR = Na/\sqrt{Ca + Mg/2}$$

Seeds of corn (*Zea mays* L, maize cultivar S.C. 128), rice (*Oryza sativa*, Sakha 101), Fahl berseem and wheat in the two seasons, were one of the distribution of certified seed under the supervision of the Egyptian Ministry of Agriculture. Planting and harvesting datesof crop sequence, corn, rice, fahl berseem and wheat in the two seasons were presented in Table 4.

Table 4. Planting and harvesting dates of crop sequence.

crops	2013/14 season		2014/15 season	
	Planting date	Harvesting date	Planting date	Harvesting date
Corn	15/5/2012	21/9/2012	20/5/2013	26/9/2013
Rice	20/5/2012	1 /10/2012	18/5/2013	30/9/2013
F. berseem	3/10/2012	2/12/2012	2/10/2013	30/11/2013
Wheat	5/12/2012	9/5/2013	3/12/2013	7/5/2014

Cereal unit:

The yield of all crops were changed to units of cereal according by Brockaus (1962) for judicious comparison between 100 kg for each crops as follow : maize =1 unit , rice =1 units ,wheat = 1 unit , fahl berseem = 0.25 unit , straw yield for rice and wheat = 0.15 unit , maize stover = 0.14 unit.

Table 5. The average yield of crop sequence in both seasons.

Treatments		Rice		Corn		F berseem
		Grain yield (ardab fad^{-1})	Straw yield (ton fad^{-1})	Grain yield (ardab fad^{-1})	Stover yield Ton fed^{-1}	Green yield Ton fed^{-1}
2013/14 season						
Control Rice	(T1)	2.59	2.25	-	-	-
Chopping Rice	(T2)	2.87	2.52	-	-	-
Rice +F. berseem	(T3)	2.91	2.57	-	-	6.10
Control Corn	(T4)	-	-	25.42	3.65	-
Chopping Corn	(T5)	-	-	27.26	3.83	-
Corn + F. berseem	(T6)	-	-	27.70	3.98	6.66
2014/15 season						
Control Rice	(T1)	2.94	2.32	-	-	-
Chopping Rice	(T2)	3.31	2.65	-	-	-
Rice +F. berseem	(T3)	3.46	2.78	-	-	6.27
Control Corn	(T4)	-	-	27.16	3.79	-
Chopping Corn	(T5)	-	-	30.20	3.94	-
Corn + F. berseem	(T6)	-	-	31.36	4.17	6.70

Gross return from each treatment was calculated in Egyptian pounds(LE) at praises of LE2210 / t for (Grain yield) Rice , LE 129 / t for (Straw yield) Rice , LE314 and 315 / ardab for (grain yield) Corn , LE136 / t for (stover yield) Corn , L.E150 and 160 / t for f. berseem and LE388 and 411 / Ardab for (grain yield) wheat, LE624 and 632/t for (Straw yield) wheat, (Agricultural Statistics (2013/14 and 2014/15), Economic Affairs Sector; Ministry of Agriculture;Egypt;(in Arabic).

Net Return

Gross return, cost and net return from each treatment was calculated in Egyptian pounds (LE) at praises, (Agricultural Statistics (2013/14 and 2014/15), Economic Affairs Sector; Ministry of Agriculture; Egypt;(in Arabic). The obtained data were statistically analyzed using the SAS program and LSD test at the 5% level of probability was used to compare the treatments means according to Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Some growth parameter and yield of wheat as affected by studied treatments:

Data in Tables 6 and 7 showed significant effect for fahal berseem residues, corn stover andrice straw as remnants of plants on plant height, number spikelets $spike^{-1}$, flag leaf area cm^{-2}, number of plants m^{-2}, number of grains $spike^{-1}$, 1000 grains weight, grain yield fad^{-1}, biological yield ton fad^{-1}in the first and second seasons, while, spike length, was significant effect in the first season and not significant effect in the second season. Meanwhile strew yield fad^{-1} was not significant effect in the first and second seasons.

Data in Tables 6 and 7 showed that the highest values of plant height, spike length, number of spikelet $spike^{-1}$, number of plants m^{-2}, flag leaf area, number of grains $spike^{-1}$, weight of 1000 grains, grain yield fad^{-1}, strew yield fad^{-1} and biological yield ton fad^{-1}were obtained by treated soil with fahal berseem residues, chopped corn stover and chopped rice straw, while the lowest one were obtained in untreated soil with corn stover or rice straw. Treated soil with fahal berseem residues, corn stover and rice straw under different treatments increased some growth parameters and yield of wheat compared to untreated soil in two seasons. Treatments could be arranged in the following order regarding: the main effects fahal berseem residues> chopped corn stover or rice straw > control under soil treated with fahal berseem residues, corn stoveror rice straw in the both seasons. Obtained results are in agreement with those obtained by Hood *et al*. (2000)and Bijay-Singh *et al*. (2001).

Plant height

Table 6 showed that response of wheat plant height among the residues studied treatments were significant in the first and second seasons, which maize + fahll berseem + wheat crop sequence gave the greater increase in wheat plant height compared with the other treatments. The highest plant height and values were 87.00 and 88.37 cm, with an increase of 14.8 and 1.85 % respectively, in both seasons as compared to the other treatments, due to fahl berseem residues which increased availability of soil N and organic matter in addition to their improvement of soil physical properties. As a result, wheat absorbed the largest amount of nitrogen and had taller plants. These results were in accordance with Selim and Gouda (1998) ,Nawar (2004) and Khalil *et al*. (2011) they reported, that when clover preceded crop produced taller plants were superior to those grown after non legumes, and this is due to increase soil N and organic matter in addition to the improvement of soil physical properties (El-Sodany and Abou-Elela (2010).

Flag leaf area:

Table 6 showed significant effect among the residues studied treatments in the first and second seasons , which maize + fahll berseem + wheat crop sequence gave the highest flag leaf area cm^2 values are 25.09 and 24.34, with an increase of 23.05 and13.57 % , respectively, in both seasons as compared to the other treatments, due to fahll berseem residues which increased consumption of more nitrogen fertilizer gave a higher values of flag leaf area cm^{-2}, this imply higher photosynthetic efficiencies leading to more assimilates production and translocation to the sinks, leading to produce higher flag leaf area cm^2. These results conformed to the results obtained by Selim and Gouda (1998) , and Khalil *et al* (2011).

Table 6. Some growth parameter and yield of wheat as affected by studied treatments S and Ns indicate p <0.05 and not significant, respectively.

Treatments		Plant Height (cm)	Spike length (cm)	No. spikelet in spike	Flag leaf area (cm^2)	number of plants m^{-2}
				2013/14 season		
Rice Straw		82.11	13.11	22.77	21.91	253.21
Corn Stover		84.33	13.36	23.33	23.59	254.66
LSD0.05		0.36	Ns	Ns	0.44	Ns
	Control	75.90	12.20	21.66	20.39	244.3
	Chopping	86.90	13.25	22.66	22.78	255.5
	Fahalbers	87.00	14.26	24.83	25.09	261.99
LSD0.05		0.29	0.74	1.66	0.42	4.13
	Control	75.20	13.03	22.33	19.67	240.98
Rice Straw	Chopping	85.60	13.23	23.00	21.79	253.54
	Fahal .bers	87.80	13.53	23.00	25.09	259.95
	Control	76.50	12.56	22.33	21.07	247.61
Corn Stover	Chopping	85.90	13.46	23.00	23.76	258.37
	Fahal .bers	88.40	13.60	24.66	25.09	263.15
LSD0.05		0.08	Ns	Ns	Ns	5.53
				2014/15 season		
Rice Straw		87.16	13.21	24.33	22.11	268.93
Corn Stover		87.62	13.66	25.66	24.33	279.74
LSD0.05		0.34	Ns	Ns	Ns	Ns
	Control	87.16	13.21	24.33	22.11	268.93
Rice Straw	Chopping	87.62	13.66	25.66	24.33	279.74
	Fahal .bers	0.34	Ns	Ns	Ns	Ns
	Control	86.76	13.13	23.66	21.43	266.29
Corn Stover	Chopping	87.03	13.53	24.66	23.9	273.35
	Fahal .bers	88.37	13.65	26.65	24.34	283.34
LSD0.05		1.14	Ns	1.53	1.25	Ns
	Control	82.84	12.90	22.22	20.79	268.23
Rice Straw	Chopping	86.42	13.46	25.33	23.15	271.67
	Fahal .bers	91.23	13.76	25.66	25.25	277.27
	Control	84.52	13.20	23.66	21.46	273.37
Corn Stover	Chopping	87.12	13.53	26.11	23.32	276.94
	Fahal .bers	92.23	13.76	26.99	25.36	278.54
LSD0.05		1.48	Ns	Ns	1.99	2.00

Number of spikelets spike^{-1}:

Table 6 showed significant effect among the residues studied treatments in the first and second seasons, which maize + fahll berseem + wheat crop sequence gave the highest number of spike lets spike^{-1}, and values are 24.83 and 26.65, with an increase of 14.63 and12.62 %, respectively, in both seasons as compared to the other treatments, due to fahll berseem residues which increased availability of soil N and organic matter in addition to their improvement of soil physical properties. These increases due to the success rate of pollination and fertilization of number of spikelet's /spike. However, when increasing consumption of more nitrogen fertilization rates gave the highest number of spikelets spike^{-1}, because the lack of N in the soil cause a big loss in a number of grain as a result of failure to spikelets fertilization and / or an increase in abortions advanced grain due to insufficient supply of N and lack of soil fertility. Similar results have been reported by Hassan (1995), Nawar (2004) and Khalil *et al* (2011).

Number of plants m^{-2}:

Table 6 showed significant effect among the residues studied treatments in the first and second seasons, which maize + fahll berseem + wheat crop sequence gave the highest number of plants m^{-2} and values are 261.99 and 283.34, with an increase of 7.24 and 6.40 %, respectively, in both seasons as compared to the other treatments, due to increased fertility of the soil after planting clover it led to a high rate of germination to optimize m^{-2} due to the availability of nutrients in the soil.

Spike length (cm):

Table 6 showed significant effect among the residues studied treatments in the first season, which maize + fahll berseem + wheat crop sequence gave the highest spike length with value 14.26 cm, with an increase of 16.8%, in the first season as compared to the other treatments, and showed insignificant response in the second season. It was observed minimal variation, due to the genetic control on this trait and insignificant response to this residue of crop sequences.

Number of grains spike^{-1}:

Table 7 showed significant effect among the residues studied treatments in the first and second seasons , which maize + fahll berseem + wheat crop sequence gave the highest number of grains spike^{-1} and values are 72.66 and 75.55, with an increase of 6.55 and 12.20 %, respectively, in both seasons as compared to the other treatments, due to increased fertility of the soil after planting fahll berseem it led to a high rate of the availability of nutrients in the soil , this imply higher photosynthetic efficiencies leading to more assimilates production and translocation to the sinks , and also caused increases the success rate of pollination and fertilization of higher number of spikelet in spike and thus increase the number of grains spike^{-1}. These results were in agreement with the results of Hassan (1995), Nawar (2004) and Khalil *et al* (2011).

Table 7. Some growth parameter and yield of wheat as affected by studied treatments S and Ns indicate p <0.05 and not significant, respectively.

Treatments		No. Grain spike^{-1}	1000 Grain weight, (g)	Grain yield (Ard. fed^{-1})	Strew yield (tonfed^{-1})	Biological yield (ton fed^{-1})
				2013/14 season		
Rice Straw		69.66	54.13	20.98	1.40	4.78
Corn Stover		71.33	63.52	21.41	1.46	4.79
LSD0.05		0.89	0.64	Ns	Ns	Ns
	Control	66.33	55.04	20.58	1.34	4.64
	Chopping	72	59.33	21.34	1.47	4.95
	Fahal berseem	72.66	62.09	21.65	1.48	4.75
LSD0.05		1.19	0.42	0.26	Ns	1.55
Rice Straw	Control	65.11	52.46	20.37	1.29	4.57
	Chopping	71.11	56.97	21.17	1.44	4.82
	Fahal .bers	72	65.86	21.81	1.46	4.90
Corn Stover	Control	67.11	53.2	20.24	1.38	4.62
	Chopping	72	58.11	21.43	1.50	4.85
	Fahal .bers	73.66	66.33	22.13	1.52	4.94
LSD0.05		3.73	0.57	0.20	Ns	Ns
				2014/15 season		
Rice Straw		71.33	49.59	22.46	1.41	5.03
Corn Stover		73.33	50.70	23.43	1.49	5.23
LSD0.05		0.36	Ns	Ns	Ns	Ns
	Control	67.33	48.91	20.94	1.42	4.35
	Chopping	74.11	49.24	22.97	1.44	5.26
	Fahal .bers	75.55	52.30	24.98	1.50	5.77
LSD0.05		1.43	1.37	2.84	Ns	1.07
Rice Straw	Control	65	49.83	19.16	1.37	4.90
	Chopping	73.33	50.20	23.63	1.46	5.15
	Fahal .bers	75.66	50.27	24.66	1.48	5.18
Corn Stover	Control	69	50.03	21.64	1.32	5.08
	Chopping	74.66	50.23	24.16	1.53	5.20
	Fahal .bers	76.33	50.33	24.71	1.59	5.30
LSD0.05		1.92	Ns	0.24	Ns	Ns

1000 Grain weight (g):

Table 7 showed significant effect among the residues studied treatments in the first and second seasons , which maize + fahll berseem + wheat crop sequence gave the highest 1000 Grain weight, gm and values are 62.09 and 52.30, with an increase of 12.80 and 6.93 %, respectively, in both seasons as compared to the other treatments, due to increased fertility of the soil after planting fahll berseem it led to a high rate of the availability of nutrients in the soil this imply higher photosynthetic efficiencies leading to more assimilates production and translocation to the sinks, and also caused increases the 1000 grain weight. The present results are consistent with the results of Shaalan *et al* (2014) and Asadian and Nejad(2014).

Grain yield (ardab fad^{-1}):

Table 7 showed significant effect among the residues studied treatments in the first and second seasons, which maize + fahll berseem + wheat crop sequence gave the highest grain yield ardab fad^{-1} and values are 21.65 and 24.98 ardab fad^{-1}, with an increase of 5.19 and 19.29 %, respectively, in both seasons as compared to the other treatments, due to increased fertility of the soil after planting fahll berseem it led to a high rate of the availability of nutrients in the soil this imply higher photosynthetic efficiencies leading to more assimilates production and translocation to the sinks, and also caused increases the grain yield, due to the beneficial effect for fahl berseem on wheat compared to other treatments because fahl berseem supplied the soil nutrients necessary and that improve the soil characteristics. The present results are consistent with the results of Shaalan *et al* (2014), in addition Asadian and Nejad (2014).

Strew yield (ton fed^{-1}):

Table 7 showed in significant effect among the residues studied treatments in the first and second seasons, which maize + fahll berseem + wheat crop sequence gave the highest strew yield (ton fed^{-1}) and values are 1.48 and 1.50 ton fed^{-1}, with an increase of 10.44 and 5.63 %, respectively, in both seasons as compared to the other treatments.

Biological yield (ton fad^{-1}):

Table 7 showed similar trends for grain yield which revealed significant effect among the residues studied treatments in the first and second seasons, which maize + fahll berseem + wheat crop sequence gave the highest biological yield ton fad^{-1} with values 4.75 and 5.77 ton fad^{-1}, with an increase of 2.37 and 3.64 %, respectively, in both seasons as compared to the other treatments, due to increased fertility of the soil after planting fahll berseem it led to a high rate of the availability of nutrients in the soil this imply higher photosynthetic efficiencies leading to more assimilates production and translocation to the sinks. As a result, wheat absorbed the largest amount of nitrogen and had taller plants, and also caused increases the grain yield ard^{-1} fad, due to the beneficial effect for fahl berseem on wheat compared to other treatments because fahl berseem supplied the soil nutrients necessary and that improve the soil characteristics. These results were in accordance with Selim and Gouda (1998),Nawar (2004) and Khalil *et al*. (2011) they reported, that when clover preceded crop produced taller plants were superior to those grown after non legumes, and this is due to increase soil N and organic matter in addition to the improvement of soil physical properties El-Sodany and Abou-Elela, (2010), and also the present results are consistent with the results of Shaalan *et al* (2014), in addition Asadian and Nejad(2014).

Response of wheat traits to the interaction of crop sequence and soil treatments:

Tables 6 and 7 revealed similar trends for the interaction of crop sequences X soil treatments in all studied traits, in both seasons, which showed significant effect among the residues studied treatments for plant height, number of plants m^{-2}, number of grains spike^{-1}, grain yield ard. fad^{-1}, biological yield ton fad^{-1}, in both seasons, while 1000 grain weight was significant effect in the first season and not significant effect in the second season , meanwhile spike length, number of spikelet's spike^{-1}, strew yield fad^{-1} was not significant effect in both seasons. The results indicated that the crop sequence of maize + fahll berseem + wheat gave the highest values in both seasons compared with the other treatments due to increase soil N and organic matter in addition to the improvement of soil physical properties El-Sodany and Abou-Elela(2010),Shaalan *et al* (2014), and Asadian and Nejad (2014).

Effect of crop sequence on cereal unit:

Data in Tables 8, 9 showed that crop sequence of maize + fahll berseem + wheat gave the highest values of cereal units and values are (90.52 and 99.84) in both seasons, respectively, compared with the other treatments due to increase soil N and organic matter in addition to the improvement of soil physical properties . While, the lowest values were observed with rice + wheat (65.95 and 67.13) in both seasons, respectively. These results were in accordance with El-Sodany and Abou-Elela, (2010) Shaalan *et al* (2014), and Asadian and Nejad (2014).

Table 8. Cereal units of Rice, Corn, Fahll berseem and Wheat crop sequence in both seasons.

Treatments		Rice		Corn		F berseem	Wheat		total
		Grain yield	Straw yield	Grain yield	Stover yield	Green yield	Grain yield	Straw yield	
2013/14 season									
Rice wheat (control)	(T1)	25.90	3.38	-	-	-	28.93	1.93	60.14
Rice - chopping -wheat	(T2)	28.70	3.60	-	-	-	31.91	2.15	66.36
Rice- F berseem – wheat	(T3)	29.10	4.36	-	-	8.54	32.71	2.18	76.89
Corn - control	(T4)	-	-	35.59	5.48	-	30.36	2.06	73.49
Corn- chopping straw-wheat	(T5)	-	-	38.16	5.75	-	-	2.245	78.75
Corn - F berseem – wheat	(T6)	-	-	38.78	5.96	9.32	33.21	2,27	87.27
2014/15 season									
Rice – wheat (control)	(T1)	29.40	3.48	-	-	-	28.74	2.91	64.53
Rice - chopping straw- wheat	(T2)	33.10	3.98	-	-	-	35.46	2.19	74.73
Rice- F berseem - wheat	(T3)	34.60	4.17	-	-	8.78	36.90	2.22	86.67
Corn - wheat (control)	(T4)	-	-	38.02	5.69	-	32.46	1.98	78.15
Corn- chopping straw-wheat	(T5)	-	-	42.28	5.89	-	36.24	2.28	86.69
Corn - F berseem – wheat	(T6)	-	-	43.90	6.21	9.38	36.32	2.38	98.19

Table 9. Average of cereal units of Rice, Corn, Fahll berseem and Wheat crop sequence in both seasons.

Cropping system	Cereal units First season	Cereal units Second season	Mean
Rice- Wheat (control) (T1)	60.14	64.53	62.34
Rice- Chopping straw- wheat (T2)	66.36	74.73	70.55
Rice - F.berseem - Wheat (T3)	76.89	86.67	81.78
Corn - Wheat (control) (T4)	73.49	78.15	75.82
Corn-Chopping stover - wheat (T5)	78.75	86.69	82.72
Corn - F.berseem - Wheat (T6)	87.27	98.19	92.73

Cereal units from each treatment of crop sequence in both seasons was calculated according by Brockaus (1962) for judicious comparison between 100 kg for each crops as follow : maize =1 unit , rice =1 units ,wheat = 1 unit , fahl berseem = 0.25 unit , straw yield for rice and wheat = 0.15 unit , maize stover = 0.14 unit .

Table 10. Total income of Rice, Corn, Fahll berseem and Wheat crop sequence in both seasons.

Treatments	2013/14 season	2014/15 season	mean
Rice-wheat (control) (T1)	14470.42	15250.24	14860.33
Rice-chopping straw-wheat (T2)	15500.86	17968.55	16734.705
Rice-F. berseem-wheat (T3)	15858.76	18738.18	17298.47
Corn-wheat (control) (T4)	17192.52	18799.12	17995.82
Corn-chopping stover-wheat (T5)	18331.36	20945.56	19638.46
Corn- F. berseem-wheat (T6)	18780.66	21612.91	20196.785

Gross return from each treatment was calculated in Egyptian pounds(LE) at praises of LE 2210/t for (Grain yield) Rice, LE 129/t for (Straw yield) Rice, LE 314 and 315/ardab for (grain yield) Corn, LE 136/t for (stover yield) Corn, L.E.150 and 160/t for f. berseem and LE388 and 411/ardab for for (grain yield) wheat, LE 624 and 632/t for (Straw yield) wheat, (Agricultural Statistics (2012/2013 – 2013/2014), Economic Affairs Sector; Ministry of Agriculture;Egypt;(in Arabic).

Economic Evaluation:

Table 10 showed that crop sequence of maize + fahll berseem + wheat gave the highest values of total income and values are (L.E. 18780.66and 21612.91) in the first and second seasons ,respectively, compared with the other treatments in both seasons , due to increase soil N and organic matter in addition to the improvement of soil physical properties.

Net return:

Table 11 showed that crop sequence of maize + fahll berseem + wheat gave the highest values of net return and values are (L.E. 7893.66and 9835.91) in the first and second seasons ,respectively, compared with the other treatments in both seasons, due to increase soil N and organic matter in addition to the improvement of soil physical properties.

Table 11: Net return of Rice, Corn, Fahll berseem and Wheat crop sequence in both seasons.

Treaments	2013/14 season			2014/15 season		
	Gross return	Cost	Net return	Gross return	Cost	Net return
Rice-wheat (control) (T1)	14470.42	10013	4457.42	15250.24	10847	4403.24
Rice-chopping straw-wheat (T2)	15500.86	10913	4587.86	17968.55	11847	6121.55
Rice-F. berseem-wheat (T3)	15858.76	11257	4601.76	18738.18	12197	6541.18
Corn-wheat (control) (T4)	17192.52	9543	7649.52	18799.12	10377	8422.12
Corn-chopping stover-wheat (T5)	18331.36	10643	7688.36	20945.56	11577	9368.56
Corn-F berseem-wheat (T6)	18780.66	10887	7893.66	21612.91	11777	9835.91

Gross return, Cost and Net return from each treatment was calculated in Egyptian pounds (LE) at praises, (Agricultural Statistics (2012/ 2013 – 2013/2014), Economic Affairs Sector; Ministry of Agriculture; Egypt ;(in Arabic).

Nutrient Availability in soil and some physical properties of soil as affected by studied treatments after wheat harvest:

Some physical properties*:*

Data in Table 12, show that the effect of fahll berseem, corn stover and rice straw as remnants of plants on pH, EC, soluble ions and sodium adsorption ratio (SAR). The likelihood that sodium present in irrigation water will cause permeability problems can be evaluated by computing a parameter known as the sodium adsorption ratio, or SAR.In short, the SAR is a ratio of the concentration of sodium ions to the concentration of calcium plus magnesium ions. Note that in this expression, the concentrations for Na, Ca, and Mg are expressed in $mmolL^{-1}$.

Nitrogen, phosphorus and potassium availability*:*

Data in Table 13 show that the effect of fahll berseem, rice straw and corn stover as remnants of plants on N, P and K availability, organic matter and C/N ratio of soil after wheat harvest. Fahll berseem and soil treated with rice straw or corn stover under different treatments increased nutrient availability and organic matter compared to untreated soil in the two seasons. On the other hand, all soil treatments decreased C/N ratio compared with untreated soil. The highest values of nutrient availability and organic matter were obtained by fahll berseem and treated soil with chopped corn stover and rice straw , while the lowest one were obtained in untreated soil with rice straw and corn stover.

Treatments could be arranged in the following order regarding the main effects fahal berseem > chopped corn stover or rice straw > control under soil treated with fahalberseem, corn stover orrice straw in the both seasons. Taking the mean effect of treatments into consideration, the data show that Fahal berseem and soil treated with corn stover orrice straw gave N, P and K availability and organic matter greater than untreated soil. This result could be due to the high nutrient content and the low C/N ratio in residual effect of fahal berseem compared to corn stover orrice straw. Similar results were obtained by Merwad and Abd El Fattah (2015).From the data presented in table (13), results showed that the crop sequence of maize + F.bersem + wheat gave the highest values of N, P and K ppm availability and organic matter % compared to the untreated ones. These increases represent 29.12, 3.97, 230 ppm and 0.16 %, 26.26, 2.88 , 522 ppm and 0.62 %, while crop sequence of rice + F.bersem + wheat gave the highest values of N, P and K availability and organic matter % compared to the untreated ones. These increases represent 22.49, 1.61, 70 ppm and 0.12 %, 19.88, 2.66, 190 ppm and 0.60 % in both seasons, respectively.

Table 12. Soil pH, soil salinity, soluble ions concentration and SAR as affected by studied treatments after wheat harvest S and Ns indicate p <0.05 and not significant, respectively.

Remnants type (A)	Treatments (B)	pH (1:2.5)	EC, $dS\,m^{-1}$	Cations, $mmolL^{-1}$ Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	Anions, $mmol_cL^{-1}$ Cl^{-}	$HCO_3^{=}$	$SO_4^{=}$	SAR
					2013/14 season						
Rice Straw		7.91	0.94	2.23	1.63	5.49	0.19	3.98	3.76	1.90	3.94
Corn Stover		7.93	0.96	2.11	1.69	5.56	0.20	3.91	3.89	2.03	4.05
LSD0.05		Ns	Ns	0.09	Ns	Ns	0.07	Ns	Ns	1.69	0.40
	Control	8.08	1.04	2.25	1.50	5.37	0.20	3.95	4.25	2.43	3.92
	Chopping	7.83	0.93	2.00	1.50	5.22	0.20	4.06	3.83	1.43	3.95
	Fahal	7.87	0.89	2.25	2.00	5.98	0.17	3.82	3.40	2.04	4.10
LSD0.05		Ns	0.08	0.10	0.65	0.38	0.02	0.40	0.28	0.79	0.27
Rice Straw	Control	8.07	1.04	2.50	1.50	5.12	0.20	3.79	4.25	2.43	3.62
	Chopping	7.83	0.93	2.00	1.50	5.22	0.17	4.37	3.97	0.95	3.95
	Fahal	7.88	0.89	2.25	2.00	5.98	0.17	3.84	3.40	2.05	4.10
Corn Stover	Control	8.08	1.04	2.00	1.50	5.22	0.17	3.78	4.25	2.43	3.95
	Chopping	7.82	0.93	2.25	2.00	5.98	0.20	4.03	3.69	1.90	4.10
	Fahal	7.85	0.89	2.00	1.50	5.61	0.23	3.84	3.4	2.05	4.24
LSD0.05		Ns	Ns	0.12	0.84	Ns	0.15	0.52	Ns	1.03	0.35
					2014/15 season						
Rice Straw		7.93	1.01	2.13	1.80	5.98	0.22	3.75	3.83	2.88	3.86
Corn Stover		7.95	1.17	2.53	3.71	5.04	0.16	2.73	4.07	4.95	3.46
LSD0.05		Ns	0.32	0.96	2.32	0.18	0.07	Ns	0.74	2.87	1.42
	Control	8.09	1.17	2.24	2.83	5.37	0.19	3.53	4.15	4.16	3.57
	Chopping	7.89	1.03	2.16	2.36	5.33	0.22	3.18	3.89	3.65	3.65
	Fahal	7.84	1.07	2.59	3.07	5.84	0.16	3.02	3.83	3.94	3.78
LSD0.05		0.01	0.11	0.49	1.22	0.59	0.03	0.63	0.30	1.62	0.93
Rice Straw	Control	8.06	1.07	2.00	1.50	5.65	0.20	3.75	3.97	3.00	3.77
	Chopping	7.89	0.94	2.00	2.00	6.52	0.22	3.12	3.65	2.85	4.11
	Fahal	7.84	0.95	1.50	1.50	6.09	0.18	2.99	3.62	2.81	4.47
Corn Stover	Control	8.11	1.26	2.82	3.22	4.56	0.18	3.55	4.33	5.31	3.12
	Chopping	7.89	1.08	3.18	4.13	5.15	0.21	2.32	3.98	4.45	3.19
	Fahal	7.86	1.18	2.47	4.15	5.09	0.16	2.73	3.85	5.07	3.30
LSD0.05		Ns	0.14	0.64	.58	0.76	0.12	0.81	0.39	2.10	1.20

Table 13. Nutrient Availability in soil and some physical properties of soil as affected by studied treatments after wheat harvest S and Ns indicate p <0.05 and not significant, respectively.

Remnants type	Treatments	Nutrient Availability, N ppm	P ppm	K ppm	OC, %	OM, %	C/N Ratio	BD, $Mg.m^{-3}$	RD, $Mg.m^{-3}$	TP, %	SP, %
						2013/14 season					
Rice Straw		25.99	6.29	475.20	0.91	1.55	9.16	1.15	2.65	56.81	56.60
Corn Stover		26.03	7.31	518.00	0.92	1.59	8.97	1.14	2.64	56.93	56.82
LSD0.05		Ns	0.83	30.97	Ns	Ns	Ns	Ns	Ns	Ns	Ns
	Control	25.89	5.81	440.00	0.88	1.49	9.70	1.22	2.64	53.99	53.79
	Chopping	25.99	6.42	470.00	0.92	1.59	9.28	1.15	2.63	56.95	56.65
	Fahal	26.15	8.19	580.00	0.95	1.63	8.22	1.06	2.66	60.89	60.00
LSD0.05		1.52	1.11	84.43	Ns	Ns	1.47	0.05	Ns	2.58	2.30
	Control	25.91	5.56	440.00	0.88	1.48	9.88	1.22	2.63	53.61	53.61
Rice Straw	Chopping	25.99	6.59	460.00	0.92	1.57	8.99	1.13	2.63	56.65	57.36
	Fahal	26.14	7.11	570.00	0.93	1.60	8.40	1.08	2.65	61.21	61.51
	Control	25.87	5.51	440.00	0.88	1.50	9.78	1.21	2.64	54.11	54.17
Corn Stover	Chopping	25.99	6.59	480.00	0.92	1.61	8.99	1.14	2.63	56.63	56.65
	Fahal	26.16	9.47	590.00	0.96	1.66	8.36	1.01	2.66	61.41	61.89
LSD0.05		1.31	1.43	109.25	Ns	Ns	Ns	Ns	Ns	Ns	Ns
						2014/15 season					
Rice Straw		25.99	4.01	334.25	0.97	1.51	10.31	1.10	2.64	58.72	58.33
Corn Stover		26..01	5.86	501..00	1.16	2.00	8.82	1.06	2.64	59.98	59.85
LSD0.05		Ns	0.97	101.51	0.15	0.34	Ns	0.10	Ns	6.07	5.62
	Control	25.88	4.43	346.50	.99	1.57	8.34	1.20	2.62	54.39	54.20
	Chopping	25.00	4.91	393.50	1.07	1.80	11.08	1.04	2.65	61.51	61.51
	Fahal	26.13	5.60	513.00	1.13	1.90	9.28	1.01	2.67	62.17	62.17
LSD0.05		1.02	0.88	40.22	Ns	Ns	Ns	0.09	Ns	3.40	3.80
	Control	25.91	3.58	350.00	0.84	1.43	13.33	1.22	2.63	53.91	53.61
Rice Straw	Chopping	25.99	4.74	380.00	1.09	1.55	9.97	1.07	2.62	59.46	59.16
	Fahal	26.01	5.64	480.00	1.19	2.05	8.57	1.02	2.65	61.51	61.51
	Control	25.86	3.58	353.00	0.90	1.48	8.82	1.17	2.61	56.92	55.17
Corn Stover	Chopping	26.01	5.91	440.00	1.15	1.98	8.55	1.05	2.67	60.67	60.67
	Fahal	26.12	6.46	500.00	1.20	2.07	8.1	0.97	2.67	63.67	63.57
LSD0.05		1.43	1.14	52.04	Ns	Ns	Ns	Ns	Ns	Ns	Ns

Notes: OC, OM, BD, RD, TP and SP refer to organic carbon, organic matter, bulk density, real density, total porosity and soil porosity respectively.

CONCLUSION

Generally, using crop sequence of maize + Fall. bersem + wheat or a remnants of corn and rice plants improved physical and chemical properties of soil for the next planting, and wheat growth, yield and its components because they increase soil fertility, increase plant efficiency and thus increase productivity significantly.

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تاثير بقايا التعاقب المحصولى للأرز والذرة الشامية والبرسيم التحريش على انتاجية القمح وخصوبة التربة.

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أقيمت تجربة حقلية بمحطة البحوث الزراعية بالجميزة محافظة الغربية خلال موسمي ٢٠١٣ / ٢٠١٤ و ٢٠١٤/ ٢٠١٥ لدراسة تأثير بقايا قش الأرز وحطب الذرة والبرسيم الفحل على انتاجية محصول القمح وخصوبة التربة. وقد نفذت التجربة فى تصميم القطع الشريطية (الشرائح المتعامدة) فى ثلاث مكررات حيث كانت محاصيل الأرز والذرة الشامية فى الشرائح العمودية، ووضعت معاملات قش الأرز وحطب الذرة للتربة فى الشرائح الافقية فى الموسمين كالتالى: (١) التربة غير معاملة ببقايا قش الأرز. (٢) معاملة التربة بقش الأرز المفروم ٣٣ % من قش الأرز ثم الرى مباشرة. (٣) التربة معاملة ببقايا البرسيم الفحل حشة واحدة. (٤) التربة غير معاملة ببقايا حطب الذرة. (٥) معاملة التربة بحطب الذرة المفروم ٣٣ % من حطب الذرة ثم الرى مباشرة. (٦) التربة معاملة ببقايا البرسيم الفحل حشة واحدة. ولقد أظهرت النتائج مايلى: زيادة العناصر الكبرى N, P, K الميسرة فى التربة نتيجة تحلل بقايا البرسيم الفحل حشة واحدة وفرم حطب الذرة وفرم قش الأرز بالتربة و الذى أدى الى تحسين خصوبة التربة وصفاتها الطبيعية والكيمائية وانعكس ذلك معنويا على زيادة انتاجية محصول القمح ومكوناته مقارنة بباقى المعاملات فى كل من الموسمين. وقد أوضحت الدراسة أن أفضل المعاملات هى زراعة الذرة الشامية يعقبه برسيم فحل حشة واحدة ثم زراعة القمح والتى أدت الى زيادة خصوبة التربة ، وانعكس ذلك معنويا على زيادة انتاجية محصول القمح مقارنة بباقى المعاملات حيث أعطت أعلى القيم من وحدات الحبوب (٨٧,٣ و ٩٨.٢) فى حين أعطى التعاقب المحصولى أرز ثم قمح أقل القيم من وحدات الحبوب (٦٠,١ و٦٤.٥) فى كلا الموسمين على الترتيب. وبحساب عائد الفدان بوحدات الحبوب اتضح تفوق محصول القمح و مكوناتة الناتج من التعاقب المحصولى ذرة شامية ثم برسيم فحل حشة واحدة ثم قمح بالجنية المصرى.(١٨٧٨٠,٦٦و٢١٦١٢,٩١) وأعطت عائد نقدى (٩٨٣٥,٩١و٧٨٩٣,٦٦للفدان) على التعاقب المحصولى أرز ثم برسيم فحل حشة واحدة ثم قمح (١٥٨٥٨,٧٦و١٨٧٣٨,١٨)وأعطت عائد نقدى (٤٦٠١,٧٦ و٦٥٤١,١٨ للفدان) فى كل من الموسمين على الترتيب مقارنة بباقى المعاملات تحت ظروف التجربة.