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Net income evaluation of closing the gap of wheat grains and forage

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Abstract

Two field experiments were carried out at Experimental Station Farm, Faculty of Agriculture, Mansoura University, Dakahlia Governorate, Egypt, during 2015/2016 and 2016/2017 seasons to decide the effect of previous crops, tillage treatments, irrigation treatments and nitrogen fertilizer levels on straw and grain yields of bread wheat Misr 1 cultivar in addition evaluation net income of closing the gap of wheat grains and forage. Each preceding short time crops was performed in separate experiment. Each experiment of preceding crops was carried out in a strip-split plot design with three replicates. Growing peas as short time crop previous of wheat and using tillage treatment (well prepared the experimental field through two ploughings, compaction, division and then divided into the experimental units) besides irrigation every 4 weeks (5 irrigations), which consumed 1875 m^3/fed in addition mineral fertilizing plants with 60/fed (75 of the recommended dose) resulted in highest values of grain and straw yield/fed in the first and second seasons. the highest net income/L.E. for grain yield (ardab/fed), straw yield (t/fed), grain and straw yields/fed were achieved by growing peas as short time crop previous of wheat and using tillage treatment (well prepared the experimental field through two ploughings, compaction, division and then divided into the experimental units) besides irrigation every 4 weeks (5 irrigations), which consumed 1875 m^3/fed in addition mineral fertilizing plants with 60/fed (75 of the recommended dose). It can be concluded that growing peas or beans as short time crop preceding of wheat and using tillage treatment (well prepared the experimental field through two ploughings, compaction, division and then divided into the experimental units) besides irrigation plants every 3 weeks (6 irrigations), which consumed 2250 m^3/fed in addition mineral fertilizing plants with 80/fed in order to maximize net income of wheat and closing the gap of wheat grains and forage.

Keywords: Wheat, preceding crops, tillage treatments, irrigation treatments, N-levels, yields, net income.

Introduction

Wheat (*Triticum aestivum* L.) is the most important and widely grown cereal crops in Egypt and all over the world. In that manner, wheat supplies about 20 percent of the food calories for the world's people. Wheat is used mainly as a human food. It is nutritious, concentrated, easily stored and transported and easily processed into various types of food like bread, macaroni, biscuit and sweets. Although wheat is useful as a livestock feed. In Egypt, the gap between wheat consumption and production is continuously increased due to steady increases in the country population with limited cultivated area. Thus increasing wheat productivity, either horizontal or vertical through scientific basis is a national target to fill this gap.

It is well recognized that vertical expansion and maximize productivity of any crop could be achieved through using suitable agronomic practices. In addition, the pronounced role of the agronomical processes such as suitable preceding previous crops, tillage treatments, irrigation treatments and nitrogen fertilizer levels has very imperative effect on wheat yields and net income of closing the gap of wheat grains and forage.

Wheat production differs depending on the preceding summer crop. The legume crops are the best resources than cereals because of their ability to improve soil fertility and save mineral nitrogen. When crops are grown in system, the fertilizer needs of an individual crop cannot be precisely determined without taking into account the nature of preceding crop, its yield level and residual effect of fertilizer application. Growing of a legume crop in the previous season affect the growth and development of wheat. Yields are higher when cereals follow a legume as this saves nitrogen and breaks the disease cycle of grains **(Kumar and Sharma, 2000)**. Species of preceding crops significantly affect wheat yield and grain legumes such as mungbean might help to maximize wheat yield in a crop rotation system (**Maadi *et al.*, 2012)**. When suggested recommendations of nitrogen fertilizer, it is necessary to consider cropping sequence, because the need for nutrients by crop would vary depending upon the preceding crop type and its inputs usage **(Bharathi *et al.*, 2013)**. The response of wheat grain yield to the preceding crop was high. Wheat grain yield was highest following alfalfa, and was 33% lower following wheat. The yield increase of wheat following alfalfa was mainly due to an increased number of spikes per unit area and number of grains per spike, while the yield decrease following wheat was mainly due to a reduction of spike number per unit area **(Ercoli *et al.*, 2014)**. Growing soybean and green gra crop significantly produced higher grain and straw yields of wheat than preceding maize crop **(Usadadiya *et al.*, 2014)**. **Attia *et al.* (2018)** showed that growing clover Fahl cultivar as short time crop preceding of wheat produced the highest values of plant height, spike length and 100-grain weight in both growing seasons. While, growing peas as short time crop preceding of wheat resulted in the highest values of grain yield and straw yields/fed in both seasons.

Tillage has been chief aspect of technological development in the evolution of agriculture, in particular in food production. The objectives of tillage the soil involves; seedbed preparation, water and soil conservation besides weed control. Tillage also has various physical, chemical and biological effects on the soil. The physical effects such as aggregate-stability, infiltration rate, soil and water conservations, consequently have a direct effect on soil productivity and yield sustainability, which led to an enhanced nutrient uptake and better yield of field crops (**Arif *et al.*, 2007**). Results of reduced tillage practices for cereal crops demonstrated advantage of less intensive tillage systems compared to conventional deep tillage systems (**Jug et al., 2006**). The wheat grain and straw yield was not increased by the tillage treatment *i.e.* tillage (crop residues removed), tillage (crop residues retained), no-tillage (crop residues removed) and no-tillage (crop residues retained). They concluded that no-tillage + crop residues and legume based rotation treatment were beneficial under the dry conditions **(Mohammad *et al.*, 2012)**. Conservation-focused tillage systems, *i.e.*, no tillage, could be reduced yields, thus produced better yields and provide environmentally friendly options (**Lu *et al.*, 2015)**. Reduced and no-tillage practices can be alternative to conventional tillage practices of wheat under Mediterranean conditions (**Acar *et al.*, 2017)**. Disrupting compacted layers and loosening the soil by tillage may increase infiltration of water relative to no-till management **(Blanco-Canqui *et al.*, 2017)**. **Attia *et al.* (2018)** showed that highest values of plant height, spike length, 100-grain weight, grain and straw yields/fed were achieved by well prepared the experimental field through two ploughings, compaction, division and then divided into the experimental units.

Drought and its consequent stress are one of the important factors which restrict agriculture production in Egypt and reduce the use efficiency of dry lands. Therefore, recognition and utilization crops tolerant to drought and the special crops improvement methods make it possible to use semi arid region. The wheat crop requires adequate water in all stages of its physiological development to attain optimum productivity. But like other cereal crops, there are critical points in its growth stages where lack of soil moisture greatly impacts grain production. Thus, precautions must be taken to prevent loss of crop productivity due to avoidable circumstances. Under water scarcity condition, plant extractable soil water depletion of more than 45% of available soil water must be avoided even during non-critical stages of the wheat crop (**Panda *et al.*, 2003)**. More moisture favors greater number of tillers and lodging percentage. For maximum yield of wheat the crop may be irrigated after five weeks interval. Excessive and earlier than five weeks irrigation interval can be harmful for the optimum yield of wheat (**Khan *et al.*, 2007)**. Optimum grain yield was produced at 50% of soil water deficit as supplemental irrigation (**Karam *et al.*, 2008)**. Irrigating wheat grown in sandy soil with an amount of either 1.0 or 0.8 of ETc with fertigation application in 80% of application time is recommended to enhance growth and yield, and to reduce wheat's damage caused by extreme climate change (**Ibrahim *et al.*, 2012)**. Responses of wheat growth to water deficits vary depending on wheat species and growth stages. Highly positive correlation's coefficient was attained among wheat plant characters, except with water consumptive during growing season of wheat plant. Water consumptive was negatively correlated with the other studied wheat plant characters (**Mansour and Abd El-Hady, 2014)**. **Attia *et al.* (2018)** showed that irrigation wheat plants every 3 weeks (6 irrigations), which consumed 2250 m^3/fed gave the highest values of yield and its components in both seasons.

Nitrogen supply to the plant will influence the amount of protein, protoplasm and chlorophyll formed. The amount of applied nitrogen in plants must be carefully managed to ensure that, N will be available throughout the growing season and the vegetative and reproductive development will be not restricted (**Brich and Long, 1990 and Zhang *et al.* 2008**). Nitrogen uptake and utilization by plants and wheat are determined by genotypic differences and are linked to a variety of morphological and physiological factors, including the length and activity of the root system, the intensity of nitrate uptake, activity of nitrate reductase, sink of grains, carbohydrate production and N losses due to soil characteristics and leaching (**Shibu *et al.* 2010**). In spite of mineral nitrogen fertilizer have a good effect on plant productivity, nevertheless it's also have a pollutant effect on the environment. Whereas, it is more rapidly leaching to ground water, which affects human and animal health. Nitrogen fertilization at the level of 90 kg N/fed significantly exceeded other levels (50 and 70 kg N/fed) in photosynthetic pigments, growth characters, yield components and yield and quality characters over both seasons (**Seadh *et al.*, 2008)**. Raising mineral nitrogen fertilizer level from 25 to 50, 75 and 100 kg N/fed resulted in significant increases in spike length, grain and straw yields/fed and protein content of grains. Also, NPK uptake of grain and straw were significantly increased (**Antoun *et al.*, 2010)**. Grain and straw yields/fed and protein content were significantly increased by increasing nitrogen fertilizer levels from 0 to 30, 60 and 90 kg N/fed (**Atia and Ragab, 2013**). Mineral fertilizing with 100 % of the recommended rate *i.e*. 75 kg N/fed gave the highest grain and straw yields and its components of wheat as compared with 67 or 133 % of the recommended rate (**Attia *et al.*, 2013)**. The best significant values of grain and straw yields/fed were obtained by adding 60or 90 kg N/fed. On the other hand, the lowest ones were recorded for the control (**Seleem and Abd El-Dayem, 2013**). Application of 80,110 and 120 kg N/ha were statistically identical in respect of spike length. The best nitrogen rate for the high economical increases of studied parameters was 80 kg N/ha, which gave the highest spike length (7.98 cm). While, maximum grain yield (2.15 t/ha) resulted from application of 100 kg N/ha (**Shirazi *et al.*, 2014**). Wheat plants fertilized with 100% of the recommended dose of nitrogen (80.0 kg N/fed) had the highest values of yield attributes, followed by plants fertilized with 80% of the recommended dose (64.0 kg N/fed) and lastly that fertilized with 60% of the recommended dose (48.0 kg N/fed) with significant differences among them in both seasons (**Seadh and El-Metwally, 2015)**. Fertilizing wheat plants with 262 kg N/ha resulted the highest values of yield attributes and significantly exceeded other studied levels *i.e.*

214 and 166 kg N/ha (**Kandil *et al.*, 2016)**. Mineral fertilizing wheat plants with the highest level of nitrogen (100 % of the recommended doses *i.e.* 80 kg N/fed) gave the highest values of growth characters, yield and its components (**Seadh *et al.*, 2017)**. **Attia *et al.* (2018)** showed that mineral fertilizing wheat plants with 100 % of the recommended dose *i.e.* 80 kg N/fed gave the highest values of plant height, spike length, 100-grain weight, grain and straw yields/fed in both seasons.

Therefore, this investigation was carried out to evaluation net income of closing the gap of wheat grains and forage and study the effect of previous crops, tillage treatments, irrigation treatments and nitrogen fertilizer levels on straw and grain yields of bread wheat Misr 1 cultivar under the environmental conditions of Dakahlia Governorate, Egypt.

Materials and Methods

Two field experiments were carried out at Experimental Station Farm, Faculty of Agriculture, Mansoura University, Dakahlia Governorate, Egypt, during 2015/2016 and 2016/2017 seasons. These experiments were aimed to decide the effect of previous crops, tillage treatments, irrigation treatments and nitrogen fertilizer levels on straw and grain yields of bread wheat Misr 1 cultivar besides evaluation net income of closing the gap of wheat grains and forage and maximizing land productivity of wheat and other forage crops via introducing an appropriate short time crop during the time period between the end of maize crop and the beginning of wheat crop as shown in Fig. 1.

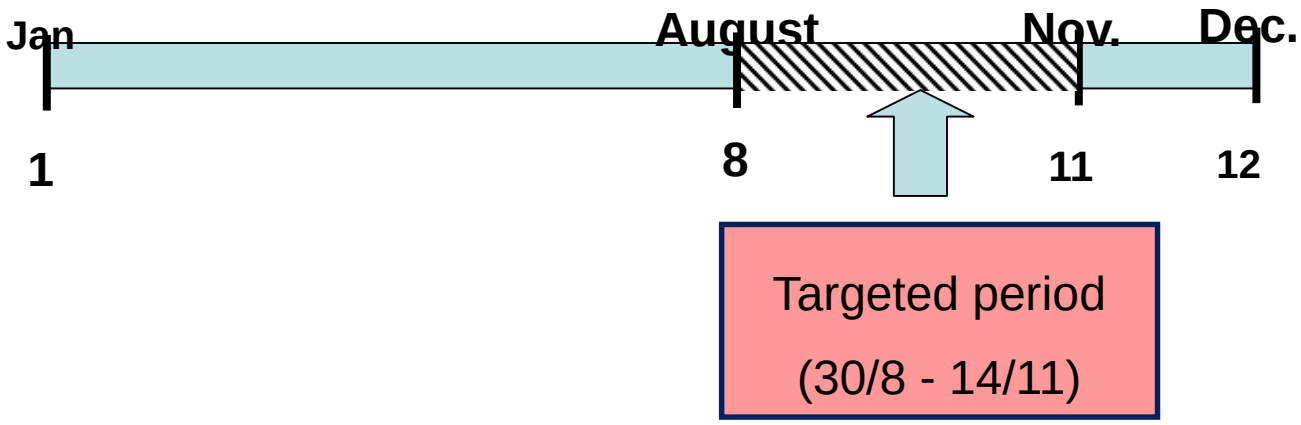

Fig. 1: The project aims at maximizing land productivity of wheat and other forage crops via introducing an appropriate short time crop during the time period between the end of maize crop and the beginning of wheat crop

The Egyptian wheat Misr 1 cultivar that used in this investigation was obtained from Wheat Research Section, Field Crops Research Institute, Agricultural Research Center, Giza, Egypt.

Each previous crop (without, beans, peas and clover "Fahl cultivar") was performed in separate experiment. Each experiment of preceding crops was carried out in a strip-split plot design with three replicates. Each experiment included eighteen treatments, two tillage treatments, three irrigation treatments and three nitrogen fertilizer levels.

The vertical-plots were included tillage treatments (no-tillage and tillage). In the tillage treatment, the experimental field was well prepared through two ploughings, compaction, division and then divided into the experimental units (3 × 3.5 m occupying an area of 10.5 m^2). While, in the non-tillage treatment, the experimental field was left without tillage after the previous short time summer crops, and each experimental basic unit was 3 × 3.5 m occupying an area of 10.5 m^2 also.

The horizontal-plots were devoted to three irrigation treatments as follows:

1- Irrigation every 3 weeks (6 irrigations), which consumed 2250 m^3/fed.
2- Irrigation every 4 weeks (5 irrigations), which consumed 1875 m^3/fed.
3- Irrigation every 5 weeks (4 irrigations), which consumed 1500 m^3/fed.

The first irrigation (Mohayah irrigation) was carried out after 14 days from sowing, then the other irrigations were followed as previously mentioned.

While, the sub – plots were allocated to three nitrogen fertilizer levels (N-levels) as follows:

1- 50 of the recommended dose (40 kg N/fed).
2- 75 of the recommended dose (60 kg N/fed).
3- 100 of the recommended dose (80 kg N/fed).

The nitrogen fertilizer in the form of ammonium nitrate (33.5 % N) was applied at the aforesaid rates as broadcasting in two equal doses prior the first and the second irrigations.

The soil of experimental site was clayey in texture with an electrical conductivity (EC) of 1.7 dS/m, pH of 7.85 and organic matter 2.90 over both seasons.

Calcium super phosphate (15.5 % P_2O_5) was applied during soil preparation at the rate of 150 kg/ha. Potassium sulphate (48 % K_2O) at the rate of 50 kg/ha was broadcasted in one dose before the second irrigation. Grains of wheat cultivars were sown at the rate of 70 kg/ha, during the last week of November by using hand drilling Afar method in both seasons. The common agricultural practices for growing wheat according to the recommendations of Ministry of Agriculture were followed, except the factors under study.

Studied characters

1- Grain yield (ardab/fed). It was calculated by harvesting whole plants in each plot and air dried, then threshed and the grains at 13 % moisture were weighted in kg and converted to ardab per feddan (one ardab = 150 kg ; one feddan "fed" = 4200 m^2).

2- Straw yield (t/fed). The straw resulted from whole plants in each plot was weighted in kg/plot, then it was converted to ton per feddan.

3- Net income/L.E. for grain yield (ardab/fed), straw yield (t/fed), grain and straw yields/fed and grain, straw yields and previous crops in summer /fed.

4- Economic assessment of both seasons.

The obtained data were statistically analyzed according to the technique of analysis of variance (ANOVA) for the strip split – plot design for each experiment (preceding summer crops), then combined analysis was done among preceding summer crops experiments as published by **Gomez and Gomez (1984)** using "MSTAT-C" computer software package. Least significant difference (LSD) method was used to test the differences among means of treatment at 5 % level of probability as described by **Snedecor and Cochran (1980)**.

Results and Discussion

1. Grain and straw yields/fed:

Regarding the effect of the interactions among previous crops, tillage treatments, irrigation treatments and N-levels on grain and straw yields/fed, it was significant on in the first and second seasons as shown from results in Tables 1, 2, 3 and 4.

Table 1: Grain yield (ardab/fed) as affected by the interactions among previous crops, tillage treatments, irrigation treatments and N-levels during the first season (2015/2016).

Irrigation treatments	N-levels	Previous crops							
		Without		Beans		Peas		Clover	
		No Tillage	Tillage	No Tillage	Tillage	No Tillage	Tillage	No Tillage	Tillage
2250 m^3	50%	11.40	23.50	21.50	12.10	18.60	23.00	19.70	17.60
	75%	12.50	18.60	12.30	20.50	18.70	21.80	21.20	16.70
	100%	13.30	22.60	26.10	24.10	10.10	25.20	15.80	14.90
1875 m^3	50%	15.20	13.30	20.90	24.50	14.70	25.30	20.80	17.40
	75%	14.40	23.40	21.40	24.20	17.60	28.60	18.80	23.70
	100%	14.60	17.20	24.20	24.30	13.30	26.10	20.60	24.60
1500 m^3	50%	10.10	22.50	17.40	16.50	22.10	26.50	19.10	26.70
	75%	18.60	27.30	11.90	17.20	21.20	23.30	12.30	13.60
	100%	21.40	24.70	17.30	16.10	22.80	24.20	20.70	21.40
LSD at 5%		1.3							

Table 2: Grain yield (ardab/fed) as affected by the interactions among previous crops, tillage treatments, irrigation treatments and N-levels during the second season (2016/2017).

Irrigation treatments	N-levels	Previous crops							
		Without		Beans		Peas		Clover	
		No Tillage	Tillage	No Tillage	Tillage	No Tillage	Tillage	No Tillage	Tillage
2250 m^3	50%	20.60	26.60	22.30	16.60	21.00	26.00	24.30	22.00
	75%	15.60	21.30	16.60	23.60	21.30	24.60	24.00	24.60
	100%	16.00	22.60	24.00	26.60	14.30	28.00	25.60	24.30
1875 m^3	50%	18.30	19.60	24.00	27.00	16.60	27.30	23.60	24.00
	75%	17.30	22.30	24.30	27.00	20.00	28.00	24.30	26.60
	100%	19.00	20.00	26.00	24.00	17.60	27.30	23.60	27.00
1500 m^3	50%	11.30	22.60	19.00	19.00	24.60	25.00	19.60	26.70
	75%	21.00	25.30	16.00	19.60	24.00	26.30	17.00	25.60
	100%	24.30	23.30	18.30	19.00	25.60	27.00	17.60	24.30
LSD at 5%		1.33							

Table 3: Straw yield (t/fed) as affected by the interactions among previous crops, tillage treatments, irrigation treatments and N-levels during the first season (2015/2016).

Irrigation treatments	N-levels	Previous crops							
		Without		Beans		Peas		Clover	
		No Tillage	Tillage	No Tillage	Tillage	No Tillage	Tillage	No Tillage	Tillage
2250 m^3	50%	1.51	2.61	3.37	2.75	2.81	3.30	3.32	4.32
	75%	2.25	3.17	2.53	4.38	3.95	2.86	4.34	3.43
	100%	1.92	2.93	3.45	3.44	2.39	4.02	2.75	3.36
1875 m^3	50%	2.58	3.62	2.93	3.46	2.88	3.40	3.96	2.85
	75%	2.85	3.62	2.31	3.39	4.08	4.79	2.56	2.73
	100%	3.37	3.62	2.21	2.15	3.01	3.20	3.17	2.69
1500 m^3	50%	1.35	4.17	3.89	3.44	2.78	4.34	3.25	2.78
	75%	1.39	3.90	2.73	4.47	3.10	3.02	3.05	3.20
	100%	2.83	3.83	4.12	4.15	3.25	4.55	4.31	3.25
LSD at 5%		1.25							

Table 4: Straw yield (t/fed) as affected by the interactions among previous crops, tillage treatments, irrigation treatments and N-levels during the second season (2016/2017).

Irrigation treatments	N-levels	Previous crops							
		Without		Beans		Peas		Clover	
		No Tillage	Tillage	No Tillage	Tillage	No Tillage	Tillage	No Tillage	Tillage
2250 m^3	50%	2.20	2.33	3.23	2.90	3.00	2.80	3.03	3.66
	75%	2.22	2.70	3.00	2.56	3.16	3.43	3.13	3.43
	100%	2.28	2.66	3.30	2.73	3.06	3.26	3.73	3.10
1875 m^3	50%	2.73	2.60	3.66	3.23	3.70	2.60	3.10	3.40
	75%	2.34	3.16	3.13	3.13	2.83	3.93	3.00	2.83
	100%	3.15	2.13	3.53	3.10	3.23	3.36	3.46	3.60
1500 m^3	50%	2.19	2.90	2.96	3.56	2.66	3.53	3.23	3.26
	75%	2.30	3.16	2.03	2.60	3.06	3.13	3.53	3.26
	100%	2.46	3.13	2.80	2.80	3.36	3.13	3.56	3.80
LSD at 5%		1.01							

It is clearly seen that, growing peas as short time crop previous of wheat and using tillage treatment (well prepared the experimental field through two ploughings, compaction, division and then divided into the experimental units) besides irrigation every 4 weeks (5 irrigations), which consumed 1875 m^3/fed in addition mineral fertilizing plants with 60/fed (75 of the recommended dose) resulted in highest values of grain and straw yield/fed in the first and second seasons (Tables 1, 2, 3 and 4). On the contrary of that, left the field without cultivation and tillage before sowing wheat and irrigation every 5 weeks (4 irrigations), which consumed 1500 m^3/fed additionally fertilizing plants with 50 % of the recommended dose *i.e.* 40 kg N/fed gave the lowest values of grain and straw yield/fed in the first and second seasons of this study.

These results might have been due to the role of legume crops like clover or peas in improvement of soil fertility, save mineral nitrogen and breaks the disease cycle of grains (**Ercoli *et al.*, 2014 and Usadadiya *et al.*, 2014)**. The increases in yields due to tillage treatment may be ascribed to weaken the soil strength, reduce compaction and allow the free movement of air and water. Also, this tillage treatment was carried with the objective of changing the soil physical properties and to enable the plant to show their full potential in order to promote plant growth (**Arif *et al.*, 2007 ; Acar *et al.*, 2017 and Blanco-Canqui *et al.*, 2017)**. This increase in yields due to deceasing irrigation stress by irrigation every 3 weeks "6 irrigations", which consumed 2250 m^3/fed may be due to provide moisture for wheat plants continuously which allows better growth, thereby enhancement vegetative growth attributes and enhance photosynthesis process, consequently improvement growth and yields of wheat. On the contrary, inadequate supply of water at critical development stages and high sensitivity of different wheat to water stress are of immense importance. Where, water is also important for the plant for maintaining its turgidity (**Ibrahim *et al.*, 2012 and Mansour and Abd El-Hady, 2014)**. These increases due to increased mineral fertilization levels may be due to the key role of nitrogen which is considered one of the feed key elements of plant nutrition, and it increases the vegetative growth the plant forms a strong plant with long screws (**Shirazi *et al.*, 2014 ; Seadh and El-Metwally, 2015 and Seadh *et al.*, 2017).**

2- Net income:

Regarding the effect of the interactions among previous crops, tillage treatments, irrigation treatments and N-levels on net income *i.e.* net income/L.E. for grain yield (ardab/fed), straw yield (t/fed), grain and straw yields/fed and grain, straw yields and previous crops in summer/fed, the obtained results of this study apparently cleared that there was a significant effect in the first and second seasons as shown from results in Tables 5 through 11.

Table 5: Net income/L.E. for grain yield (ardab/fed) as affected by main effects and the interactions among previous crops, tillage treatments, irrigation treatments and N-levels during the first season (2015/2016).

Irrigation treatments	N-levels	Previous crops							
		Without		Beans		Peas		Clover	
		No Tillage	Tillage	No Tillage	Tillage	No Tillage	Tillage	No Tillage	Tillage
2250 m^3	50%	11275	17325	16225	11055	14630	17050	15235	14080
	75%	11715	14630	11165	15675	14685	16390	16060	13585
	100%	13970	16830	18755	17655	9955	18260	13090	12595
1875 m^3	50%	12760	11715	15895	17875	12485	18315	15840	13970
	75%	12320	17270	16170	18975	14080	20130	14740	17435
	100%	12430	13860	17710	17765	11715	18755	15730	17930
1500 m^3	50%	7920	16775	6105	13475	16555	17710	14905	19085
	75%	14630	13780	10945	13860	16060	17215	11165	11880
	100%	16170	17985	13915	13255	16940	17710	15785	16170

Main effects:		LSD at 5%
Previous crops	Without: 14388 Beans: 14804 Peas: 16035 Clover: 14960	605
Tillage	No Tillage: 13881 Tillage: 1621216	*
Irrigation	1500 m^3: 14410 1875m^3: 15560 2250 m^3: 15170	522
N-levels	50%: 14723 75%: 14888 100%: 15528	605
Interactions among previous crops, tillage, irrigation and N-levels		1815

Table 6: Net income/L.E. for grain yield (ardab/fed) as affected by main effects and the interactions among previous crops, tillage treatments, irrigation treatments and N-levels during the second season (2016/2017).

Irrigation treatments	N-levels	Previous crops							
		Without		Beans		Peas		Clover	
		No Tillage	Tillage	No Tillage	Tillage	No Tillage	Tillage	No Tillage	Tillage
2250 m^3	50%	11330	17380	15015	11880	14300	17050	16115	14850
	75%	11550	14465	11880	15730	14465	16280	15950	16280
	100%	14080	15180	15950	17380	10615	18050	16830	16115
1875 m^3	50%	12815	13530	15950	17600	11880	17765	15730	15950
	75%	12265	15015	16115	17600	13750	18150	16115	17380
	100%	13200	13750	17050	15950	12430	17765	15730	17600
1500 m^3	50%	8965	15180	13200	13200	16280	17150	13530	17435
	75%	14300	16665	11550	13530	15950	17215	12100	16830
	100%	16115	15565	12815	13200	16830	17600	12430	16115

Main effects:		LSD at 5%
Previous crops	Without: 15709 Beans: 16634 Peas : 17754 Clover: 17692	522
Tillage	No. Tillage: 15789 Tillage: 18108	*
Irrigation	1500m^3: 14737 1875 m^3: 15641 2250 m^3: 14994	456
N-levels	50%: 10218 75%: 14909 100%: 15037	NS
Interactions among previous crops, tillage, irrigation and N-levels		2915

Table 7: Net income/L.E. for straw yield (t/fed) as affected by main effects and the interactions among previous crops, tillage treatments, irrigation treatments and N-levels during the first season (2015/2016).

Irrigation treatments	N-levels	Previous crops							
		Without		Beans		Peas		Clover	
		No Tillage	Tillage	No Tillage	Tillage	No Tillage	Tillage	No Tillage	Tillage
2250 m^3	50%	1812	3132	1668	3300	3372	3960	3984	5184
	75%	2700	3804	3036	5256	4740	3432	5208	4116
	100%	2304	3516	4140	4128	2868	4824	3300	4032
1875 m^3	50%	3096	4344	3516	4152	3456	4080	4752	3420
	75%	3420	4344	2772	4068	4896	6564	3072	3276
	100%	4044	4344	2652	2580	3612	3840	3804	3228
1500 m^3	50%	1620	5004	4668	4128	3336	5208	3900	3336
	75%	3396	4680	3276	5748	3720	3624	3660	3840
	100%	4044	4596	4944	4980	3900	5460	5172	3900

Main effects:		LSD at 5%
Previous crops	Without: 3569 Beans: 3831 Peas: 4160 Clover: 3954	96
Tillage	No Tillage: 3551 Tillage: 4206	*
Irrigation	1500 m^3: 3567 1875 m^3: 3805 2250 m^3: 4174	288
N-levels	50%: 3783 75%: 3955 100%: 3898	NS
Interactions among previous crops, tillage, irrigation and N-levels		1500

Table 8: Net income/L.E. for straw yield (t/fed) as affected by main effects and the interactions among previous crops, tillage treatments, irrigation treatments and N-levels during the second season (2016/2017).

Irrigation treatments	N-levels	Previous crops							
		Without		Beans		Peas		Clover	
		No Tillage	Tillage	No Tillage	Tillage	No Tillage	Tillage	No Tillage	Tillage
2250 m^3	50%	2628	2796	3876	3480	3600	3360	3636	4392
	75%	2664	3240	3600	3072	3792	4116	3756	4116
	100%	2736	3192	3960	3276	3672	3912	4476	3720
1875 m^3	50%	3276	3120	4392	3876	4440	3756	3720	4080
	75%	2808	3792	3756	3756	3396	4560	3600	3396
	100%	3780	2556	4236	3720	3876	4032	4152	4320
1500 m^3	50%	2620	3480	3552	4272	3192	4236	3876	3912
	75%	2760	3792	2436	3120	3672	3756	4236	3912
	100%	2952	3756	3360	3360	4032	4716	4272	3120

Main effects:		LSD at 5%
Previous crops	Without: 3108 Beans: 3616 Peas: 3815 Clover: 4007	120
Tillage	No Tillage: 3577 Tillage: 3696	NS
Irrigation	1500 m^3: 3544 1875 m^3 : 3706 2250 m^3: 3660	108
N-levels	50%: 3649 75%: 3486 100%: 3776	156
Interactions among previous crops, tillage, irrigation and N-levels		732

Table 9: Net income/L.E. for grain and straw yields/fed as affected by main effects and the interactions among previous crops, tillage treatments, irrigation treatments and N-levels during the first season (2015/2016).

Irrigation treatments	N-levels	Previous crops							
		Without		Beans		Peas		Clover	
		No Tillage	Tillage	No Tillage	Tillage	No Tillage	Tillage	No Tillage	Tillage
2250 m^3	50%	13975	20457	17845	14355	18002	21010	19219	19264
	75%	14019	18434	14201	20931	19425	19822	21268	17701
	100%	16298	20346	22895	21783	12823	23084	16390	16627
1875 m^3	50%	15856	16059	19411	22027	15941	22395	20592	17390
	75%	15740	21614	18942	23043	18976	25338	17812	20711
	100%	16474	18204	20362	20345	15327	22595	19534	21158
1500 m^3	50%	9732	21779	10773	17603	19891	24274	18805	22421
	75%	18014	24095	14221	19608	19780	20839	14825	15720
	100%	19566	22581	18859	18235	20840	23170	20957	20070

Main effects:	
Previous crops	Without: 17957 Beans: 20196 Peas: 18635 Clover: 18914
Tillage	No Tillage: 17433 Tillage: 20419
Irrigation	1500 m^3: 18066 1875 m^3 : 19365 2250 m^3: 19345
N-levels	50%: 18507 75%: 18843 100%: 19426

Table 10: Net income/L.E. for grain and straw yields/fed as affected by main effects and the interactions among previous crops, tillage treatments, irrigation treatments and N-levels during the second season (2016/2017).

Irrigation treatments	N-levels	Previous crops							
		Without		Beans		Peas		Clover	
		No Tillage	Tillage	No Tillage	Tillage	No Tillage	Tillage	No Tillage	Tillage
2250 m^3	50%	13994	20176	18891	15360	17900	20410	19751	19242
	75%	14286	17705	15480	18802	18257	20396	19706	20396
	100%	16708	18372	19910	20656	14287	22062	21306	19835
1875 m^3	50%	16091	16650	20342	21476	16320	21521	19450	20030
	75%	15073	18807	19871	21906	17146	21920	19715	20776
	100%	16980	16306	21286	19670	16306	21797	19882	20720
1500 m^3	50%	11593	18660	16752	17472	19472	22386	17406	21347
	75%	17060	20457	13986	16650	19622	20971	16336	20742
	100%	19067	19321	16175	16560	20862	22316	16702	20675

Main effects:	
Previous crops	Without: 17072 Beans: 18402 Peas: 19597 Clover:19734
Tillage	No Tillage: 17610 Tillage: 18701
Irrigation	1500 m^3: 18282 1875 m^3: 19168 2250 m^3:18954
N-levels	50%: 18558 75%: 18523 100%: 19022

It could be noticed that the highest net income/L.E. for grain yield (ardab/fed), straw yield (t/fed), grain and straw yields/fed were achieved by growing peas as short time crop previous of wheat and using tillage treatment (well prepared the experimental field through two ploughings, compaction, division and then divided into the experimental units) besides irrigation every 4 weeks (5 irrigations), which consumed 1875 m^3/fed in addition mineral fertilizing plants with 60/fed (75 of the recommended dose) in the first and second seasons (Tables 5, 6, 7, 8, 9 and 10). Adversely, the lowest values of net income/L.E. for grain yield (ardab/fed), straw yield (t/fed), grain and straw yields/fed were resulted from left the field without cultivation and tillage before sowing wheat and irrigation every 5 weeks (4 irrigations), which consumed 1500 m^3/fed additionally fertilizing plants with 50 % of the recommended dose *i.e.* 40 kg N/fed in the first and second seasons. Concerning net income/L.E. for grain, straw yields and previous crops in summer /fed, the highest values were obtained from growing beans as short time crop previous of wheat and using tillage treatment (well prepared the experimental field through two ploughings, compaction, division and then divided into the experimental units) besides irrigation every 4 weeks (5 irrigations), which consumed 1875 m^3/fed in addition mineral fertilizing plants with 60/fed (75 of the recommended dose) in the first and second seasons (Tables 11 and 12). On the contrary, the lowest values of net income/L.E. for grain, straw yields and previous crops in summer /fed were resulted from left the field without cultivation and tillage before sowing wheat and irrigation every 5 weeks (4 irrigations), which consumed 1500 m^3/fed additionally fertilizing plants with 50 % of the recommended dose *i.e.* 40 kg N/fed in the first and second seasons.

Table 11: Net income/L.E. for grain, straw yields and previous crops in summer /fed as affected by main effects and the interactions among previous crops, tillage treatments, irrigation treatments and N-levels during the first season (2015/2016).

Irrigation treatments	N-levels	Previous crops							
		Without		Beans		Peas		Clover	
		No Tillage	Tillage	No Tillage	Tillage	No Tillage	Tillage	No Tillage	Tillage
2250 m^3	50%	13975	20457	29945	26455	27152	30160	24219	24264
	75%	14019	18434	26301	33031	28575	28972	26268	22701
	100%	16298	20346	34995	33883	21973	32234	21390	21627
1875 m^3	50%	15856	16059	31511	34127	25091	31545	25592	22390
	75%	15740	21614	31042	35143	28126	33424	22812	25711
	100%	16474	18204	32462	32445	24477	31745	24534	26158
1500 m^3	50%	9732	21779	22873	29703	29041	34488	23805	27421
	75%	18014	24095	26321	31708	28930	29989	19825	20720
	100%	19566	22581	30959	30335	29990	32320	25957	25070

Main effects:	
Previous crops	Without: 17957 Beans: 30735 Peas: 29346 Clover: 23914
Tillage	No Tillage: 23995 Tillage: 26981
Irrigation	1500 m^3: 24629 1875 m^3 : 25928 2250 m^3: 25907
N-levels	50%: 25015 75%: 25406 100%: 25907

Table 12: Net income/L.E. for grain, straw yields and previous crops in summer /fed as affected by main effects and the interactions among previous crops, tillage treatments, irrigation treatments and N-levels during the second season (2016/2017).

Irrigation treatments	N-levels	Previous crops							
		Without		Beans		Peas		Clover	
		No Tillage	Tillage	No Tillage	Tillage	No Tillage	Tillage	No Tillage	Tillage
2250 m^3	50%	13994	20176	30991	27460	27050	29560	24751	24242
	75%	14286	17705	27580	30902	27407	29546	24706	25396
	100%	16708	18372	32010	32756	23437	31212	26306	24835
1875 m^3	50%	16091	16650	32442	33576	25470	30671	24450	25030
	75%	15073	18807	31971	34006	26296	29870	24715	25776
	100%	16980	16306	33386	31770	25456	30947	24882	26920
1500 m^3	50%	11593	18660	28852	29572	28622	31536	22406	26347
	75%	17060	20457	26086	28750	28772	30121	21336	25742
	100%	19067	19321	28275	28660	30012	31466	21702	25675

Main effects:	
Previous crops	Without: 17072 Beans: 30502 Peas: 28747 Clover: 24734
Tillage	No Tillage: 24172 Tillage: 26355
Irrigation	1500 m^3: 24844 1875 m^3 : 25730 2250 m^3: 25216
N-levels	50%: 25121 75%: 25086 100%: 25584

3- Economic assessment:

From obtained results in Tables 13 and 14, the highest expenses of previous crops were resulted from growing clover as short time crop previous of wheat and the lowest values were obtained from growing peas as short time crop previous of wheat in both seasons. The highest revenues of previous crops were resulted from growing beans as short time crop previous of wheat and the lowest values were obtained from growing peas as short time crop previous of wheat in both seasons. The highest net profit of previous crops were resulted from growing beans as short time crop previous of wheat and the lowest values were obtained from growing peas as short time crop previous of wheat in both seasons. The highest revenues of wheat crop (grains and straw yield) were resulted from growing pea as short time crop previous of wheat and the lowest values were obtained from left the field without cultivation and tillage before sowing wheat in both seasons. The highest net profit were resulted from growing beans in the first season and clover in the second season pea as short time crop previous of wheat and the lowest values were obtained from left the field without cultivation and tillage before sowing wheat in both seasons. The highest net outcome L.E./fed were resulted from growing beans in the first season and clover in the second season pea as short time crop previous of wheat and the lowest values were obtained from left the field without cultivation and tillage before sowing wheat in both seasons. The highest percentage of net outcome were resulted from growing beans in the first season and clover in the second season pea as short time crop previous of wheat and the lowest values were obtained from growing peas as short time crop previous of wheat in both seasons.

Table 13: Economic assessment in 2015/2016 season.

Activities L.E./fed / previous crops	Without	Pea	Bean	Clover
Expenses of previous crops	-	2000	6060	6160
Revenues of previous crops	-	5000	12100	9150
Bean (pods: 2.6/ton + Straw: 4.59 ton), Pea (pods: 2.19/ton + Straw:3.91 ton) and Clover (17.0 ton).				
Net profit of previous crops	-	3000	6040	3010
Expenses of wheat crop	8185	8185	8185	8185
Revenues of wheat crop (grains and straw yield)	10057	11014	10735	12296
Net profit	10057	14014	16775	15306
Net outcome L.E./fed	-	3957	6718	5249
% Net out come	control	40 %	64 %	50 %

Table 14: Economic assessment in 2016/2017 season.

Activities L.E./fed / previous crop	Without	Pea	Bean	Clover
Expenses of previous crops	-	2000	6060	6160
Revenues of previous crops	-	5000	10450	9800
Bean (pods: 2.75 ton + Straw: 5.09 ton), Pea (pods: 2.09 ton + Straw: 4.25 ton) and Clover (17.0 ton).				
Net profit of previous crops	-	3000	4360	3640
Expenses of wheat crop	8200	8200	8200	8200
Revenues of wheat crop (grains and straw yield)	8875	11530	10200	11400
Net profit	8875	14530	14590	15040
Net outcome L.E./fed	-	5600	5715	6165
% Net out come	control	60 %	60 %	70 %

Conclusion

It can be concluded that growing peas or beans as short time crop preceding of wheat and using tillage treatment (well prepared the experimental field through two ploughings, compaction, division and then divided into the experimental units) besides irrigation plants every 3 weeks (6 irrigations), which consumed 2250 m^3/fed in addition mineral fertilizing plants with 80/fed in order to maximize net income of wheat and closing the gap of wheat grains and forage.

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