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Closing the gap of wheat grains and forage

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Abstract

A field experiment was carried out at Experimental Station Farm, Faculty of Agriculture, Mansoura University, Dakahlia Governorate, Egypt, during 2015/2016 and 2016/2017 seasons to maximize land productivity of wheat and other forage crops via introducing an appropriate short time crops (without, beans, peas and clover) during the time period between the end of maize crop and the beginning of wheat crop. In addition, study the effect of tillage treatments, irrigation treatments and nitrogen fertilizer levels on yields and its components of bread wheat Misr 1 cultivar. 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. The obtained results 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. The 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. 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. 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. It can be concluded that growing peas as short time crop preceding of wheat and using tillage treatment 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 wheat productivity under conditions of Dakahlia Governorate, Egypt.

Keywords: Wheat, beans, peas, clover, preceding crops, tillage treatments, irrigation treatments, nitrogen fertilizer levels, yields

Introduction

Wheat is used mainly as a human food. It is easily processed into various types of food like bread, macaroni, biscuit and sweets. Although wheat is useful as a livestock feed. Wheat production is not sufficient for local consumption in Egypt. Therefore, great efforts have been employed to increase wheat production by improving yield per unit area to meet the constant demand and reduce the gap between the production and the consumption of wheat.

It is well known 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 short time crops, tillage treatments, irrigation treatments and nitrogen fertilizer levels has very imperative effect on yield and its components of wheat crop.

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. In this respect, **Kumar and Sharma (2000)** realized that 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. **Maadi *et al.* (2012)** showed that 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. **Bharathi *et al.* (2013)** demonstrated that 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. **Ercoli *et al.* (2014)** found that 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. **Usadadiya *et al.* (2014)** showed that growing soybean and green gra crop significantly produced higher grain and straw yields of wheat than preceding maize crop.

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**). **Mohammad *et al.* (2012)** revealed that 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. **Lu *et al.* (2015)** concluded that conservation-focused tillage systems, *i.e.*, no tillage, could be reduced yields, thus produced better yields and provide environmentally friendly options. **Acar *et al.* (2017)** showed that reduced and no-tillage practices can be alternative to conventional tillage practices of wheat under Mediterranean conditions. **Blanco-Canqui *et al.* (2017)** reported that disrupting compacted layers and loosening the soil by tillage may increase infiltration of water relative to no-till management.

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. **Panda *et al.* (2003)** recommended that 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.

Khan *et al.* (2007) showed that more moisture favours 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. **Karam *et al.* (2008)** concluded that optimum grain yield was produced at 50% of soil water deficit as supplemental irrigation. **Ibrahim *et al.* (2012)** concluded that 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. **Mansour and Abd El-Hady (2014)** showed that 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.

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. **Seadh *et al.* (2008)** revealed that 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. **Antoun *et al.* (2010)** stated that 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. **Atia and Ragab (2013**) revealed that 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. **Attia *et al.* (2013)** stated that 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. **Seleem and Abd El-Dayem (2013)** showed that 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 (without addition of nitrogen fertilizer). **Shirazi *et al.* (2014)** revealed that 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. **Seadh and El-Metwally (2015)** showed that 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. **Kandil *et al.* (2016)** revealed that fertilizing wheat plants with 262 kg N/ha resulted the highest values of yield attributes and significantly exceeded other studied levels (214 and 166 kg N/ha). **Seadh *et al.* (2017)** showed that 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.

Thus, this investigation was carried out to maximize land productivity of wheat and other forage crops via introducing an appropriate short time crops (without, beans, peas and clover) during the time period between the end of maize crop and the beginning of wheat crop. Additionally, study the effect of tillage treatments, irrigation treatments and nitrogen fertilizer levels on yields and its components of bread wheat Misr 1 cultivar under the environmental conditions of Dakahlia Governorate, Egypt.

Materials and Methods

In order to maximize land productivity of wheat and other forage crops via introducing an appropriate short time crops during the time period between the end of maize crop and the beginning of wheat crop, a field experiment was carried out at Experimental Station Farm, Faculty of Agriculture, Mansoura University, Dakahlia Governorate, Egypt, during 2015/2016 and 2016/2017 seasons. Besides, this study aimed to determine the effect of tillage treatments, irrigation treatments and nitrogen fertilizer levels on yields and its components of bread wheat Misr 1 cultivar.

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 preceding short time crops (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 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- Plant height (cm): It measured from the soil surface to the top of the main stem spike.
2- Spike length (cm): It was determined as the distance from the base of main spike to the top as average of ten spikes.
3- 100 – grain weight (g): It was determined by weighting 100 grains of each sample.
4- 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).
5- Straw yield (t/fed). The straw resulted from previous sample was weighted in kg/plot, then it was converted to ton per feddan.

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. Effect of preceding short time crops:

Regarding the effect of preceding short time crops *i.e.* without, beans, peas and clover (Fahl cultivar) on yield and its components *i.e.* plant height, spike length, 100-grain weight, grain yield (ardab/fed) and straw yield (t/fed), it was significant on 100-grain weight (in the second seasons), grain yield (ardab/fed) and straw yield (t/fed) in both seasons vice versa concerning other studied characters as shown from results in Table 1.

It is clearly seen that, growing clover Fahl cultivar as short time crop preceding of wheat was the best transaction to increase plant height, spike length and 100-grain weight, which produced the highest values of these characters in both growing seasons. While, growing peas as short time crop preceding of wheat resulted in the highest values of grain yield (ardab/fed) and straw yield (t/fed) in both seasons. On the contrary, control treatment (leave the field without cultivation) gave the lowest values of all studied characters in both seasons.

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. These results are in partial compatible with those recorded by **Kumar and Sharma (2000, Maadi *et al.* (2012), Bharathi *et al.* (2013), Ercoli *et al.* (2014) and Usadadiya *et al.* (2014**.

2- Effect of tillage treatments:

Regarding the effect of tillage treatments on yield and its components *i.e.* plant height, spike length, 100-grain weight, grain yield (ardab/fed) and straw yield (t/fed), the obtained results of this study apparently cleared that there was a significant effect, on grain yield/fed (in both seasons) and straw yield/fed (in the first season), whereas other studied characters exhibited insignificant effect in both seasons (Table 1).

It could be noticed that the highest values of plant height, spike length, 100-grain weight, grain yield (ardab/fed) and straw yield (t/fed) were achieved by well prepared the experimental field through two ploughings, compaction, division and then divided into the experimental units. Adversely, the lowest values of these characters were resulted from left the experimental field without tillage after the previous short time summer crops in both seasons.

The increases in yield and its components 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**). These results are in coincidence with those reported by **Mohammad *et al.* (2012)**, **Lu *et al.* (2015), Acar *et al.* (2017) and Blanco-Canqui *et al.* (2017)**.

3- Effect of irrigation treatments:

From obtained results in Table 1, yield and its components *i.e.* spike length (in the second season), 100-grain weight, grain yield/fed and straw yield/fed (in the two seasons) were significantly affected by different studied irrigation treatments.

There were substantial differences in all studied characters among various irrigation treatments *i.e*. 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 and 3) Irrigation every 5 weeks (4 irrigations), which consumed 1500 m^3/fed in both seasons. Control treatment (irrigation every 3 weeks "6 irrigations", which consumed 2250 m^3/fed gave the highest values of yield and its components under study in both seasons. However, irrigation every 5 weeks (4 irrigations), which consumed 1500 m^3/fed was accompanied with the least values of all studied characters in the first and second seasons. It was worthy to mention that irrigation every 4 weeks (5 irrigations), which consumed 1875 m^3/fed arranged between aforementioned irrigation treatments with respect their effect on yield and its components in both seasons.

Table 1: Plant height, spike length, 100 grain weight, grain and straw yields/fed as affected by preceding short time crops, Tillage, Irrigation and Nitrogen fertilizer as well as their interactions during 2015/2016 (S_1) and 2016/2017 (S_2) seasons.

Characters / Treatments	Plant height (cm)		Spike length (cm)		100-grain weight (g)		Grain yield (ardab/fed)		Straw yield (t/fed)	
	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2
A- Preceding short time crops:										
Without	89.3	88.3	11.0	11.3	6.9	7.1	24.2	25.4	2.97	2.62
Beans	90.5	89.6	11.5	12.5	7.0	7.4	24.9	26.9	3.12	3.12
Peas	90.8	89.8	11.5	12.1	7.1	7.5	27.1	28.8	3.52	3.63
Clover	92.5	91.5	11.9	12.2	7.2	7.7	24.6	28.6	3.36	3.19
F. test	NS	NS	NS	NS	NS	*	*	*	*	*
LSD at 5%	-	-	-	-	-	0.2	1.1	0.9	0.08	0.10
B- Tillage treatments:										
No tillage	90.6	89.5	11.5	11.9	7.0	7.4	23.2	25.5	2.96	3.12
Tillage	91.5	90.0	11.6	12.1	7.1	7.5	27.2	29.3	3.53	3.17
F. test	NS	NS	NS	NS	NS	NS	*	*	*	NS
C- Irrigation treatments:										
2250 m^3/fed	91.9	90.9	11.7	12.2	7.3	7.6	26.3	28.1	3.43	3.20
1875 m^3/fed	90.7	89.8	11.6	12.1	7.1	7.5	24.7	27.3	3.21	3.18
1500 m^3/fed	89.7	88.7	11.2	11.7	6.9	7.3	24.6	26.8	3.09	3.04
F. test	NS	NS	NS	*	*	*	*	*	*	*
LSD at 5%	-	-	-	0.4	0.2	0.2	0.9	0.8	0.14	.09
D- Nitrogen fertilizer levels (ration of the recommended dose i.e. 80 kg N/fed):										
50 %	89.9	88.9	11.4	11.8	7.1	7.4	24.3	27.1	3.15	3.07
75 %	91.1	90.1	11.4	11.9	7.1	7.5	25.1	27.4	3.21	3.13
100 %	91.3	90.3	11.6	12.2	7.4	7.6	26.2	27.8	3.38	3.24
F. test	NS	NS	NS	NS	NS	NS	*	NS	NS	*
LSD at 5%	-	-	-	-	-	-	1.1	-	-	0.13
E- Interactions:										
A×B	NS	NS	NS	NS	*	*	*	*	*	*
A×C	NS	NS	NS	NS	NS	NS	*	*	*	*
B×C	NS	NS	NS	NS	NS	NS	NS	NS	*	*
A×B×C	NS	NS	NS	NS	*	*	*	*	*	*
A×D	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
B×D	NS	NS	NS	NS	NS	NS	NS	NS	*	*
A×B×D	NS	NS	NS	NS	*	*	*	*	*	*
C×D	NS	NS	NS	NS	*	*	NS	NS	*	*
A×C×D	NS	NS	NS	NS	*	*	*	*	*	*
B×C×D	NS	NS	NS	NS		*	NS	NS	*	*
A×B×C×D	NS	NS	NS	NS	*	*	*	*	*	*

This increase in yield and its components 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. These findings are in good conformity with those reported by **Karam *et al.* (2008), Ibrahim *et al.* (2012) and Mansour and Abd El-Hady (2014)**.

4. Effect of nitrogen fertilizer levels:

With reference to the effect of nitrogen fertilizer levels on yield and its components *i.e.* plant height, spike length, 100-grain weight, grain yield (ardab/fed) and straw yield (t/fed), it is apparent from obtained results indicated that each increase in nitrogen fertilizer levels was accompanied with gradual increase in all studied characters without significant differences among them, with exception grain yield/fed (in the first season) and straw yield/fed (in the second season) as shown from results in Table 1.

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 yield (ardab/fed) and straw yield (t/fed) in the first and second seasons. However, mineral fertilizing wheat plants with 75 % of the recommended dose *i.e.* 60 kg N/fed ranked secondly after the highest level of nitrogen fertilization in the first and second seasons. Whereas, mineral fertilizing wheat plants with 50 % of the recommended dose *i.e.* 40 kg N/fed produced the lowest values of all studied characters in the first and second seasons.

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. These results are in good accordance with those of **Seadh *et al.* (2008), Antoun *et al.* (2010), Attia *et al.* (2013), Shirazi *et al.* (2014), Seadh and El-Metwally (2015) and Seadh *et al.* (2017).**

5. Effect of interactions:

About the effect of interaction, there are a lot of significant special effects of the interactions among four studied factors on the studied characters as showed in (Table 1). We present only the significant interaction among preceding short time crops, tillage treatments, irrigation treatments and nitrogen fertilizer levels on grain yield/fed only.

The interaction among preceding short time crops, tillage treatments, irrigation treatments and nitrogen fertilizer levels had a significant effect on grain yield/fed during both growing seasons. Growing peas 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 resulted in highest values of grain yield/fed in both seasons (Tables 1 and 2). The second best interaction treatment was growing clover fahl cultivar as short time crop preceding of wheat and using tillage treatment moreover irrigation plants every 3 weeks as well mineral fertilizing plants with 80/fed in both seasons. in both seasons. On the other hand, the lowest values of grain yield/fed were produced 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 both seasons.

Table 2: Grain yield (ardab/fed) as affected by the interaction among preceding short time crops, tillage treatments, irrigation treatments and nitrogen fertilizer levels during the first season (2015/2016).

Preceding crops		Without		Beans		Peas		Clover	
Irrigation	N-levels	No Tillage	Tillage	No Tillage	Tillage	No Tillage	Tillage	No Tillage	Tillage
2250 m^3	50%	25.4	31.5	29.5	20.1	26.6	31.0	27.7	25.6
	75%	20.5	26.6	20.3	28.5	26.7	29.8	29.2	24.7
	100%	21.3	30.6	34.1	32.1	18.1	36.6	23.8	34.7
1875 m^3	50%	23.2	21.3	28.9	32.5	22.7	33.3	28.8	25.4
	75%	22.4	31.4	29.4	34.5	25.6	32.2	26.8	31.7
	100%	22.6	25.2	32.2	32.3	21.3	34.1	28.6	32.6
1500 m^3	50%	14.4	30.5	11.1	24.5	30.1	33.2	27.1	22.9
	75%	26.6	35.3	19.9	25.2	29.2	31.3	20.3	21.6
	100%	29.4	32.7	25.3	24.1	30.8	32.2	28.7	29.4
LSD 5%		3.3							

Table 3: : Grain yield (ardab/fed) as affected by the interaction among preceding short time crops, tillage treatments, irrigation treatments and nitrogen fertilizer levels during the second season (2016/2017).

Preceding crops		Without		Beans		Peas		Clover	
Irrigation	N-levels	No Tillage	Tillage	No Tillage	Tillage	No Tillage	Tillage	No Tillage	Tillage
2250 m^3	50%	25.6	31.6	27.3	21.6	26.0	31.0	29.3	27.0
	75%	20.6	26.3	21.6	28.6	26.3	29.6	29.0	29.6
	100%	21.0	27.6	29.0	31.6	19.3	33.1	30.6	33.0
1875 m^3	50%	23.3	24.6	29.0	32.0	21.6	32.3	28.6	29.0
	75%	22.3	27.3	29.3	33.0	25.0	32.0	29.3	31.6
	100%	24.0	25.0	31.0	29.0	22.6	32.3	28.6	32.0
1500 m^3	50%	16.3	27.6	24.0	24.0	29.6	29.3	24.6	31.7
	75%	26.0	30.3	21.0	24.6	29.0	31.3	22.0	30.6
	100%	29.3	28.3	23.3	24.0	30.6	32.0	22.6	29.3
LSD 5%		3.6							

Conclusion

It can be concluded that growing peas 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 wheat productivity.

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