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Nitrate Translocation Through Clay Soil into Drainage Water as Affected by Land Leveling and Cut off Irrigation under Wheat Cultivation

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ABSTRACT

A field experiment was conducted at Sakha, Res. Station during two winter seasons (2017/2018 and 2018/2019), to evaluate the effect of land leveling (Traditional and Laser land leveling) and cut off irrigation (without cutoff and cutoff irrigation) on nitrate losses into drainage water in clay soil as well as yields, N-uptake and irrigation water productivity (PIW) of wheat. Results showed that: Laser land leveling and/or cutoff irrigation led to reduce of irrigation water amount, drain discharge rates and cumulative discharges compared to traditional leveling and/or irrigation.NO_3^- contents of the soil after N-fertilizer application under Laser land leveling and/or cut off irrigation were higher than traditional leveling and/or irrigation. Laser land leveling and/or cutoff irrigation led to less amount of nitrogen losses in drainage water. The overall average values of NO_3^- losses were 17.94, 14.20, 12.45 and 8.16 $kgfed^{-1}$ for traditional leveling with traditional irrigation, traditional leveling with cut off irrigation, Laser leveling with traditional irrigation and Laser land leveling with cut off irrigation, respectively. The corresponding values of nitrogen losses were 4.05, 3.21, 2.81 and 1.84 $kgfed^{-1}$, respectively. Laser land leveling with or without cut off irrigation led to enhancing yields, N-uptake and PIW of wheat. Laser land leveling application resulted in increasing wheat grain yield by 11.73% and N-uptake by 6.50 $kgfed^{-1}$ than traditional leveling. Laser land levelling application lead to reducing nitrate losses into drainage water, thereby increased the efficacy of N fertilizers and increased the wheat productivity**.** Cut off irrigation reduced the potential for nutrient-N loss through better irrigation.

Keywords: Clay soils, Drainage, Land leveling, Irrigation, Nitrate losses, Wheat.

INTRODUCTION

Drainage water contamination by nitrate with the development of intensive farming systems has become a worrying threat to the environment and economy. Increased flow of drains supplies the nitrate concentration in the outlet water, which increases health risks to mankind if water is used as a drinking source (Kladivko *et al*. 2004 and 2010). Ramadan *et al*.2009, Maija *et al*. 2012 and El-Hawary 2012 reported that, when the majority of the water flow occurs the major mass losses of nitrate occur in addition to NO3- losses, occurs throughout the growing season. Bjorneberg *et al*. (1998) and Bakhsh *et al*. (2002) showed a high correlation ($R2$ = 0.89) were found between volume of drainage water flow and leaching losses of NO3-N into drainage water. The substantial variation of nitrate amount in drainage water may be attributed to some factors involving soil characteristics, amount of irrigation water, drainage conditions and fertilizers forms (Nasseem, 1991, Bakhsh *et al*., 2002 and Ramadan *et al*.2009). Nitrate transport into field drainage tile (out of the rhizosphere) depends on soil hydraulic characteristics, amount of irrigation water, N-fertilizer source, amount and time of nitrogen application (Gheysari *et al*., 2009). Few researchers have studied subsurface drain flows to evaluate leaching losses of nutrients under various agricultural management practices (Drury *et al*., 1996; Bakhsh *et al*., 2002; Ramadan *et al*., 2009; Kladivko *et al*., 2010; Maija *et al*. 2012 and El-Hawary 2012; Antar 2013; Khafagy, *et al*., 2018).

Precise leveling of the soil resulted in a good improvement in agricultural water management, rising irrigation efficiency, saving labor and reducing energy requirements for irrigation water pumping (Omara, 2003). Precision land leveling leads to visible changes (decreased or increased) for the properties of top soil layers (Brye, 2007). The benefits of laser land leveling according to Rickman, 2002 and Jat, *et al*., 2006 are: 1) Precision leveling of the soil surface leads to an appropriate distribution of soil moisture which resulting in a good seed germination and hence higher crop production efficiency. 2) Irrigation can be controlled and reducing water losses by surface runoff by using precision leveling of the soil surface. 3) Accurate leveling of soil surface increases irrigation efficiency and reduces fertilizer loss problems. 4) Problems of weeds, diseases, insects and all pests of the soil can be reduced by using laser leveling of the soil surface. 5) A precisely leveled surface leads to improve wheat crop stand and yield. And 6) In general, laser leveling of the soil surface reduces the consumption of agricultural inputs such as seeds, fertilizers, pesticides and fuel and consequently increasing the economic returns for crops.

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Wheat (Triticum aestivum) is the principal winter crop in Egypt, it is the most important grain crop in the world.

The world production exceeds that of any other grain crop, and in many respects it is superior to any other human food. Wheat is the major bread making cereal, and Egypt has to supplement production by importing just over half of its needs to supply the annual demand. The analysis of drain flows provide information on the quality of water that moves between and below the drain. Controlled of irrigation and some agricultural practices studies under drainage conditions may be useful in reduction of NO3- losses as well as enhancing water quality. The goals of this study are to evaluate the impact of land leveling (Traditional and Laser land leveling) and cutoff irrigation (Traditional and cutoff irrigation) on NO3- losses into drainage water; yields, uptake and irrigation water productivity of wheat crop.

MATERIALS AND METHODS

A field experiment was conducted at the Experimental Farm of Sakha Res. Station through the two seasons (2017/2018 and 2018/2019), to evaluate the effect of land leveling (Traditional and Laser land leveling) and irrigation (without cut off and cut off irrigation at 85% from strip length) on leaching losses of nitrate into drainage water in clay soil, yields, uptake and irrigation water productivity of wheat crop. The location is situated at 31.087 N and 30.937 E. The tile drains were spaced to simulate a 30-m spacing, 100-m length and 1.2 m depth with a slope of 0.1%. The soil has a clayey in texture; the average soil textural is 16.55% sand, 31.77% silt and 51.68 % clay. Before cultivation, soil samples were collected up to 0.6 m depth, for analysis. The main chemical and physical properties of the soil are located in Table (1).

Table 1. The initial some soil characteristics of the experimental field.

Soil depth (cm)	Particle size distribution%			Texture class	Bulk density g/cm^3	EC, dSm^{-1}	CEC Meq/100g soil	PH	O M (%)	NO_3^- (ppm)
	Sand	Silt	Clay							
0---20	17.45	30.02	52.53	Clay	1.12	2.46	43.87	8.13	2.15	28
20---40	15.22	32.88	51.9	Clay	1.22	2.87	39.95	8.09	1.21	22
40---60	17.08	32.41	50.51	Clay	1.25	2.61	37.18	8.11	0.76	14
Mean	16.58	31.77	51.65	Clay	1.20	2.65	40.33	8.11	1.38	21.33

EC-soil salinity, OM-Organic matter,

The experiments design was a randomized complete block and four treatments as follows:

1- Traditional land leveling with traditional irrigation without cutoff.
2- Traditional land leveling with cutoff irrigation at 85 % from slide length.
3- Laser land leveling with traditional irrigation without cutoff.
4- Laser land leveling with cutoff irrigation at 85 % from slide length.

Wheat (Triticum aestivum) Giza 168 variety was planted on November 11, 2017and November 15, 2018 All plots received a total of 50 Kg Ca-superphosphate/fed., during tillage operation. Nitrogen fertilizer in the form of urea was added at a rate of 75 Kg N/fed, in two doses (before the first and the second irrigations). During the two wheat growing seasons, all agricultural operations were performed as recommended.

Through irrigations cycles, to monitor water table level and to collect groundwater samples, in midway between field drains, observation wells were installed. The discharge rates (Q) at drain outlets were measured as mm/day according to Dieleman and Trafford (1976). Several water samples were collected from tile effluent and groundwater at different times of the day were taken for analysis. The water samples taken from tiles were analyzed for nitrate using Kjeldahl method (Cottenie *et al*., 1982). Soil samples were taken up to 0.6 m depth, before fertilizer application, after the first, the second and the third irrigations and after wheat harvested for analyzed of NO^-_3 (according to Cottenie *et al*., 1982). The wheat was harvested on 12th April in 2018 and 20th April in 2018 to determine grain and straw yields. Wheat samples (grain and straw) were dried at 70°C, grounded with a mill and its nitrogen content was determined using Kjeldahl digestion method (Cottenie *et al*., 1982). N-uptake (kg fed^{-1}) was calculated by multiplying dry yield (kg fed^{-1}) by nitrogen %.

Irrigation water:

Irrigation water was measured by using a rectangular sharp crested weir. The discharge was calculated using Masoud (1969) equation.

$$Q = CL\,(H)^{1.5}$$

Where: **Q = Discharge (m^3s^{-1})**
L = Length of the weir crest (m).
H = Head above the weir crest (m).
C= Empirical coefficient (1.84).

Productivity of irrigation water (kgm^{-3}) was calculated according to Ali *et al*., (2007).

Statistical analysis:

Data for yield and its components of wheat were noted and subjected to statistical analysis by ANOVA method (Snedecor and Cochran 1980). Treatments were compared by Duncan's multiple range test (Duncan, 1955). The overall averages of two seasons were taken for the discussion.

RESULTS AND DISCUSSION

Amount of irrigation water applied (m^3fed^{-1}):

The quantity of water applied inclusive rainfall (7.5cm) during wheat growing season is shown in Table (2). Data showed that, sowing irrigation had received the highest amount of irrigation water comparing with the other irrigations ones. Results indicated that, Laser land leveling and/or cut off irrigation were more pronounced on reducing irrigation water amount. Also, Laser land leveling was superior to cutoff irrigation on reduction of irrigation water amount. Whereas, traditional land leveling and irrigation received the highest irrigation water amount (2231 m^3fed^{-1}) followed by traditional land leveling with cutoff irrigation (2125m^3fed^{-1}) and laser land leveling with traditional irrigation (1980m^{3}fed^{-1}). While, the lowest irrigation water amount was achieved with Laser land leveling combined with cutoff irrigation (1878m^{3}fed^{-1}). This is due to, decreasing irrigation period under Laser leveling and/or cutoff irrigation. Laser leveling improves irrigation efficiency through better irrigation (Rickman, 2002 and Jat, *et al*., 2006).

Table 2. Irrigation water applied (m^{3}fed^{-1}) during irrigations cycles with treatments.

Treatments	Amount of irrigation water applied (m^{3}fed^{-1})						
	Planting irri.	First irri.	Second irri.	Third irri.	Forth irri.	mean	Total
Traditional land leveling with traditional irrigation.	504	345	346	356	365	315	2231
Traditional land leveling with cutoff irrigation.	506	328	335	324	318	315	2125
Laser land leveling with traditional irrigation.	423	279	302	331	331	315	1980
Laser land leveling with cutoff irrigation.	420	248	272	312	312	315	1878

Drain discharge (m^{3}fed^{-1}):

Result of drain discharge (Fig 1) was reduced with time particularly in the first few days after irrigation.

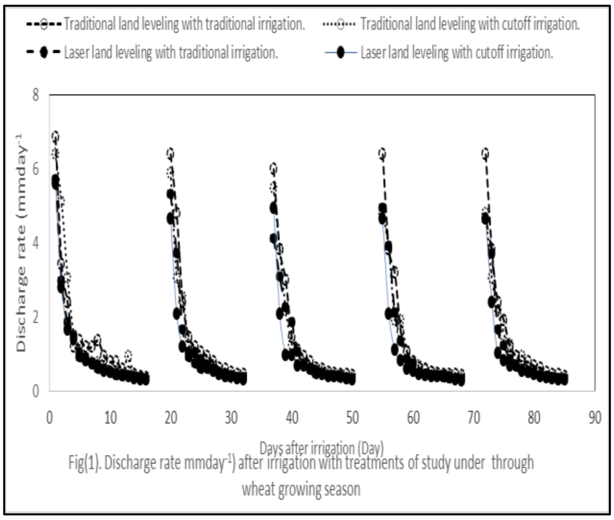

Fig. 1. Discharge rate mmday^{-1}) after irrigation with treatments of study under through wheat growing season

The rates of drain discharge ranged from 4.13 to 6.86 mm day^{-1} after one day from irrigations and 0.30 to 0.48 mm day^{-1} before the next irrigation. Ramadan *et al.* (2009) and Antar (2013) found that, in clay soil, the plurality of discharge water is from water move through macro pores and soil cracks. The discharge flow reduces quickly when the soil saturates next a few days of irrigation. Drain discharge rates were higher under traditional land leveling and/or traditional irrigation comparing with Laser land leveling and/or cutoff irrigation. Whereas, drain discharge rates varied from 0.48 to 6.86 mmday^{-1} under traditional land leveling with traditional irrigation and from 0.32 to 6.40 mmday^{-1} under traditional land leveling with cutoff irrigation. Also, varied from 0.32 to 5.72 mmday^{-1} under laser land leveling with traditional irrigation and the lowest discharge rates from 0.30 to 5.60 mm day^{-1} under Laser land leveling combined with cutoff irrigation.

Cumulative drain discharges (m^{3}fed.$^{-1}$) during sowing irrigation were higher comparing with the irrigation ones. Cumulative discharges (m^{3}fed.$^{-1}$) were higher with traditional land leveling and/or traditional irrigation compared to Laser land leveling and/or cutoff irrigation for all irrigation cycles. Total cumulative drain discharges through the wheat growing seasons were 460.76, 403.48, 359.17 and 308.36 m^{3}fed. $^{-1}$ for traditional land leveling with traditional irrigation, traditional land leveling with cutoff irrigation, Laser land leveling with traditional irrigation and Laser land leveling with cutoff irrigation, respectively. This is may be due to the high values of irrigation water amount with conventional irrigation and traditional land leveling compared to Laser land leveling and cutoff irrigation (Table 3).

Nitrate in soil:

Nitrate content (Table 4) of the soil was decreased with increasing depth. This may be attributed to the increasing percentage of organic matter in the soil surface layer than subsurface layer. Nitrate contents of the soil were low (from 16 to 26 ppm) before N-fertilizer application and increased after addition of N-fertilizer (varied from 33 to 81 ppm) while, it reduced at the end of the seasons (varied from 16 to 33 ppm). This tendency may be refer to rapid N-uptake by plants through the growing season. These results were confirmed with Antar, (2013) and Khafagy *et al*., (2018).

Results (Table 4) show that, nitrate content of the soil after N-fertilizer addition under Laser land leveling with or without cutoff irrigation were higher as compared to traditional land leveling with or without cutoff irrigation. Also, the content of NO_3^- in the soil under cutoff irrigation was higher than traditional irrigation. This explained on the basis of Laser land leveling and cutoff irrigation which were reduced drain water flow and so, increased the amounts of nutritive in the soil. Forasmuch, Laser land leveling and cutoff irrigation enhancing irrigation efficiency and decreases the possibility for nutritive loss.

Table 3. The mean values of cumulative discharge (m^{3}fed.$^{-1}$) of drainage water for irrigation cycles with studied treatments,

Treatments	Cumulative discharge (m3fed^{-1})					
	Planting irri.	First irri.	Second irri.	Thread irri.	Forth irri.	Total
Traditional land leveling with traditional irrigation.	100.81	93.64	87.61	88.27	90.44	460.76
Traditional land leveling with cutoff irrigation.	99.33	77.14	76.29	76.02	74.70	403.48
Laser land leveling with traditional irrigation.	78.85	69.90	69.44	72.21	68.77	359.17
Laser land leveling with cutoff irrigation.	76.66	60.86	58.49	54.75	57.60	308.36

Table 4. The overall of NO_3^- content (ppm) of the soil before and after fertilizer and at harvesting with studied treatments.

Treatments	Soil depth (cm)	Before fertilizer	After 1st Irri	After 2nd Irri	After 3rd Irri	At harvesting
Traditional land leveling with traditional irrigation.	0-15	26	50	65	45	25
	15-30	18	41	49	36	18
	30-60	16	34	38	33	16
Average		20.0	41.7	50.7	38.0	19.7
Traditional land leveling with cut off irrigation.	0-15	26	54	68	55	26
	15-30	18	44	49	40	20
	30-60	16	34	40	33	17
Average		20.0	44.0	52.3	42.7	21.0
Laser land leveling with traditional irrigation.	0-15	26	55	74	60	30
	15-30	18	44	54	45	23
	30-60	16	35	41	33	18
Average		20.0	44.7	56.3	46.0	23.7
Laser land leveling with cutoff irrigation.	0-15	26	59	81	66	33
	15-30	18	48	57	49	27
	30-60	16	39	46	38	20
Average		20.0	48.7	61.3	51.0	26.7

Nitrate in drainage water:

Nitrate concentrations in drainage water through the wheat growing seasons (Figs 2) were ranged from 13.0 to 65.0 ppm. Nitrate in drainage water before N-fertilizer addition were low (from 15.0 to 21.0 ppm) and rising after N-fertilizer addition (after the first and second irrigations) which were ranged from 38.0 to 65.0 ppm then, reduced again with the latter irrigations. The results indicated that, the nitrate content in drainage water was paralleled to the nitrate content of the soil in the two growing seasons. The redaction losses of nitrate with the latter irrigations, may be refer either to the redaction of nitrogen in the soil solution and/or to the rising demand of wheat crops for nitrogen with this growth stage. These results were confirmed with Maija *et al*. (2012) and Antar, (2013).

The highest concentrations of nitrate (Fig 2) in drainage water were recorded with traditional land leveling and/or traditional irrigation while, the lowest concentrations were recorded with Laser land leveling and/or cut off irrigation. The low concentrations of nitrate were more pronounced under Laser land leveling combined with cut off irrigation (Fig 2). In this concern, Antar (2013) concluded that, Laser leveling allows for control of water distribution with negligible water losses.

Laser leveling as well as cut off irrigation (Khafagy *et al*., 2018) reduced the potential for nutrient loss through better irrigation and runoff control.

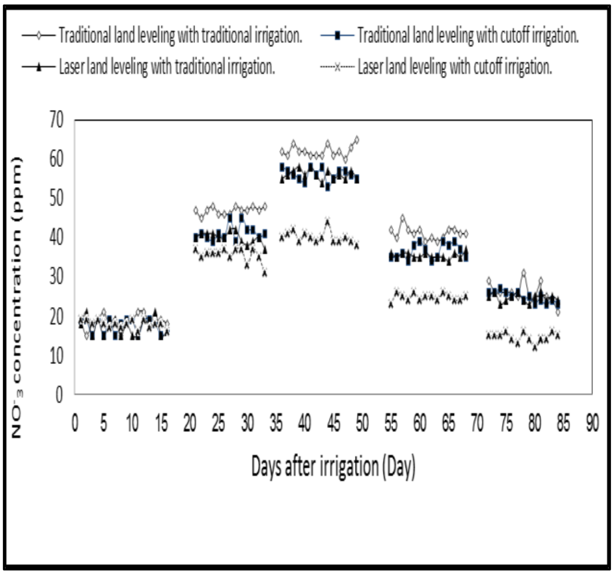

Fig. 2. NO^-_3 concentration (ppm) of drainage water for irrigation cycle with treatments of study during wheat growing season

Total losses of nitrogen via drainage water:

Total estimated losses of nitrogen in drainage water under land leveling and irrigation are presented in Table 5.

Table 5. The overall mean values of nitrogen losses into drainage water during wheat growing seasons with studied treatments.

Treatments	Cumulative discharge (m^3fed)	NO3(ppm)	NO3,kg	N-NO3(kg)
Traditional land leveling with traditional irrigation.	460.76	38.94	17.94	4.052
Traditional land leveling with cutoff irrigation.	403.48	35.19	14.20	3.206
Laser land leveling with traditional irrigation.	359.17	34.66	12.45	2.811
Laser land leveling with cutoff irrigation.	308.36	26.48	8.16	1.843

The application of Laser land leveling and/or cut off irrigation were superior to traditional land leveling and/or traditional irrigation on reducing nitrogen losses. Results indicated that, Laser land leveling and/or cut off irrigation application led to less amount of nitrogen losses in drainage water. Also, Laser land leveling was superior to cut off irrigation on reducing N losses. The overall mean values of nitrate losses were 17.94, 14.20, 12.45 and 8.16 kg fed^{-1} for traditional land leveling with traditional irrigation, traditional land leveling with cut off irrigation, Laser land leveling with traditional irrigation and Laser land leveling with cut off irrigation, respectively. The corresponding values of nitrogen losses in drainage water were 4.05, 3.21, 2.81 and 1.84 kg fed^{-1}, respectively. In this concern, Antar (2013) found that Laser land leveling caused decrease of nitrogen losses in drainage water than traditional leveling. Also, Khafagy *et al.* (2018) came up with similar results.

Nitrate leaching losses from the rhizosphere can be affected by the nitrogen content of the soil and the time of water percolation from the root zone. Leaching losses of nitrogen can be affected by the time between supply of available form nitrogen to the soil and N-uptake by plant (Bakhsh *et al*., 2002 and Antar 2013). This may be attributed to the control of water allocation with lack water losses with Laser land leveling and cut off irrigation. The redaction of nitrogen losses with Laser land leveling and cut off irrigation may be due to, the chance for more leaching downward for both water and its load of fertilizers could be happened under conventional land leveling and conventional irrigation. In this consequence, Bjorneberg *et al*. (1998) and Bakhsh *et al*. (2002) reported a high correlation (R^2 = 0.89) were noticed between flow volume of drainage water and NO_3-N leaching losses into drainage water.

Yield and N-uptake:

Results (Table 6) indicated that Laser land leveling application achieved significant increase in wheat grain yield and insignificant in straw yield comparing with traditional land leveling. Results showed that, increasing of wheat grains yield were 11.73 % under laser land leveling application compared to traditional land leveling. On the other hand, results showed that insignificant effects were noticed between cut off and traditional irrigation treatments for grain and straw yield of wheat crop. Whereas, results of wheat yields recorded nearly the same values under traditional irrigation and cut off irrigation (Table 6).

The combination between traditional land leveling with traditional irrigation or cut off irrigation resulted in low value of wheat grain yield. While, the combination between Laser land leveling with traditional irrigation or cut off irrigation resulted in high value of wheat grain yield. The average values of wheat grain yield were 2490, 2540, 2830 and 2790 kg fed.$^{-1}$ for traditional land leveling with traditional irrigation, traditional land leveling with cutoff irrigation, Laser land leveling with traditional irrigation, Laser land leveling with cut off irrigation, respectively. Concerning, the combination between land leveling with irrigation treatments, data showed, no obvious differences for wheat straw yield.

In this concern, Rickman, (2002) and Jat, *et al*., (2006) reported that, a precisely leveled soil surface leads to uniform soil moisture distribution, resulting in a good germination, enhanced input use efficiency and improved crop stand and yield. Also, these increments in production of wheat crop could be attributed to that under laser land leveling, which accompanied with less irrigation water, more energy is forced to extract more water with its content of fertilizers, which in turn resulted in decreasing the withdrawn of fertilizers. These results were confirmed with El-Hamdi and El-Knany (2000) and Antar *et al*., (2013).

N-uptake (Table 6) values by wheat plants were parallel to the yield results. Whereas, Laser land leveling led to in significant increase for N-uptake by wheat grain yield and insignificant effects for straw yield compared to traditional land leveling. Laser land leveling application resulted in increasing N-uptake by wheat grain yield to be 6.50 kgfed^{-1} more than traditional leveling. On the other hand, results showed that, cut off irrigation resulted in somewhat increase for N-uptake by grain and straw of wheat crop than traditional irrigation. The mean values of N-uptake were 45.70 and 47.10 kgfed.$^{-1}$ by wheat grain yield and 9.63 and 9.74 kgfed.$^{-1}$ by straw yield for traditional and cutoff irrigation, respectively.

Results showed that, N-uptake by wheat grain yield were higher under the combination between Laser land leveling with traditional irrigation or cut off irrigation while, the low value was noticed under traditional land leveling with traditional irrigation or cut off irrigation. The average values of N-uptake by wheat grain yield were 41.83, 44.45, 49.53 and 49.66 kg fed.$^{-1}$ for traditional land leveling with traditional irrigation, traditional land leveling with cut off irrigation, Laser land leveling with traditional irrigation, Laser land leveling with cut off irrigation, respectively. Data also showed, no obvious differences in N-uptake by straw yield of wheat crop for the combination between treatments of land leveling with irrigation.

Increasing N-uptake by wheat could be attributed to that under Laser land leveling and cut off irrigation which accompanied with less water content, more energy is forced to extract more water with its content of fertilizers, which in turn resulted in decreasing the withdrawn of fertilizers. Also, it due to the less losses of N with these treatments and consequently increasing available N in the soil. Similar results were monitored with El-Hamdi and Knany (2000) and Antar, (2013).

Table 6. The overall mean values of yields and N-uptake for wheat plant with different treatments.

Treatments	Wheat yields (kg fed^{-1})		N-uptake (kg fed^{-1})	
	Grains	Straw	Grains	Straw
land leveling				
Mean- Traditional land leveling	2515	1980	43.1	9.83
Mean Laser land leveling	2810	1980	49.6	9.541
F test	**	ns	**	Ns
LSD 0.05 %				
Irrigation				
Mean- traditional irrigation	2660	2000	45.7	9.63
Mean- cutoff irrigation.	2665	1960	47.1	9.741
F test	ns	ns	ns	Ns
LSD 0.05 %				
land leveling x irrigation				
Traditional land leveling with traditional irrigation.	2490b	2000	41.83c	9.90
Traditional land leveling with cutoff irrigation.	2540b	1960	44.45b	9.76
Laser land leveling with traditional irrigation.	2830a	2000	49.53a	9.36
Laser land leveling with cutoff irrigation.	2790a	1960	49.66a	9.72

Productivity of irrigation water (PIW, kg m^{-3})

Data in Table (7) cleared that the Laser land leveling with or without cut off irrigation were more pronounced relative to traditional land leveling with or without cut off irrigation in enhancing PIW of wheat yields. The average values of PIW were 1.12, 1.20, 1.43 and 1.49 kg m^{-1} for grain yield and 0.90, 0.92, 1.01 and 1.04 kg m^{-1} for straw yield for traditional land leveling with traditional irrigation, traditional land leveling with cut off irrigation, Laser land leveling with traditional irrigation, Laser land leveling with cut off irrigation, respectively.

Table 7. Water productivity (kgm^{-3}) of wheat yields with different treatments.

Treatments	Amount of irrigation water applied (m^{3}fed)	Water proactivity (kgm^{-3})	
		Grains	Straw
Traditional land leveling with traditional irrigation.	2231	1.12	0.90
Traditional land leveling with cutoff irrigation.	2125	1.20	0.92
Laser land leveling with traditional irrigation.	1980	1.43	1.01
Laser land leveling with cutoff irrigation.	1878	1.49	1.04

This may be due to reduction of nutrient leaching with Laser land leveling, thereby increase the efficacy of mineral fertilizers and increasing the wheat productivity**.** Also, it due to the less amount of irrigation water with Laser land leveling with or without cut off irrigation compared to traditional leveling and irrigation.

Economic Evaluation:

The effect of land leveling and cut off irrigation on wheat crop can be arranged on the basis of economic evaluation in the descending order as follows: CL > IL> IT > CT

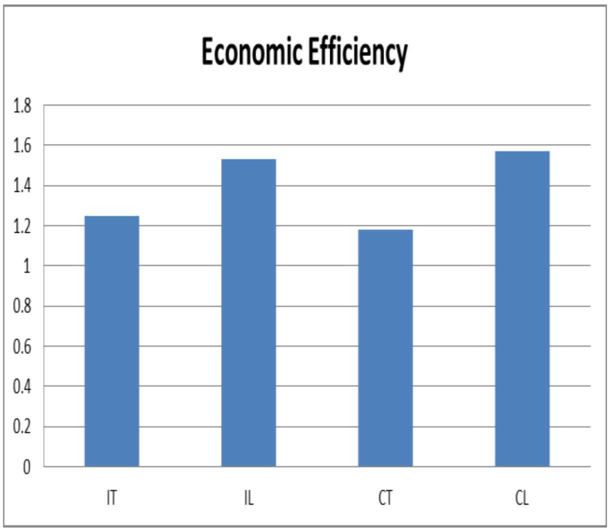

Fig. 3. The overall mean values of economic efficiency as affected by Land leveling and cut off irrigation for wheat crop during 2018 and 2019growing seasons.

CONCLUSION

Laser land levelling application with or without cut off irrigation lead to reduction of nitrate losses into drainage water, thereby increase the efficacy of N fertilizers and increasing the wheat productivity**.** Cutoff irrigation reduces the potential for nutrient loss through better irrigation and runoff control.

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انتقال النترات في الأرض الطينية متأثرة بالتسوية بالليزر والري إلى مياه الصرف تحت زراعة القمح

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أجريت تجربة حقلية في مزرعة محطة البحوث الزراعية بسخا خلال الموسم الشتوي (٢٠١٧ و٢٠١٨) بهدف دراسة تـأثير تسوية الارض (التسوية بالليزر والتسوية التقليدية) والري (إقاف الري عند ٨٥% من طول الشريحة والري التقليدي) على غسيل و فقد النترات إلى مياه الصرف في الأرض الطينية وأيضا علي الإنتاجية والنيتروجين الممتص والإنتاجية المائية لمحصول القمح. وتشير النتائج إلي:- نقص كمية مياه الري وانخفاض معدل تصريف المصارف للماء وانخفاض إجمالي كمية المياه المنصرفة باستخدام التسوية بالليزر مع/أو إقاف الري عند ٨٥% من طول الشريحة مقارنة بالتسوية العادية مع /أو الري التقليدي. زيادة محتوى التربة من النترات بعد اضافة السماد النيتروجيني باستخدام التسوية بالليزر مع/أو إقاف الري عند ٨٥% من طول الشريحة مقارنة بالتسوية العادية مع /أو الري التقليدي. وايضا تطبيق التسوية بالليزر مع/أو إقاف الري عند ٨٥% من طول الشريحة ادي الى نقص كمية النيتروجين المفقودة في ماء الصرف. حيث ان متوسط قيم النترات المفقودة في مياه ١٧.٩٤، ١٤.٢٠، ١٢.٤٥، ٨.١٦ كجم للفدان للمعاملات التسوية التقليدية مع الري التقليدي، التسوية التقليدية مع إقاف الري، التسوية بالليزر مع الري التقليدي، التسوية بالليزر مع إقاف الري على التوالي. وكانت القيم المقابلة للفقد في صورة نيتروجين ٤.٠٥، ٣.٢١، ٢.٨١، 1.٨٤ كجم للفدان على التوالي. إستخدام التسوية بالليزر مع أو بدون إقاف الري عند ٨٥% من طول الشريحة أدى الى تحسين الإنتاجية والنيتروجين الممتص والإنتاجية المائية لمحصول القمح. حيث ان تطبيق التسوية بالليزر أدي الي زيادة انتاج القمح من الحبوب حوالي ١١.٧٣% والنيتروجين الممتص بالحبوب ٦.50 كجم للفدان مقارنة بالتسوية العادية. وعموما فإن إستخدام التسوية بالليزر أدى الى تقليل فقد النترات في ماء الصرف ومن ثم زيادة كفاءة التسميد النيتروجيني وزيادة انتاجية القمح. كما ان إيقاف الري عند٨٥% من طول الشريحة يقلل من فقد النترات من خلال تحسين كفاءة استخدام مياة الري.