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EFFECT OF MINIMUM TILLAGE ON CONSERVATION OF PRECISE LEVELED SOIL TO PRODUCE SOME WINTER CROPS AFTER RICE

Dr Bahnas, O. T. *

ABSTRACT

During 2006 winter season, this study was carried out at Kalabsho Region, El-Dakhlia Governorate, to find out the effect of minimum tillage on conservation of precise leveled soil to produce some winter crops after rice harvest. During 2006 summer season, before rice planting, the soil was leveled using laser control equipment. After rice harvest, two experiments were established for planting clover, representing the flat planting and sugar beet, representing the ridge planting. Each experiment was designed statistically as a split plots with three replications. The main plots were located for the precision land leveling treatment levels of 0, 0.01, 0.02 and 0.03% slope, comparing with the traditional leveling using the hydraulic scraper and the sub plots were devoted for the tillage methods levels of minimum tillage (chisel plough one pass) and conventional tillage (chisel plough 2 passes(, comparing with no-till. The obtained results could be concluded as follows:

1. *The minimum tillage at the precision land leveling slope of 0.02% achieved the more desirable soil characteristics (the moderate soil mean weight diameter of 50 mm, the higher soil moisture content of 22.85%, the lower soil bulk density of 1.30 g/cm^3, the lower soil penetration resistance of 1.21 MPa and the higher available soil macronutrients concentration of 30, 14 and 318 ppm for N, P and K, respectively).*
2. *The minimum tillage at the precision land leveling slope of 0.02% accomplished higher degree of soil topography conservation and recorded the lower difference between the highest and the lowest spots.*
3. *The minimum tillage at the precision land leveling slope of 0.02% achieved the higher beet yield of 28.65 Mg/fed with a sucrose yield of 22.04% and complemented the higher total dry (14% moisture*

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content d.b.) clover yield of 17.10 Mg/fed (2.12, 3.32, 4.04, 4.36 and 2.87 Mg/fed for 1st, 2nd, 3rd, 4th and 5th cuts, respectively).

So, it is recommended to apply the minimum tillage, especially with the ridge planting, after rice harvest to conserve the precise leveled soil.

INTRODUCTION

In Egypt, rice is the most predominant cultivated summer crop. It is the most important staple food after wheat and one of the major export agricultural commodity. Rice is considered as one of the highly irrigation demand crops **(Abu-Zaid, 1995 and Mourad et al., 2003)**. Rice is cultivated as a fully irrigated crop with standing water. Water is a major constituent of plant tissue, a reagent in chemical reactions and is essential for cell enlargement through increasing turgor pressure. Rice plant can transpire the potential rate even when soil moisture content is around the field capacity **(Nour et al., 1994 and Nour et al., 1997)**.

The subsequent irrigation and the excess water due to the misuse of irrigation application contribute to the ground water shallow aquifers, causing several acute problems i.e. nutrient leaching, raising ground water table …. etc. Consequently, such problems are negatively affecting the next cultivated crop yield and reducing fertilizer and water use efficiency **(Abd El-Aal et al., 2005)**.

The precision land leveling allows maintenance of a uniform water depth within the rice field, increases water use efficiency by maintaining shallow water depths up to panicle initiation stage, helping in better seedling establishment which helps in term for early tillering. In addition, it achieves better utilization of nutrients by managing uniform depth of water through out the field. Also, it enhances the oxygen diffusion is more uniformity. Furthermore, it minimizes the deep percolation of water to a certain extent **(El-Sahrigi et al., 2002, El-Raie et al., 2003 and El-Raie et al., 2004)**.

The Egyptian farmers are commonly accustomed to plant the winter crops after rice without tillage. **Abd El-Mageed (1989**) and **El-Sayed and Ismail (1994)** found that no-till achieved disagreeable soil properties, comparing with some tillage methods.

So, there is increasing interest in minimum tillage as a proper method of reducing crop production costs and improving soil conditions **(El-Banna et al., 1987, El-Nakib and Fouad 1990and Abd El-WAhab, 1994)**.

This study aimed to identify the effect of minimum tillage on conservation of précised leveled soil to produce some winter crops after rice.

MATERIAL AND METHODS

Experimental Procedure:

1. Experimental site and soil characteristics:

During 2006 winter season, this study was established in reclaimed sandy soil at Kalabsho Region, El-Dakhlia Governorate. The previous crop was rice. During 2006 summer season, at the same experimental site the study of **Bahnas et al. (2009)** was established. Before rice planting, the soil was leveled using laser control equipment at 0, 0.01, 0.02 and 0.03%, comparing with the traditional leveling using the hydraulic scraper.

According to the standard procedures as cited by **El-Serafy and El-Ghamry (2006)**, tables (1) and (2) demonstrate the soil mechanical analysis and some soil characteristics of the experimental site.

Table (1): Soil mechanical analysis of the experimental site.

Sand, %			Silt, %	Clay, %
Coarse, %	Fine, %	Total, %		
82.40	2.20	84.60	7.60	7.80

Table (2): Some soil characteristics of the experimental site.

Soil leveling degree	Moisture content, % (d.b.)	Bulk density, g/cm^3	Penetration resistance, MPa	Available macronutrients, ppm		
				N	P	K
0 slope	18.35	1.60	1.21	21.55	10.20	303.80
0.01% slope	18.65	1.52	1.19	22.15	10.85	306.55
0.02% slope	19.88	1.40	1.16	23.74	11.25	310.00
0.03% slope	18.94	1.47	1.17	22.80	10.95	308.95
Traditional leveling	17.47	1.65	1.23	19.00	9.75	300.85

2. Soil topography:

Soil topography was studied in terms of surveying grid. According to **Mc Clung et al. (1985)**, the experimental field survey was determined and shown in Figure (1).

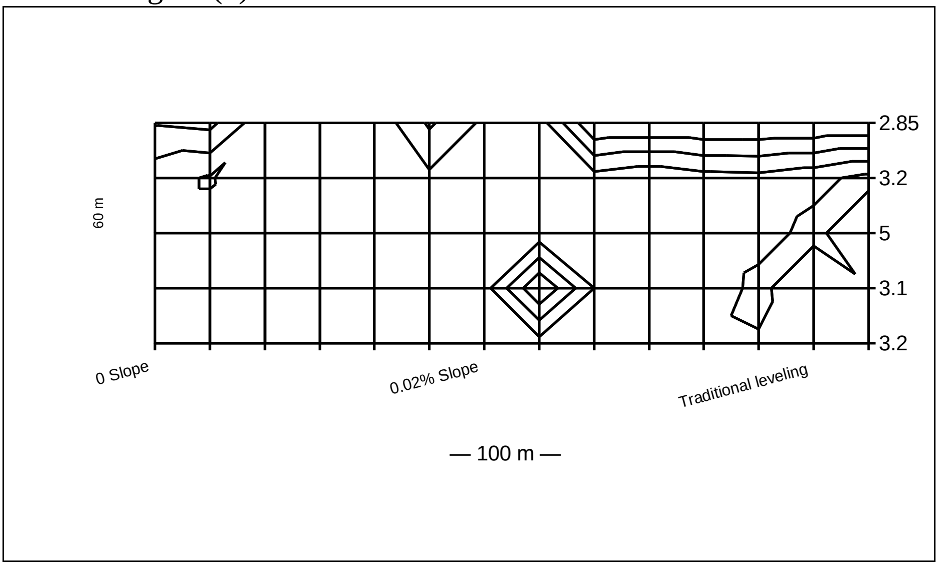


Fig. (1): Schematic diagram of the experimental site grid survey.

3. Treatments and statistical design:

After rice harvest, the experimental area of 1.50 fed (100 x 60 m) was bisected into two equal portions to establish two experiments as follows:

1. Flat planting experiment: The selected clover seeds of Giza 10 variety with a rate of 17 Kg/fed were drilled using a mounted seed drill of 21 rows with 0.15 m row spacing.
2. Ridge planting experiment: The selected sugar beet seeds of Top variety with a rate of 2.00 Kg/fed were planted using a pneumatic planter at row spacing of 0.60 m with 0.20 m hill spacing at the same ridge. Five ridges were attached to the planter to accomplish planting and ridging at the same time.

Each one of the experiments was designed statistically as a split plots with three replications. The main plots were located for the precision land leveling treatment levels of 0, 0.01, 0.02 and 0.03% slope, comparing with the traditional leveling using the hydraulic scraper and the sub plots were devoted for the tillage methods of minimum tillage (chisel plough one pass) and traditional tillage (chisel plough 2 passes), comparing with no-till.

Measurements:

1. Soil characteristics:

At harvest, the soil mean weight diameter was determined as cited by **Kepner et al. (1982)**, the soil moisture content (d.b.), the soil bulk density and the soil penetration resistance were determined according to **ASAE (1992)** and the available soil macronutrients concentration is determined as cited by **El-Serafy and El-Ghamry (2006)**.

2. Soil topography:

At harvest, according to **Mc Clung et al. (1985)**, the soil topography is studied in terms of surveying grid and standard deviation.

3. Sugar beet and clover crop yield:

At harvest, for each treatment, an area of 1 m^2 was taken randomly to determine sugar beet and clover crop yield. This procedure was replicated three times. The mean value of beet yield was calculated and sucrose yield was estimated colorimetrically on a lead acetate extract of fresh macerated as cited by **Blakeney and Mutton (1980)**. The mean value of clover yield at each one of five cuts was calculated on basis of 14% moisture content (d.b.).

Statistical Analysis:

SAS computer software package was used to employ the analysis of variance test and the LSD tests for clover and sugar beet crop yield data.

Regression and Correlation Analysis:

Microsoft Excel 2007 computer software was used to carry out the simple regression and correlation analysis to represent the effect of the precision land leveling slope levels on clover and sugar beet crop yield under the tillage treatment levels.

RESULTS AND DISCUSSION

1. Soil Characteristics:

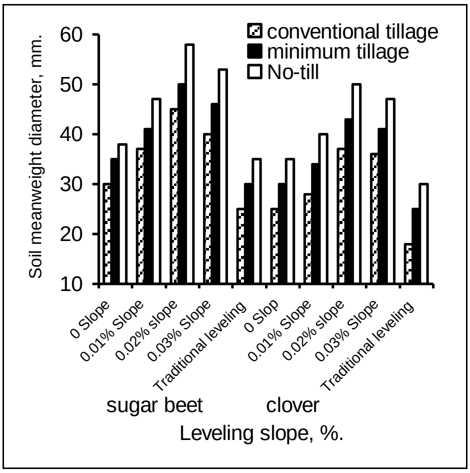
Figures (2) and (3) exhibits that the minimum tillage at 0.02% precision land leveling slope after sugar beet harvest complemented more desirable soil characteristics among the other treatments. It achieved the moderate soil mean weight diameter of 50 mm, the higher soil moisture content of 22.85%, the lower soil bulk density of 1.30 g/cm^3, the lower soil penetration resistance of 1.21 Mpa and the higher available soil macronutrients concentration of 30, 14 and 318 ppm for N, P and K, respectively. This result may be illustrated that the minimum tillage beaks the soil aggregates, creating soil particles of smaller pore spaces with grater free pore spaces per unit of soil volume. This phenomenon leads to lowering the mechanical connections between the soil particles. So, the soil resistance to the moisture diffusion decreases. Then, the soil bulk density and the soil penetration resistance decrease. Consequently, the soil aeration increases that enhances the soil organic matter mineralization, releasing more amount of the available macronutrients.

On the contrary, the conventional tillage consummated lower soil meen weight diameter value due to the tillage intensity which encloses the soil pore spaces of higher surface tension that increases the soil bonding forces, leading to pore spaces increment, that create an aggregated structure of the higher values of soil bulk density and soil penetration resistance. Consequently, the soil nutrients release diminishes.

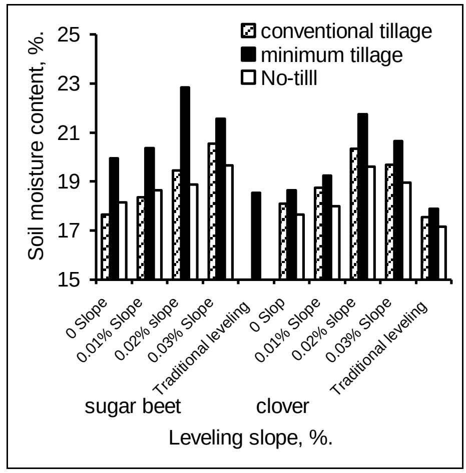
Furthermore, the lower degree of soil pulverization that related with the no-till which associated with the lower soil moisture content as a result of soil drying causes higher soil cohesion between the soil particles, leading to diminishing the pore spaces volume, causing the degradation in soil characteristics.

Data display that planting both sugar beet and clover improves the soil characteristics. As the sugar beet grows, it transfuses and penetrates the soil, creating a disconnected structure of the desirable characteristics. In addition, the ridge planting decreases the water percolation as a result of distributing the soil surface. Whilst, the growth of clover as a legumes is fixing atmospheric nitrogen and involving the excess uptake of nutrient cations over anions from soil solution. This results in the net efflux of

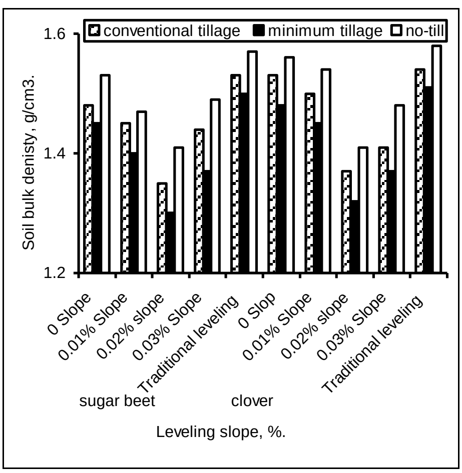
H3O + ions from plant roots into the rhizosphere, resulting in the accumulation of soil organic matter.



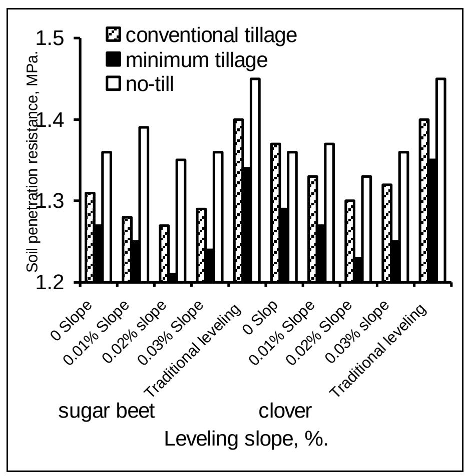
a. Mean weight diameter (MWD).



b. Moisture content.

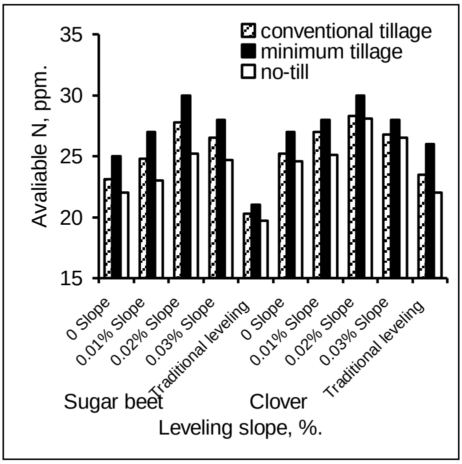


c. Bulk density.

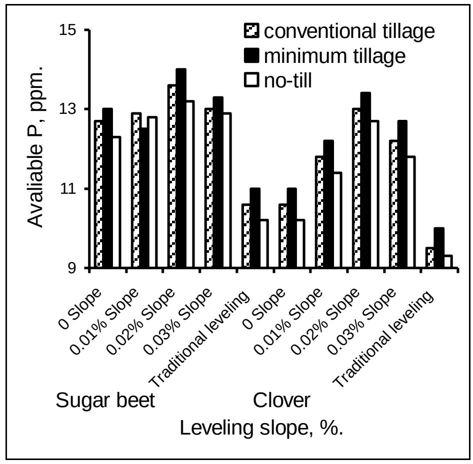


d. Penetration resistance.

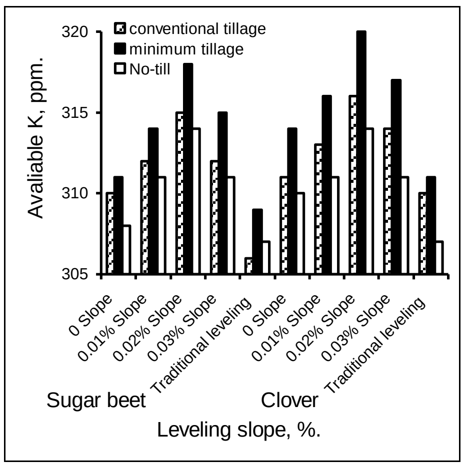
Fig. (2): Effect of minimum tillage on some soil characteristics.



a. Available soil N.



b. Available soil P.



c. Available soil K.

Fig. (3): Effect of minimum tillage on available soil macronutrients concentration.

2. Soil Topography:

Figure (4) reveals the significant effect of the minimum tillage on the soil topography conservation, especially at 0.02% precision land leveling slope after sugar beet harvest. The minimum tillage after sugar beet harvest at precision land leveling slope of 0, 0.01, 0.02 and 0.03% and traditional leveling recorded the lower value of the difference between the highest and the lowest spots of 0.80, 0.20, 0.20, 0.40 and 1.50 m, with an average level for the total spot readings of 3.22, 3.20, 3.04, 3.15 and 3.45 m and a standard deviation of ± 0.3526, ± 0.2386, ± 0.1285, ± 0.2646 and

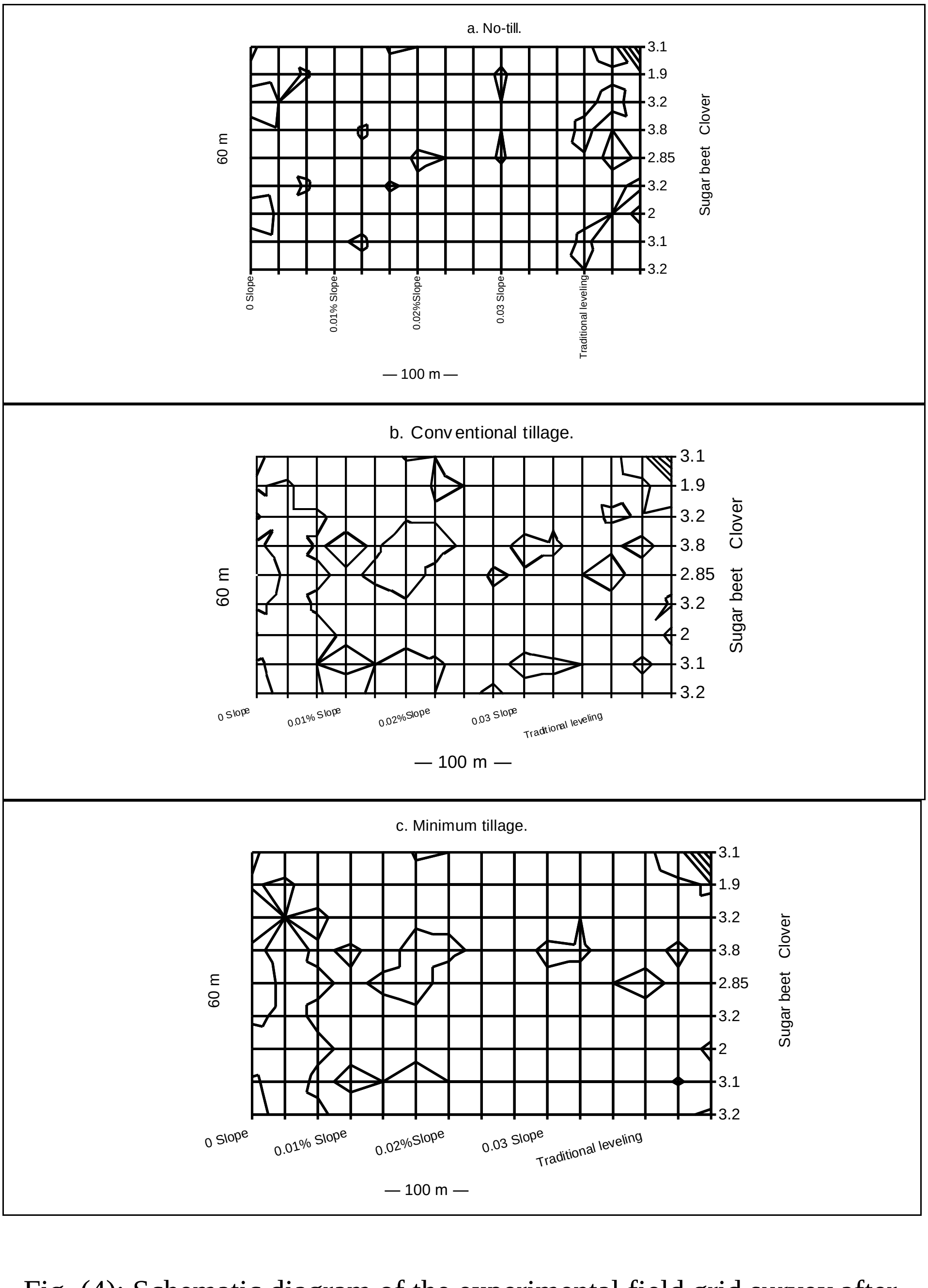


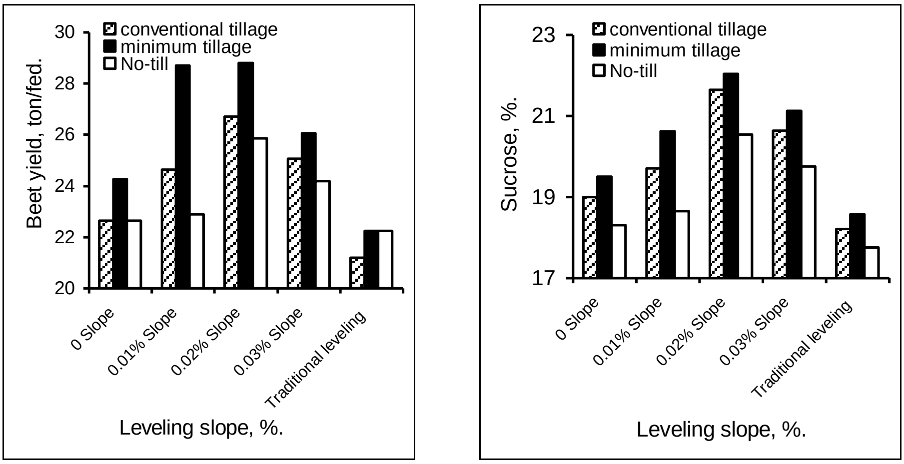
Fig. (4): Schematic diagram of the experimental field grid survey after sugar beet and clover harvest.

± 0.4521, respectively. In addition, no-till after clover harvest at precision land leveling slope of 0, 0.01, 0.02 and 0.03% and traditional leveling accomplished the higher value of the difference between the highest and the lowest spots of 1.60, 1.10, 0.80, 1.80 and 1.90 m, with an average level for the total spot readings of 3.50, 3.42, 3.40, 3.47 and 3.87 m and a standard deviation of ± 0.5881, ± 0.3470, ± 0.2796, ± 0.3351 and ± 0.5638, respectively.

This finding could be explained that the minimum tillage creates a proper disturbed surface which lowers the soil curette. In addition, this proper seed bed facilitates both the application and removal of soil water for irrigation and drainage. These practices can result in high efficiency of irrigation water application, uniform distribution of irrigation water and elimination of tail water. The irrigation water penetrated more rapidly in this proper seedbed than in other cases. When application of water continued the soil water content become greater than other cases. The rapid infiltration of water to depth appeared to be mainly due to the greater continuity of channels in soil which are not disturbed by either the intensive tillage or no-till. Also, the ridge planting achieved more soil surface conservation than the flat planting due to the corrugated surface as a result of distributing the soil surface into ridges which minimizes the soil sweeping.

3. Crop Yield:

Figures (5) and (6) indicate that the effect of tillage methods on sugar beet and clover crop yield is to a large degree attributable to the difference in soil characteristics. The figures demonstrate the significant effect of minimum tillage on crop yield among the other treatments. It achieved the higher beet yield of 28.65 Mg/fed with a sucrose yield of 22.04% and complemented the higher total dry clover yield of 17.10 Mg/fed (2.12, 3.32, 4.04, 4.36 and 2.87 Mg/fed for 1st, 2nd, 3rd, 4th and 5th cuts, respectively). This finding is attributed to the more favorable soil characteristics of moderate clod diameter with larger pore spaces. This environment is desirable for root growth and oxygen diffusion.



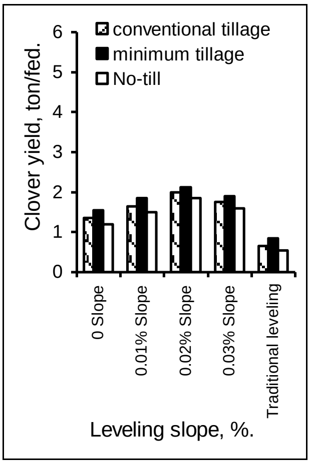
a. Beet. b. Sucrose.

Fig. (5): Effect of minimum tillage on beet and sucrose yield.

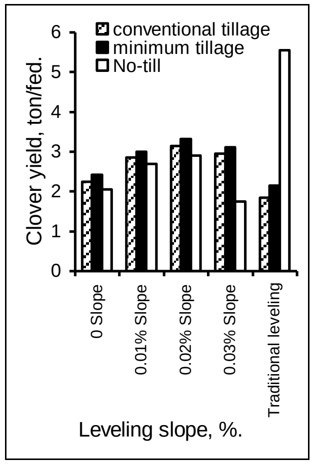
The conventional tillage achieved lower sugar beet and clover crop yield than that was obtained using the minimum tillage. It creats aggregated soil structure of higher relative penetration resistance and bulk density values. This structure is due to the frequent vehicles traffic which increases the soil compaction which reduced the depth of root penetration and proliferation. Also, this effect reduces the soil hydraulic conductivity. Hence, drainage of water to reach the field capacity required a longer period, and the soil infiltration rate decreases. These conditions lead to a poor development of roots because of restricting root penetration and proliferation.

On the other hand, the no-till of overly steep surface may result in poor surface drainage and muddy soil conditions, resulting in lower rate of plant establishment.

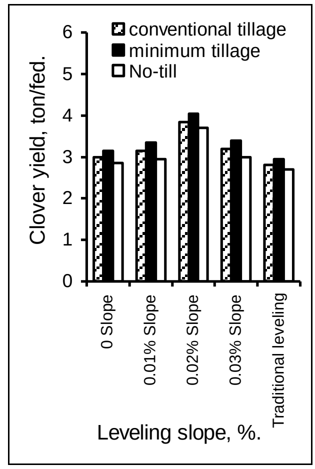
The analysis of variance test indicates that there was high significant difference in beet yield due to the precision leveling slope treatment and the tillage treatment. L. S. D. test shows that applying the precision land leveling at 0.02% slope and adopting the minimum tillage achieved the higher beet yield among the other treatments.



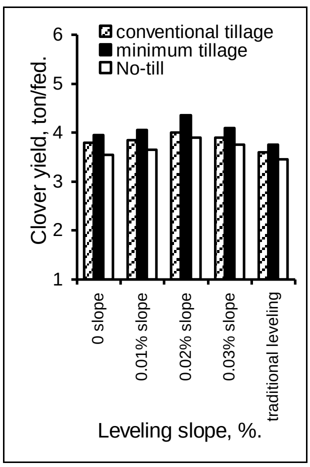
a. 1st cut.



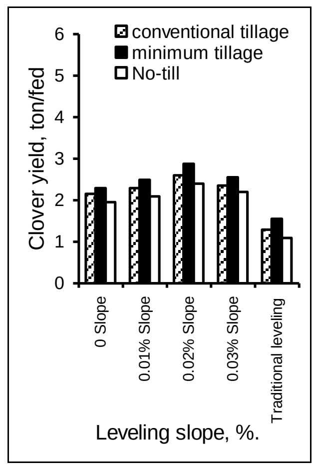
b. 2nd cut.



c. 3rd cut.



d. 4th cut.



e. 5th cut.

Fig. (6): Effect of minimum tillage on dry clover yield.

The obtained data of the regression and correlation analysis reveal that there was a highly significant positive correlation between beet crop yield (y) and precision land leveling slope (x) as follows:

Conventional tillage: $y = -1.1000\,x^2 + 6.3500\,x + 17.404$ ($R^2 = 0.9513$)

Minimum tillage : $y = -1.3793\,x^2 + 0.6067\,x + 18.3060$ ($R^2 = 0.9660$)

No-till : $y = -0.6429\,x^2 + 3.9071\,x + 18.9200$ ($R^2 = 0.6731$)

The analysis of variance test indicates that there was high significant difference in clover yield due to the precision leveling slope treatment and the tillage treatment. L. S. D. test shows that applying the precision land leveling at 0.02% slope and adopting the minimum tillage achieved the higher clover yield among the other treatments.

The obtained data of the regression and correlation analysis reveal that there was a highly significant positive correlation between total clover crop yield (y) and precision land leveling slope (x) as follows:

Conventional tillage: $y = -0.9375\, x^2 + 5.3422\, x + 8.0125$ ($R^2 = 0.7191$)

Minimum tillage : $y = -0.1239\, x^2 + 7.5010\, x + 9.5460$ ($R^2 = 0.9682$)

No-till : $y = -0.7125\, x^2 + 4.2575\, x + 7.8625$ ($R^2 = 0.8571$)

CONCLUSION

The obtained results of this study could be concluded as follows:

1. The minimum tillage at the precision land leveling slope of 0.02% achieved the more desirable soil characteristics, allowing releasing higher amount of available soil macronutrients.
2. It accomplished higher degree of soil topography conservation.
3. It achieved the higher beet yield of 28.65 Mg/fed with a sucrose yield of 22.04% and complemented the higher total dry (14% moisture content d.b.) clover yield of 17.10 Mg/fed (2.12, 3.32, 4.04, 4.36 and 2.87 Mg/fed for 1st, 2nd, 3rd, 4th and 5th cuts, respectively).

So, it is recommended to apply the minimum tillage, especially with the ridge planting, after rice harvest to conserve the precise leveled soil.

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<u>الملخص العربى</u>

تأثير الحرث الأدنى على صون التربة المسواة تسوية دقيقة لإنتاج بعض المحاصيل الشتوية عقب الأرز

د/ أسامة طه بهنس*

أجريت هذه الدراسة بمنطقة قلابشو بمحافظة الدقهلية خلال الموسم الشتوي لعام ٢٠٠٦, وذلك لدراسة تأثير الحرث الأدنى على صون التربة التي سبق تسويتها بالتسوية الدقيقة لزراعة بعض المحاصيل الشتوية عقب الأرز, حيث أنه قد تم إجراء التسوية الدقيقة للتربة قبل زراعة الأرز خلال الموسم الصيفي لعام ٢٠٠٦, وعقب حصاد الأرز أقيمت تجربتان الأولى لزراعة بنجر السكر ليمثل الزراعة على خطوط, والثانية لزراعة البرسيم المصري ليمثل الزراعة على أرض منبسطة, وقد تم تنفيذ كلاً من التجربتين وتصميمهما إحصائياً في قطع منشقة في ثلاثة مكررات, حيث أن القطع الرئيسة تضمنت معاملة التسوية الدقيقة للتربة (عند إنحدار ٠, ٠,٠١, ٠,٠٢, ٠,٠٣%) بالمقارنة مع التسوية التقليدية للتربة باستخدام القصابية الهيدروليكية, وقد إشتملت القطع الشقية على معاملة الحرث (الحرث الأدنى بالمحراث الحفار حرثة واحدة والحرث التقليدي بالمحراث الحفار حرثتين متعامدتين) بالمقارنة مع عدم الحرث, وقد أوضحت النتائج م يلي:

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١. حقق الحرث الأدنى عند إنحدار ٠,٠٢% عقب زراعة بنجر السكر أفضل خصائص للتربة, حيث أنه حقق القيمة المتوسطة لقطر متوسط أوزان حبيبات التربة بمقدار ١٥ ممو أعلى قيمة لنسبة رطوبة التربة بمقدار ٢٢,٨٥%, وأقل قيمة للكثافة الظاهرية بمقدار ١,٣٠ جم/سم٣, وأقل قيمة لمقاومة التربة للإختراق بمقدار ١,٢١ ميجا باسكال, وأعلى قيمة للعناصر الغذائية الميسرة بالتربة بمقدار ٣٠و ١٤و ٣١٨ جزء في المليون للنيتروجين والفوسفور والبوتاسيوم على الترتيب.

٢. حقق الحرث الأدنى عند إنحدار ٠,٠٢% عقب زراعة بنجر السكر أفضل درجة للمحافظة على طبوغرافية التربة حيث أنه قد أعطى أقل فرق بين أعلى وأدنى منسوب للتربة.

٣. حقق الحرث الأدنى عند إنحدار ٠,٠٢% أعلى قيمة لمحصول لبنجر السكر بمقدار ٢٨,٦٥ طن/فدان بنسبة سكر بمقدار ٢٢,٠٤%, وكذلك أعلى قيمة لملحصول الكلي الجاف للبرسيم المصري بمقدار ١٧,١٠ طن/فدان (٢,١٢و ٣,٣٢و ٤,٠٤و ٤,٣٦و ٢,٨٧ طن/فدان عند كل من الحشات الأولى والثنية والثالثة والرابعة والخامسة على الترتيب).

ولذا فإنه يوصى باستخدام الحرث الأدنى عند زراعة المحاصيل الشتوية عقب الأرز –خاصة في حالة الزراعة على خطوط- لصون التربة التي سبق تسويتها بالتسوية الدقيقة.